Demography and health in early medieval Maastricht: Prosopographical observations on two cemeteries

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in early medieval Maastricht*

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on two cemeteries*

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PROEFSCHRIFT

ter verkrijging van de graad van doctor
aan de Universiteit Maastricht
op gezag van de Rector Magnificus,
Prof. mr. G.P.M.F. Mols
volgens het besluit van het College van Decanen
in het openbaar te verdedigen
op donderdag 15 december 2005 om 14.00 uur

door

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Voor Marijke
(28 mei 1938 - 24 juli 1998)

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1

Introduction

In 634 AD the deacon Grimo from Verdun made his will. Among the many beneficiaries named in his testament, we find the 'lepers of Maastricht' to whom he donated one of his possessions.¹ Generally, this is interpreted as a donation to a leper house or a *xenodochium*. In the early medieval period a *xenodochium* was a hospital or hospice for foreigners, pilgrims, paupers and the sick.² This remark in Grimo's testament informs us about the presence of *leprosi* in Maastricht and it suggests there was organised care for these lepers. Grimo's testament is one of the oldest textual sources of information on the health of the inhabitants of Maastricht. For the early medieval period a few glimpses are all there is.³ In this respect Maastricht, an important centre during the early medieval period, is not an exception. Despite the advances that have been made in the historiography of early medieval Europe, we still know little about the actual living conditions and health situation during that period. The aim of this study is to learn more about the living conditions of the early medieval inhabitants of Maastricht. Because of the scarcity of written sources, it was necessary to consult an alternative type of source: human skeletal remains.

Since the beginning of the twentieth century the way historians approach the past has changed considerably. Next to traditional topics like religious and political history, man as an individual or as a member of a group has moved to the centre of attention. Gradually interest in daily life, in man's fears, joys and other aspects has grown. The study of history now often includes elements of disciplines like sociology, economy, cultural anthropology or psychology. At the same time a change took place in the type of sources that are used. Texts are no longer the sole source of information. Paintings, buildings, works of art, also every-day objects and archaeological findings contribute to the image of the past. Still, even in the best cases, when it comes to a description of living conditions in early medieval Europe, most theories are based on circumstantial evidence or extrapolation. For the early medieval period written and other types of sources tell us little about biological aspects of life, like child mortality, mean age at death, population growth, status related differences in health, etc. Moreover, the sources on these

¹ The text reads: 'leprosi Treiectenses', Levison, 1948, p. 118-138.

² A *xenodochium* often fell under the supervision of the bishop. In 549 AD at the church council of Orléans the Merovingian bishops issued a canon indicating that the organisation of the care for the sick and imprisoned was considered to be one of the episcopal responsibilities. Pontal, 1989, p. 128. Niermeyer, 1984, p. 1137-1138.

³ Four written sources provide information on life, death and health of inhabitants and visitors of early medieval Maastricht. The oldest source is a group of five inscribed Christian tombstones. On these stones from the fifth and sixth centuries AD in several cases the age at death is recorded. (In: Boppert, 1986, p. 64-96.) Gregory of Tours, a well-known historian from the sixth century, described in his *historiarum libri decem* the death of bishop Servatius. Gregory writes that the bishop suffered from a slight fever when he arrived in Maastricht and that he died there. This occurred around the end of the fourth century (In: Gregory of Tours, 1951, p. 47.) The third source is Grimo's will, mentioned in the text and written in 634. (In: Levison, 1948, p. 118-138.) In a fourth early medieval source the healing powers of the relics of saint Marcellinus and saint Peter cure three inhabitants of Maastricht of various maladies, Einhard, 1887, p. 2614.

subjects are not only scarce, they are also not available for every region. Because of the unequal geographical distribution and paucity of data, discerning geographical and chronological variation is almost impossible.

No wonder that leafing through handbooks and monographs on the early medieval period we find little about the biological aspect of history. Most authors of reference works on early medieval Europe only dedicate some general remarks to demography or health. Others avoid the topic altogether.⁴ Those that endeavour to discuss biological matters come across serious difficulties. An example of the problem can be found in George Duby's: 'The early growth of the European economy', originally published in 1973. When he argued that famine remained a permanent threat in Europe during the seventh and eighth century, Duby used as evidence a written source mentioning a great famine among the Gauls in 580 AD and mortality figures calculated for tenth and eleventh century Hungarians.⁵ This illustrates the scarcity of sources and especially the lack of physical anthropological data at the time. Duby had to extrapolate these findings to the period of his interest and he implicitly considered evidence from Hungary representative for the whole of Europe. Nevertheless, his decision to use skeletal data can be regarded as an early application of osteoarchaeological data in mainstream history.

Duby's example has not been followed on a large scale in the historiography of early medieval Europe. This is not the result of a lack of skeletal data. Human skeletons have been studied methodically since the nineteenth century. Traditionally, anthropometry and racial differences were the principal topics. Since the Second World War, physical anthropologists and palaeopathologists increasingly focus their osteological studies on the conditions of life in the past.⁶ They collect demographical information and try to determine the health situation of ancient populations. Because of a lack of communication between the disciplines, the influence of recent physical anthropological and palaeopathological investigations on historical literature has been limited.⁷ Such studies had more effect on archaeological literature. Several archaeological monographs on specific sites include physical anthropological data in an appendix.⁸ Physical anthropological reports are also published in archaeological journals.⁹ Because human skeletal remains are often presented in exhibitions, various exhibition catalogues devote some pages to the results of physical anthropological and palaeopathological studies.¹⁰ However, even in archaeological publications the integration of

⁴ Reference works with some general remarks on demographical aspects: Ewig, 1980; Lebecqz, 1990; Theis, 1990; Fossier, 1991; McKitterick, 1995.

⁵ Duby, 1979, p. 29.

⁶ E.g. see introductory in Roberts, 1995 and Aufderheide, 1998.

⁷ R. Panhuysen, 1995, p. 263-266.

⁸ Examples of monographs with physical anthropological appendices: Bay-Schuller, 1976, p. 317-368; D' Hulst, 1990, p. 106-121; Schaeffer, 1963.

⁹ E.g.: Pilet et al., 1990, p. 3-140; Janssens, 1970, p. 29-42.

¹⁰ Auboire, 1988, p. 180-183; Buchet, 1996, p. 662-667; Kunter and Wittwer-Backofen, 1996, p. 653-661; Wahl, 1985, p. 288-313. Czarnetzki and co-workers organised an exhibition that was exclusively devoted to the study of early medieval human remains: Czarnetzki et al., 1989.

archaeological findings and osteological data is a process that still seems to be in its initial stage.¹¹

As indicated above, historians have hardly used skeletal data as a genuine source of information on living conditions in early medieval Europe.¹² Until now historians have sought the answer to questions of demography and health in documentary sources (E.g. Carolingian polyptychs) and field data (E.g. the size of houses and settlements or the extent of land used for agriculture.) Skeletal data offer an opportunity to extend our knowledge of the living conditions in early medieval Europe. Excavated human remains are a direct source of information on matters of demography and health.¹³ Physical anthropological and palaeopathological investigation of these remains can produce reliable data for the study of the demographical situation and the occurrence of disease and trauma. For the early medieval period in particular, with its scarcity of written sources, a combination of skeletal, archaeological and historical data has great potential. Especially, since numerous inhumations are often found at Merovingian and Carolingian sites.

Like other places in the region, Maastricht is not rich in documentary sources on living conditions in the early middle Ages.¹⁴ Excavations of early medieval cemeteries in and around Maastricht however, have unearthed an alternative source. In the past fifty years considerable numbers of human skeletons from this period have been brought to light by archaeologists. The related archaeological findings and historical sources provide sufficient information to categorise many of these inhumations according to period and some even by social class. Thus these skeletons are an excellent source to study diachronic and status-related differences in health and living conditions. What is special in this case is the fact that we have the opportunity to study different groups of skeletons that come from one place. So we can rule out the possibility that variation among populations is related to geographical differences. For this study, human remains found at two sites were examined. The graves at the first site, the Servaas church site, range from the second half of the fourth century until the eighteenth century. However, the majority of individuals were buried there between the sixth and tenth century. These graves can be considered as typical "*ad sanctos*" burials, since they were all interred around the supposed grave of Saint Servatius. Those at the second site, the Boschstraat site, date from the seventh and eighth centuries. A total of 336 skeletons from both cemeteries was examined. This study will focus on the 238 individuals that could securely be ascribed to one of

¹¹ The publication of the cemetery of Saint-Martin de Fontenay presents the archaeological and osteological data in an integrated manner: Pilet, 1994. Another example of the beneficial effects of the integration of archaeological and skeletal data is M.L. Powell's study of the health situation in a North American tribal society, the Moundville Chiefdom: Powell, 1988.

¹² This does not mean that there is no literature on this subject. Articles and conference proceedings have indicated the potential of an interdisciplinary approach. For the medieval period two examples of a fertile dialogue between historians, archaeologists and physical anthropologists are: Herrmann and Sprandel, 1987 and Herrmann and Sprandel, 1988.

¹³ For an overview of the sources available for palaeodemography and the value of skeletal data among these see: Russell, 1983, p. 217-229 and Herlihy, 1987, p. 1-7.

¹⁴ In an overview of all written sources relating to Maastricht between 359 and 923 AD Van Ommeren counted 51 written sources containing some information on Maastricht. Van Ommeren, 1991.

the three periods between circa 350 and 950 AD. The number of 238 individuals incorporated in our study is rather meagre for a time span of six centuries. However, we must keep in mind that at the time settlements were much smaller. For early medieval Maastricht we have no evidence that allows for a reliable estimate of the total number of inhabitants. When we juxtapose the investigated skeletons with the estimated number of deaths in Maastricht our sample might represent around one per cent of the total number of deaths in Maastricht. Despite their small number, skeletons from the late Roman period (circa 350-480 AD) are incorporated because they were relatively well preserved and yielded sufficient data to provide a good starting point for the study of demographical developments. Human skeletal remains dated between 480 and 950 AD were found in larger amounts, allowing for statistical analysis of possible variation. Skeletons from later periods were found in small numbers and were in general poorly preserved. Consequently, these skeletal remains were not considered appropriate to represent the period between 950 and 1800 AD.

The first objective of this study was to collect evidence of the variation in health and disease patterns in the early medieval population. Secondly, these descriptive data were used to analyse the presence of status-related variation or chronological developments in demography and health. In addition, the characteristics of the spatial distribution of individuals were examined to learn more about the processes that determined the layout of the cemeteries. With this approach it is hoped to find answers for site-specific issues like: the presence of special burial areas for children or women; the existence of clusters of graves for family members or social groups; the effectiveness of the prohibition on burial inside the church. In this sense the physical anthropological and palaeopathological data may be considered prosopographical observations. To evaluate the situation in Maastricht it was considered useful to compare the Maastricht populations with other early medieval skeletal series. Standard physical anthropological methods were used to collect demographical data, like sex, age, stature, metric and non-metric variation. Health-related data, e.g. Harris lines, degenerative changes and fractures, were evaluated in co-operation with a group of medical specialists. The archaeological findings were studied for an assessment of the status of the graves and the dating of the inhumations. The results of this assessment were used to categorise the skeletal data by period and status. All skeletons were described and their features were recorded in reports per site.¹⁵ As this study focuses on the comparison of populations, the description and discussion of skeletal data has been limited to those data that were available for a sufficient number of individuals. This means that comparison by statistical methods had the potential to produce significant results. Or, in the case of trauma for example, the skeletal data should be illustrative and representative for a population.

Some aspects of the arrangement of this book resemble the edition and publication of a written source. In chapter two the context of our source, the excavated human remains, is described. This consists of an overview of the geographical situation and the historical and archaeological developments in and around Maastricht from the late Roman period to the end of the tenth century. Archaeological details on the Servaas site and Boschstraat site are given in

¹⁵ R. Panhuysen, 2005a and R. Panhuysen, 2005b.

the third chapter which reviews the chronological and social classification of the graves. A detailed description of the material aspects of a manuscript is a standard and necessary component of the edition of a written text. In the same way describing the condition of the skeletal remains that were available for study is useful in our case. Therefore, the quantity and quality of the skeletal material and the possible effects of post-depositional processes are discussed in chapter four. Chapter five summarises the physical anthropological and palaeopathological methods. In chapter six the results of this investigation are presented. The discussion of a selection of results, considered important for the purpose of our study, can be found in chapter seven. A comparison will be made for the various aspects by group and by period. In the same chapter the spatial distribution of the sexes, age groups and pathological and other characteristics are analysed. The last chapter recapitulates the conclusions from the previous chapters.

The table of contents of this book illustrates that it not only is intended as a publication of the physical anthropological evidence but also as an attempt to evaluate the information from this type of source. For this purpose, methods and data from three disciplines: history, archaeology and physical anthropology have been used. Each of these has a separate scientific approach, terminology and literature. The interaction of the various disciplines opens up a plethora of possible variables and topics to compare and discuss. This necessitated a selection of those topics which had the best potential to provide information on possible variation in demography and health. In this respect, child mortality, growth, age at death, stature, arthropathies, dental pathology and infectious disease and a limited number of metric and non-metric variables were considered the most promising. Of course, the study of a limited number of skeletons from one place will not yield conclusive evidence for a whole region and period. Still, if this study demonstrates that the integration of data and methods culminates in a better knowledge of living conditions in early medieval Maastricht and if, through its results, this study can contribute to the acceptance and wider use of skeletal remains as a valuable historical source, then it will have fulfilled its goal.

2

Historical and archaeological setting

In recent years archaeological excavations and critical evaluations of written sources have led to a resurgence of the debate on early medieval Maastricht. This debate has focused on topics related to Saint Servatius and the role of the church and aristocracy in the development of Maastricht.¹⁶ The framework of this study does not allow for an in depth discussion of all questions concerning the late Roman and early medieval history of Maastricht. Presented here is an overview of the developments in late Roman and early medieval Maastricht based on available historical literature. References to a more complete account of the historical and archaeological developments can be found in the text below. Van Ommeren's compilation of the available documentary sources concerning Maastricht between 359 and 923 AD shows that written sources are relatively scarce.¹⁷ Fortunately, during the last 50 years archaeological excavations at early medieval sites in Maastricht have brought to light a substantial set of data. These data cannot completely compensate for the shortage of documentary evidence. Use and interpretation of the data from excavations is hampered since few of these excavations have been analysed or published in full.¹⁸ Still, the information disclosed by these excavations has helped to elucidate some aspects of the early medieval history of Maastricht.

The periodisation in this chapter was set by local and regional developments and the situation at the investigated burial sites. With reference to the late Roman period (circa 300-480 AD) there is no difference to most traditional divisions. For the caesura between the following Merovingian and Carolingian period the year 700 AD was chosen.¹⁹ Around this time the Arnulfing-Pippinid dynasty, the ancestors of Charlemagne, began to establish their authority in the middle Meuse valley, the part of the Frankish territory to which Maastricht belonged.²⁰ Although officially the Merovingian kings still ruled the whole territory of the Franks, there are

¹⁶ Topics in this discussion are the transition from the late Roman to the Merovingian period, Servatius as a historical figure, the development of the ecclesiastical complex inside the fortified settlement and at the presumed burial site of Servatius and the position of the local aristocracy in relation to the rise to power of the Arnulfing-Pippinid dynasty. E.g. Kroos, 1985; T. Panhuysen and Leupen, 1990; De la Haye, 1994; Leupen, 1997; Dierkens, 2000; Theuws, 2001; T. Panhuysen and De la Haye, 2002; Theuws 2003 and Theuws in press. Furthermore, a series of studies of material remains from recent excavations of Roman and early medieval finds in Maastricht has been published. E.g. Van Lith, 1987; Van Lith, 1988; Dijkman, 1993; Kooistra, 1996; T. Panhuysen, 1996b; Dijkman and Eryvynck, 1998; Bakels and Dijkman, 2000.

¹⁷ Van Ommeren, 1991.

¹⁸ In 2002 the Saint Servatius project has started. This NWO-funded programme, carried out by the Archaeological Centre of the University of Amsterdam and the Archaeological Service of the City of Maastricht under the direction of professor F. Theuws (<http://cf.hum.uva.nl/archeologie/servatius/index.htm>) aims at the publication and analysis of three excavations in and around the Sint Servaaskerk.

¹⁹ Traditionally the crowning of Charlemagne's father Pippin II in 751 AD was regarded as the start of the Carolingian period. Recent reference works more and more consider the years around 700 AD as the caesura between the periods. As far as the historical aspects are concerned there are arguments for both 700 AD and 751 AD. E.g., Wood, 1994, p. 323; McKitterick, 1995.

²⁰ Ewig, 1980, p. 39-42.

reasons to assume that the forefathers of Charlemagne started to expand their influence in the middle Meuse valley around 700 AD. The archaeology of Maastricht supports the view that the situation changed around the start of the eighth century. From circa 700 AD ecclesiastical building activities suggest the advent of a new era, which is also reflected in a transformation in burial customs.

GEOGRAPHY AND PREHISTORY

The landscape

Nowadays Maastricht is the capital of the province Limburg, the southernmost province of the Netherlands. In the west the city borders directly on Belgium and in the east Germany is less than 30 kilometres away. The present frontiers are comparatively modern. Until the nineteenth century these national borders had little effect on the course of history in Maastricht. During the first millennium after Christ, the developments in Maastricht were closely related to events in nearby 'Belgian' and 'German' regions and places like Tongeren, Liège, Aachen, Jupille, Herstal and Stavelot-Malmédy. In fact the four regions that today co-operate in the Euregio Meuse-Rhine cover an area that provides a suitable geographical frame for the history of Maastricht and its surroundings.²¹ Because Maastricht is situated in the northern foothills of the Ardennes, there is more variation in elevation than farther north in the Netherlands.²² The city is situated on the banks of the River Meuse, which runs from the south to the north. South of the city the river valley is relatively narrow; to the north the valley becomes broad and shallow. During the last two million years the rise of the Ardennes highlands has caused a shift of the riverbed of the Meuse from the east to the west over a distance of circa 25 kilometres. This process has resulted in a "terraced" structure of the landscape east and west of Maastricht (see figure 2-1).

At present the elevation of the city is between 48 and 52 metres above standardised sea level (in Dutch "Normaal Amsterdams Peil" further mentioned as NAP). In the east, southwest and west middle and high terraces surround the city. In the east the rise of the terrain is comparatively gradual. The eastern and southeastern terraces, which slope upward from circa 60 metres to 150 metres above NAP, are foothills of the highlands of the Ardennes and the Eifel. On the left bank of the Meuse the middle and high terrace are closer to the river and the city. At that side of the river the middle terrace of Caberg even extends into the medieval city. Also near to the centre is the high terrace of Sint-Pietersberg (110 metres above NAP). The River Jeker approaches Maastricht from the south-west and flows between the high terrace of Sint-Pietersberg and the city. When the Jeker reaches the almost horizontal terrain of the Meuse valley, it splits up into several branches. Before they flow into the Meuse all of these branches are united again. In the past the separate streams of the Jeker created a marshy area at the southern limits of Maastricht.

²¹ A variety of articles on the archaeology and history of the Euregio can be found in: Bauchhenß and von Prittwitz u. Gaffron, 1992.

²² Hartmann, 1986, p. 19-25; T. Panhuysen, 1996b, p. 15-17; Renes, 1988, p. 15-20 and Wieger, 1992, p. 1-15.

FIGURE 2-1 The landscape of Maastricht and environs. 1 = under 50 metres above NAP, 2 = between 300 and 600 metres above NAP (after T. Panhuysen, 1996b, p. 16).

Natural resources

The strategic position of Maastricht on the banks of the River Meuse determined the development of the settlement. At least since Roman times were goods transported via this river. Because it crossed geographical obstacles like the Ardennes the Meuse was a major route of transportation in the region.²³ In Maastricht a road, built by the Romans following an east-westerly trajectory, crossed the south-north oriented waterway. Other contributing factors to the development of Maastricht were the presence of fertile soils, raw materials for building, and clay for pottery. Maastricht's soil consists of loamy river sediments. On higher grounds, eroded

²³ Breuer, 1969, p. 47-54.

loessial deposits are common. Genuine un-eroded loess is found on the middle and high terraces.²⁴ The first farmers in the region settled around 5300 BC in the east of Limburg on loess soils. Later as agricultural tools improved, the more fertile river sediments in the valley of the Meuse were preferred. For a long period the valley of the Meuse and its tributaries were the most densely settled and cultivated area in the region. The loess soils on the more remote higher terrace southeast of Maastricht remained largely uninhabited until the twelfth century AD.²⁵ The fertile soil was not the only natural resource available in the area around Maastricht. For building purposes the population of Maastricht had at its disposal: marl (a soft type of limestone), silex and calcium oxide concentrations (a raw material for the production of mortar found in the marsh among the streams of the Jeker). The presence of clay deposits among the river sediments favoured the local production of pottery. Ceramic vessels were produced in the river valley at least as early as 500 BC.²⁶ The discovery of four pottery kilns from the Merovingian period, on the site of a nineteenth century ceramic factory, provided further proof of the ample opportunities for the local production of ceramics.²⁷

The earliest human habitation in the Maastricht area

Human activity is attested within the present city limits from as early as 250,000 years before present.²⁸ Remains from various younger prehistoric cultures have been excavated in recent years.²⁹ Archaeological findings, relating to the period immediately before the appearance of the Romans, indicate that the area north of the confluence of the Meuse and Jeker was inhabited during the late Iron Age, viz. since the end of the first century BC.³⁰ From the beginning of the Roman period the traces of habitation become more intensive. A road following an east-westerly trajectory was the most prominent feature of Roman Maastricht. Before the road approached the riverbank it seems to have made two right-angle turns. In the vicinity of the present-day Vrijthof the road was positioned on a causeway of circa 10 metres wide and 2 metres above the original surface. The route through Maastricht connected two important Roman administrative centres: Bavay in the west and Cologne in the east. Most likely the road was constructed under Agrippa in the second decade BC.³¹ At an early stage a bridge was built to facilitate the passage over the river Meuse. On the basis of the dendrochronological dating of wooden remains of the bridge it was assumed that there were at least three building phases.

²⁴ T. Panhuysen, 1996b, p. 17.

²⁵ Hartmann, 1986, p. 182-184 and Renes, 1988, p. 19-20.

²⁶ Dijkman, 1989, p. 37-39.

²⁷ T. Panhuysen et al., 1992, p. 264-267.

²⁸ Roebroeks, 1992.

²⁹ E.g. four cemeteries with cremation graves were excavated in the past ten years. These cemeteries dated from 1000 to 500 BC. Dijkman, 1995, Dijkman, 1997, and Dijkman and Hulst, 2000.

³⁰ T. Panhuysen, 1996b, p. 20 and 32.

³¹ Dating of the road Mertens, 1987 p. 17. Excavation of the road at the Vrijthof in 1973: Bloemers, 1973a, Bloemers, 1973b. A small section of the road was excavated in 2003 at the Vrijthof in Maastricht for a detailed archaeological investigation and a re-evaluation of the results from the previous investigation of the road. Dijkstra and Flamman, 2004.

The oldest construction phase dated from the first century AD.³² Most of the traces of habitation on both sides of the river have been discovered around the main Roman road and other intersecting roads. The local circumstances in the flat terrain adjacent to the river were not very favourable for a permanent settlement. At many locations elevation of the terrain was necessary to create suitable conditions for housing. No buildings from the first century, except some funerary monuments, appear to have been constructed of stone. During the first century most structures must have been made of perishable materials. Later, in the second and third centuries AD, several buildings of stone were erected. Most of them were concentrated in a small area along the river. Among building complexes in this zone the remains of a sanctuary and public baths have been excavated.³³

Numerous fragments of funerary monuments from the first to the third century inform us about the function of the settlement. In a monograph on this category of finds T. Panhuysen analysed the remains of these monuments in relation to the topography of Roman Maastricht. According to his view, the monuments were placed to commemorate rich veterans of the Roman army, wealthy landowners and merchants from Maastricht and the surrounding *villae*. The combined evidence suggests Maastricht was a centre of trade and possibly had administrative functions as well.³⁴ Also it served as a central place for the numerous *villae* in the river valley and along the roads. Around 270 AD the scene changed abruptly. Archaeological evidence indicates the settlement was almost completely demolished. At this time Germanic peoples migrated from the east into the Roman empire. Little is known about the precise cause of the devastation of Maastricht or its fate in the sixty years between circa 270 and 330 AD. Because of its strategic position at a river crossing it is unlikely that the place was completely deserted for long. There are some indications that around 270 AD a provisional wall was built to create a place of refuge.³⁵

LATE ROMAN MAASTRICHT (CIRCA 300-480 AD)

Topography

Intensive building activities mark the beginning of the late Roman period in Maastricht. In the second quarter of the fourth century the central area of the Roman settlement was cleared and surrounded by a stone wall of circa 170 by 90 metres, strengthened with ten towers.³⁶ In the literature this stronghold is often designated as a *castrum*.³⁷ The fortification of Maastricht is symptomatic of the restoration of Roman authority in the provinces at the perimeter of the

³² T. Panhuysen, 1996b, p. 22-25; Vos, 2002.

³³ T. Panhuysen, 1996b, p. 33-51.

³⁴ T. Panhuysen, 1996b, p. 443.

³⁵ T. Panhuysen, 1996b, p. 250; T. Panhuysen, 1996a, p. 121-126.

³⁶ Dendrochronological dating of oak piles that once supported the riverside walls showed that the wood came from trees felled in the spring of 333 AD. In: T. Panhuysen, 1996b, p. 51-58 and p. 437.

³⁷ T. Panhuysen and Leupen, 1990, p. 424-426; T. Panhuysen, 1996b, p. 52-53.

empire.³⁸ It also stresses the military function of Maastricht as a stronghold on a crossroads of strategically important routes of transportation.

FIGURE 2-2 Topography of Maastricht in the late Roman period. Legend: 1 = Servaas pandhof site and Servaas church site; —○—○— fourth century fortified wall; + = graves (after T. Panhuysen and Leupen, 1990, p. 443).

The topography of late Roman Maastricht was dominated by the same elements that had previously determined the layout of Maastricht. The roads and bridge remained in use and still formed the framework around which Maastricht evolved. On the left bank, the walled centre of

³⁸ Brulet, 1995, p. 103-112.

the settlement protected the approach to the bridge. Analogous to other fortified river crossings, it is possible that a smaller fortification guarded the bridge on the right bank.³⁹ Not only inside the fortified centre but also around the walls and along the roads traces of intensive habitation were excavated.

The advent of Christianity

The spread of Christianity is a new phenomenon in the late Roman province *Germania Secunda*, the province to which Maastricht belonged at that time. Historical evidence for the Christianisation of Maastricht comes in part from the writings of Gregory of Tours, a bishop of Tours (France) writing in the sixth century. He describes how Servatius, the bishop of the diocese Tongeren, died on his way to Maastricht. According to Gregory, Servatius was interred at a cemetery along the Roman road.⁴⁰ Gregory gives no date for this event and there are no reliable written sources that mention the year of Servatius' death. However, from the records of church councils it is known Servatius was active around the middle of the fourth century, and is mentioned for the first time in 343 AD. In 359 AD he is mentioned for the last time.⁴¹ Most historians assume he died before the end of the fourth century.⁴² Gregory's story concerning Servatius' visit to Maastricht and his burial near that place are interpreted as indicative of the presence of Christians in Maastricht. It is possible that Gregory's account of the death of Servatius echoes more or less the actual events in the second half of the fourth century. Nevertheless he was writing more than two hundred years later. Theuws recently has argued that the tale of the burial of Servatius in Maastricht may have been a construct of bishop Monulphus. Monulphus was a contemporary of Gregory of Tours and the burial of Servatius in Maastricht could have been used to legitimate the transfer of the bishop's see from Tongeren to Maastricht and aid in the promotion of the church he built in Maastricht as the centre of the Saint Servatius cult.⁴³

The only solid and contemporary proof for the presence of Christians in Maastricht are Christian grave stones found at excavations and as building material in the present Sint Servaas church. Five gravestones with Christian decorations and texts have been documented as spolia in the walls and as archaeological finds in the subsoil of the church of Sint Servaas church. These

³⁹ T. Panhuysen and De la Haye, 2002, p. 102.

⁴⁰ Gregory of Tours, 1951, p. 47.

⁴¹ Brennecke, 1986.

⁴² The time of death of Servatius is still the subject of debate. Since the seventeenth century the year 384 AD has been designated as the year of his death. However, as indicated there is no written source to support this. Recent introductions to the discussion can be found in: (for his participation in the church councils of Sardica and Rimini) Brennecke, 1986, p. 17-32; (for an overview of life and legend) De la Haye, 1985a, p. 25-26. Recently De la Haye has discussed the questions related to the death of Servatius in more detail and he seems to have changed of opinion. In this article De la Haye argues that there may have been two persons by the name of Servatius. One of these may have died in the fifth century: De la Haye, 1994, p. 5-28. A critical review of the evidence and literature concerning the historic figure of Servatius and the development of Maastricht during the Roman and early medieval period is presented in T. Panhuysen and De la Haye, 2002.

⁴³ Theuws, 2001, p. 170-171; Theuws, 2003, p. 12-13. and T. Panhuysen and De la Haye, 2002, p. 107-110

gravestones dated from the fifth and sixth centuries AD.⁴⁴ The archaeological record provides further indications in support of a rather early presence of Christians in Maastricht. Changes in the burial custom in the fourth century AD may be associated with the arrival of Christianity. During the first three centuries after Christ, cremation graves were the prevalent type of burial in and around Maastricht and often grave-goods were present in these graves.⁴⁵ From the fourth century on, inhumation graves without grave-goods became the standard type of burial.⁴⁶ The largest number of inhumation graves was found at a cemetery situated south of the Roman road to Tongeren.⁴⁷ As will be discussed in more detail in the next chapter this cemetery is also the place where Servatius was buried according to Gregory of Tours. The fourth century graves found at this site were all inhumation graves. The inhumations in the graves were placed with the head to the west and feet to the east and several were without grave-goods. The combination of these three characteristics suggests they were Christian burials. Excavations inside the fortified centre of Maastricht provided another hint of the arrival of Christianity. In this central area the archaeologists found Samian ware (a comparatively luxurious type of pottery) decorated with Christian symbols. Judging from their context these finds date from the fifth and the first half of the sixth century. The fact that many fragments of this specific type of Samian ware were concentrated in the area where the episcopal church was supposedly situated, could be associated with the presence of Christians.⁴⁸

During the late Roman period Maastricht belonged to the *civitas Tungrorum*, a district within the province *Germania Secunda*. Nearby Tongeren, a large urban centre 18 kilometres west of Maastricht, was the capital of this district at the time. As the capital of the *civitas* the city gave its name to the diocese and was probably the major residence of the bishop. In the fourth century Tongeren decreased in size, the length of the walls around the city was reduced from 4500 to 2800 metres. For the fifth century few traces of habitation have been found in Tongeren. Recent excavations inside the present church of Our Lady in Tongeren have brought to light the remnants of a church that might date from the fifth century. Altogether, the impression is that the size and importance of Tongeren gradually declined.⁴⁹ Until now the exact reason for the waning of Tongeren is unknown. Depopulation and the abandonment of settlements and villae are recorded for many places in the northern provinces. A higher mortality due to violent incursions of Germanic peoples, migration to safer areas or the deportation of enslaved

⁴⁴ Boppert, 1986, p. 64-96.

⁴⁵ For an example of a cremation grave excavated close to the Saint Servaas church site: Goossens, 1927. An overview of the location and grave types from the first to the third century AD see: T Panhuysen and De la Haye, 2002, p. 100.

⁴⁶ For an introduction to the shift from cremation burials to inhumation burials and the possible association with Christianity see Morris, 1992, p. 52-69 and p. 206-208.

⁴⁷ Excavations at four sites have yielded graves from this cemetery: the Pandhof site Timmers, 1955, Soeters, 1989, the Vrijthof site Bloemers, 1973a, the Servaasklooster site and the Servaas church site T Panhuysen, 1991.

⁴⁸ Dijkman, 1993, p. 129-172, especially p. 158.

⁴⁹ On the dwindling of Tongeren: Vanderhoeven et al., 1992, p. 387-389 and Tongeren in the 5th and 6th centuries: Mertens, 1990, p. 71. Recently in Vanderhoeven, 2002, p.85.

inhabitants are often mentioned as causes that led to a reduction of inhabited places.⁵⁰ It has also been suggested that effective birth control may have contributed to a lower child rate in the Roman period.⁵¹ Around the middle of the third century the depopulation seems to have affected the northern provinces of the Roman Empire. With this in mind, the invasions and forced migrations in the second half of the third and in the fourth century can also be regarded as a result of the population decline.⁵² For Maastricht nothing indicates that the population decreased. On the contrary, traces of continuous habitation since the fourth century have been found and the settlement area may even have been enlarged.⁵³ It is possible that already by the late Roman period some of the urban and religious functions of Tongeren were transferred to Maastricht. As will be indicated below the developments in the sixth century support this theory, but for the fifth century there is no substantial evidence.

Economy

Our knowledge of the economical circumstances in late Roman Maastricht is limited. As a port and a central place for *villae* in the region, trade would have been important for the local economy. Most of these *villae* in the river valley and along the Roman road were focused on agriculture. In the third century the first wave of Germanic immigrants caused a disruption of occupation and production at many *villae*. Furthermore this caused a decline in the number of settlements.⁵⁴ Excavations have further shown that in the fourth century the grounds and sometimes buildings of most *villae* were re-used. Maastricht appears to have been one of the surviving or reviving central places where the agricultural products from the remaining *villae* could be traded.⁵⁵ This idea is corroborated by the excavation of a large rectangular Roman

⁵⁰ Werner, 1973, p. 289. The scarcity of sources and their geographical dispersion impedes progress in the field of historical demography. As a result no reliable figures are available on the size of the population and population density in the late Roman period. Parkin, 1992, p. 60-66.

⁵¹ Riddle, 1994, p. 63-65 and p. 87-101. Harris and Ross, 1987, p. 80.

⁵² Despite the fact that this population decline is an important aspect of late Roman and early medieval history the true nature and scale are still unknown. There are indications that while the population in northern Gaul declined in the fourth century, the territories on the right bank of the Rhine saw no decrease in population. It cannot be excluded that these Frankish grounds were even confronted with a rise in the number of inhabitants. Theuvs and Hiddink, 1996, p. 66.

⁵³ In the fifth century the hitherto uninhabited land southwest of the fortified centre becomes inhabited. T. Panhuysen, 1986, p. 130-131. T. Panhuysen and Leupen, 1990, p. 432-433.

⁵⁴ For northern Gaul Brulet has found that especially those settlements that were not situated near the network of roads were deserted between the last quarter of the third century and the end of the fourth century. From the end of the fourth century he notices a diversification of the remaining rural settlements and points out there was a continuous development of settlements in the Meuse Valley. Brulet, 1990, p. 292-296. Van Ossel suggests that these diverse settlements already date from the middle of the fourth century AD and were new foundations adapted to the changing circumstances. Van Ossel, 1992, p. 171-184.

⁵⁵ A general survey of the role of *villae* in the area: de Groot, 1987, p. 81-86. Introductory articles on the occupation history of two *villae* in the region indicate what happened in the rural area around Maastricht. For Neerharen-Reekem, a villa of moderate size a few kilometres west of Maastricht see: De Boe et al., 1992, p. 477-496. The villa was deserted around the middle of the third century and reoccupied from the second half of the fourth century into the fifth century. A villa in Voerendaal, situated about twenty kilometres

building within the walled centre of fourth century Maastricht. Most likely this is a *horreum*, a building designed for the storage of grain, often found in a military context.⁵⁶ Ceramics and glass from areas like northern France were excavated in Maastricht, showing the existence of long distance exchange in the first three centuries AD.⁵⁷ Trade intensity possibly diminished in the fourth and fifth centuries due to the depopulation of other cities and rural areas. There are no reasons to assume production and commerce came to a halt entirely. The local manufacture of Samian ware, attested for the fifth century, also suggests there was at least a regional market for more luxurious products.⁵⁸

The inhabitants

Judging from the transformation of Maastricht into a stronghold the Romans must have felt that the strategic situation had changed. No longer could they leave Maastricht, on the crossroads of an important waterway and the route that connected Cologne with its Roman hinterland, without solid protection. In the fourth century Cologne, the capital of the province *Germania Secunda*, faced a growing population of Germanic tribes along the eastern border of the province.⁵⁹ Traditionally historians assume that most "barbarians" entered the Roman Empire either as *laeti* or as *foederati*. *Laeti* were people of Germanic origin who were captured during military actions, mostly in the late third and early fourth century. They were forced to work as farmers in depopulated areas and had military duties as well. *Foederati* were groups or sometimes whole tribes who settled within the empire as federates. Often they formed units in the auxiliary army, under the leadership of their own rulers.⁶⁰ Although other Germanic tribes passed through the northern part of the empire, the Franks were the most prominent tribe to settle in the area. Traditionally they were divided in two main groups: the Rhine Franks and the Salian Franks.⁶¹ The Rhine Franks lived in the fourth century on the right bank of the Rhine. During the same period the Salian Franks settled within the Roman Empire. In 358 AD emperor

east of Maastricht, shows a different pattern. The grounds of this large villa were occupied from the first century BC to the eighth century AD. In: Willems, 1992, p. 526-534.

⁵⁶ T. Panhuysen, 1996b, p. 59-61, Bakels and Dijkman, 2000, p. 27.

⁵⁷ Dijkman, 1992, p. 375-376.

⁵⁸ Dijkman, 1992, p. 368-370.

⁵⁹ Theuvs and Hiddink, 1996, p. 66.

⁶⁰ Werner, 1973, p. 290. Both *foederati* and *laeti* had to contribute men to the army. Ewig, 1993, p. 11. Böhme, 1996, p. 91-101.

⁶¹ In contrast to the Salian Franks, who seem to have formed one tribe, the Rhine Franks were a conglomerate of tribes that had settled in the lower Rhine region. Today the distinction between Rhine and Salian Franks is considered to be of little relevance. Older written sources mention tribes on the right side of the Rhine with names like *Bructeri*, *Chattuarii*, and *Chamavi*. In the fifth and sixth centuries the tribes west of the Rhine occur in the sources as *Ripuarii*, *Masuarii*, *Hasbanienses*. These names were often associated with their geographical location. Ewig, 1993, p. 9-10, Ewig, 1980, p. 12-13.

Julian (355-361 AD)⁶² allowed the Salian Franks to remain in *Toxandria*, a region circa 50 kilometres northwest of Maastricht.⁶³

No unequivocal archaeological evidence for the presence of persons from Germanic origin has been found for fourth-century Maastricht. In the fourth century after three centuries of Roman presence the population in and around the fortification may still have consisted mostly of Gallo-Romans. When exactly the first Germanic people settled in Maastricht can only be learned from archaeological findings or from future provenance studies of the human skeletal remains. The oldest indication for the presence of people of Germanic origin in Maastricht comes from a Christian gravestone inscribed with a Germanic name. According to W. Boppert this stone was placed in the second half of the fifth or the early sixth century. A second gravestone dates from the sixth century.⁶⁴ The names on these stones, *Aluuefa* and *Felegaridus* show that either people of Germanic origin were buried in Maastricht, or Germanic names were in usage by the local population of Maastricht.⁶⁵ In both cases this occurrence of Germanic names makes it plausible that at least by the end of the fifth century people of Germanic origin had settled in or around Maastricht. Support for this assumption comes from a grave excavated close to the place where the gravestones have been found. Ypey has shown that the decoration of the sword sheath found in this grave typologically belongs to a group found mainly in the present Belgian province of Namur. He dates the object, decorated with a human head between stylised bird-heads, to the second half of the fifth century and mentions that the decoration is considered of Germanic origin.⁶⁶ Still, the find of such an object cannot be considered absolute proof of the ethnic affiliation of the individual in the grave.

Altogether, the archaeological evidence does not resolve the matter of the actual arrival of people of Germanic origin. Both the tombstones, the re-emergence of grave-goods and the ethnic context of these grave-goods suggest individuals of Germanic origin were buried in Maastricht by the end of the fifth century. Still, the evidence is indirect and the Germanic names and grave goods may also indicate a change in fashion or an adaptation to the fact that Germanic groups acquired administrative control over the region. On the other hand the above-mentioned finds of Samian ware suggest local culture was also continued at least to the fifth century. The traditional assumption that ethnic groups might be recognised on the basis of grave goods and anthropometrical data seems highly unlikely. In view of the evidence that Germanic people entered the empire as farmers or soldiers from as early as the end of the third century, we may assume that they mixed with the Gallo-Roman population long before the end of the fifth

⁶² In this study for widely known historical figures anglicised personal names will be used whenever available. For less well-known persons Latin names will be used. If possible, the years when a person was in function will be placed behind his/her name between brackets, when a person is mentioned in the text for the first time.

⁶³ Demougeot, 1979, p. 93 and Ewig, 1993, p. 10-11.

⁶⁴ Boppert, 1986, p. 75-80 and p. 83-87.

⁶⁵ Recently the name *Bobo* was added to the list of Germanic names from Maastricht. This name was mentioned on a sword found in an early Merovingian grave and is thought to be the name of the owner of the sword. Dijkman, 2003.

⁶⁶ Ypey, 1985, p. 6-9. In the same article Ypey (p. 2-6) describes a bronze decoration from a belt, dating from the middle of the fifth century. Unfortunately this find from Maastricht was not found in an archaeological context.

century. Therefore, it is plausible that a heterogeneous population with Gallo-Roman and Germanic elements populated Maastricht. The long history of contact among these three ethnic groups, their mobility and possibly their own heterogeneity make it highly unlikely that separate ethnic groups would be recognisable through using traditional anthropological methods. Biomolecular methods and isotope analysis provide a better chance to study the provenance and genetic relations of the inhabitants of Maastricht. First generation immigrants could theoretically be recognised by studying the isotopic ratios in their bones and teeth, which is expected to be of a different signature than of persons living on the same site since birth. Detailed analysis of the ancient DNA might also shed light on the genetic composition of the population.

With respect to the social structure of the population of Maastricht we have to rely on archaeological findings. At the time of the construction of the *fortification* Maastricht may have been a military settlement. However, indications other than the defensive walls and towers have never been found. There were few finds of military equipment, too few to suggest the permanent presence of military units. This might imply that Maastricht became a centre with a civilian population soon after its fortification. Sometimes an impression of the social stratification and ethnic composition can be obtained from the study of grave-goods and grave types. For late Roman Maastricht however, the prevailing customs seem to hamper such an analysis of the graves. Probably under Christian influence the inclusion of grave-goods became almost obsolete among the Gallo-Roman population. Until now, only one cemetery from this period has been excavated. Parts of this cemetery have been found at three sites in and around the Saint Servaas church and monastery. Late Roman graves found at these sites have yielded few grave-goods and showed little variation in grave type. Thus, the cemetery provides no insight into social differentiation.⁶⁷ Inscribed gravestones found at late Roman cemeteries, for example in the province Belgica Prima, give the impression that people of all sorts were buried at Christian cemeteries.⁶⁸ Morris concludes that the less privileged generally appear to be underrepresented on the gravestones.⁶⁹ This could be an indication that people were buried at different cemeteries according to social status, but it does not rule out the possibility that they were buried at the same cemeteries. For Maastricht Soeters and T. Panhuysen assumed that the cemetery at the site of the Saint Servatius church and monastery was used to bury the “traditional Roman population and the new Germanic elite”.⁷⁰

⁶⁷ Verwers, 1986, p. 56-71. Soeters is of the opinion that the average Gallo-Roman inhabitant was inhumed at the Pandhof site: Soeters, 1989, p. 46.

⁶⁸ Gauthier, 1975, *passim*.

⁶⁹ Morris, 1992, p. 164-166.

⁷⁰ Soeters, 1989, p. 46; T. Panhuysen and De la Haye, 2002, p. 105.

MEROVINGIAN MAASTRICHT (CIRCA 480-700 AD)

THE FRANKISH REVOLUTION

Not the deposition of emperor Romulus Augustulus in 476 AD, but the accession of Clovis (481-511 AD) in 481 AD as king of the Salian Franks best marks the beginning of a new era in northwestern Europe. Clovis' reign laid the foundation for the Frankish kingdom; a political entity that would determine the course of European history in the following centuries. This kingdom was not created overnight. It was a consequence of the disintegration process of the Roman governmental system in the West. This had started decades before the enthronement of Clovis. After the murder of Emperor Valentinian III in 454 AD Roman authority gradually lost its grip on remote provinces, as it was no longer able to defend the limits of the empire. The dissolution process did not proceed at the same pace in every part of the empire, but region after region detached. Sometimes a *pro forma* dependency on the Roman Empire was continued. Several new rulers based their authority on the investment with high Roman offices. In the province of *Germania Secunda* the transition of authority into the hands of the Franks seems to have occurred without much turmoil.

This placid revolution was probably facilitated by the long presence of Germanic inhabitants in the area. As indicated above since the third century Germanic groups and individuals of various tribes had settled in the northern provinces. As a result of this, the Franks, originally living east of the Rhine, are supposed to have easily integrated with the Gallo-Roman and Germanic population living west of the Rhine. Around 440 AD they already dominated the rural areas in the provinces *Germania Secunda*, *Belgica Prima* and the northern half of *Germania Prima*.⁷¹ After the middle of the fifth century they seem to have established themselves in urban centres as well. At that time the Frankish elite completed the gradual take-over of secular authority. Their territory occurs in the sources as *Francia rinensis*.⁷² Maastricht also belonged to *Francia rinensis*. Just like Namur and Dinant it was situated on the western border. The southern limit of *Francia rinensis* lay around Mainz and Toul. To the east the border was formed by the lands right of the Rhine, from whence the Rhine Franks came. In the north their territory ended with the Betuwe.⁷³ Gregory of Tours, writing about the settlement of the Franks in the lands west of the Rhine, describes how they appointed kings in the various *pagi* and *civitates*. Ewig interprets his remarks as an indication that in the second half of the fifth century the political landscape of *Francia rinensis* consisted of a collection of small kingdoms. So-called *regales* or "petty kings" ruled territories that covered former Roman administrative units like *civitates* and *pagi*. At an early stage there also was a tendency to concentrate power over larger regions. Cologne, the ancient Roman metropolis, apparently surpassed the other kingdoms and became

⁷¹ Both Brulet and Van Ossel have noticed the appearance of a different type of settlement in this area that remained in use into the early medieval period Brulet, 1990 and Van Ossel, 1992. It seems plausible that these new settlements with activities in the manufacture of metal, antler objects, pottery and glass were a consequence of the intensification of habitation.

⁷² Ewig, 1980, p. 9-10.

⁷³ Ewig, 1993, p. 16.

the central place from where *Francia rinensis* was ruled.⁷⁴ Around the end of the fifth century Cologne was the residence of the only known king of *Francia rinensis*, Sigibert.

FIGURE 2-3 The central and northern part of the Frankish kingdom, c. 600 AD.

Between 509 and 511 AD machinations of king Clovis of the Salian Franks (482-511 AD) led to the murder of both king Sigibert of *Francia rinensis* and Sigibert's son Chlodoric. This resulted in Clovis' usurpation of the throne in *Francia rinensis*.⁷⁵ With this manoeuvre Clovis united the territories of the Franks. Soon after the unification of the two Frankish kingdoms Clovis died. After his death the kingdom was divided among his sons. The various parts were reunited after the extinction of the respective branches of the family. This occurred several times during the Merovingian period. As all divisions were followed by re-unification, *Francia rinensis* remained a part of the Frankish kingdom until the dissolution of the Carolingian Empire in the ninth century. Between 482 AD and 639 AD the political history of the Merovingian kingdom was dominated by the kings and their entourage. After the death of Dagobert I (638/9) the influence of the *maior domus*, originally a high official at the royal court, increased until this dignitary prevailed over the king. By the end of the seventh century the Arnulfing-Pippinid family acquired enough authority to use the office of *maior domus* to rule the whole Frankish kingdom. Around that time the northern part of the kingdom consisted of two large regions: Neustria and

⁷⁴ Ewig, 1980, p. 12-14; Wood, 1994, p. 36

⁷⁵ Ewig, 1980, p.17.

Austrasia. *Neustria* was the heartland of the Merovingian dynasty, consisting of the Seine valley and Northern France. The other region *Austrasia* was a political entity that had developed in the eastern part of the Frankish kingdom. It consisted of the territories of *Francia rinensis*. Despite the ethnically mixed population, a sense of unity had evolved in this part of the kingdom. This development led to *Austrasia* becoming a counterweight to *Neustria* around the end of the sixth century.⁷⁶

MEROVINGIAN MAASTRICHT AS A REGIONAL CENTRE

The assessment of the position of Maastricht during the period of Frankish settlement in the territories west of the Rhine remains troublesome. Reliable documentary sources are missing. Only since the second half of the sixth century does Maastricht appear in the documentary sources. On the basis of these sources we may assume that Maastricht was a regional centre in *Austrasia*, with religious and administrative functions. This is illustrated by the fact that two Merovingian kings held meetings in Maastricht at which they issued new laws or charters.⁷⁷ Another marker of a regional centre in the Merovingian period was the presence of a mint. Subsequent moneyers minted coins in Maastricht, establishing next to Rheims and Metz, one of the three major mints in *Austrasia*.⁷⁸ Judging from the more than 160 coins recovered from Maastricht and the relatively long series of 12 moneyers working in Maastricht, it was the most important mint in northwestern Europe.⁷⁹ In the seventh century two of the moneyers who worked in Maastricht, Rimoaldus and Madelinus, minted virtually identical coins both in Maastricht and Dorestad.⁸⁰ Wood has suggested that the mint in Dorestad, a large centre of trade circa 175 kilometres north of Maastricht, may have been subordinate to Maastricht.⁸¹ Another indication for a central role were the visits of the Merovingian kings to Maastricht.⁸² Given the fact that Merovingian kings visited Maastricht it is possible that a *palatium* existed in Maastricht or its immediate surroundings in Merovingian times. Hitherto no trace of such a building complex has been found.⁸³

The bishops of Maastricht

Beside the visits of kings, the presence of bishops in Maastricht also qualifies the city as a prominent centre in the region. The exact moment when the bishops made Maastricht their

⁷⁶ Wood, 1994, *passim*; Ewig, 1980, *passim*; Lejan, 1996, p. 222-226.

⁷⁷ In 595 AD Childeric II (575-596 AD) and in 667 AD and 669/70 AD Childeric II (662-675 AD) in: Van Ommeren, 1991, p. 5-48. See numbers: 8, 17, 18.

⁷⁸ Grierson and Blackburn, 1991, p. 135.

⁷⁹ Pol, 1995, p. 186-187 and Theuvs, 2003, p. 9-11.

⁸⁰ Grierson and Blackburn, 1991, p. 137.

⁸¹ Wood, 1994, p. 298.

⁸² Merovingian kings formally did not reside in one city. With his court the king travelled through the kingdom from place to place.

⁸³ It has been suggested by Grierson that the letters "PA" on coins struck by the moneyer Godefredus were an indication for the presence of a *palatium*. Grierson and Blackburn, 1991 p.136-137. Pol has shown that this interpretation of these letters on the coins of Godefredus was incorrect.

main residence cannot be determined. Medieval chroniclers of the diocese interpreted Servatius' travel to Maastricht as a relocation of the episcopal see. According to them the bishop's see remained in Maastricht from the end of the fourth century until the eighth century, when the bishops moved to nearby Liège. It is difficult to discern fact from fiction in the available written sources. Therefore, modern historians have doubts about the transferral of the episcopal see and the medieval list of bishops of Maastricht.⁸⁴ On the list of bishops appears the symbolic number of twenty-one names. Many of these seem to have been legendary personages. Only the existence of eleven bishops can be corroborated by documentary sources.⁸⁵ The first bishop who is mentioned in a reliable source after Servatius is bishop Falco at the beginning of the sixth century. Shortly after Falco, bishop Domitianus must have been in office as a bishop of Maastricht. Domitianus attended a church council in Clermont in 535 AD.⁸⁶ For circa 170 years between Servatius and Domitianus we have no reliable information on the names and numbers of bishops or where they resided. Like in other dioceses, the episcopal see may have been vacant from time to time during the fifth and first half of the sixth century.⁸⁷ The hazy situation concerning the episcopacy does not imply a breach in Christianity in Maastricht. Inscribed tombstones and indirect indications like Christian symbols on locally produced ceramics bear witness to the presence of a Christian community.⁸⁸

A remark added after Domitianus' name on the list of bishops who attended the church council of Clermont is the first indication that the Merovingian bishops of the diocese Tongeren resided in Maastricht. Later sources even indicate a change in the name of the diocese and write about the "bishop of Maastricht".⁸⁹ Maastricht was certainly not the only residence of the bishops, they also resided and some were even inhumed in places like Dinant, Namur and Huy.⁹⁰

⁸⁴ De la Haye, 1985a; T. Panhuysen and De la Haye, 2002.

⁸⁵ De la Haye, 1985a, p. 16.

⁸⁶ Pontal, 1989, p. 104-107.

⁸⁷ Pfaffgen and Ristow, 1996, p. 152. Weidemann, 1990, p. 286.

⁸⁸ See above: page 22.

⁸⁹ Late Roman and early medieval bishops often resided in more than one place in their diocese. However, most of the time one place functioned as a main residence. The changes in the denomination of the bishop of Tongeren indicate that first Tongeren, later Maastricht and finally Liège were the centre of the diocese. When Maastricht became the main residence is unknown. It is possible that Servatius already moved the episcopal see from Tongeren to Maastricht. Clear indications that Maastricht was the main episcopal residence appear much later in the documentary sources. The first is found in the acts of the council of Clermont in 535 AD. These were signed by bishop Domitianus as bishop of Tongeren. A remark is added that implies he resided in Maastricht. In this text a similar text was added to explain the provenance of the bishop of the ancient diocese Javouls, who then resided in Mendes. Because of the similarity of these additions it has been argued that the explanatory remarks were part of the original text of the acts of the council and not later interpolations by the author of a transcript. In 614 AD a bishop Bettulfus attended the council of Paris. He is designated as the bishop of Maastricht and not named bishop of Tongeren. Later sources follow this practice. For an overview of the sources see: van Ommeren, 1991, p. 5-48: numbers: 6, 10, 15, 31, 47, 48. For introductions, recent opinions and references to further literature on the subject of the episcopal see: Werner, 1980, p. 228-229; De la Haye, 1985a, p. 19-47; Pontal, 1989, *passim*; T. Panhuysen and Leupen, 1990, p. 430-432; Leupen, 1997; Dierkens, 2000; Theuvs, 2001; T. Panhuysen and De la Haye, 2002.

⁹⁰ Werner, 1980, p. 325-327.

The changed name of the diocese suggests Maastricht was the principal residence of the bishops at the time. Maastricht probably remained the principal episcopal centre in the diocese until bishop Hubertus (703/706-727 AD) arranged the translation of the corpse of his predecessor Lambertus from Maastricht to Liège. Thus Hubertus initiated a process which would eventually lead to the transfer of the episcopal see to Liège.⁹¹ What the influence of the bishops on Maastricht was during the two hundred years before this transfer is hard to tell. Many sources only mention the presence or existence of the subsequent bishops. Few texts also describe the deeds of these bishops in Maastricht. These texts note that bishop Monulphus (between circa 549 - 590 AD) built a church near the grave of Servatius.⁹² Later the description of the life of bishop Lambertus informs us that bishop Lambert was educated in the entourage of his predecessor bishop Theodardus (around 670 AD). This may be seen as an indication of the presence of a cathedral school in the entourage of the bishop.⁹³

An administrative centre

The territorial division of the former *civitas* Tungrorum and its function in the administration is unclear for the early Merovingian period.⁹⁴ Developments in other *civitates* show that these remained important in the administrative system, especially as taxation districts. Each *civitas* was governed from a central city, where the king's officials resided and archives were kept. Often it was also the seat of the *comes* or *graphio*, the highest authority in the *civitas*, who was probably invested with judicial and military duties.⁹⁵ The presence and activities of bishops, the presence of a venerated tomb of a saint and a funerary church in combination with the visits of kings and the minting of coins indicate that Maastricht was an important regional centre in the Merovingian period. At the same time, neighbouring Tongeren seems to have dwindled to a size that was incompatible with the functions of the centre of a *civitas*. Recent finds have shown that a church was built and various locations were used as a cemetery indicating Tongeren was not completely deserted during the fifth and sixth centuries.⁹⁶ More activity was noticed in Maastricht during the same period. Maastricht appears to be the best candidate to have

⁹¹ Werner, 1980, p. 280-319.

⁹² Gregory of Tours, 1885, p. 790.

⁹³ Vita Landiberti, (1913), p. 355.

⁹⁴ Maastricht occurs in a written source of 614 AD as a '*civitas*', which can indicate both a city and a *civitas* at that time. Twenty years later the will of Grimo mentions the existence of a '*Tongrinse territorio*'. This suggests there still was a notion of the ancient *civitas* Tungrorum. From the seventh century the sources speak of districts like the *pagus Hasbaniensis* and *pagus Mosariorum*, which were situated in the region around Maastricht. These *pagi* originated in the Merovingian period.

⁹⁵ Wood, 1994, p. 60-61. The first evidence for the presence of a *comes* in Maastricht dates from 908 AD, this does not exclude older origins for this function. In fact in the eighth century hagiography of St. Lambertus, bishop of Maastricht, Lambertus father is designated as '*praeses*' in Maastricht. The meaning of this title in the seventh or eighth century is rather ambiguous. In general it indicates that Lambertus' father was a dignitary. Parallels in other source indicate the expression '*praeses*' may sometimes be read as '*comes*'. Werner, 1980, 244-248.

⁹⁶ Vanderhoeven, 2002, p. 85-88.

substituted Tongeren as the central place in the region.⁹⁷ In the treaty of Meerssen (870 AD) a “*districtus Trektis*” is mentioned. Several authors have interpreted this as an indication that Maastricht was the centre of a Merovingian district.⁹⁸

THE ARCHAEOLOGY

Reflections of the prominent position of Maastricht can be found in the archaeological record. An important aspect of the archaeology of Maastricht is the continuity between the late Roman and the Merovingian period. Unlike other places, there are no signs of an interruption in habitation between the two periods. Another new development is the growth of the inhabited area. If Maastricht did not already have urban qualities in the late Roman period, it most likely acquired an “urban status” in the Merovingian period, hence the denomination *urbs treiectinsis*, ‘the city of Maastricht’, in the written sources from this time.⁹⁹

Continuous habitation

Continuity of habitation, industrial activity and inhumation were found at several sites in Maastricht. At the Derlon site the stratigraphy revealed that the walls of the *fortification* remained visible until the end of the Carolingian period.¹⁰⁰ During the Merovingian period the remainder of these Roman walls enclosed a space that is characterised by a very slow stratigraphical build-up since the end of the fifth century. Around the same time a thick layer was formed during the Merovingian period. T. Panhuysen interprets this as an indication that the space inside the *fortification* was used for formal activities by religious or secular authorities.¹⁰¹ The southern half of the *fortification* in particular may have been used for ecclesiastical purposes. Most fragments of ceramics, decorated with Christian motifs, were found in that area. In all likelihood this was the part of Maastricht where the bishop and his entourage may have dwelt and where the oldest church can be expected. Contemporaneous intensive habitation around the *fortification* caused a rapid growth of the layers in the stratigraphy. Other locations that show continued occupation during the fifth century are: Jodenstraat site, Grote Staat area, and Hondstraat site.¹⁰² For the next century there are indications that the inhabited area around the *fortification* and the roads expanded. New sites with traces of habitation or human activity in the sixth century are the Mabro site, Rijksarchief site and on the right bank of the Meuse the Rechtstraat site.¹⁰³ Also a little further away from the *fortification*, new centres of activity emerged, adding to the image of expansion in Merovingian Maastricht. Approximately two kilometres south of the *fortification* at the Lage Kanaaldijk site

⁹⁷ Werner, 1980, p. 247.

⁹⁸ Leupen, 1997; T. Panhuysen and De la Haye, 2002, p. 104.

⁹⁹ Gregory of Tours, 1986, p. 72-74.

¹⁰⁰ T. Panhuysen, 1984, p. 30-31.

¹⁰¹ T. Panhuysen, 1984, p. 39. T. Panhuysen, 1986, p. 125-146.

¹⁰² T. Panhuysen, 1986, p. 130-132 and Sablierolles et al., 1997, p. 293-313.

¹⁰³ T. Panhuysen, 1984, p. 71.

FIGURE 2-4 Merovingian Maastricht. Excavated sites: 1 Sint Servaas complex; 2 Derlon; 3 Witmakersstraat; 4 Boschstraat; 5 Jodenstraat; 6 Church of Our Lady; 7 MABRO; 8 Rijksarchief; 9 Lage Kanaaldijk; 10 Céramique; 11 Sint Martinus church; —○—○—○= fourth century fortified wall; + = graves (after Sablerolles et al., 1997, p. 295).

traces of habitation from the sixth and seventh centuries were excavated.¹⁰⁴ Closer to the fortification, 600 metres north, at the Boschstraat site the excavated dirt pits suggest the presence of a small settlement that originated in the seventh century.¹⁰⁵

Merovingian building activities

Beside a few traces of the construction of houses of a more perishable nature in the aforementioned areas, there are also buildings in stone.¹⁰⁶ Inherited from the Romans were the bridge and the *fortification*. The bridge supposedly functioned until the thirteenth century.¹⁰⁷ Recently the remaining foundations of the bridge in the riverbed have been examined and surveyed. Surprisingly, no evidence was found for repair works or renewal of the foundations of the bridge after the fourth century.¹⁰⁸ As indicated above, the remnants of the walls of the *fortification* remained visible until the end of the Carolingian period. Some stone buildings constructed for the first time during this period have also been excavated. At the Servaas church site the remains of a church built adjacent to the grave of Servatius were recovered. There is little doubt that this church was the '*templum magnum*' built by bishop Monulphus in the second half of the sixth century to replace a wooden oratory.¹⁰⁹ Other buildings uncovered around the stone-built church at the Servaas Pandhof site and the Servaas Stijfskapel site probably served ecclesiastical purposes as well. They may either have housed a religious community, or accommodated the bishop and his entourage. This is an issue that will be hard to resolve as there is no documentary evidence for the existence of a religious community in Maastricht before the first half of the eighth century, nor is it clear where the bishop's quarters were.

Four more buildings with a public function may have existed in Merovingian Maastricht. Some of these could have been executed in stone. A good candidate would be the old church of the Christian community in Maastricht. This church supposedly stood in the southeastern corner of the *fortification*. Today, a Romanesque church stands at that location, but there are indications that the present 'Church of Our Lady' replaced an older predecessor.¹¹⁰ If ever there was a separate building to function as a *palatium* in Merovingian times it has not been stated in any of the written source nor has its position been indicated by archaeological findings.

¹⁰⁴ Hulst, 1995, p. 6-7.

¹⁰⁵ T. Panhuysen, 1986, p. 134.

¹⁰⁶ For an overview of the state of the discussion concerning various early medieval buildings see: T. Panhuysen and De la Haye, 2002, p. 105-115.

¹⁰⁷ T. Panhuysen and Leupen, 1990, p. 436-437.

¹⁰⁸ Vos, 2002.

¹⁰⁹ Gregory of Tours, 1885, p. 790.

¹¹⁰ T. Panhuysen and Leupen, 1990, p. 439-441. Inside the fortification one particular building has long been regarded as a Merovingian church. T. Panhuysen has determined that the building originally was constructed in the late Roman period, probably as a *horreum*, a granary. However, he does not exclude the possibility this building was later transformed into a church. T. Panhuysen, 1996b, p. 59-61 and p. 427; T. Panhuysen and De la Haye, 2002 p. 106. The archaeobotanical evidence provides corroborating evidence for the presence of a *horreum*: Bakels and Dijkman, 2000, p. 25.

Furthermore there is the facility for the lepers of Maastricht, in all likelihood a *xenodochium*, mentioned in Grimo's will. Bishop Domitianus may well have founded such a *xenodochium* some time after 549 AD. For in that year Domitianus attended the Church council of Orléans. On this occasion Merovingian bishops not only issued canons that made the care for the sick and poor one of the episcopal responsibilities, they also confirmed the creation of a *xenodochium* in Lyons.¹¹¹ This meeting may well have set an example for the bishops how to provide for the needy. If indeed such a *xenodochium* was built in Maastricht, one of the places to expect such a facility would be in the vicinity of the monastic buildings found at the Servaas site. For a last building with a public function we again have to rely on assumptions and extrapolations. Close to the east bank of the Meuse stands a church that is dedicated to St. Martin. Churches under the patronage of St. Martin often date from the early medieval period because Martin was considered the patron saint of the Franks. Furthermore, not wholly reliable reports mention the presence of Merovingian graves south of the present church. Based on this flimsy evidence the existence of a Merovingian church at the location of the present church of Saint Martin has been suggested.¹¹²

Production centre

At almost all sites in Merovingian Maastricht remains of the local manufacture of goods like glass beads, pottery, antler combs and various types of metalwork were found.¹¹³ Figure 2-4 presents an overview of the distribution of these industrial activities in Merovingian Maastricht. The scale of production and the variety of crafts is exceptional for the Merovingian period.¹¹⁴ Maastricht appears to have been a major production centre of goods for a local and regional market. The excavation of pottery from Maastricht's kilns on sites as far as 180 kilometres to the north attested to Maastricht's role as a production centre.¹¹⁵ This is also in agreement with Maastricht's role as an important mint in *Austrasia* and the widespread use of its coins. With respect to food some data have been collected in recent years. Kooistra investigated 68 soil samples from late Roman and Merovingian sites in Maastricht. She did not find unequivocal evidence concerning agricultural production in Maastricht and surroundings. However, within the boundaries of the *fortification* traces of food processing and storage were found. A pit containing the charred remains of spelt, a type of wheat, was found at the Wolfsstraat site. The contents of this pit dated from the seventh century AD.¹¹⁶ We can only speculate about the reasons for the presence of storage of grain in the centre of Maastricht. It is tempting to assume a connection with the secular or ecclesiastical authorities within the *fortification*. Maybe the wheat was collected as tax, or it came from church property. Storage for trading purposes cannot be ruled out either, but this would be expected in other areas of Maastricht. Evidence of

¹¹¹ Portal, 1989, p. 128; Wood, 1994, p. 105.

¹¹² T. Panhuysen and Leupen, 1990, p. 440-441.

¹¹³ For an overview of local manufacture of objects from animal skeletal remains: Dijkman and Ervynck, 1998.

¹¹⁴ Sablerolles et al., 1997, p. 293-313.

¹¹⁵ Based on a personal communication by R. Proos mentioned in: Sablerolles et al., 1997, p. 294.

¹¹⁶ A second pit was found in the immediate surroundings: Kooistra, 1996, p. 279-289.

food storage is also important in light of the physical anthropological investigation. It implies the presence of quantities of food arriving in Maastricht, possibly from its environs. This was a necessary provision to sustain a larger community. And it may possibly have guaranteed the presence of food during periods of food shortage. Further information concerning the vegetable constituents of diet in Maastricht was collected from various late Roman and early medieval sites. Bakels and Dijkman found that during the first millennium AD there was, in general, little diachronic change in the variety of grain, vegetables and fruit on hand for consumption.¹¹⁷

Cemeteries

The increase in inhabited areas is paralleled by a growth in the number of cemeteries and the number of recovered inhumations during the Merovingian period. The existing late Roman cemetery at the sites of the Servaas complex remained an important burial place. All around the Servaas church, which stands at the centre of this complex, people were inhumed. (Parts of this cemetery were excavated at the Servaas Pandhof site, Servaasklooster site, Stiftskapel site, the Servaas church site and possibly the Vrijthof site.) Precious grave-goods, found in some of these graves and grave types, like monumental tuff stone sarcophagi, illustrate the above average social position of a considerable proportion of these individuals. It is assumed that the presence of the supposed grave of Saint Servatius attracted "*ad sanctum*" burials. Less information is available about other Merovingian cemeteries in Maastricht. Inside the fortification walls, a few graves from the Merovingian period were recently excavated at the Onze Lieve Vrouwekerk site.¹¹⁸ These graves were probably located close to the old church that was used by the Christian community of Maastricht since the late Roman period. New burial places originated at several locations around the inhabited area and near various settlements in the vicinity. At the Vrijthof site, close to the Servaas complex, a separate cemetery came into existence. Some 150 graves dating from the sixth and seventh centuries were excavated at this site.¹¹⁹ Approximately a century later a smaller cemetery was created at the Boschstraat site, which was used during the seventh and early eighth centuries for the burial of at least 54 people. Other new cemeteries were excavated at the Lage Kanaaldijk site, the Céramique site and in Borgharen (a cemetery originating at the site of a Roman villa).¹²⁰ Not far from Maastricht in Belgium lies the Merovingian cemetery of Rosmeer. The results of the excavation were published in 1970, with a contribution by Janssens on the physical anthropology and palaeopathology.¹²¹ For some cemeteries there are no hard data available; their existence is inferred from older written reports on the presence of graves and grave goods. There is information that there were also Merovingian cemeteries on the flanks of a hill to the southwest of Maastricht, locally known as the Sint Pietersberg.¹²² On the right bank, the area around the church of Saint Martin is thought

¹¹⁷ Bakels and Dijkman, 2000.

¹¹⁸ T. Panhuysen and De la Haye, 2002, p. 105.

¹¹⁹ Bloemers, 1973a, p. 53-54.

¹²⁰ Lage Kanaaldijk: Hulst, 1995; Céramique: Panhuysen et al., 1992, p. 263-264; Borgharen: R. Panhuysen, 2000, Dijkman, 2003.

¹²¹ Janssens, 1970.

¹²² T. Panhuysen, 1986, p. 135.

to be the location of a Merovingian cemetery.¹²³ As indicated above, most cemeteries show a change in the burial custom. Unlike the sober late Roman graves, a considerable number of graves from the sixth and seventh centuries contained grave-goods. Various objects such as like utensils, jewellery and weapons were found in the graves. The variation in the use of grave-goods both among and within the cemeteries allows us insight into the composition of the population at the time.

The Merovingian population

Population growth

Many places in the region show a disruption or a decrease in occupation between the fifth and first half of the seventh century. However, this trend is not present in all areas; in the region around Maastricht some sites have shown that certain areas went through a phase of population increase.¹²⁴ Deteriorating climatological conditions, migrations and epidemics may have been interacting causes that lead to the depopulation of other settlements. A general recovery is visible from the second half of the seventh century.¹²⁵ The expansion of the inhabited space and the increasing number of burials indicate that Maastricht started to grow earlier, around the end of the fifth century. Whether this growth was a result of immigration or natural population increase remains to be determined. At least the archaeological evidence suggests that immigration was an important factor. Contemporaneous with Maastricht's expansion we find more and more signs of Germanic influences like the custom of grave-goods and the occurrence of Germanic names on tombstones. In part, this may be a consequence of a popularisation of the culture of the new elite. However, it is likely that the 'Germanisation' is also the result of an influx of people of Frankish origin. Therefore, the buried population of this period would have consisted of a mix of Gallo-Romans and Germanic people who lived in Maastricht and surrounding settlements since the late Roman period and a group of Frankish newcomers, arriving by the end of the fifth century. It may be that towards the middle or end of the Merovingian period Maastricht also witnessed the emigration of a proportion of its population. With regard to this, Theuws signals a repopulation of the territories northwest of Maastricht starting around the middle of the sixth century.¹²⁶ Most of the new settlements had ties with Austrasian ecclesiastical institutions. Therefore, he assumes the new possessions were founded by *Austrasian* nobility and populated by people from nearby settlements.¹²⁷ For cemetery sites nearer to Maastricht the same trend was found. Heymans' study of the

¹²³ T. Panhuysen, 1986, p. 134-135.

¹²⁴ Some examples of sites where signs of renewed or increased habitation have been found: Voerendaal (NL): Willems, 1992, p. 526-534 and Bakels, 1996, p. 139-146; Donk (B): Van Impe et al., 1992, p. 559-562.

¹²⁵ Verhulst, 1995, p. 481.

¹²⁶ Theuws, 1988, p. 162.

¹²⁷ Theuws, 1988, p. 127.

cemeteries in the Belgian province Limburg also revealed that most burial sites originated around the middle of the sixth century.¹²⁸

Social order

The advent of the new Frankish inhabitants would have altered the social order in Maastricht and environs. From Salian law, a sixth century codification of Frankish law, we know Merovingian society legally consisted of three social orders determined by birth: the freemen or *liberi*, the half-free or *liberti* and the unfree or *servi*. This simple three-ranked system was however only the basis of a far more intricate social order. By law special positions were acknowledged to various groups of people like servants of the king, men at arms and artisans. This created opportunities for social mobility. E.g., servants of the king could be recruited from all three orders, allowing the unfree to rise to high positions. Another way for the unfree and half-free to acquire enhanced legal protection and possibly a better social position was through craftsmanship.¹²⁹ Next to the worldly social order, the church appears to have had its own hierarchy. The ecclesiastical hierarchy may also have provided the means to rise in society.

Through the Frankish laws we are informed about the theoretical social order, however, we know little about its effect on society. Further analysis of cemetery finds from the region is expected to inform us better on the structure and mechanisms of Merovingian society. Still, the available information provides some clues for the analysis of Merovingian society. Narrative and historiographical sources for example show the existence of nobility in the area. A new local or regional elite emerged and the tuffstone sarcophagi and precious grave-goods found at the Servaas sites show they may have adopted the custom of being buried close to the presumed grave of Servatius. Within the Merovingian social order, the elite was mainly recruited from the class of the freemen. What their exact position was in comparison to other social groups has yet to be established. For the Meuse-Demer-Schelde region Theuws assumes that the differences among the various social orders were not so large that it became *de facto* a dual system with an elite and a substrate agricultural population.¹³⁰ Maastricht's cemeteries seem to represent various layers of society and therefore offer the opportunity to examine the effect of social differentiation on the living conditions.

In general living conditions seem to have been good, after all the growth of Maastricht and its emergence as a centre of production and trade suggest the city experienced a period of economic growth. However, rapid expansion, if unaccompanied by a proportional increase in food-production, may incidentally have led to what Verhulst has named 'accidents of growth': famine.¹³¹ Another threat for people living together in larger numbers was the occurrence of epidemics. Although there is no written evidence that large-scale plagues reached northwestern Europe during the Merovingian period, we cannot entirely rule out the possibility. The presence of "lepers" in Maastricht suggests that at least some inhabitants suffered from diseases.

¹²⁸ Heymans, 1978, p. 66-134.

¹²⁹ Staab, 1996, p. 479-484.

¹³⁰ Theuws, 1988.

¹³¹ Verhulst, 1995, p. 483.

Violence seems to have been a common element of Merovingian politics. To what extent the inhabitants of Maastricht were exposed to violence cannot be learned from written sources. Here again the study of human remains may provide some insight.

CAROLINGIAN MAASTRICHT (CIRCA 700-950 AD)

FROM AUSTRASIA TO LOTHARINGIA

Since Pippin II († 714 AD), the forefathers of Charlemagne held the function of *maior domus* almost continuously and ruled in *Austrasia* practically without interference from the Merovingian king. In 751 AD the politics of the Arnulfing-Pippinid family culminated in a situation that allowed the *maior domus* Pippin III († 768 AD) to depose king Childeric III and become king himself.¹³² Charlemagne (768-814 AD) succeeded his father Pippin and he extended the Frankish kingdom and welded it into a cultural unity that would long survive its political unity. In agreement with Frankish custom all Carolingian rulers divided the kingdom among their sons. Charles himself made plans to divide his empire among his three sons in 807 AD. As only one son outlived him these plans were never put into practice. Apparently the provision of all sons with a part of the heritage was considered more important than keeping the empire together. The frailty of the political unity would come to light after the death of Charlemagne's son and successor, Louis the Pious (814-840 AD). In 843 AD at the treaty of Verdun the Frankish empire was split into three parts and divided among the sons of Louis. The eldest son, Lothar († 855 AD), acquired the 'Middle Kingdom', a long territory from *Frisia* in the north to Italy in the south comprising both the "crown jewels" Aachen and Rome. The death of Lothar again led to a division of the 'Middle Kingdom'. On this occasion his son Lothar II († 869 AD) came into possession of the lands north of Burgundy up to the North Sea, a kingdom that was soon named after its ruler, the *regnum Lotharii* or *Lotharingia*. When Lothar II died without a legitimate heir his uncles laid claims to his territory. In 870 AD Charles the Bald and Louis the German met to divide Lothar's kingdom between the two of them. This partition, known as the treaty of Meerssen, ignored both the linguistic frontier and the sense of unity that was emerging in *Lotharingia*.¹³³ In the north, the Meuse became the border between the West Frankish Kingdom and the East Frankish Kingdom.¹³⁴ The treaty of Meerssen did not provide a definitive

¹³² Wood, 1994, *passim*.

¹³³ The empire of Lothar II only existed for about fifteen years. Nevertheless a political unity evolved out of this kingdom that would have a long lasting influence on Western European history. Its emergence does not seem to be based on ethnic or linguistic grounds, nor did it follow the borders of archiepiscopal or episcopal provinces. Although, it did not form a geographical entity (dense forests like the Ardennes must have been serious obstacles and barriers, unifying elements were the old cities and settlements along the two axes of the territory, the rivers Rhine and Meuse. The consolidation of the territory seems to be rooted in a shared political history and structure, which revolved around the river valleys. The origins of this sense of unity possibly dated from the period before the Carolingian Empire.

¹³⁴ Nelson, 1995, p. 110-141 and Fried, 1995, p. 142-168.

arrangement of hegemony over *Lotharingia*. For almost sixty years sovereignty over *Lotharingia* was a matter of dispute between the East and West Frankish Kingdom.

Conflicts between the various rulers of the Carolingian dynasties and Viking raids, which had become a recurring scourge since the early ninth century, appear to have weakened the supremacy of the kings, thus creating opportunities for the regional nobility to expand their authority in various parts of the kingdom. Between the end of the ninth and the middle of the tenth century an increasing number of counts and dukes appear in the documentary sources. In *Lotharingia* the nobility seems to have profited from the ambiguous situation in which neither the West nor East Frankish kings succeeded in gaining effective control over the territory. Between 895-900 AD the *regnum Lotharii* was revived and temporarily became a separate kingdom under the rule of king Zwentibold.¹³⁵ Only through the politics of the East Frankish king, Henry the Fowler (911-936 AD), and his son Otto I (936-973 AD) was the larger part of *Lotharingia* incorporated in the East Frankish Kingdom.

FIGURE 2-5 Maastricht and surrounding places in the Carolingian period.

¹³⁵ Zwentibold was an illegitimate son of Arnulf (887-899 AD), the ruler of the East Frankish Kingdom.

Several of the most important possessions of the forefathers of Charlemagne, the Arnulfing-Pippinid family, were situated near Maastricht. From the beginning of the eighth century, the time of Pippin II († 714 AD), their presence in the area is evident. Many of the places they often visited, the *palatii* of Herstal and Jupille, the stronghold Chèvremont and later Charlemagne's residence in Aachen, all lay within a radius of forty kilometres from Maastricht. This region, the middle Meuse region, was also the area whence the Arnulfing-Pippinid family recruited its supporters.¹³⁶ Documentary evidence of a possible connection between Maastricht and the Carolingian rulers is scarce and indirect. Their ties with the religious community around the grave of St. Servatius are the clearest sign of their involvement with Maastricht. Before the eighth century the religious community seems to have been ruled by the bishops. Werner assumes that during the eighth century the Carolingians succeeded in gaining control over this institution.¹³⁷ An indication of a link with the court of Charlemagne is the appointment of Alcuin, an intimate of Charlemagne, as abbot of the Saint Servatius monastery in Maastricht. Later the lay-abbot Einhard, another well-known protégé of Charlemagne, succeeded Alcuin.¹³⁸

After the death of Louis the Pious in 840 AD the evidence of personal involvement of Carolingian rulers with Maastricht becomes more specific. As decided by the treaty of Verdun (843 AD) Maastricht fell within the borders of the empire of Lothar I. During the ninth century the term 'near Maastricht' occurs often in the sources to indicate a place of venue for the Carolingian kings.¹³⁹ Not all of these meetings actually took place, but one of them acquired some fame as it resulted in the treaty of Meerssen.¹⁴⁰ In 870 AD this treaty determined the partition of the empire of Lothar II between his two uncles. Thenceforth Maastricht became a city on the border between the West Frankish Kingdom and the East Frankish Kingdom. The Annals of St. Bertin mention that Charles the Bald received the abbey of St. Servatius as a result of the partition.¹⁴¹ Who acquired authority over the rest of Maastricht is not evident from the sources. It is not unlikely though that the arrangement implied that the rest of Maastricht also fell under the rule of Charles the Bald.¹⁴² After 870 AD Maastricht and immediate surroundings remained a place where Charles the Bald would arrange important meetings. In 872 for example he sailed down the Meuse to meet two Viking chiefs and to accept one of them as his vassal. Ten years after the treaty of Meerssen, Maastricht changed hands again. At the treaty of Ribémont in 880 AD, Louis the Younger, the East Frankish king (876-882) acquired the territories and

¹³⁶ Werner, 1980, p. 484.

¹³⁷ Werner, 1980, p. 337.

¹³⁸ Deeters, 1970, p. 27, references to the sources: Van Ommeren, 1991, p. 28. no. 45 and p. 29: no. 49.

¹³⁹ Van Ommeren, 1991, p. 34-36.

¹⁴⁰ It is uncertain if the present day Meerssen is the place where the treaty of 870 was negotiated and signed. In the *Annales Bertiniani* it is related that the treatment was signed along the Meuse halfway between Meerssen and Herstal. That would be somewhere between Maastricht and Visé. According to Hartmann Eijdsen most likely is the place where the treaty came into being. (1883), p. 109; Hartmann, 1986, p. 141-142.

¹⁴¹ Van Ommeren, 1991, p. 36.

¹⁴² Theuws 2004 in press.

FIGURE 2-6 Overview of the early pagi in Lotharingia (after Ewig, 1980, p.53).

possessions which Charles the Bald had received in 870 AD.¹⁴³ The year following the treaty of Ribémont the Vikings raided Maastricht and a period of unrest seems to take a start. New partitions and rapid political changes in the West and East Frankish Kingdoms created an unstable political climate in which rapidly moving Viking bands became a serious threat to places inland, which had hitherto remained unharmed.

As in other regions of the Carolingian Kingdoms, in *Lotharingia* too, political instability led to the ascent of the local nobility. One of them, Ragnar Longneck († 915 AD), may have had his base

¹⁴³ Ewig, 1980, p. 183.

in the region around Maastricht. He probably descended from Gilbert ¹⁴⁴, who is mentioned with the title of '*comes Mansuariorum*'.¹⁴⁵ Nonn has argued that this title implies he was invested with authority in the whole Meuse region.¹⁴⁶ Ragnar seems to have succeeded his father as a count in at least two *pagi*, 'counties' that formed a part of the Meuse region. He held this office in two territories not far from Maastricht: the *pagus Hasbaniensis* and the *comitatus Maselant*.¹⁴⁷ Ragnar first appears in the sources around 880 AD when he is involved in the defence of Lotharingia against Viking raids.¹⁴⁸ His battles with the Nordic invaders continued until circa 886 AD; apparently his military skills increased his prestige. After the threat of the Vikings had waned Ragnar became one of the noblemen whose alliance was essential for every king who intended to govern Lotharingia. Around the beginning of the tenth century Ragnar had acquired an impressive amount of possessions and benefices, widely dispersed over Lotharingia. Among these were important monasteries like those of Stavelot-Malmédy, Echternach and the St. Maximinian abbey in Trier. Ragnar also gained authority over the monastery of St. Servatius in Maastricht. According to a graphic description by Richerus of Reims the West Frankish king, Charles IV the Simple (898-922 AD) attended the funeral of Ragnar around the end of 915 AD.¹⁴⁹

Ragnar's son Gilbert II (circa 915-939 AD) succeeded his father in most of his functions. In the following years conflicts arose between Gilbert II and Charles the Simple and an opposing

¹⁴⁴ Gilbert I first occurs in the annals as he abducted and married a daughter of emperor Lothar I in 846 AD. Because Gilbert was a vassal of Charles the Bald this even led to a conflict between the two royal brothers Charles and Lothar in which the third brother Louis the German tried to mediate. *Annales Fuldenses*, (1891), p. 36-38.

¹⁴⁵ Nithard, 1907, p. 31.

¹⁴⁶ Nonn, 1983, p. 93.

¹⁴⁷ Exact boundaries are not known for these *pagi*; the *pagus Hasbaniensis* consisted of territories to the west and southwest of Maastricht, whereas the *comitatus Maselant* covered the Meuse valley between Maastricht and Roermond/Venlo. (The *comitatus Maselant* should not be confused with the larger *comitatus Mansuariorum*, *Maselant* seems to have been a part of the larger Meuse region.) Werner, 1980, p. 259 n. 2. For variations in spelling and names see some of the excerpts in: Van Ommeren, 1991, p. 38 and p. 42-43.

¹⁴⁸ Between circa 881 and 885 AD the Vikings were active in Ragnar's territories. In 885 AD the Northmen suffered defeat in their winter camp in the *pagus Hasbaniensis*. (The account of this event does not mention the involvement of Ragnar, however the action took place in his own *pagus*. *Annales Fuldenses*, (1891), p. 102. In the following years Ragnar seems to have continued the battle in other regions. One interesting account mentions that he was captured by the Vikings and was freed in exchange for the liberation of twelve Viking leaders, which were held by Ragnar's men. Sources on Ragnar's confrontations with the Vikings: Folcuin, 1841, p. 62 and Dudo, 1865, p. 150-151.

¹⁴⁹ According to Richerus Ragnar Longneck was buried '*apud Marsna palatium*'. Richer, 1930, p. 72. Today Meerssen (in some publications spelled 'Meerssen') is a place in the Meuse valley circa six kilometres north-northeast of Maastricht. Between circa 840 and 920 AD a place called Marsna or Marsna palatium (the palace of Meerssen) often occurs in the sources. Most of the time the palace of Meerssen is mentioned to describe events that took place '*apud*' the palace, meaning 'near' or 'next to' a place and (less often though) 'in' a place. Therefore it is hard to determine where exactly those events took place. In Meerssen, in Maastricht, in the stronghold known as Harburc, in other places in the area known or unknown, or in the open space? The palace of Meerssen itself emerges in the sources from around the middle of the ninth century. Werner, 1980, p. 465. Until now archaeologically no traces of Carolingian Meerssen have been uncovered.

Lotharingian family. Despite this antagonism Gilbert II managed to gradually increase his authority in *Lotharingia*. An intricate web of alliances and the possession of two strategically placed strongholds close to Maastricht allowed him to stay in control. Around 925 AD he allied with the East Frankish king Henry the Fowler. This allowed him to consolidate his power and he officially became duke of *Lotharingia*. His marriage with Gerberga, a daughter of Henry the Fowler, symbolised his eminent position and the permanent nature of the alliance with Henry. Charters and annals show that Gilbert II was an active ruler. In the south of *Lotharingia* he directed the construction of strongholds. He stimulated a reform movement in the *Lotharingian* monasteries. When in 936 AD Otto I succeeded his father as king of the East Frankish kingdom, Gilbert II participated in the crowning ceremonies. Soon after Otto's enthronement the king was confronted with a rebellion of East Frankish nobles. His brother Henry also participated in this uprising. Gilbert long avoided becoming involved in the conflict. When asked for his support by Otto in 938 AD he refused and decided to join the opposition. Returning from a military expedition in Saxonia he encountered supporters of king Otto by Andernach on the Rhine. There he drowned while crossing the river.¹⁵⁰

The lives of Ragnar and Gilbert II are discussed here in some detail because of their connection with Maastricht. Maastricht was situated in the middle of the pagi they ruled. Their most important strongholds, in which they retreated at times of danger, Chèvremont and Harburc, were located on a short distance to the south and north of Maastricht. Both Ragnar and Gilbert II seem to have been very determined to become and remain lay-abbot of the Saint Servatius monastery. For Ragnar more explicit clues of a link with Maastricht are missing.¹⁵¹ In the case of Gilbert II there are more indications he resided in Maastricht. Jocundus, an eleventh century author, extensively describes Gilbert's activities in Maastricht.¹⁵² Although Jocundus certainly mixed fact and fiction in his writings, his stories were based on information he collected locally. About Gilbert II he explicitly writes that he resided in Maastricht; he also mentions the duke built a new wall around the monastery of Saint Servatius and the palace.¹⁵³ Furthermore Jocundus writes that Gilbert was buried in the Saint Servatius church in

¹⁵⁰ R. Panhuysen, 1989, *passim*.

¹⁵¹ Unless we interpret his burial "near the palace of Meerssen" as indicative for his burial in Maastricht. Richer, 1930, p. 72.

¹⁵² Jocundus writings on the life of St. Servatius, the translation of the saint's body and the miracles that occurred during and after Servatius' life have long been considered mostly fictive and only partially realistic. Deeters showed that several of the events Jocundus described were also mentioned in other sources, implying that we should not discard all of the information Jocundus has to offer. Recently additional support for the reliability of Jocundus was excavated. A lead-cross covered with texts commemorating the life and death of provost Humbertus (a contemporary of Jocundus) was found at the Servaas church site. The text on the cross corroborated Jocundus' reports about Humbertus. This has raised the question if his writings contain more elements of valuable and veritable information. His description of Gilbert's activities in Maastricht could well be placed in this category and may have been based on older sources and locally available information. Jocundus, 1856, p. 85-126; Boeren, 1972, p. 31-49; Deeters, 1970, p. 135-136; De la Haye, 1988, p. 327-328; T. Panhuysen, 1988, p. 159-163.

¹⁵³ Jocundus, 1856, p. 105. Among the stories collected by Jocundus is also a peculiar account of Gerberga, Gilbert's wife, who stole fabrics from the treasure of Saint Servatius and later returned these remorsefully.

Maastricht.¹⁵⁴ Jocundus probably dramatised the life of Gilbert II and his wife, but it is likely that the essence, namely the presence of Gilbert II in Maastricht, was no fabrication.

CENTRAL PLACE

Although the exact role of Maastricht in many developments is unclear we may infer that the city was situated in the centre of the region where the fate of *Lotharingia* was repeatedly played out.¹⁵⁵ In review of the abovementioned developments it has been concluded that the region around Maastricht was first essential for the rise of the Carolingian family and later a crucial region for the control over Lotharingia.¹⁵⁶ A strong economy may well have contributed to this situation. Documentary sources show Maastricht remained a significant mercantile centre. Signs of this were the toll collection, a weekly market and the accounts in the written sources suggesting Maastricht was a crowded port of trade.¹⁵⁷ Carolingian coinage also confirms the continuity of Maastricht's strong economic position. Coins were minted in Maastricht for almost all Carolingian rulers who exercised authority over the region: Charlemagne, Louis the pious, Lothar I, Lothar II, Louis the German and Charles III the fat.¹⁵⁸ Gilbert II also issued coins bearing his name. (A duke with coinage in his own name is a rarity in the early tenth century.) In the context of practically continuous minting activities in Maastricht there are reasons to assume that Gilbert's coinage was also minted in Maastricht.¹⁵⁹ In general it may be concluded that Maastricht retained a central position in the regional economy and politics.

RELIGIOUS LIFE

The ecclesiastical situation changed when bishop Lambert was murdered in Liège, between 703 and 705 AD.¹⁶⁰ His body was brought to Maastricht and buried there. Lambert's successor bishop Hubert (703/706-727 AD) decided to rebury Lambert in Liège in a church specially built for that purpose.¹⁶¹ There he promoted the veneration of the 'martyred' bishop. Through a gradual process, not visible in the documentary sources, the transition of the episcopal see from Maastricht to Liège was completed. Werner among others tried to establish the causes for Hubert's decision, but he could not find a conclusive answer. The nearness to the Carolingian

¹⁵⁴ Jocundus, 1856, p. 124

¹⁵⁵ Apparently meetings between kings and nobles in the Carolingian era were organised in the open field, on ships on the river or in rural palaces, but seldomly in cities. The fact that several decisive meetings took place around Maastricht certainly exemplifies the importance of the region and will have been a consequence of its position on the border between the East and West Frankish kingdom.

¹⁵⁶ Werner, 1980, p. 481-486

¹⁵⁷ Van Ommeren, 1991, p. 27-28: no. 43 and p. 31-33: no. 56 and no. 60. That Maastricht continued to be a centre of trade is confirmed by coins on which Maastricht is mentioned as 'IN PORTO TRIECTO'. 'Porto' is a term used for centres of trade. Grierson and Blackburn, 1991, p. 198.

¹⁵⁸ Grierson and Blackburn, 1991, p. 197, p. 203, p. 217, p. 227, p. 235.

¹⁵⁹ Frère, 1977, p. 87-88

¹⁶⁰ Werner, 1980, p. 268-273.

¹⁶¹ De la Haye, 2002, p. 121.

palaces of Herstal and Jupille and Hubert's own predilection for the place may have contributed to the transfer of the episcopal see.¹⁶²

How the movement of the episcopal household to Liège affected the ecclesiastical institutions in Maastricht remains speculative.¹⁶³ Around the same time as Hubert initialised the move to Liège the oldest allusion to the monastery of Saint Servatius occurs in the *Gesta Fontanellensis*.¹⁶⁴ The history of the monastery Fontanelle describes how a certain Wando was sent into exile (between 719-747 AD) to the monastery of Saint Servatius. Since the end of the eighth century the monastery increasingly appears in the written sources, often in relation to possessions of the abbey. In the following years the Saint Servatius monastery acquired properties in various regions of Lotharingia.¹⁶⁵ Whether or not the Saint Servatius monastery was a monastic or a canonical community has long been the subject of debate. The second known abbot was Einhard, who was also a lay-abbot of two other canonical communities in Ghent. Einhard remained in function during the reign of Louis the Pious when it was considered objectionable that lay-abbots governed monastic communities, while there was no objection against lay-abbots for canonical communities. For the tenth century there is decisive evidence for their secular status in a charter of 946 AD, mentioning the '*canonici loci S. Servacii*'.¹⁶⁶ Therefore, Deeters' assumption that the monastery of Saint Servatius began as a canonical community seems most plausible.¹⁶⁷

THE ARCHAEOLOGY

In the archaeological record the Carolingian period is represented by building activities and inhumations. Few other traces are available. In Maastricht the remains of the Carolingian period appear to have suffered most from subsequent developments. Expansion and intensification of the urban occupation has on many sites disturbed the archaeological record to the Carolingian levels. The impression from the written sources that Maastricht remained a crowded and important centre of trade can neither be confirmed nor refuted by archaeological evidence.

A Carolingian centre of trade

From an archaeological perspective, Carolingian Maastricht remains rather elusive. Apart from some larger structures and cemeteries little is known about housing and production activities. A bridge over the Meuse survived throughout the Carolingian period and remnants of the *fortification* seem to have been visible until the end of the Carolingian period. By then the

¹⁶² Werner, 1980, p. 280-282.

¹⁶³ See for examples of this discussion: Deeters, 1970, Leupen, 1997, Dierkens, 2000, Theuvs, 2001 and T. Panhuysen and De la Haye, 2002.

¹⁶⁴ (1936), p. 24.

¹⁶⁵ Deeters, 1970, *passim*.

¹⁶⁶ Wampach, 1935, p. 160.

¹⁶⁷ Deeters, 1970, p. 28-29.

remainder of the walls were delapidated to use the stone for new buildings.¹⁶⁶ From the beginning of the eighth century there are traces of temporary habitation inside the *fortification*. T. Panhuysen assumes these may have housed travelling traders and craftsmen.¹⁶⁹ The continued presence of craftsmen in Maastricht is confirmed by the excavated fragments of moulds for bronze objects from the eighth century. The production of objects of antler and bone, an important local craft in the Merovingian period, seems to have ended before the Carolingian period.¹⁷⁰ At the Mabro-site few traces of the early Carolingian period were found. This changes by the end of the Carolingian period, in the tenth century, when timbered houses were constructed on this spot.¹⁷¹ Construction works of a different nature were uncovered at the Servaas church site. There a larger church, richly decorated with coloured glass, mosaics and sculptured elements replaced the Merovingian *templum magnum*.¹⁷² In comparison with the Merovingian period the information is much scantier. However, the historical and numismatic evidence suggest Maastricht remained a place of considerable economic, political and ecclesiastical importance.

Cemeteries

The Carolingian burial custom differs from the Merovingian in two aspects. Gradually the isolated burial grounds were deserted. By the end of the eighth century interment took place almost exclusively at cemeteries around a church or chapel.¹⁷³ As churches and chapels were not as numerous and widespread as burial sites, this must generally have led to a reduction of the number of cemeteries. Consequently, at the remaining cemeteries this resulted in increased inhumations. Excavations have proved the continuity of inhumations into the Carolingian period for the Servaas church and the Pandhof site. In Maastricht an example of a cemetery that was discontinued is the Boschstraat cemetery. This cemetery seems to have become obsolete around the middle of the eighth century. Carolingian inhumations differed in another aspect from Merovingian inhumations. The practice of placing goods in the graves rapidly declined in the Carolingian period. In this respect the Maastricht cemeteries follow this trend. By the end of the seventh century neither precious nor simple grave-goods were enclosed in the graves.

The continuation of the cemetery at the Lage Kanaaldijk site seems surprising, as there is no church reported at the site for the Carolingian period.¹⁷⁴ However, careful inspection of the

¹⁶⁶ T. Panhuysen, 1984, p. 91.

¹⁶⁹ *Ibidem*, p. 38-39.

¹⁷⁰ Dijkman and Ervynck, 1998, p. 81-82.

¹⁷¹ *Ibidem*, p. 69.

¹⁷² T. Panhuysen, 1990, p. 541-553. Evidence presented in this publication suggests that the basilica shaped church may have been constructed around the end of the seventh century or the early eighth century.

¹⁷³ A development observed in various regions of the Frankish Kingdoms, e.g. Colardelle, 1983, p. 364.

¹⁷⁴ Walls of a church have been found at the site, but these date from the twelfth century. Secondary use of the limestone sarcophagi in relation with the twelfth century church is unlikely as several of the sarcophagi were dated as Carolingian because of the stratigraphical evidence. Hulst, 1995, p. 7-8.

layout of the Carolingian cemetery shows a church may have existed at the site. If so this church would have been constructed of perishable materials as no substantial traces were recovered during recent excavations. The only indication for the possibility of a Carolingian church at this site comes from the placement of four limestone sarcophagi. These sarcophagi were placed in groups of two rows with the head in the west and the feet in the east; the sarcophagi were placed in line: the foot-end of the westernmost against the head end of the easternmost.¹⁷⁵

FIGURE 2-7 A detail of the excavation plan of the Lage Kanaaldijk site. Two lines of two sarcophagi are depicted to the right of the octagonal chapel (after Hulst 1995).

FIGURE 2-8 Two limestone sarcophagi found at the Lage Kanaaldijk site. In analogy with the findings at the Servaas church site these sarcophagi appear to be placed along a wall. Assuming that the sarcophagi were placed on the outside of the church the wall would have been on the right side of the sarcophagi (Photograph: City of Maastricht).

At the Servaas church site the same type of sarcophagus was often found in a comparable situation. There it could be established that all sarcophagi, which were placed in line, were positioned along a wall of a basilica shaped church.

From the position of the two sarcophagi in the south it can be deduced they were placed on the south side of a wall. This wall may either have been an outside wall or an inside wall separating an aisle from a nave. The distance between the two lines of sarcophagi was approximately five metres, which seems more fitting for an aisle than a nave, but then it may have been a small church. Additional support for the hypothesis of the existence of a church or chapel at this site can be deduced from the position of the Carolingian inhumations that were

¹⁷⁵ Hulst, 1995.

not interred in sarcophagi. These are found south of the two lines of sarcophagi. This would place them outside a possible church, which is a phenomenon that was also observed at the Servaas church site. At this site trench or coffin graves were predominantly placed outside the Carolingian church. In total nineteen sarcophagi of limestone have been excavated in this area, only five during modern excavations. Sarcophagi may be considered as expensive graves. Most likely burial in a sarcophagus was a privilege reserved for people of a higher social position. At this cemetery sarcophagi seem to have been relatively abundant.¹⁷⁶ Who were buried at the Lage Kanaaldijk site will be difficult to determine. For a correct analysis of the inhumations it is important to consider that the apparent vicinity of the grave of Saint Servatius was not the only attractive place as a last resting-place for representatives of the local elite.¹⁷⁷

The Carolingian population

In the historical literature it is assumed that from the second half of the seventh century onwards the European population increased. Demographical analysis of Carolingian polyptychs shows an estimated growth of 1% for the eighth and ninth centuries, leading to a doubling of the population on some of these estates in a time span of half to one and a half centuries.¹⁷⁸ Whether the population of Maastricht increased as well could not be determined on the basis of the inhabited space. Einhard writes around 830 AD about Maastricht in his times that it had many inhabitants, predominantly merchants.¹⁷⁹ Maybe the physical anthropological data will yield some information on the demographical tendencies in Carolingian Maastricht. With respect to the social order it is difficult to determine any developments in Maastricht. Persons dependent of the Saint Servatius monastery appear in two written sources.¹⁸⁰ These persons seem to live in Maastricht. This suggests that a proportion of the inhabitants of Maastricht were unfree and half-free personnel of the monastery. Whether the differences in social position were also associated with differences in health conditions has to be analysed. The same holds true for the possible impact of violence surrounding the murder of bishop Lambert in the early eighth century, the Viking raids in the second half of the ninth century and possibly the conflicts among the various factions in Lotharingia during the first half of the tenth century.

¹⁷⁶ For an overview of the finds of monolithic limestone sarcophagi in the Netherlands see: Lammers, 1992, p. 377-434.

¹⁷⁷ According to local tradition bishop Lambert was temporary buried in his father's grave at this cemetery. See T. Panhuysen and De la Haye, 2002.

¹⁷⁸ Verhulst, 1995, p. 481-483.

¹⁷⁹ Einhard, 1887, p. 261.

¹⁸⁰ Van Ommeren, 1991, p. 29, nr.49 and 32: nr. 58.

3

Archaeological description of the Servaas and Boschstraat sites

This chapter will describe the archaeological context of the two sites with human remains examined in this study: the Servaas church site and the Boschstraat site.¹⁸¹ Both sites are situated in the present city centre of Maastricht. The history of the Servaas site as a burial place started in the late Roman period (300-480 AD). During the Merovingian (480-700 AD) and Carolingian (700-950 AD) period the area evolved into an ecclesiastical and administrative centre of regional importance. Large numbers of graves surrounded the church and adjoining monastic buildings. After the construction of a Romanesque church (consecrated in 1039) the number of burials inside the church decreased significantly.¹⁸² From that time on people were buried in places like the Stijfs chapel (chapel of the canons) and around the Romanesque church. In comparison with the Servaas church site, the cemetery at the Boschstraat site was small. Furthermore, it was in use for a relatively short time span, viz. from the seventh to the beginning of the eighth century AD.

CEMETERIES IN LATE ROMAN AND EARLY MEDIEVAL MAASTRICHT

Among the most noticeable remains of Maastricht's history between 350 and 950 AD are various burial sites in and around the present city. Hitherto sections of at least nine late Roman and early medieval cemeteries have been excavated in Maastricht. These cemeteries vary in size and character. Some, like the burial site at the Céramique site, may have been small, comprising only a few graves; while a site such as the excavated sections of the Servaas cemetery comprised at least 900 graves (Figure 3-13). Three out of nine cemeteries were found to be associated with a church, namely the Servaas cemetery, the Church of Our Lady burials and the Lage Kanaaldijk cemetery. The cemeteries also varied with respect to their geographical distribution. Burials at sites like the Servaas cemetery, the Vrijthof, the Church of Our Lady and probably the Céramique site were positioned close to the living quarters in and around the former Roman settlement. Whereas, burials at sites like the Boschstraat, the Lage Kanaaldijk, the Heukelstraat and Borgharen probably were associated with separate settlements.

¹⁸¹ This chapter is based on publications presenting the preliminary results of several excavations and two reports. References to published information can be found in the endnotes. All available data on the graves and disturbed inhumations at both sites were collected in two reports: R. Panhuysen, 2005a, R. Panhuysen, 2005b.

¹⁸² T. Panhuysen has suggested that inside the church the number of burials was already reduced since 813 AD and later, when a concrete floor was laid. T. Panhuysen, personal communication 2004.

FIGURE 3-1 An overview of the early medieval cemeteries in Maastricht that were (partially) excavated during the past 50 years. 1) Servaas cemetery, 2) Vrijthof I cemetery, 3) Vrijthof II cemetery, 4) Borgharen cemetery, 5) Heukelstraat, 6) Boschstraat cemetery, 7) Church of Our lady burials, 8) Céramique site burials and 9) Lage Kanaaldijk cemetery.

Nr.	Site	Cemetery	Excavated	Period in yr. AD	Excavated	Graves	Individuals recovered
1	Servaas sites	Servaas cemetery ¹	1919, 1953-1989	350-950	Incomplete	Ca. 920	Ca. 720
2	Vrijthof ² (Trench 4-6)	Vrijthof I	1969-1970	500-700 ³	Incomplete	Ca. 200	Ca. 235
3	Vrijthof ² (Trench 3)	Vrijthof II	1969-1970	?	Incomplete	Ca. 15	Ca. 15
4	Borgharen Pasestraat	Borgharen	1995-1999	500-650	Incomplete	13	13
5	Heukelstraat ⁴	Heukelstraat	1997	550-625	Incomplete	3	0
6	Boschstraat ⁵	Boschstraat	1980-1984	600-725	Complete ⁶	Ca. 50	54
7	Church of Our Lady ⁸	Church of Our Lady	1996	700-900	Incomplete	Ca. 10	10
8	C�ramique ⁹	C�ramique	1991	500-700	Incomplete	3	3
9	Lage Kanaaldijk ¹⁰	Lage Kanaaldijk	1847-1994	600-950	Incomplete	31	25
Total				350-950		Ca. 1230	Ca. 1090

TABLE 3-1 Nin late Roman and early medieval burial sites that were excavated.¹⁸³

In the burial sites excavated in the past fifty years a total of circa 1230 late Roman and early medieval graves were excavated. Historical information and archaeological finds suggest the existence of more early medieval cemeteries in and around Maastricht.¹⁸⁴ The two sites in this study were mainly chosen from the available skeletal series for practical reasons. Both the Servaas church and the Boschstraat sites had been excavated quite recently and the accompanying documentation was complete and available in Maastricht. Furthermore, the number of individuals and the state of preservation of the skeletal remains appeared to be suitable for the collection of sufficient physical anthropological and palaeopathological data and would allow comparisons between the two sites. Other skeletal series from excavations like the Pandhof site and the Vrijthof site consisted of large numbers of individuals. However, at the time this study started the material and documentation of these excavations were stored at different locations. These older excavations had been carried out using less rigorous documentation methods. This was especially true for the Vrijthof excavation, which was in part a rescue excavation.¹⁸⁵ Therefore, the skeletal remains excavated at the Servaas church site and the Boschstraat site seemed to be the best option to collect data on life conditions in early medieval Maastricht.

¹⁸³ References in the table: (1) The respective sites that formed part of the Servaas cemetery will be discussed further below. (2) Bloemers, 1973a. (3) Personal communication M. Kars. (4) Bloemers, 1973a. (5) Hulst and Dijkman, 2001, R. Panhuysen, 2000, Dijkman, 2003. (6) Hulst and Dijkman, 1997. (7) T. Panhuysen, 1984, p. 80 and p. 123-132. (8) Unpublished report de Koning, 1996. (9) Panhuysen et al., 1992, p. 263-264. (10) Hulst, 1995.

¹⁸⁴ An example of such a cemetery is the cemetery situated at the foot of the northern slope of a hill locally known as the Sint Pietersberg, T. Panhuysen 1984, p. 80 and T. Panhuysen 1986, p. 135.

¹⁸⁵ At present the skeletal remains, grave goods and archaeological documentation of the Pandhof and Vrijthof excavations are studied within the framework of the Saint Servatius project.

GRAPHIC REPRESENTATION OF THE CEMETERIES

An important tool for the analysis of the burial customs at the two cemeteries is the spatial analysis of the distribution of graves within the cemetery. For this purpose a set of digital maps was made. On these maps standardised symbols of fixed size depict all grave types and the find spots of disarticulated bone. The length of each adult grave on the maps is either 1.80 metres (trench graves and coffins) or 1.97 metres (all other inhumations). Children's graves are represented by smaller symbols, scaled down to about 75 to 30 per cent of the size of graves of adult individuals. Maps of the Servaas church site also display the remnants of buildings, e.g. churches, chapels and monastic structures. Since the original walls were seldom found, reconstructions based on the remaining robber trenches are shown. These trenches were often wider than the original walls. On the map this could lead to difficulties in discerning the graves below the walls which antedated the construction of the walls, from those which had been dug against these walls. In general graves that antedated the various buildings or phases can be recognised on the maps as walls or robber trenches (trenches dug to extract building material from derelict walls and foundations) intersect them completely. Unless stated otherwise, all excavation plans and maps are shown with the north approximately at the top of the page. As scales of the drawings may vary, rulers of 10 or 50 metres are included in the maps.

GRAVE TYPES

Various classifications of grave types have been published.¹⁸⁶ The variety in grave types found in medieval western Europe depends among other factors on the condition of the local soil and the availability of materials to construct graves. Therefore, most classifications are developed to fit the situation in a single cemetery or a geographical region. From the existing classifications 8 grave types were selected to categorise the burials from the Servaas church site and the Boschstraat site (see figure 3-2). A ninth category was used to indicate disarticulated human remains. The grave types encountered at the two sites are described below. (Dimensions mentioned in all descriptions indicate the mean length and width of the interior of graves of adult individuals. Because very few graves were intact and the original level was rarely preserved, it was not possible to calculate representative averages for the depth of the graves below the surface level at the time of burial.)

¹⁸⁶ The typo-chronology of various regions in France was published in Galinié and Zadora-Rio, 1996, for Normandy Pilet, 1996, for South-western France Boissavit-Camus et al., 1996, for South-eastern France Colardelle et al., 1996. Additional typo-chronologies in monographic studies for France have been published for the Northern French Alpine region Colardelle, 1983 p. 345-354, a very extensive typology for the region south-east of the River Oise Durand, 1988 p. 146-191 and for Brittany Guigon, 1994 p. 18.

FIGURE 3-2 Symbols used to depict grave types and redeposited bone on maps of the Servaas church and Boschstraat site. 1) trench grave; 2) trench grave marked with stones; 3) coffin; 4) tuff stone sarcophagus; 5) stone-built grave; 6) lime stone sarcophagus; 7) stone-built tomb (trapezoid variety); 8) tile grave and 9) disarticulated bone.

Trench graves

Trench graves were rectangular or oblong grave cuts, often recognisable by a difference in colour between the grave fill and the undisturbed soil. In several cases even the traces of a grave cut were missing, leaving the articulated skeleton as the only indication for the existence of a grave. In fact trench graves are categorised as such because of the absence of evidence for the use of a wooden coffin. Therefore, it has to be considered that some of the graves which looked like trench graves were actually coffin graves in which the wooden parts had completely decomposed. However, as will be demonstrated in the following chapter, analysis of the preservation of skeletal material shows a different decomposition pattern for trench graves in comparison to coffin burials. Therefore, it seems probable that most trench graves and wooden coffins could be correctly categorised. Additional support for the distinction between trenches and wooden coffins comes from the position in which some of the skeletons were found. In several trench graves skeletons were lying with their legs splayed or their arms at a distance from the thorax (Figure 3-4). Boddington described similar inhumations and understandably inferred that this skeletal arrangement is not compatible with inhumation in a narrow coffin.¹⁸⁷ Since most wooden coffins were rather narrow, a splayed position of the arms and/or legs was considered an indication that these individuals had probably been buried in trench graves.¹⁸⁸ The position of the extremities is not indicative of the type of grave in all cases. Regarding burials with the arms close to the body and the legs close together often it could not be determined whether individuals were buried in coffin graves or in trench graves. Archaeological

¹⁸⁷ Boddington, 1987, p. 36.

¹⁸⁸ Most wooden coffins from both sites were rather narrow, measuring around 50 centimetres in width.

FIGURE 3-3 Servaas church site, grave 112, trench grave. The individual was buried with the upper extremities against or on the thorax and the lower extremities fairly close to each other (Photograph: City of Maastricht).

FIGURE 3-4 Boschstraat site, trench grave. The individual was buried with the upper extremities against or along the thorax and the lower extremities splayed (Photograph: City of Maastricht).

evidence and illuminated manuscripts show that the wrapping of corpses in cloth was common.¹⁸⁹ Such individuals wrapped in cloth and buried in a trench graves could resemble inhumations in narrow coffins after complete decomposition of the coffin.

Trench graves were common at both sites: in total 115 trench graves were excavated, 78 at the Servaas church site and 37 at the Boschstraat site. Trench and coffin graves were found in the same areas of the cemeteries. With respect to the average size of the graves, a difference was noted between the Servaas church site and the Boschstraat site. In general the trench graves of adult individuals at the Servaas church site were slightly narrower but considerably longer than those at the Boschstraat site. At the Servaas church site trench graves were 205 cm long and 55 cm wide. Those at the Boschstraat site measured 180 by 60 cm.

¹⁸⁹ Durand, 1988 p. 164-169.

TRENCH GRAVES MARKED WITH STONES

Small numbers of stones were found at the head and/or foot end of six trench graves at the Boschstraat site. Because of the presence of these stones and the central position in the cemetery of two of these graves this was considered a separate type of trench grave. Comparable graves were not found at the Servaas church site. Recent investigations of the Vrijthof cemetery have shown that this grave type was in use at this cemetery. At the Boschstraat site the number of stones varied from 1 to 18. Most of the stones were positioned at the head and foot end of the graves. As was described by Rosieux it is possible that these stones may originally have been placed as grave markers at the surface.¹⁹⁰ With an average length of 195 cm and a width of 60 cm, these graves were larger than the common trench graves at the Boschstraat site. Two out of six of these graves occupied a central position in the cemetery.

WOODEN COFFINS

Graves were classified as a wooden coffin grave if one or more of the following features were associated with the grave: remains of wood; coffin nails; a distinct rectangular or trapezoid discoloration of the soil. No differentiation could be made between burial on a wooden board, graves framed by wooden boards without the use of nails (a formwork) and proper wooden coffins constructed from at least 6 wooden planks and fixed with nails and coffin fittings.¹⁹¹ No evidence for the use of wooden boards was found and iron coffin nails were present in almost half the number of wooden coffin graves. Therefore we assume that the major part of the graves categorised as wooden coffins were typical wooden coffins. One burial at the Servaas church site may possibly have been a wooden grave chamber. This is a specific type of wooden coffin characterised by a relatively large width and sometimes by interior divisions in the grave.¹⁹² Transverse wooden beams under large wooden coffins, regularly found at other early medieval cemeteries, were not discovered at any of the two sites.¹⁹³ At the Servaas church site 31 graves were categorised as wooden coffins. In sixteen of these burials iron nails were found. Only two wooden coffins were recognised at the Boschstraat site. On average wooden coffins measured circa 200 by 60 cm.

¹⁹⁰ Cited in Treffort, 1996, p.123-124.

¹⁹¹ For a description of formwork and coffin graves see Henrion and Hunot, 1996.

¹⁹² In other early medieval cemeteries the wooden grave chamber often is justifiably treated as a separate category. Within this study we refrained from doing so since this grave type was represented by one single burial, of which the classification as burial chamber was not unequivocal. Furthermore in aspects like bone preservation and chances of recovery wooden chambers were probably similar to wooden coffins.

¹⁹³ E.g., at a Merovingian cemetery in Borsbeek: De Boe, 1970, p. 104, or at a nearby Merovingian cemetery in Rosmeer: Roosens et al., 1976, p. 10-11 and p. 29-30.

FIGURE 3-5 Boschstraat site, a trench grave with stones at the head and foot end. At the foot end a ceramic vessel was found. The smaller bones of the hand and feet and the atlas were displaced during excavation (Photograph: City of Maastricht).

FIGURE 3-6 Servaas church site, a large coffin containing the skeletal remains of an adult female and two infants (Photograph: City of Maastricht).

SARCOPHAGI OF TUFF STONE

In Maastricht sarcophagi made of volcanic tufa or tuff stone were found exclusively at the Servaas church and Pandhof site.¹⁹⁴ In Maastricht these sarcophagi were generally composed of four parts, two for the bottom and two for the lid of the sarcophagus. These parts fit together and were probably hewn from one block of stone and later sawn in two to facilitate the transport of the sarcophagus and its deposition in the burial pit. Generally the two halves of the coffin lid were sealed with a strip of lead and the space between the bottom of the sarcophagus and the covering lid was sometimes filled with mortar. Inside the Servaas church seven graves of this type were found. In two cases the roof shaped cover, also made of tuff stone was still in

¹⁹⁴ T. Panhuysen assumes these sarcophagi were made from volcanic tuff stone from the Eifel in analogy of the tuff stone used in the Roman period in Maastricht, T. Panhuysen personal communication and T. Panhuysen 1996b, p. 101-102. Samples from these tuff stone sarcophagi have not yet been examined for provenance.

place. This type of burial displayed similarities to late Roman sarcophagi and is found on sites dating from the late Roman to the Merovingian period.¹⁹⁵ The average interior dimensions were 180 by 50 cm. In at least one of these tuff stone sarcophagi coffin nails were found, indicating that the deceased was placed inside the sarcophagus in a wooden coffin. At the Pandhof site just north of the Servaas church site a relatively large number of these sarcophagi was found (at least 10 tuff stone sarcophagi). No tuff stone sarcophagi were found at the Vrijthof site.¹⁹⁶ This type of sarcophagus was not a common finding in early medieval cemeteries. An example of a site in the region where several tuff stone sarcophagi were excavated is the Sankt Severin church in Cologne.¹⁹⁷

FIGURE 3-8 Servaas church site, grave 86, stone-built grave, not plastered and with a floor of loam (Photograph: City of Maastricht).

STONE-BUILT GRAVES

Stone-built graves were mostly constructed from roughly hewn quarry stone, carboniferous sandstone and flint. Several of these graves had red or white plastered walls. Often the floor consisted of the loam on the bottom of the grave cut, in some instances the floor was paved with fragments of ceramic tiles. At the Servaas church site 43 graves of this type were excavated, not

¹⁹⁵ Pfaffgen, 1992, volume 1 p.324-327, and volume 2 *passim*.

¹⁹⁶ Statements on the presence of tuff stone sarcophagi at the Pandhof site and the Vrijthof site are based on recent studies carried out in the context of the Saint Servatius Project.

¹⁹⁷ Pfaffgen, 1992, volume 1 p.324-327, and volume 2 *passim*.

one was found at the Boschstraat site. Stone-built graves measured approximately 185 by 55 centimetres. None of these graves was found with an intact cover. Therefore, it remained unclear what kind of material was used to cover these graves. Most likely large slabs of stone served as a covering lid. However, the possibility that wooden covers were used cannot be ruled out.¹⁹⁸

FIGURE 3-8 Servaas church site, grave 86, stone-built grave, not plastered and with a floor of loam (Photograph: City of Maastricht).

SARCOPHAGI OF LIMESTONE

Like the tuff stone sarcophagi and stone-built graves, sarcophagi of Jurassic limestone were only found at the Servaas site and not at the Boschstraat site. At the Pandhof site just north of the Servaas church site at least another 7 limestone sarcophagi were excavated. All sarcophagi of limestone at the Servaas church site were hewn out of one piece of stone. In several cases a fitting cover was found in its original position. Some sarcophagi were covered with a reused stone lid. In those cases the cover did not exactly match the coffin. All of the 36 limestone sarcophagi were trapezoid in shape. Their mean interior length was 180 cm. The mean width

¹⁹⁸ This option is also suggested for the more recent stone-built graves found at St Andrew, York: Stroud and Kemp, 1993, p. 153.

was 50 cm at the head and 25 cm at the foot. At least 7 or more limestone sarcophagi were found during the Pandhof excavation; one or two sarcophagi were found at the Vrijthof site. Lammers studied a large series of limestone sarcophagi from Maastricht, within the framework of a study of limestone sarcophagi from the upper Meuse Valley.¹⁹⁹ In this study he also published the results of a petrographic study of the composition and possible provenance of the sarcophagi by C. Overweel. Most sarcophagi from Maastricht were made from a type of limestone that was vacuolair or spongy oolith. Overweel suggests the area of provenance of most of the Maastricht sarcophagi was probably situated along the upper course of the River Meuse, between Savonnières and Chémery (France).²⁰⁰ According to Lammers' study Maastricht is the place with the largest number of limestone sarcophagi and the Servaas church site is the site where most sarcophagi have been excavated hitherto.²⁰¹

FIGURE 3-9 Servaas church site, excavation trench 12, five fragmented and complete limestone sarcophagi originally positioned outside along a wall of a contemporaneous basilica shaped church. Later this wall was removed and its stones were collected for other building activities leaving behind a "robber trench" (Photograph: City of Maastricht).

¹⁹⁹ Lammers, 1992. As will be discussed below the dates he provided for the sarcophagi from the Servaas church site from Maastricht have to be revised on the basis of the results of the Carbon 14 dating.

²⁰⁰ Lammers, 1992, p 404.

²⁰¹ Lammers, 1992.

STONE-BUILT TOMBS

Seven stone-built graves with an interior length exceeding 200 cm were categorised as stone-built tombs. The shape of these tombs could be either rectangular or trapezoid. Like stone-built graves, the stone-built tombs were constructed mostly with quarry stone and flint. In some cases local Maastricht cretaceous limestone was used as a construction material. Apart from the size and the use of limestone this type of grave differed from other stone-built graves due to the greater thickness of the walls. Often these stone-built tombs had a floor consisting of the same materials as the walls. Fragments of any covering lids were not found. All seven stone-built tombs were found at the Servaas church site. The average dimensions of these tombs were 220 cm by 55 cm.

FIGURE 3-10 Servaas church site, grave 1, stone-built tomb (Photography: City of Maastricht).

TILE GRAVES

One tile grave was found at the Servaas site. Four vertically placed ceramic tiles created a rectangular space. Two tiles were placed at the southern side, in the west no tile was found. Within this confined space the articulated skeletal remains of a child were buried (see figure 3-11). At the Pandhof site seven tile graves were excavated.²⁰²

DISARTICULATED HUMAN REMAINS

At both sites disarticulated bones were recovered from disturbed burials. In some cases old graves were deliberately used as charnel deposits composed of skeletal material that was found during early medieval building activities. At the Servaas site remains of at least 97 individuals were not found as articulated skeletons in situ. Inhumations at the Boschstraat site were less often disturbed. At that site the bones of 10 individuals could not be associated with any particular grave.

²⁰² Soeters, 1989, p. 22.

FIGURE 3-11 Servaas church site, grave 21, tile grave, constructed of four roof tiles, containing the skeletal remains of a young child (Photograph: City of Maastricht).

FIGURE 3-12 Servaas church site, grave 72, the foot end of a largely demolished stone-built tomb containing the skeletal remains of disturbed graves. Recognisable on the photograph are two skulls, long bones vertebrae and ribs. Since the grave was intersected by a foundation wall of the present church the skeletal remains were probably collected and placed in this grave during building activities related to the construction of the Romanesque phase of the present church (Photograph: City of Maastricht).

HISTORY OF THE SERVAAS CHURCH SITE

The present Servaas church dominates the Vrijthof, the central square of Maastricht. Its long and rich history has attracted treasure diggers and scholars alike.²⁰³ From the beginning of the twentieth century on, interest in the past church and monastery prompted small-scaled archaeological investigations.²⁰⁴

²⁰³ For an overview of the activities of treasure diggers in the Servaas church see De la Haye, 1985b, p. 173-175.

²⁰⁴ For example: Kalf, 1916, p. 17-44 and Goossens, 1920, p. 64-65.

Nr.	Site	Excavated	Period in yr. AD	Excavated	Graves	Individuals recovered
1.1	Servaas Pandhof	1953-1954	350-950	Incomplete	Ca. 600	Ca. 400
1.2	Vrijthof (Trench 2)	1969-1970	350-950	Incomplete	Ca. 100	Ca. 50
1.3	Servaasklooster	1980	350-700	Incomplete	14	14
1.4	Servaas Stiftskapel	1981	350-700	Incomplete	4	4
1.5	Servaas church	1981-1989	350-950	Incomplete	Ca. 200	244
1	Total Servaas cemetery	1953-1989	350-950	Incomplete	Ca. 920	Ca. 720

TABLE 3-2 Excavated sections of the Servaas cemetery (only late Roman and early medieval burials were included).

The State Service for Archaeological Investigations (ROB) carried out systematic excavations in the building complex of the 'Sint Servaas'. In 1953-54 eight excavation trenches were dug in the cloister next to the church. Since then, the excavation has been known as the Servaas Pandhof site (indicated as 1.1 in Figure 3-13).²⁰⁵ This excavation was the first to uncover a large series of burials from the Servaas cemetery. During later excavations of the State Service for Archaeological Investigations, in 1969 and 1970 on the adjacent Vrijthof, one of the excavation trenches, namely trench 2, encompassed another section of the Servaas cemetery (indicated as 1.2 in Figure 3-13).²⁰⁶ One of the first excavations carried out by the Archaeological Service of Maastricht was situated just west of the Servaas church. At this site, known as the Servaasklooster site, several early medieval graves from the Servaas cemetery were documented in 1980 (indicated as 1.3 in Figure 3-13).²⁰⁷ In 1981 the Archaeological Service of Maastricht investigated the Servaas Stiftskapel site (a chapel for the chapter of canons dated to the end of the eleventh century AD, adjacent to the Servaas church; indicated as 1.4 in Figure 3-13).²⁰⁸ At the deepest level of this excavation four Merovingian graves were uncovered which were also a part of the Servaas cemetery. Despite these archaeological investigations, knowledge of the earliest history of the church itself was limited until excavations inside the church started in 1985 (excavations indicated as 1.5 in Figure 3-13).²⁰⁹ Because of planned reconstruction works, and the installation of under floor heating, the soil below the church floor would be severely disturbed. An archaeological investigation was therefore imperative.

²⁰⁵ Glazema and Ypey, 1956, Verwers, 1986 and Soeters, 1989.

²⁰⁶ Bloemers, 1973a, p. 52-54; Bloemers, 1973b, p. 244-250.

²⁰⁷ T. Panhuysen 1982 [#38], p. 49 n. 42; GOBM dossier 218 and T. Panhuysen 1990.

²⁰⁸ T. Panhuysen 1982 The majority of burials at this site dated from the late medieval period. The skeletal remains from this site were studied by Janssen and Maat, 1999.

²⁰⁹ T. Panhuysen 1990, T. Panhuysen 1991, T. Panhuysen 1992b.

FIGURE 3-13 An overview of late Roman and early medieval cemeteries in and around the Servaas church. The numbers refer to sites and cemeteries listed in Tables 3-1 and 3-2. Sites indicated with a number ranging from 1.1 to 1.5 all excavated sections of the large Servaas cemetery. This figure is based on data collected by the author and preliminary data from the Saint Servatius project.

Between 1985 and 1989 the Archaeological Service of the city of Maastricht dug 38 excavation trenches, mostly inside the present church building (Figure 3-14).²¹⁰ The site comprised an area of approximately 800 square metres. The excavation team manually removed nearly 2,000 cubic metres of soil to document 4,400 square metres of surface area and profiles.²¹¹ Until now only interim reports and a short first analysis of the results have been issued.²¹² For a full evaluation

²¹⁰ Only trench 8, 34 and 35 were dug outside the church.

²¹¹ T. Panhuysen 1992b, *passim*.

²¹² Interim reports and publications by T.A.S.M Panhuysen 1981-1991: several articles in *De Sint Servaas*, p. 3, 5-7, 17, 181-182, 189, 200-201, 205-206, 216-217, 221-223, 239-240, 309-322, 383-386, 391-394; preliminary conclusions in: T. Panhuysen 1990, p. 541-553 and T. Panhuysen

of the development of the Servaas church site it is necessary to include the available information from the above listed excavations in the vicinity.

FIGURE 3-14 The plan of the Sint Servaas church with the 38 excavation trenches of the Servaas church site and the location of two excavations within the same building complex.

TOPOGRAPHY

The excavated area of the Servaas church site lay on a small protrusion of the western middle terrace, along the valley of the Meuse. The early medieval grave with the highest position was excavated in trench 12. Since the bottom of the grave was situated at 51.70 metres above Normal Amsterdam Level (NAP) the original surface was probably at least above 52.00 metres above NAP. Within a relatively short distance to the east the level slopes circa 5 metres down.²¹³

1991, p. 15-24. Unpublished report on the burials by R.G.A.M. Panhuysen: R. Panhuysen, 2005b

²¹³ This is calculated from the difference between the bottom of the highest grave in trench 12 at 51.70 metres above NAP and the bottom of grave 203 in trench 36, which was situated at approximately 46.60 metres above NAP.

It has been assumed that a branch of the river Jeker flowed through the lower southern area of the Vrijthof, creating a humid marsh-like terrain.²¹⁴ However, the first results of the Saint Servatius project indicate that the middle of the Vrijthof was used as a burial ground at some time during the first millennium. In addition, the excavation documentation provides no evidence that the southern part of the Vrijthof was still marshy in the Roman period.²¹⁵ The soil found at the Servaas church site and in the surrounding area was loess-loam. An important aspect of this site was its position south of the Roman road that connected the city of Tongeren with Cologne. This road was positioned on an artificial bank running from the west to the east.

PERIODISATION OF THE SERVAAS SITE

For the Servaas church site a relative chronology was devised based on archaeological findings consisting of stratigraphical evidence and datable objects associated with the graves. A few events related to the construction of the religious complex at this site were mentioned in written sources providing a means to calibrate the relative chronology at some points. Furthermore radiocarbon dating was applied to increase our understanding of the chronological developments (Table 3.3)

In the archaeological record four phases were recognised between circa 350 and 1800 AD. The first three phases were each named after a building that was considered characteristic for the phase: the “*cella* phase” (circa 350-480 AD), the “*templum* phase” (circa 480-700 AD) and the “*basilica* phase” (circa 700-950 AD).²¹⁶ The fourth phase was named the “Geldulphus phase” after the provost who directed the construction works of the present church. As indicated in the introduction, the inhumations associated with the fourth phase are beyond the scope of this study. Archaeological findings show that the first three phases also roughly corresponded with the periodisation of the late Roman, the Merovingian and the Carolingian period as described in the previous chapter. However, since they did not correspond exactly with these historical phases it was decided to use the chronology derived from the building phases. Neither radiocarbon dates nor grave goods provided exact dates in years AD for the transition from one phase to the next. Consequently many of the dates in this study are of a more relative nature than absolute.²¹⁷ The graves and the human skeletal remains were dated because of their association with the building phases. Some graves could be dated within periods of fifty years because of well-datable grave goods. In most cases the archaeological evidence simply allowed for the attribution to one of the aforementioned phases.

²¹⁴ T. Panhuysen 1982, p. 52-55.

²¹⁵ Personal communication M. Dijkstra, 2004.

²¹⁶ T. Panhuysen 1990 and T. Panhuysen 1991.

²¹⁷ Within the framework of the Saint Servatius project 2002-2006 the results of the excavations in and around the Saint Servaas church are being collected in a large database. Furthermore an attempt is made to refine the dating of the various phases on the basis of archaeological evidence and radiocarbon dating. It is expected that this will lead to a more detailed dating of the consecutive phases.

Number	Grave	Number	14C-number	Result	Calibrated range (68% 1 sigma)	13C (‰)	Archaeological context	Phase
C1	122	13-07-01	GrN-221119	1570±30 BP	438-460 AD	-19.43	Below templum phase graves	Cella
C2	203	36-01-03	GrA-6665	1640±50 BP	340-540 AD (OxCal)	-20.15	Without indication of age	Cella
T1	31	02-05-08	GrA-6645	1580±50 BP	420-540 AD (OxCal)	-20.03	Grave-goods dated 525-575 AD	Templum
T2	24	03-05-05	GrA-6551	1350±50 BP	640-770 AD (OxCal)	-21.07	Grave-good dated 600-650 AD	Templum
T3	93	11-06-08	GrA-6644	1430±50 BP	565-665 AD (OxCal)	-20.00	Grave-goods dated 500-550 AD	Templum
T4	160	18-03-02	GrA-6646	1540±50 BP	450-600 AD (OxCal)	-20.51	Grave-good dated 600-650 AD	Templum
T5	164	21-07-01	GrA-6640	1630±50 BP	350-550 AD (OxCal)	-19.86	Grave-goods dated 600-650 AD	Templum
B1	1	01-03-03	GrN-221117	1250±30 BP	690-784 AD	-20.51	On extension of basilica transept	Geldulphus
B2	168	24-04-07	GrA-6699	1310±50 BP	660-780 AD (OxCal)	-19.17	Sarcophagus early basilica phase	Basilica
B3	175	25-03-03	GrN-22120	1360±30 BP	650-672 AD	-19.77	Sarcophagus early basilica phase	Basilica
B4	179	26-06-02	GrN-22121	1330±30 BP	654-690 AD	-19.15	Sarcophagus early basilica phase	Basilica
B5	187	28-02-05	GrN-22122	1340±30 BP	652-682 AD	-20.05	Sarcophagus early basilica phase	Basilica
G1	161	19-01-04	GrA-6485	1120±50 BP	880-1000 AD (OxCal)	-20.05	Grave of Geldulfus, † 1049 AD	Geldulphus
G2	200	34-01-01	GrN-22123	1060±30 BP	961-1012 AD	-19.83	Construction present church (ca. 1039 AD)	Geldulphus
G3	80	07-08-03	GrN-22118	1050±30 BP	972-1014 AD	-19.48	Reused sarcophagus on basilica wall	Geldulphus
G4	143	17-03-01	GrA-6491	980±50 BP	1020-1160 AD (OxCal)	-19.86	Grave of Humbertus, † 1086 AD	Geldulphus
G5	162	19-01-03	GrA-6541	300±40 BP	1520-1650 AD (OxCal)	-20.24	Grave John of Brederode, † 1702 AD	Geldulphus

TABLE 3-3 Carbon 14 dates from 17 human bone samples from the Servaas church excavation, ordered by building phase. Calibrated ranges printed in a dark shade were older, those in a light shade were younger than expected according to the archaeological context (All samples were analysed at the Centre for Isotopic Research, Groningen the Netherlands)

Seventeen human bone samples from inhumation graves were selected for radiocarbon dating. Nine samples were chosen either because they were considered representative for a particular phase or were expected to be of use to date the period of transition between two phases. Eight samples were selected because associated grave goods provided a specific indication concerning the calendar date of the time of burial.²¹⁸ This last sample category may provide information on the validity of radiocarbon dates. Three of the calculated intervals were in accordance with the expected dates. The calculated intervals of five of these radiocarbon dates proved to be older than the intervals expected on the basis of the grave finds. Two burials with a lead cross, providing an exact date of death, had radiocarbon dates that were circa 150 and 60 years older than expected. Another two burials, dated by the grave goods had radiocarbon dates circa 200 and 100 years older. Only one burial had a radiocarbon date that was younger than expected, viz. circa 100 years. What caused these differences is of importance for a correct application of ^{14}C dates in the chronology of the Servaas church site. It is conceivable that the archaeological dating of the burial and its grave goods was flawed. Such inaccuracies can only be corrected by a thorough re-examination of grave finds and stratigraphical evidence that is currently undertaken within the framework of the Saint Servatius project. However, it should be taken into consideration that reservoir effects were also a possible cause of bias in the radiocarbon dates.

Recently more attention has been paid to reservoir effects in radiocarbon dating. Radiocarbon dating is based on the presence of ^{14}C , which is formed high in the atmosphere. Because of the constant uptake of ^{14}C during life the amount of ^{14}C in the tissue of living individuals is ideally in equilibrium with the ^{14}C content of atmospheric CO_2 . At the time of death the incorporation of atmospheric ^{14}C in the tissue of the organism ends. Carbon 14 is unstable and radioactive, which causes the amount of ^{14}C to decrease at a known rate from the time of death. Measurement of the remaining ^{14}C allows for the calculation of a radiocarbon date. However, inorganic environments like seawater and freshwater form a reservoir of ^{14}C in which the amount of ^{14}C generally is much lower than in the atmosphere. The consumption of organic material from these surroundings will lead to a lower uptake of ^{14}C in the organism, which will bias the radiocarbon dating of such organisms. E.g. due to the uptake of carbon lower in ^{14}C from a freshwater environment, fishes and other organisms caught alive today may yield a radiocarbon date indicating the organism was 1500 years old. A substantial consumption of such organisms by humans will also lead to radiocarbon dates that are older than the actual date of the individual.²¹⁹

²¹⁸ Three burials were dated very precise by the find of a lead cross in the grave, viz. Geldulphus, Humbertus and John of Brederode. On these crosses the year of death was mentioned. All well-dated specimens were examined for a study by dr. Lanting of Groningen University on reservoir effects in Dutch skeletal remains.

²¹⁹ Lanting and van der Plicht, 1996.

Location	Period	$\delta^{13}\text{C}$	N	Publication
Maastricht	Roman and medieval	$-19.94 \pm 0.51\text{‰}$	16	Table 3.3
The Netherlands	Roman	$-20.66 \pm 0.86\text{‰}$	81	Lanting and van der Plicht 1996
The Netherlands	Medieval	$-19.73 \pm 0.73\text{‰}$	46	Lanting and van der Plicht 1996
Torgny (Belgium)	6th-7th century	$-19.8 \pm 0.33\text{‰}$	20	Polet and Katzenberg 2003
Ciply (Belgium)	6th-7th century	$-20.2 \pm 0.33\text{‰}$	9	Polet and Katzenberg 2003

TABLE 3-4 Comparison of $\delta^{13}\text{C}$ values from Maastricht and the Netherlands in the Roman and medieval period and two Merovingian cemeteries from Torgny and Ciply.

Generally reservoir effects are caused by the consumption of considerable amounts of fish and shellfish, containing less ^{14}C than atmospheric CO_2 . For the consumption of sea fish the $\delta^{13}\text{C}$ values provide an indication whether this may have been an important constituent of the diet.²²⁰ The consumption of large amounts of sea fish would have resulted in less negative $\delta^{13}\text{C}$ values in the samples. The mean $\delta^{13}\text{C}$ value for Maastricht is lower than the value calculated for Roman samples from The Netherlands but higher than the medieval samples as calculated by Lanting and van der Plicht. The difference among the samples is small, 12 out of 16 samples from the Servaas site have a $\delta^{13}\text{C}$ value within one standard deviation of the mean calculated for the Roman period. Lanting and van der Plicht suggest that the diachronic shift in the $\delta^{13}\text{C}$ values they found might have been the result of an increase in the consumption of sea fish in the medieval period because of Christian dietary instructions.²²¹ However, in the case of Maastricht the distance from the sea renders it unlikely that sea fish was an important dietary constituent.²²² Furthermore no diachronic trend is recognisable in the $\delta^{13}\text{C}$ values. Given its location on the banks of the river Meuse it is possible, even likely that freshwater fish was an important dietary component in Maastricht.²²³ Because of the $\delta^{13}\text{C}$ values found in freshwater fish one would expect that $\delta^{13}\text{C}$ values of its consumers would be more negative.²²⁴ A diachronic trend in that direction is not recognisable in our $\delta^{13}\text{C}$ values. Consequently the $\delta^{13}\text{C}$ values provide no indication for large dietary changes in late Roman and early medieval Maastricht. Comparison of the $\delta^{13}\text{C}$ values of Maastricht with data collected by Polet and Katzenberg for two Merovingian cemeteries in Belgium shows considerable agreement between these sites. Measurement of the $\delta^{15}\text{N}$ values for the same samples allowed Polet and Katzenberg to infer that marine fish was not an important component of diet at these inland sites.²²⁵

²²⁰ The interpretation of ^{13}C values is not straightforward since various dietary components may have adverse effects on the ^{13}C values. Preferably ^{15}N values and other isotopes should be available for analysis. See Lanting and van der Plicht, 1996 and Bayliss et al., 2004.

²²¹ Lanting and van der Plicht, 1996, p. 507-510.

²²² Only marine fish that was salted or otherwise preserved could reach Maastricht and still be suitable for consumption.

²²³ It is of interest to mention the find of the vertebra of a bleak (*Alburnus alburnus*) in one of the templum phase burials: grave 94, the grave of the so-called "Rich lady".

²²⁴ See table 2 in Lanting and van der Plicht, 1996.

²²⁵ Polet and Katzenberg, 2003, p. 530.

The discrepancy between radiocarbon and archaeological dates in the case of the five abovementioned burials can be considered as an indication that reservoir effects may lead to bias in the dates of individual graves. In the case of four burials the radiocarbon dates were 200 to 100 years older than the expected dates. Nevertheless, there are no reasons to assume that all radiocarbon dates have to be corrected. Three radiocarbon dates of graves with a specific date matched fairly well with the expected dates. In addition the other nine radiocarbon dates, determined to test the chronology at the Servaas church site, were in agreement with the dates expected for each phase and the sequence of dates seems to be in agreement with the stratigraphical relations. The radiocarbon dates referring to the *cella*, *templum* and *basilica* phase will be discussed in the separate sections on each phase. More research on the possible impact of diet-related reservoir effects on the Servaas church radiocarbon dates is necessary. Such research should include other isotopes like nitrogen to establish a more refined view of dietary components and possible dietary changes in Maastricht.

THE CELLA PHASE (CIRCA 350-480 AD)

DEVELOPMENT OF THE LATE ROMAN CEMETERY

The first traces of human activity found at the Servaas church site and environs are related to mortuary practices. The oldest graves in the area around the Servaas church site were excavated near the southern side of the Roman road. Best documented is a tile grave containing cremated remains, found by Goossens in a street called Sint Servaasklooster near the Keizer Karelplein in 1926. According to Goossens this grave, from the middle of the third century AD, belonged to a larger cemetery along the Roman road.²²⁶ Towards the end of the Roman period inhumations replaced the cremation graves as the preferred grave type in Maastricht.²²⁷ No cremation graves were found at the Servaas church site, the Servaas Pandhof site or the Vrijthof site. Probably the origin of the Roman cemetery was situated north or north-west of these sites and nearer to the Roman road. The oldest inhumation graves in the area have been found at the Servaas Pandhof site, although a few graves may possibly date from the third century AD. The oldest securely dated burials were (on the basis of grave goods) from the first half of the fourth century AD.²²⁸ The Roman cemetery extended towards the Servaas church site and the

²²⁶ Goossens, 1927, p. 55-59. Further cremation graves in the area could not be documented. Nevertheless, in his publication Goossens mentions six more locations where Roman finds were discovered, which may well have been grave goods. See also T. Panhuysen 1996b p. 64-73

²²⁷ In other parts of the Netherlands cremation continued to be a common practice well into the Merovingian period. The shift from cremations to inhumations as the common type of burial in the Roman provinces has been much discussed. Although the shift is visible in the whole Roman empire there is a wide variety in local ritual and the chronology of the process. See for example: Morris, 1992, p. 31-69, and: Koch, 1996, p. 723.

²²⁸ Verwers, 1986, p. 64. When reading this article one should be aware that Verwers based the date of some graves on their elevation. Dating on the basis of the elevation of the grave is not possible at this site, since the cemetery is partially lying on a slope. Furthermore, it has been established that several early medieval graves were buried at the same level as late Roman burials

Servaasklooster site. According to T. Panhuysen the oldest graves at these sites date from approximately the second half of the fourth century AD, therefore they are considered of late Roman date.²²⁹ Older Roman burials have not been found at the Servaas church site or the Servaasklooster site. The *cella* phase was dated to the late Roman period because of the absence of older Roman finds and the presence of late Roman finds like coins and fragments of Samian ware.²³⁰

FIGURE 3-15 Inhumations from the *cella* phase. Darker shades indicate excavation trenches that were excavated less deep than other trenches, but in most cases the late Roman cultural layer was reached. C1 = grave 122, radiocarbon date: 1570±30 BP; C2 = grave 203, radiocarbon date: 1640±50 BP

At the Servaas church site all *cella* phase inhumations were found in the northern part of the excavated area. Although the level with the oldest recognisable traces of human activities was not explored in every excavation trench, it is likely that the distribution pattern of burials and finds reflects the actual situation of use during the *cella* phase. Finds of Samian ware, dating from the late Roman period, were also found exclusively in the northern part of the site.²³¹ Furthermore, traces of Roman activities and graves were absent in those southern excavation trenches which were explored down to the level at which Roman finds might be expected. The

²²⁹ T. Panhuysen 1986, p. 130 and T. Panhuysen 1982, p. 49 note 42.

²³⁰ See for example coins of late Roman date found in a water basin: T. Panhuysen 1990, p. 544 and the published typology and distribution of fragments of late Roman Samian ware from various sites in Maastricht, including the Servaas church site, Dijkman, 1993.

²³¹ Personal communication W. Dijkman

cella phase burial lying at the lowest elevation and easternmost location, was excavated at 46.60 + NAP, marked with C2 in Figure 3-15. In nearby trench 2 of the Vrijthof excavation, slightly further east of the Servaas church, no burials were found at the same level. All graves in trench 2 of the Vrijthof excavation were found at 47.13 + NAP or above. At present no dates are available for these graves. The natural elevation of the terrain was characterised by a downwards slope from west to east. Therefore, it seems unlikely that the graves positioned at 47.13 + NAP and above in trench 2 were late Roman. In that case the easternmost *cella* phase burial inside the church represents the eastern margin of the *cella* phase cemetery. Because of this position at the margin of the cemetery and the absence of finds from older Roman phases it seems probable that the graves at the margin consisted solely of late Roman graves. In which case they represent the last phase of geographical expansion of the Roman cemetery which originated near the Roman road and in time expanded in a southern direction. This would mean that graves from the beginning of the cemetery were situated to the north close to the Roman road. Later burials (at least a selection) were positioned at the margins of the cemetery, which gradually expanded in a southerly direction. The two radiocarbon dates (C1 and C2 in Figure 3-15) from the *cella* phase would fit this trend, since the calibrated date range for these samples centred around the first half of the fifth century.

As indicated in the previous chapter, the continuity of habitation during the fifth century is often difficult to perceive in late Roman settlements in north-western Europe. For the late Roman cemetery recovered at the Servaas church site, the Servaas Pandhof site and the Servaasklooster site, a number of arguments suggest that the site continued to be used as a cemetery during the fifth century. As mentioned above, the radiocarbon dates suggest that people were buried here in the first half of the fifth century. Other indications for burial at the Servaas cemetery during the fifth century are grave goods found at the Pandhof and the Servaasklooster sites²³² and the presence of fifth to sixth century gravestones.²³³

CELLA MEMORIAE

Among the inhumations at the late Roman cemetery the remains of a small building were found. It was excavated in the centre of the present church. The rectangular floor plan with exterior dimensions of 4.30 by 3.90 metres had walls of worked quarry stone. Because of its shape, size and position on the periphery of the late Roman cemetery the building could be identified as a mausoleum or *cella memoriae*.²³⁴ The entrance to this building was situated in the northern wall, facing the Roman road that passed at a distance of circa 100 metres. No traces of a late Roman grave or an original floor level were found inside the building due to the disturbing effects of

²³² Although graves of this period often lack grave goods, several graves at the Servaas Pandhof site contained fourth century coinage. Verwers has argued that some of these graves with fourth century coins may date from the fifth century. Verwers, 1986, p. 68-70. At the Servaasklooster site one of the graves contained a sword sheath that could be dated by the decorative elements as a piece from the middle of the fifth century. Ypey, 1985, p. 6-9.

²³³ Boppert, 1986.

²³⁴ Similar constructions on various late Roman cemeteries have also been identified as *cellae memoriae*, e.g. at the late Roman cemetery in Poundbury at least 11 structures were mausolea or *cellae memoriae*: Farwell and Molleson, 1993, p. 45-61.

FIGURE 3-16 Left: At the bottom of the trench the remnants of two parallel walls are visible, the northern part of the west and east walls of the *cella memoriae*. Right: Fragment of the south-western corner (40) of the *cella memoriae*, wall (39) is a remainder of the church that was built over the *cella* in Merovingian times (Photographs: City of Maastricht).

later burial activities. On the outside near the entrance of the building a floor level was found that appeared to represent the original level at the time of the construction of the *cella*. The above ground section of the walls of the *cella* started at circa 50.90 above NAP. Next to the southern wall of the *cella* archaeologists unearthed a late Roman water basin, made of *opus signinum*, a type of concrete made of crushed tiles consolidated with mortar. The recovered remains of this basin were found at a lower level, between 50.15 and 50.30 metres above NAP. The excavating archaeologist T. Panhuysen has interpreted this basin as a possible baptismal basin associated with the *cella memoriae*.²³⁵ Dating of the *cella* and the basin was based on the material used for the construction, the shape and dimensions of the building and two coins found at the bottom of the adjacent basin dating from the last decades of the fourth century AD. The terminus post quem deduced from these coins is 379 AD and the terminus ante quem was the demolition of the *cella* which took place at the latest in the seventh century.²³⁶ Hitherto no other stone-built constructions of the late Roman period were found at the Servaas church site, at the Servaas Pandhof site or any of the other surrounding sites.

Since its discovery the *cella memoriae* has become an important element in the discussion concerning the authenticity of the tradition that bishop Servatius was buried in Maastricht and the development of the Servaas monastery.²³⁷ Gregory of Tours' account of Servatius' burial in Maastricht and the subsequent construction of churches and burial activities have long been considered evidence for the burial of Servatius at the site of the present Servaas church. The position of the *cella* matches with the description of the grave of bishop Servatius in the works

²³⁵ T. Panhuysen 1991, p.18-19.

²³⁶ T. Panhuysen 1990, p. 544.

²³⁷ Dierkens, 2000, Theuws, 2001, T. Panhuysen and De la Haye, 2003 and Theuws, 2003

of Gregory of Tours. According to this bishop writing towards the end of the sixth century, Servatius died while he was visiting Maastricht. Gregory mentions that the bishop was buried "next to the public road".²³⁸ The archaeological dating of the *cella* around 400 AD, could correspond with the period in which Servatius died: supposedly sometime after 359 AD when he attended the Council of Rimini. In the sixth century a church was built just east of the location of the *cella memoriae* and later the location of the *cella* was incorporated in this church. Also the two subsequent churches included the location of the *cella*.²³⁹ Further indications that local traditions considered this spot central to the cult of saint Servatius was the creation of a monastery dedicated to Servatius and written sources such as the writings of Jocundus.²⁴⁰ However, the earliest indications that Servatius was buried in Maastricht date from the end of the sixth century, two hundred years after his death. Undisputed evidence that Servatius was buried at the excavated Roman cemetery is lacking. Nevertheless, the construction of three churches at the location of the *cella memoriae*, in combination with the written sources show that from the sixth century on local tradition considered this spot as the burial place of Servatius.

²³⁸ Gregory of Tours, *History of the Franks* book II chapter 5; especially line 6-8: "Hic vero ad Treiectinsem urbem accedens, modica pulsatus febre, recessit a corpore, ablatusque a fidelibus, iuxta ipsum agerem publicum est sepultus." In: Gregory of Tours, 1986, p. 74-75. Also: Gregory of Tours, 1951, p. 47. In another work: *Gregorii episcopi Turonensis, Liber in gloria confessorum*. Gregory of Tours, 1885, on page p. 790, Gregory writes: "... qui et sepultus refertur iuxta ipsum pontem aggeris publici." Although the texts slightly differ they have always been interpreted in the same sense. From both texts it was understood that Servatius was buried next to the road. Actually the wording of the second text seems to provide additional information that fits very well with the location of the *cella memoriae*. In the second text Gregory used the word "agger" instead of "ager". "Agger" means an embankment of earth or rubble, or a road. Here it is used in combination with the word "publici", the genitive of "publica", which according to Niermeyer can be translated as highway. Niermeyer, 1984, p. 870. In combination "aggeris publici" therefore has the connotation of a road constructed on an embankment. Excavations at the Vrijthof site have confirmed the presence of a Roman road on an embankment. About hundred metres northeast of the *cella memoriae* Bloemers excavated the remains of a Roman road positioned on an artificial elevation circa 2.50 metres above ground level, running in an east-westerly direction. Bloemers, 1973a, p. 52-53 and Bloemers, 1973b, p. 244-250 and Dijkstra and Flamman, 2004 p. 49-54. This unusual elevation probably served two purposes. Most importantly it facilitated a more gradual ascent or descent of the slope in the terrain that marked the beginning of the middle terrace. Another purpose of the elevation of the road concerns the beneficial effects on the drainage of the road. Although Roman roads are found at other sites in Maastricht no other stretches rise equally high above ground level. T. Panhuysen 1996b, p. 21-31. Gregory collected the information for his writings from written records and various informants: family, friends, pilgrims and visitors. In the case of Maastricht his colleague bishop Monulphus himself may have been Gregory's source. He also travelled to several of the places he described in his works. Van Dam, 1988, p. 6-10. Therefore, we may assume that the local information included in several of his accounts was often correct. This suggests that around the end of the sixth century the topography of the site where it was assumed that Servatius was buried according Gregory was similar to the find situation surrounding the *cella memoriae*.

²³⁹ In the present church one can still visit a grave of Servatius just east of the central crypt, which bears witness to the continuance of the idea that Servatius was buried in this area. However, this construction is not the excavated *cella memoriae*; it is located a few metres east of the *cella*.

²⁴⁰ Jocundus, 1856.

GRAVE TYPES, GRAVE GOODS AND SKELETAL ARRANGEMENT

Twenty-one graves were assigned to the *cella* phase. Most grave cuts were dug in the natural loess-loam deposit. In the eastern part of the cemetery the skeletons in four graves were partially subsided, suggesting that the soil had previously been disturbed in that area.²⁴¹ Among the graves of this phase one tile grave was found. Rectangular traces in the soil and a few associated iron nails indicated the presence of wooden coffins in ten graves. Ten inhumations seem to have been deposited in trench graves. Most of the trenches and coffin graves of this phase were relatively large. Adult burials were circa 65 cm wide and were more than 2 metres long. Those of children measured circa 30 cm in width, with strong variation in length.²⁴² Grave 40 was a wooden coffin with the dimensions of a grave chamber, measuring 2.40 by 1.20 metres. This coffin contained the remains of three individuals: one adult and two young children. At the Servaas Pandhof site wooden coffins and trench graves were also found, only in larger numbers.²⁴³ Some of the gravestones found in the area of the Servaas cemetery dated from the fifth century and therefore may have originated from *cella* phase graves.

No grave-goods were found in graves of the *cella* phase. As there were no obvious traces of grave robbery, there is no reason to assume this is the result of theft. Apparently it was not customary for the persons who buried their dead in this section to place non-perishable grave goods in the graves. In other parts of the late Roman cemetery, at the Servaasklooster site, some younger graves of the fifth century contained grave goods.²⁴⁴ Possible explanations for the absence of grave goods at the section of the Servaas church site may be a diachronic change in burial customs. Another options was that it was indicative of a difference in social status.

CEMETERY LAYOUT

As indicated above, the inhumations at the Servaas church site belonged to a larger cemetery. Parts of this cemetery were unearthed at the Servaas Pandhof site and the Servaasklooster site.²⁴⁵ The late Roman graves of the Servaas church site were situated at the southern boundary of this large cemetery. Although the *cella memoriae* became the central point for the building and burial activities of the following periods, no late Roman graves were found in its immediate vicinity. Because no formal cemetery limits could be discerned, it remains hitherto unknown what determined the layout of this part of the cemetery.²⁴⁶ All graves were oriented west-east, with the head to the west. There may have been an association between the grave type and the position at the cemetery. Trench graves for example were found only to the north and northwest of the *cella*. Whereas, all wooden coffin graves were concentrated northeast of the *cella*. No intercutting of graves was found for the interments of this phase. This suggests that enough

²⁴¹ Graves 12, 16, 39 and 40.

²⁴² It is recalled here that some of the gravestones found within the confines of the Servaas complex were of children, Boppert, 1986.

²⁴³ Soeters, 1989, p. 22-24.

²⁴⁴ Ypey, 1985.

²⁴⁵ No late Roman graves were found at the Servaas Stijfkapel site, the Vrijthof site or the Theater site.

²⁴⁶ A detailed and integrated study of the Roman inhumations at the Servaas Pandhof site, the Servaasklooster site and the Servaas church site may in the future provide more information about the aetiology and evolution of the cemetery.

space was available and that graves probably remained visible during the whole period. Although most of the graves were concentrated in two areas, evident clusters of graves could not be recognised.

FIGURE 3-17 Cella phase: position of the cilla memoriae and the layout of the cemetery

FIGURE 3-18 Cross section of the cemetery of the cella phase. Note that different scales were used for horizontal and vertical projection. Visible is a decrease in elevation of the graves from west to east.

A cross section of the cemetery of the *cella* phase shows how the depth of burial is determined by the natural elevation of the terrain. In the west the graves lay almost on the same level. There the grave with the highest position was found at 50.94 metres above NAP. East of the *cella* the terrain clearly slopes down. Grave 203, the easternmost inhumation was found at an elevation of 46.61 metres above NAP. The *cella* is depicted in the middle, apparently it stood near the edge of the western middle terrace. Also the burials at the Pandhof site were positioned along the edge of this terrace. As a result the height above NAP cannot be used to date the graves at these sites as Verwers attempted to do for the Pandhof site.²⁴⁷ Moreover, artificial elevation and diachronic variation in depth of burial all caused various graves from younger periods to be buried at lower heights above NAP than older burials. Elevation of the terrain may even have occurred as early as the *cella* phase. In the eastern part of trench 2 and 3 some skeletons had partially subsided in southeastern direction. The settling of the soil after artificial elevation of the terrain may have caused this. This effect was only found in a few graves suggesting only small sections of the terrain were raised. It cannot be excluded that the subsiding of skeletons was limited to a few graves lying on top of older pits.

THE *TEMPLUM* PHASE (CIRCA 480-700 AD)

CONTINUATION OF THE CEMETERY

Before a *templum magnum* was constructed, giving its name to this phase, burial activities continued at the Servaas church site. Therefore, not the construction of the *templum* but the use of tuff stone sarcophagi and the reintroduction of grave-goods mark the beginning of a new phase at the Servaas site cemetery, which coincided with the beginning of the Merovingian period. Grave goods found in these sarcophagi were dated between 480 and 550 AD. All seven sarcophagi of tuff stone were located west and northwest of the *cella*. Farther north, at the Servaas Pandhof site at least ten tuff stone sarcophagi were also discovered.²⁴⁸ These tuff stone sarcophagi are an exceptional series of burials. Only at a few sites have these massive sarcophagi been found and the number of recovered sarcophagi at the Servaas cemetery is remarkably high. Because of the costs that were involved in the production and transport of such sarcophagi and the precious grave goods found in some of them it is assumed that these were reserved for burials of high social status. Besides these sarcophagi, seven other graves were attributed to the earliest phase of the Merovingian cemetery. The distribution pattern of the 14 graves was similar to that of the Late Roman cemetery (Figure 3-19). Only one grave attributed to the early Merovingian period was found south-east of the *cella*. Moreover, the early *templum* phase graves north and north-west of the *cella* were buried at approximately the same level as the late Roman graves. This suggests that during the early Merovingian period the

²⁴⁷ Verwers, 1986

²⁴⁸ Both Verwers and Soeters mention a larger number of tuff stone sarcophagi at the Pandhof site. Soeters, 1989, p. 22-24 and Verwers, 1986, p. 61. However, a recent study of the excavation plans carried out within the framework of the Saint Servatius project indicated that only 10 tuff stone sarcophagi were found in situ.

FIGURE 3-19 *Templum* phase: the oldest Merovingian graves depicted together with the late Roman cella memoriae.

lay-out of the cemetery did not change noticeably. Inscribed gravestones, mentioned above, provided further evidence for continuation of burial practices. Four inscribed gravestones from the fifth and sixth centuries had been reused for building material of the present church. A fifth gravestone was found at the Servaas Pandhof site. The inscriptions and iconography showed that these gravestones originally marked the graves of Christians from the late Roman and the early years of the Merovingian period, thus linking the *cella* and *templum* phases.²⁴⁹

THE CONSTRUCTION OF A *TEMPLUM MAGNUM*

In his book "Glory of the confessors" Gregory of Tours dedicated a chapter to Servatius to inform his readers about two issues. Firstly he describes the miracles that occurred at the site of Servatius' grave. Secondly he mentions the construction of an impressive church (a "*templum magnum*") in a manner that indicates this event took place during Gregory's lifetime. According to Gregory's description, bishop Monulphus built this *templum magnum* to replace a wooden oratory that stood next to the grave of bishop Servatius. The contrast Gregory created in his text strongly suggests that the new church had a more permanent character and was probably built of stone. Gregory added that the remains of Saint Servatius were "translated into this church".²⁵⁰ He did not specifically indicate whether the remains were collected from the grave or the old wooden church to be translated to the new church. However, Gregory's description of a wooden church next to, or on the grave of Servatius seems to imply that Servatius still was buried in his

²⁴⁹ Boppert, 1986, p. 64-96.

²⁵⁰ Gregory of Tours, 1885, p. 744-820: Chapter 71. Translated in: Van Dam, 1988, p. 75-76.

grave at the time of the construction of the new church. Gregory did not mention any date for these events. According to van Dam, Gregory collected the stories during his life (between ca. 538/539 and 594) and edited most of the last version in the winter of 587-588.²⁵¹ Therefore, the *terminus ante quem* for the building of the *templum magnum* and the translation of saint Servatius by Monulphus is circa 588 AD. A clear *terminus post quem* is not available. Bishop Monulphus is generally held to be a contemporary of Gregory and his episcopacy has been ascribed to the second half of the sixth century.²⁵² This limits the period in which Monulphus could have built a new church to between 550 and 588 AD.

FIGURE 3-20 Plan of the Servaas church site showing the *templum magnum* as it was initially constructed next to the *cella memoriae*; the reconstruction of the eastern part is reconstructed after the example from contemporary churches.

During the excavation inside the present church, remnants of the *templum magnum* were uncovered. A few meters east of the *cella memoriae* archaeologists excavated foundations and robber trenches of a rectangular building approximately 15 metres wide. As later building activities had disturbed the eastern end of this edifice, assessing its length was not possible. The remaining fragments of the north and south walls have a length of circa 17 metres. Because of its position and the related findings, this building has been identified as the *templum magnum* of Monulphus.²⁵³ Other fragments of walls, found farther north at the Stiftskapel site

²⁵¹ Van Dam, 1988, p. 4-5.

²⁵² De la Haye, 1985a, p. 43. De Moreau, 1940, p. 35-36.

²⁵³ T. Panhuysen 1991.

and the Servaas Pandhof site, are probably the remainder of residential buildings of a monastic community or the entourage of the bishop.²⁵⁴ Below the walls of the magnum *templum* graves from the fifth century AD were found, providing a *terminus post quem*. A *terminus ante quem* is less evident, although several graves containing grave-goods from the sixth and seventh centuries were associated with this structure. The archaeological evidence indicates that at the beginning of the Merovingian period the *cella memoriae* may still have been visible. This would fit the description by Gregory of Tours that Servatius' grave was situated next to a wooden oratory that was replaced by the *templum* magnum.²⁵⁵ Remains of a wooden oratory were not found at the Servaas church site. To deduce the position of the wooden oratory from the distribution of the graves from the beginning of the *templum* phase is hardly feasible. At first glance the position of graves does not suggest these were placed inside or around a building (Figure 3-19). East of the *cella* no graves have been found but in that area only small sections could be excavated. Therefore, it is not possible to determine whether the wooden oratory was once situated in the same location as the *templum* or somewhere else.

FIGURE 3-21 *Templum* phase: the extension of the *templum* magnum (= darker shade) almost completely covered the site of the *cella*. For the construction of this extension remains of the walls of the *cella* were used as a foundation

During or after the second quarter of the seventh century the Merovingian church was enlarged. At that time an extension was built at the western end, adding five metres to the total length. As a result, the location of the former *cella memoriae* fell largely within the walls of the

²⁵⁴ T. Panhuysen 1982.

²⁵⁵ Gregory of Tours, 1885, p. 744-820: Chapter 71. Translated in: Van Dam, 1988, p. 75-76.

templum magnum.²⁵⁶ If the *cella* had not been dismantled earlier, it must have been demolished for the construction of the extension of the *templum*.

In the present chronology of the *templum* phase radiocarbon dates (Table 3-3) cannot contribute to a refined sequence of events. In general the dates fit in the established chronology. Discrepancies between the radiocarbon dates and the provisional dates based on grave finds should first be further analysed. As indicated above, reservoir effects may have led to radiocarbon dates that were too old. Ongoing work on the stratigraphical developments and a detailed study of the grave finds will in the future provide more evidence whether or not the radiocarbon dates are affected by reservoir effects.

GRAVE TYPES

Despite the fact that all tuff stone sarcophagi probably antedated the construction of the *templum*, they were still attributed to the *templum* phase because of the accompanying grave goods. The grave goods in graves 31, 88 and 94 clearly place the tuff stone sarcophagi and associated graves in the early Merovingian tradition and dates them in the first half of the sixth century AD. Of the seven graves of this type at the Servaas church site, two had remained intact until the moment of excavation. All others were severely disturbed or even demolished by later

FIGURE 3-22 An overview of the skeleton and objects in grave 94 and a cross section of this tuff stone sarcophagus. Grave 94, along the walls of the sarcophagus the coffin nails are visible as small black t-shaped objects. The grave goods were mostly found in the upper half of the sarcophagus. Their position within the space demarcated by the coffin nails suggests that originally these finds were placed inside or on top of the wooden coffin. Recognisable are, from the top to the middle, the hairpin, two fibulae and the bracelet (Drawing City of Maastricht).

burial activities and construction works. In one of the intact graves (grave 94) iron nails, positioned along the sides of the grave, indicated that a wooden coffin was used to bury the person inside the sarcophagus. In the works of Gregory of Tours there are indications that some stone sarcophagi were placed above ground.²⁵⁷ The tuff stone sarcophagi at the Servaas church

²⁵⁶ T. Panhuysen 1990, p. 544-545.

²⁵⁷ Van Dam, 1988, see also Effros, 1997.

site were found at the same elevation as late Roman inhumations in coffins. Therefore, we may conclude that these sarcophagi were not placed at ground level.

After the construction of the *templum magnum* stone-built graves became the most popular grave type. The stone-built graves appear to have replaced the tuff stone sarcophagi. The majority was constructed close to the *templum*. Several used the wall of the church or other graves as one of the sidewalls of the grave.²⁵⁸ All thirty-nine graves of this type were dated to the middle and later Merovingian period. Iron nails, found in three stone-built graves, indicate that wooden coffins were probably placed in at least a number of these graves. A special variety of this type was the twin grave. Four twin graves were recovered (Figure 3-26). They were either built as one grave with two compartments or as two separate graves positioned very close to each other. Trench graves were common during the *templum* phase. At the Servaas church site twenty-three trench graves were excavated. Wooden coffins were less common; nineteen graves were identified as burials in wooden coffins. In comparison with the tuff stone sarcophagi and the stone-built graves the trench graves and coffin graves were often placed at a greater distance from the church. However, they were also found among the stone-built graves as well as in separate clusters.

GRAVE GOODS

Various graves from the *templum* phase contained objects like knives, keys, boxes, pottery, glass, jewelry, belt sets and fibulae. In this respect, the burials were consistent with a widespread practice in early medieval Europe to place objects and possibly food and drink in a grave. The interpretation of this practice is the subject of debate. Traditionally the objects were considered the personal possessions of the deceased. Recent interpretations focus at the display of objects in the grave as part of a statement of the persons arranging the burial.²⁵⁹ At the time the data for this study were collected the restoration and analysis of the grave goods was not yet completed.²⁶⁰ Therefore, it was not possible to evaluate the quality, quantity and significance of grave goods in detail. Here only a few general observations will be presented. For thirty-three graves information on grave goods was available. Originally more graves would have contained grave goods. Due to disturbances by later construction works and burial activities a large number of the graves were disturbed and their contents dispersed in the soil. Many grave goods were found in elevation layers and near demolished graves. It is possible that people carrying out construction works incidentally removed grave goods. However, no evidence for the deliberate looting of graves was visible at the Servaas church site. At the Pandhof site at least one clear case of grave theft was recorded.²⁶¹

²⁵⁸ The tendency at Merovingian cemeteries to construct graves that were in physical contact with (older) buildings was described by Salin. Likewise Merovingian inhumations were found along the walls of a Roman villa or in prehistoric grave mounds. Salin, 1952, p. 15-21.

²⁵⁹ Effros, 1994; Härke, 1997; Dickinson, 2002.

²⁶⁰ The study of the grave goods from the Saint Servaas site is planned for 2005 and will be undertaken by M. Kars within the framework of the Saint Servatius project.

²⁶¹ In trench 1 a robber pit had been dug to collect grave goods from a tuff stone sarcophagus and a limestone sarcophagus.

FIGURE 3-23 *Templum* phase: location of five graves with exceptional grave goods.

Because of the above-mentioned post-depositional disturbances our view of the frequency and quality of grave goods is considerably obscured. From sixteen graves one object was recovered, six graves held two objects and eleven contained three or more grave-goods. Most of the objects date from the sixth century AD, the rest from the seventh century AD. After the seventh century the custom to deposit grave goods appears to have become obsolete at the Servaas church site. A broad variety of grave goods was found ranging from simple knives and iron flints to lavishly decorated belt-fittings and golden brooches. Most of the richer assemblages came from graves of women. Precious grave goods with a male connotation were also found; only some of these could be ascribed to a specific grave.

Some examples of grave goods found *in situ* will be presented below. The nature of these grave goods corroborates the idea, already evoked by the presence of tuff stone sarcophagi, that individuals of high status were buried in this section of the Servaas cemetery. Grave 94, a tuff stone sarcophagus, contained by far the largest number and most valuable grave goods. Inside the sarcophagus, archaeologists discovered numerous precious objects, which clearly showed it was the grave of a distinguished woman. Judging by the necklace with gold pendants, gilded brooches and clasps, a silver hairpin and bracelet, this was the grave of a woman of the Merovingian elite.²⁶² In comparison to contemporary graves, traditionally associated with royal status, the grave goods of grave 94 were only slightly less abundant. The other tuff stone sarcophagus that was found intact and unopened contained no grave goods. Apparently not all

²⁶² See for example the inventories of the graves of queen Arnegund and a "queen" of Cologne in: Wiczorek et al., 1996, p. 932-933 and 936-939.

prestigious graves contained grave goods. Vice versa, not only people buried in sarcophagi were bestowed with precious grave-goods. Assemblages of valuable objects like jewellery, a small bronze plated coffin or gold brocade were occasionally found in a wooden coffin or trench grave.²⁶³ The find of gold brocade in grave 164, a trench grave, was an indication for the burial of persons of high status in less elaborate grave types. Gold brocade was also found also at another section of the Servaas cemetery, viz. at the Pandhof site.²⁶⁴ In the Byzantine Empire dressing in clothes with gold brocade was reserved for members of the imperial court and high officials.²⁶⁵ Therefore, when found in contemporary western European cemeteries this fabric is generally considered a symbol of high social status.²⁶⁶

CEMETERY LAYOUT

As mentioned above, all but one of the graves of the beginning of the *templum* phase were found in the same area as the inhumations of the *cella* phase. The graves from the *cella* phase were not specifically orientated towards the *cella memoriae*. In the early *templum* phase this changed, four tuff stone sarcophagi were positioned within close range of the *cella memoriae*. Slightly further to the west three of these sarcophagi were placed in line (from north to south). At least another 10 tuff stone sarcophagi were found at the Servaas Pandhof site. During the early *templum* phase the centre of the cemetery still seems to have been situated in the area to the north. After the construction of the *templum magnum* at the cemetery, the number of burials in the area around the church increased and the focus of the cemetery seems to have shifted. From that moment, people were also buried in the southern half of the excavated area. Still, less than a third of the 88 graves were found in the southern part of the area of the Servaas church site. Most of the graves were found west and north of the church. The later construction of crypts disturbed the section inside the *templum magnum*.²⁶⁷ Consequently it was not possible to determine if people had been buried within the *templum*.

²⁶³ Examples of relatively simple graves with above average grave goods are graves 31, 86, 114 and 164. Grave 31 was a wooden coffin containing a necklace with a crystal pendant, a bracelet of amber and two silver plated pins. Grave 86, a stone-built grave, contained two necklaces, one with beads of amethyst. Furthermore it contained a knife, a strike-a-light and a buckle. In grave 114, a trench grave, two pins were found in situ on the skull. Grave 164, a trench grave, contained a bronze coffin, a bronze key, remains of gold brocade on the skull and a bone comb.

²⁶⁴ Soeters, 1989.

²⁶⁵ Codex Justinianus Leges XI 8,2 cited from Stork, 1997.

²⁶⁶ Bierbrauer associates gold brocade with a surviving upper class of Gallo-Roman origin. This ethnic interpretation may be debatable, however the scarcity of such textiles leaves little room for doubt about the social attribution. Bierbrauer, 1996, p. 114-115. Furthermore its presence was attested at other early medieval cemeteries e.g. Cologne; Pfaffgen, 1992, p. 438-52, and Lauchheim; Stork, 1997. The fabric appears to occur both in the graves of males and females, Pfaffgen, 1992 p. 451-2.

²⁶⁷ During later excavations of the crypts the floors of the crypts were left intact.

FIGURE 3-24 *Templum* phase: layout of the cemetery.

Marked cemetery boundaries were not found. As mentioned, excavations at the Servaas Pandhof site showed that the Merovingian cemetery extended to the north side of the cloister.²⁶⁸ In the northeast, the cemetery stretched at least to the Stiftskapel site.²⁶⁹ And at the Servaas church site the easternmost graves were situated in trenches 1, 2 and 5 of the Servaas site. The preliminary results of the analysis of burials in trench 2 of the Vrijthof excavations indicate that further east in the area around the apse of the present church no graves with grave goods from the Merovingian period were found. Although little information could be collected on the relation between these trenches and trench 2 of the Vrijthof excavations, it is possible that during the *templum* phase the cemetery boundary fell within this area. In the southern half of the Servaas church excavation the density of burials decreases, which might suggest the cemetery neared its boundaries in this direction. Hitherto we had no information on the distribution of burials south of the Servaas church site. In the west, burials are found in clusters without a sign that the border of the cemetery was near. Also at the Servaasklooster site a few graves from the Merovingian period were excavated. These may have belonged to the same cemetery as those at the Servaas church site.²⁷⁰ All graves of the *templum* phase were oriented with the heads in the west and feet in the east. Their alignment varies between 260 and 289 degrees. The alignment of some graves corresponds with the orientation of the walls of the *templum* magnum; other graves slightly deviated from this alignment.

²⁶⁸ Borghuis et al., 1979, p. 42.

²⁶⁹ T. Panhuysen 1982, p. 52-53.

²⁷⁰ T. Panhuysen 1982, p. 49 note 42.

A gradual chronological development from the cemetery would most likely have resulted in an even horizontal distribution of the graves. Unlike the horizontal stratigraphy visible in Merovingian *Reihengräberfelder*, the *templum* phase cemetery appears to have evolved in another way. Not only were many graves concentrated around the church, they were also placed in clusters. Within these clusters incidental intercutting of graves occurred. As far as could be determined, the clusters had no formal borders. Therefore, they were only recognisable from visual inspection of the site plan. Four larger clusters were recognised. The graves within these clusters dated from the whole Merovingian period. It could not be determined whether the late Roman graves found within some clusters were also part of these groups. The continuous use of the same limited plots suggested that a form of spatial planning existed. In general the clusters displayed a higher density of inhumations in the centre. Based on the present evidence the clusters were thought to represent cemetery areas used by specific groups of individuals. As to what kind of groups the areas were allotted to, we have no other sources than the graves and their contents. Possible factors that may have determined the composition of the clusters could have been social status, membership of a religious community, secular functions or kinship.

FIGURE 3-25 *Templum* phase: position of clusters I to IV.

Cluster I was the westernmost group, consisting of 10 graves dug at a distance of circa 30 metres from the *templum magnum*. The grave types in this cluster were much simpler than in the other clusters: either trench graves or wooden coffins. Cluster I was the only cluster in which none of the graves contained precious grave goods. Closer to the church cluster II was found, approximately at 20 metres west-north-west. This group of 14 graves was a mixture of stone-built

graves, trench graves, tuff stone sarcophagi and wooden coffins. Around the western part of the *templum magnum*, the largest cluster, cluster III, was found. It consisted of 27 graves, with a core of 21 stone-built graves. Furthermore the cluster comprised 4 tuff stone sarcophagi, a wooden coffin and a trench grave. Cluster IV was positioned close to the northern wall of the *templum* and extended 10 metres in a northerly direction. Among the 18 graves were stone-built graves, wooden coffins and trench graves. In each of the clusters II, III and IV, twin graves and graves with precious grave goods were found. Often these graves were situated in the centre of the clusters.

FIGURE 3-26 *Templum* phase: Position of the four twin graves: D1, grave 165 and 166, D2, grave 157 and 158, D3, grave 139 and 140, D4, grave 17 and 41.

Twin graves are either stone-built graves of equal size, with one grave constructed against the other, or they are stone-built graves constructed as one grave containing two separate spaces for burial. Two twin graves were found in front of the west wall of the *templum magnum*. (D2 and D3 in Figure 3-26; grave 139+140 and grave 157+158). Farther west a third twin grave was found (D1 in Figure 3-26; grave 165+166). The fourth (D4 in Figure 3-26; grave 17+41) was positioned circa four metres north of the church. Of the three twin graves west of the *templum* two (D2 and D3 in Figure 3-26) were placed in line on an axis from west to east. A third twin grave (D1 in Figure 3-26) was positioned slightly north of the axis of twin graves D2 and D3. Similar graves were also found at other cemeteries from the Merovingian period.²⁷¹ M. Colardelle

²⁷¹ E.g. three pairs of double or "twin" graves were excavated at Saint-Julien-en-Genevois (France), Colardelle, 1983 p.71. See also the distribution map of ten examples of twin graves in Merovingian France on page 374 of the same publication.

suggests these twin graves were graves of members of the same family who were successively buried next to each other.²⁷² This theory cannot be tested for the twin graves from the Servaas church site, since only one grave out of the four pairs of graves contained human remains.

FIGURE 3-27 Twin grave: grave 41 and 17 see also Figure 3-26 (Photograph: City of Maastricht).

THE BASILICA PHASE (700-950 AD)

THE CONSTRUCTION OF A BASILICA

The basilica phase begins with the construction of a new and larger church at the location of the *templum* phase church. At the same time, or somewhat later, a new building was constructed north of this church at the Pandhof site. Archaeological findings indicate that the Merovingian church was demolished and replaced by a comparatively spacious church with the ground plan of a *basilica*. The nave of the new church measured 38 metres in length and the total width of the nave and aisles was 19.70 metres. Measuring the total length of the church was not possible because construction works for the present church had disturbed the area of the choir and possible apse of the church. The location of at least one entrance to the *basilica* was situated in

²⁷² Colardelle, 1983 p 370. This hypothesis is supported by physical anthropological evidence as indicated by M.R. Sauter in a contribution to Colardelle's study, page 422.

the south wall near the western corner of the church.²⁷³ During the earliest phase this church had an earthen floor and a cancella, a fence or wall that separates the choir from the nave of the church. Possibly this cancella was decorated with bas-reliefs. Fragments of a bas-relief, depicting the "Flight to Egypt" and the "Massacre of the Innocents", were recovered below one of the oldest floors of the *basilica* (see figure 3-29). Comparison with other pre-Romanesque bas-reliefs has led various authors to conclude that this fragment was probably sculpted in the first half of the eight century.²⁷⁴ Other evidence for an exceptionally rich decoration of the *basilica* comes from the numerous fragments of painted wall-plaster, mosaic stones (including gold-leafed mosaic stones) and remains of windows with coloured glass.²⁷⁵

FIGURE 3-28 Plan of the *basilica*, first building phase of the *basilica*, extensions and modifications of the *basilica* are represented in a darker shade. North of the Servaas church site the remains of what seems to have been a monastic building were discovered at the Servaas Pandhof site.

²⁷³ The present church still has a richly decorated portal, which is richly furnished with polychrome sculpture dating from the 13th century.

²⁷⁴ T. Panhuysen 1990, p. 548, Mekking, 2000 and Dierkens, 2004.

²⁷⁵ T. Panhuysen 1990.

FIGURE 3-29 Bas-relief, representing two scenes from the New Testament: the "Flight to Egypt" (left) and the "Massacre of the Innocents". (Photograph: City of Maastricht)

THE DATE OF THE BASILICA

The scarce written sources do not mention the building of a large church at the location of the *templum magnum*. In a preliminary publication presenting an overview of the archaeological campaign of 1981-1989, T. Panhuysen suggests the *basilica* was built in the eighth century.²⁷⁶ Dierkens has recently put forward the interesting hypothesis that the construction of the *basilica* may have been contemporary with a renewal of the cult of Saint Servatius, including a new elevation of the remains of the saint.²⁷⁷ Since the available sources do not explicitly mention the construction of a new church, the dating of the construction of the *basilica* depends on archaeological findings. Work on the stratigraphy at the Servaas church and Pandhof sites is still in progress. In the near future this may provide a reliable chronology of the building activities.²⁷⁸ At present three radiocarbon dates collected from skeletal remains buried in limestone sarcophagi positioned around the cancella present the best indication as to when the *basilica* may have been built.

In total 5 samples were selected for radiocarbon analyses. Three of these samples were collected from human skeletal remains collected from sarcophagi inside the *basilica* (Figure 3-30: B2, B3 and B4). Nineteen trapezoid limestone sarcophagi were buried around the cancella below an old earthen floor, which is considered the first floor of the new *basilica*. Because of this position and the fact that the sarcophagi were sealed off by a concrete floor it is assumed that these sarcophagi dated from the earliest phase of the *basilica*. The sampled human remains were all collected from skeletal remains lying in anatomical position at the time of excavation, suggesting these were primary burials.

²⁷⁶ T. Panhuysen 1990.

²⁷⁷ Dierkens, 2004, p. 79-82. See for Dierkens view of the events around 725 AD: Dierkens, 2000, p.562-563.

²⁷⁸ T.A.S.M. Panhuysen presently is involved in this section of the Saint Servatius project.

FIGURE 3-30 Basilica phase: layout of the cemetery, B1 = grave 1, radiocarbon date: 1250±30 BP; B2 = grave 168, radiocarbon date: 1310±50 BP; B3 = grave 175, radiocarbon date: 1360±30 BP; B4 = grave 179, radiocarbon date: 1330±30 BP; B5 = grave 187, radiocarbon date: 1340±30 BP.

The results of the conventional radiocarbon analyses of samples B3 and B4 were quite consistent, especially the range found for sample B2 analysed by means of AMS was less specific. Based on the archaeological findings we assume that the sarcophagi around the cancella were deposited within a short period during the last phase of construction of the *basilica* or shortly thereafter. This was confirmed by the distribution of the calibrated radiocarbon dates which all fall between 1360 and 1310 BP.

FIGURE 3-31 Probability plots of the calibrated dates of human bone samples collected from three sarcophagi inside the church. The upper sample is sample B2, the middle B3 and the lower B4. Figure created using OxCal v. 3.9.

FIGURE 3-32 Combined results of three radiocarbon measurements of samples B2, B3 and B4.

If the previous assumption is correct the radiocarbon dates may be combined, which results in a smaller interval. The combined data indicate there is a 68% probability that the individuals interred in these sarcophagi had died between 663 and 683 AD and a 92% probability that these had died between 650 and 720 AD. Of interest in this respect is another burial in a sarcophagus (B5) just outside the entrance of the *basilica*. The archaeological findings suggest that this grave also belonged to the early phase of the *basilica*. The radiocarbon date acquired for this grave (1340 ± 30 Cal yr. BP) closely matches the dates found for the sarcophagi around the cancella.²⁷⁹ As discussed above we have to consider these data were biased by reservoir effects due to the consumption of considerable amounts of freshwater fish. Consequently the radiocarbon dates might be too old, by up to hundred years or more. Given the present evidence this possibility cannot be excluded, but there are no indications this must have been the case.²⁸⁰ A comparison of the use of trapezoid limestone sarcophagi in the burial ritual in the region may provide an indication whether an early dating is in agreement with the dating of similar sarcophagi at other sites.

In a study of limestone sarcophagi in the Netherlands and the Rhine and Meuse valley, Lammers assumes that these sarcophagi were produced from the end of the seventh or the beginning of the eighth century to the first half of the eleventh century.²⁸¹ However, there is

²⁷⁹ We could hypothesise that all four burials in sarcophagi (B2, B3, B4 and B5) occurred around the same time. In that case the combination of the radiocarbon dates would suggest there was a 95% probability that the individuals buried in these graves died between 657 and 690 AD. However, the contemporaneous burial of these graves is at present less evident than of the three sarcophagi around the cancella.

²⁸⁰ The fact that four of the radiocarbon dates closely correspond, as was expected on archaeological grounds, indicates that if there was a reservoir effect it must have had similar consequences for all four individuals.

²⁸¹ Lammers, 1992, p. 385-386 and 397. Five limestone sarcophagi found at the cemetery "De Heul" in Dorestad are dated to the eighth and ninth century, Hessing, 1994, p. 137. (The text and the illustration of these graves in the cited publication are contradictory. In the

evidence that limestone sarcophagi were used at the beginning of the seventh century. In an article discussing the famous sarcophagus of Chrodoara, found in nearby Amay, Engen dates the lower part between 589 and 634 AD.²⁸² This is the oldest documented case of the use of a trapezoid limestone sarcophagus in the region of Maastricht. In the Paris basin and the north of France this type of burial was found in considerable numbers at early medieval cemeteries. In those regions this type of burial was found from the last quarter of the sixth century.²⁸³ Therefore, it is possible limestone sarcophagi were used in Maastricht from as early as the second half of the seventh century.

All in all the available evidence for the dating of the building of the *basilica* does not allow for a very precise determination. The combination of the radiocarbon dates suggests the *basilica* was built at some time between 650 and 720 AD.²⁸⁴ It is to be expected that the ongoing analysis of burials, architectural remains and stratigraphical evidence will eventually allow for the determination of a more specific date.

During circa three hundred years of use, the *basilica* underwent several modifications. The position of the cancella was changed at least three times and two red coloured floors of *opus signinum* replaced the first earthen floor. In the tenth century the western wall was torn down to extend the *basilica*. More than ten metres were added, maybe to construct a westwork. The *augmentum* at the northeastern corner of the building was also enlarged. In the late tenth or early eleventh century the *basilica* was demolished and replaced by a new and grander church. One radiocarbon date of human remains from a stone-built tomb that was either associated with the last phase of the *basilica* or the first phase of the present-day church fits quite well with the expectations concerning the chronology. This burial had a calibrated date ranging from 961 to 1012 AD (68%). In 1039 AD the new church was dedicated. The dismantling of the *basilica* and the construction of the present church may well have taken place by the end of the tenth century.²⁸⁵

GRAVE TYPES AND CEMETERY LAYOUT

Seventy-three graves were dated to the same period as the *basilica*. A third of the graves was placed within the church. Often these graves were found below one of the floors of the *basilica*. Inside the church, limestone sarcophagi were the main grave-type. In total, 36 trapezoid limestone sarcophagi were found in and around the *basilica*. Nineteen of the sarcophagi were positioned in the nave of the *basilica* around the cancella. Two were placed in the southern *augmentum* (grave 74 and 77) and two on the inside along the northern wall of the *basilica* (grave 22 and 106). Thirteen limestone sarcophagi were found outside the church: five along the northern wall, four around the entrance of the *basilica* and four near the southern *augmentum*.

text the sarcophagi were mentioned as being of tuff stone, but the accompanying illustration shows a trapezoid limestone sarcophagus. And the text with the illustration also mentions the depicted sarcophagus was made of limestone.)

²⁸² Engen, 1985, p. 165. For the datation of the cover see Thirion, 1985, p.175 and Dierkens, 2004, p.77-79.

²⁸³ Delahaye, 1985, p.694

²⁸⁴ This implies that the abovementioned bas-relief may have been slightly older than it is dated at present.

²⁸⁵ T. Panhuysen 1990, p. 545-549; T. Panhuysen 1991, p. 20-21.

Trapezoid shaped stone-built graves must have belonged to the same category as the sarcophagi. Not only did they look like sarcophagi, they were also found in the same areas of the cemetery. Two graves of this type (grave 84 and 123) were built against the northern wall. A third one (grave 72) was placed inside the southern wall, near the southern *augmentum*. Apart from the three trapezoidal stone-built graves, two rectangular specimens were discovered: one against the northern wall (grave 83) and one west of the southern *augmentum*. Only three coffin graves were found inside the *basilica*. They were placed above one another in the southern *augmentum* (graves 73, 74 and 75). All other wooden coffin graves and trench graves were found either east of the northern *augmentum* or around its southern counterpart. In the northern group only coffins and trenches were found. Among the graves of the southern clusters were also two sarcophagi and a stone-built grave.

FIGURE 3-33 Basilica phase: represented are three larger inhumation zones in and around the basilica.

In comparison to the *templum* phase the plan of the *basilica* phase cemetery shows a striking change in layout. Instead of clusters of graves of mixed types, typical for the *templum* phase cemetery, the *basilica* cemetery was characterised by areas with very little variation in grave type. Various zones in and around the basilica seem to have been reserved for specific grave types. Three areas with a specific pattern of burials could be discerned. The first was situated inside the church around the cancella. It consisted solely of limestone sarcophagi positioned in the nave of the *basilica* along the walls of the cancella. A second zone was outside the eastern wall of the northern *augmentum*, consisting of ten trench graves. At this location the trench graves were placed in orderly rows. South of the church, east of the southern *augmentum* was a

zone with a less systematic appearance. Unlike the other zones a variety of grave types was found at this location; organised in a way that resembled the spatial organisation of the *templum* phase cemetery. Eleven trench graves, two limestone sarcophagi, two coffin graves and one stone-built grave formed this group of sixteen graves. These graves also were placed in rows parallel to the walls of the *basilica*, but in a less rigid way. The intercutting of graves suggested this area was used intensively during a large part of the *basilica* phase. Other smaller groups of graves were formed by eight sarcophagi and stone-built graves *sub stilicido* along the outside of the northern wall of the *basilica*. Four limestone sarcophagi positioned in and around the entrance to the *basilica* formed the last cluster of graves that could be recognised in the excavated section of the *basilica* phase cemetery.

The boundaries of the *basilica* phase cemetery are difficult to establish. In general very little of the cemetery area outside of the *basilica* could be observed during the Servaas church excavations. To the north, the cemetery seems to have extended at least into the cloisters excavated during the Pandhof excavations. The analysis of these graves is in progress and the first results suggest that burial activities in the cloisters continued during the *basilica* phase. A good indication for this trend is the presence of 7 limestone sarcophagi in this section of the cemetery.²⁸⁶ At the Stijftekapel site to the North east of the Servaas church site no burials can yet be ascribed to the *basilica* phase. To the east of the *basilica*, at the Vrijthof site, the continuous sequence of burials in trench 2 seems to have started during the *basilica* phase. However, more stratigraphical and chronological evidence is needed to confirm this. South of the *basilica* there is no information as to whether the cemetery extended in that direction. At the Servaas church site the situation west of the *basilica* was not systematically excavated. Until now there is no evidence that the small series of graves excavated at the Servaasklooster site continued into the *basilica* phase. Altogether only a small section of the *basilica* phase cemetery seems to have been excavated within the trenches of the Servaas church site.

BOSCHSTRAAT SITE

EXCAVATION HISTORY

Until the seventies of the twentieth century the area north of the present day market square in the city centre was dominated by industrial activities. Even today factories can still be found in this part of the city. The Boschstraat area, between the Boschstraat and the River Meuse, housed labourers and industries in the nineteenth and twentieth centuries. Prior to the construction of a new residential area circa 6000 square metres of this former industrial quarter were archaeologically investigated. Between 1980 and 1986 twenty-two trenches were excavated. Preliminary results have been published in short reports and articles.²⁸⁷

²⁸⁶ Soeters, 1989, p.24.

²⁸⁷ T. Panhuysen 1984, p. 80-81 and 123-132; Dijkman, 1994; Kooistra, 1996; Sablerolles et al., 1997.

FIGURE 3-34 Boschstraat site: an overview of the twenty-two excavation trenches.

TOPOGRAPHY

Due to medieval and post-medieval disturbances it was only possible to determine the approximate elevation of the early medieval surface level. As far as could be established the late medieval horizon seems to have been in concordance with the twentieth century relief map. With this difference, that in medieval times the elevation of the whole terrain was circa one metre to one and a half metres lower. It reached its lowest level in the southwestern part of the excavated area, around 45.40 metres above NAP. Farther north and east the landscape rose to a level of 46.80 metres above NAP. It was noticed during the archaeological investigation that the terrain gradually sloped upward in a northerly direction. The natural soil is a layer of loamy river sediment on a gravel deposit of the River Meuse. Because of the limited elevation the terrain around the site must have been inhospitable for centuries.

A MEROVINGIAN SETTLEMENT AND CEMETERY

In the Roman period the Boschstraat area was uncultivated and uninhabited. The first traces of occupation date from the sixth or seventh century.²⁸⁸ Before that the Roman road to Nijmegen on the left bank of the river was excavated west of the area. Numerous waste pits and wells were found all over the excavated area. The contents of these waste pits indicated that objects

²⁸⁸ T. Panhuysen 1984, p. 124-124, Dijkman, 1992; Dijkman and Ervynck, 1998 and Sablerolles et al., 1997.

FIGURE 3-35 Boschstraat site: an overview of the area where early medieval inhumations have been found (represented as rectangular shapes) and those parts of the site that were disturbed by later human activities to the level of the inhumations (represented by shaded areas)

of metal, antler and glass were produced in this area. Furthermore, refuse of food preparation, also found in the pits, suggests the existence of a settlement in close proximity. No house plans could be reconstructed from the excavated postholes. However, the scale and nature of activities suggests houses must have been present. Indicative of the layout of the settlement was a ditch found in the western trenches, running for at least 35 metres from north to south.²⁸⁹ A smaller ditch had been dug perpendicular to the main ditch extending 25 metres in western direction. North of this ditch a stretch of deposited gravel was found. These ditches and the gravel deposits are considered demarcations of housing lots or the remains of yards. North-east of the excavated area a concentration of waste pits suggests the presence of a separate housing area north of trench 7. Whether these areas were occupied contemporaneously, or represent different phases could not be established.

The above-mentioned refuse of various production processes provides an idea of the spread of the various crafts over the terrain, which was published by Dijkman.²⁹⁰ Finds associated with iron-working and copper-alloy working were predominantly found in the western excavation trenches: 11, 13 and 18. Remains of glass-working and antler-working were excavated mostly in eastern trenches: 1, 20 and 21. Only in the centrally situated trench number 22 traces of glass-working and antler-working were found in combination with iron-working. Copper-alloy nails (attested by the find of earthen moulds) were fabricated in the western section of the

²⁸⁹ Trench number 11, 12, 13 and 16.

²⁹⁰ Dijkman, 1992 and Dijkman and Ervynck, 1998.

excavation.²⁹¹ Because of its peripheral position the settlement area of the Boschstraat site was expected to have played a role in farming activities and the production of food. Surprisingly, a rough inventory of botanical macro-remains in 22 soil samples provided no evidence for activities related to food processing.²⁹² The finds suggest the excavated areas were predominantly used for the crafting of objects and habitation, not for growing or even processing agricultural crops. Another important feature of the findings at the Boschstraat site are the inhumation graves, which were found between the various waste pits. Some antedated the pits others were positioned over older refuse deposits. Based on stratigraphical evidence and analysis of the associated finds the inhumations are considered to date from the seventh and early eighth century.²⁹³

FIGURE 3-36 In the following maps of the layout of the inhumations at the Boschstraat site the dispersed inhumations have been projected in a plan together with the large concentration of graves in the east.

This first occupation phase of the terrain was of short duration. It was not just the cemetery which was discontinued in the eighth century. The whole area was deserted again. Possibly climatic changes or changes in the water level were a contributing or decisive factor causing the terrain to become unsuitable for habitation. The area was not re-inhabited until the thirteenth century.²⁹⁴

²⁹¹ Such nails were possibly used in the eastern section for the production of combs made of antler. This can be regarded as an argument for the contemporaneity of the two production processes and possibly also for the coexistence of the two habitation areas. Dijkman and Ervynck, 1998.

²⁹² Kooistra, 1996, p. 281-289.

²⁹³ T. Panhuysen 1986, p. 134.

²⁹⁴ T. Panhuysen 1984, p. 125.

GRAVE TYPES AND CEMETERY LAYOUT

At the Boschstraat site 50 graves could be recognised; six of these contained no skeletal remains at the time of excavation. In addition, skeletal remains were collected from ten contexts which were not recognisable as formal graves. Because of the archaeological context of these disarticulated human remains it seems plausible that these burials were contemporaneous with the other burials but were disturbed by later activities and processes. Seeing as the majority of graves were trench graves it is not surprising that even minor disturbances would make it difficult to recognise these graves during excavation. At the Boschstraat site 42 trench graves were found. Another six trench graves were lined with stones and therefore designated to a separate category. These trench graves with stones were often found in a central position. Coffin graves were comparatively rare, only two coffin graves were recovered, both of them near to the centre of the easternmost cluster.

Two patterns can be recognised in the distribution of graves. One group of inhumations was buried together in the abovementioned larger concentration of circa 50 graves and disturbed burial contexts, which formed a proper cemetery. A total of 10 inhumations were found to be more dispersed. At three places separate clusters of graves were recovered. In trench 22 a pair of graves was found approximately forty metres north west of the main group of inhumations. Further to the west in trench 13, about hundred metres from the large concentration of graves, one isolated inhumation and the disarticulated remains of a second individual were collected. A cluster of five graves was discovered in trench 16 and 18 west of the main group of graves. Because of the similarity in grave types and the absence of associated habitation traces of other periods all dispersed inhumations were dated to the same period as the main cluster.²⁹⁵ Probably the human remains found in trenches 13, 16 and 18 were associated with the nearby ditches and gravel deposits found in the western excavation trenches. Possibly the dispersed burials were interred close to houses in that area. There is no evidence that the dispersed graves were part of larger clusters. Comparison of the spread of the recovered graves and the distribution of later disturbances of the soil do not suggest that many graves were lost.²⁹⁶ This indicates the cemetery and dispersed burials were quite representative of the original number of burials at the Boschstraat site. Moreover, the cemetery in the east was almost completely excavated. Around the cemetery and the dispersed burials contemporary refuse pits were found. This suggests all burials were located close to houses. In the case of the dispersed burials this might indicate that the individuals were buried in the yards of the house where they once lived.²⁹⁷

²⁹⁵ E.g. grave 49 in trench 16 was positioned over a Merovingian rubble pit, indicating the grave dates from the late Merovingian or early Carolingian period.

²⁹⁶ The distribution of burials in the central cemetery suggests that more graves might be expected to the east and south-east. However as indicated in Figure 3-34 this area was excavated and no traces of additional burials were found.

²⁹⁷ A phenomenon which has been noticed in contemporary rural settlements. See for example Theuvs, 1998.

FIGURE 3-37 Distribution of the inhumations at the Boschstraat site.

The main group of inhumations, which was de facto a cemetery, consisted of three subsections. In the northeast the inhumations formed a comparatively large cluster, baptised cluster A. A smaller cluster of eight graves, baptised cluster B, was buried ten metres west of cluster A. Between clusters A and B a small ditch was found, oriented north-south. In addition, some post holes were observed. The association between these findings and the graves is unclear.²⁹⁸ The separation between cluster A and a third zone of burials just to the south was not well defined. In this southern zone seventeen inhumation graves were distributed over a stretch of 30 by 15 metres. In general the informal layout of the cemetery and the dispersed inhumations is similar to other burial sites from the seventh and eighth century.²⁹⁹

ORIENTATION OF THE INHUMATION GRAVES AT THE BOSCHSTRAAT SITE

The graves do not seem to have been oriented along a building or other fixed topographical features. Therefore, it is possible that the orientation of the graves was based on the point at which the sun rises on the horizon around the time of burial. Consequently the orientation of the graves might reflect seasonal influences on mortality.³⁰⁰ For 43 graves the compass

²⁹⁸ Judged by the spatial distribution of the graves in this part of the cemetery there is no clear indication for the presence of a timber chapel or other contemporaneous construction.

²⁹⁹ Both in the region around Maastricht as well as in other regions comparable distribution patterns have been found. Colardelle, 1983; Durand, 1988; Theuvs, 1988; Halsall, 1995.

³⁰⁰ Wells and Green, 1973; Fichter and Volk, 1980.

orientation was determined based on the position of the body or the alignment of the grave. The orientation was expressed in degrees of rotation in relation to the north-south axis. All 43 graves were roughly oriented along the east-west axis. Figure 3-38 shows the distribution of the graves by intervals of 5 degrees. Most graves were categorised in the interval ranging from 77.5 to 82.5 degrees. The orientation of most graves was around the 80.5 degrees, that is 9.5 degrees north of east-western axis. If we assume that the orientation of the graves was according to the true point of sunrise on the day of burial this would correspond with burial during late autumn, winter or early spring. This is in agreement with the findings of Fichter and Volk based on the analysis of two early medieval cemeteries from Southern Germany.³⁰¹

FIGURE 3-38 Orientation of 43 graves at the Boschstraat site

Three graves were oriented along the north-south axis. One of these was of a child buried at the foot end of an adult grave. Two graves³⁰² of adults were intentionally buried with an orientation along the north-south axis. These graves were laying about 20 centimetres lower than most other burials. Traditionally this orientation was interpreted as characteristic of non-Christian burials during the early Merovingian period. However, Roosens mentions that north-south oriented graves can be found in the region around the Meuse from the fifth century well into the seventh century. He doesn't consider orientation as a reliable indicator of religion.³⁰³ In the Dutch province of Limburg a north-south grave orientation was rare. Such an exception was the cemetery of Kemperkoul excavated in Sittard not far from Maastricht. This cemetery dated

³⁰¹ Fichter and Volk, 1980.

³⁰² Grave 42 and 43.

³⁰³ Van Es already concluded in 1968 from the variety in orientation of graves that a west-eastern orientation of graves generally was not linked to religion, Es, 1968. Roosens, 1973, p. 399. Also at the Servaas Pandhof site two graves were oriented north-south. Soeters, 1989, p. 24-25.

between the sixth and early eighth centuries consisted solely of north-south orientated burials.³⁰⁴ How to interpret the two north-south orientated graves is not evident. Were these older graves or were these the first graves of a group settling near Maastricht who soon traded their own habit of north-south burials for the local custom of west-east burials?

GRAVE GOODS

Nine graves contained grave goods. All grave goods were found in graves from the main cemetery. Most common were necklaces made of simple glass beads and, incidentally, some amber. Such necklaces were recovered from seven graves. One grave contained a bracelet, composed of the same type of beads as the necklaces. In one of the graves, in which a necklace was found, a piece of pottery stood at the foot end. Two more pieces of pottery were found together in another grave. The bracelet, necklaces and ceramic objects were relatively simple. Within the central group of graves most grave goods were found in cluster A. There were no indications that graves had been robbed of their valuables. Therefore, we may assume that the

FIGURE 3-39 Distribution of the grave goods over the cemetery. C = ceramic, N = necklace of glass beads, B = bracelet of glass beads

distribution of grave goods is representative for the actual distribution at the time of burial. Summing up, only about a fifth of the graves contained grave goods. The scarcity of grave goods may be associated with the dating of the graves to the seventh or early eighth century. During

³⁰⁴ Willem, 1983, p. 274-276

this period the custom of furnishing graves with goods seems to have been abandoned in Maastricht.³⁰⁵

RESUME BOSCHSTRAAT SITE

The burial ground excavated at the Boschstraat site dates from the seventh and partially from the early eighth century. It coincides with the transition from the Merovingian to the Carolingian period. The main cemetery (clusters A, B and the southern zone) has been recovered almost completely. Although many graves are positioned close to others, intercutting of graves was rare. This suggests that the cemetery was in use for a relatively short period and was used by a small population. In contrast with other Merovingian cemeteries the graves at the Boschstraat site were modest. There are no large grave pits and the grave goods are scarce and simple. The incidental ceramic vessel and the necklaces made of glass beads are plain in comparison to the precious goods found in several contemporary graves at the Saint Servaas site. The desertion of the cemetery was probably a consequence of the abandonment of the area. As indicated above this abandonment is hitherto unexplained. Possibly it was associated with changes in the local environment rendering the area uninhabitable. Otherwise the dissolution of the cemetery may also be associated with a general tendency to discontinue the use of the 'field cemeteries'. In the eighth century cemeteries not associated with a church were either abandoned or a church was built at the site of the cemetery.³⁰⁶

SKELETAL ARRANGEMENT OF THE BURIALS

For all burials data were collected regarding the position of the body, limbs and hands in the grave. Sources for these data were excavation drawings, photographs and notes in the excavation reports. Due to the frequent disruption of graves it was not possible to collect data for all burials. Only those graves for which reliable data were available in the documentation were included in Table 3-5. Concerning the position of the arms and hands it was decided to categorise them under "on abdomen" all cases in which one or both arms were found on the abdomen. None of the individuals was found lying with one or both hands on the thorax. In the *cella* sample out of twenty skeletons found in a burial context, nineteen skeletons were found in supine position, viz. laid out on their backs. The only exception was a young child buried on its right side. The burial position of the arms, hands and legs during this phase could be inspected in fourteen cases. Five individuals were buried with their arms and hands along their sides and nine individuals with one or two arms and hands on the lower abdomen. In all cases (n=14) the legs were extended. Similar burial positions were observed for the late Roman inhumations at the Pandhof site.³⁰⁷ During the *templum* phase there was less variation with respect to the skeletal arrangement. All 34 skeletons found in situ had been buried in supine position. Also in

³⁰⁵ At the Servaas church site the typical grave goods used during the Merovingian period are no longer found in graves from the end of the seventh century.

³⁰⁶ Ohler, 1990, p. 143; Chélini, 1991, p. 448-449.

³⁰⁷ Soeters, 1989, p. 25-26

		Cella	Templum	Basilica	Boschstraat	Total
Body	supine	19	34	47	38	138
	side	1			2	3
Arms and hands	both stretched along the body	5	12	29	14	60
	on abdomen	9	3	3	15	30
Legs	both straight	14	28	39	31	112
	one or both bent				1	1

TABLE 3-5 Arrangement of the body in the grave, as recorded from skeletal remains found in situ

all 29 cases, where the position of the legs could be inspected, the skeletons were lying with both legs extended. In 15 cases the arrangement of the arms and hands could be determined: 3 individuals were buried with their hands on the abdomen and 12 with their arms along their sides. All 47 burials found in situ from the *basilica* phase were buried in a supine position. Twenty-nine individuals were buried with their arms stretched along their body, only three persons were found with their hands on the abdomen. At the Boschstraat site 40 skeletons were found in situ. One skeleton was laying on the right side and another on the left side. All 38 other burials were buried in supine position. Regarding the position of the arms, in a little less than half of the cases the arms were laying straight along the body (n=14). In 15 individuals either one or both arms were bent and positioned on the abdomen. Apart from one of the individuals buried on its side with the legs slightly bent, 31 individuals were found with their legs stretched.

TYPO-CHRONOLOGY OF GRAVE TYPES AT THE SERVAAS CHURCH SITE

From the late Roman period to the end of the *basilica* phase the grave types at the Servaas church site changed considerably. These changes seem to be associated with the building phases at the site. The distribution of the six most frequently found grave types indicates that there was very little continuation in the use of four specific grave types: viz. the tuffstone sarcophagus, the stone-built grave, the limestone sarcophagus and the stone-built tomb.

Trench graves and wooden coffins were found during all three phases. In the *cella* phase they were the most used grave types and coffins and trenches were found in equal proportions. In the *templum* phase these grave types still made up a large fraction of the total graves. Together they accounted for almost half the number of graves. During this phase trenches and coffins were also found in equal proportions. This is different in the *basilica* phase. The proportion of wooden coffins appears to have decreased considerably, which was partially compensated by an increase in the number of trench graves.³⁰⁸ Together both grave types still accounted for 40 per cent of the total number of graves from the *basilica* phase. In the *templum* phase new types of graves occur on site. First were the tuff stone sarcophagi dating from the start of the *templum*

³⁰⁸ As indicated above it is also possible that wood was still used for some of these burials. Possibly some wooden coffins were not recognised as wooden coffins because no coffin fittings or wood was preserved or because these were constructed without the use of metal parts.

FIGURE 3-40 Distribution of the six most frequently found grave types (excavated at the Servaas church site) by period. Percentages are calculated per total of the six grave types per period. Included in the counts are all graves found, also graves which no longer contained human remains at the time of excavation.

phase, around the first half of the sixth century. Stone-built graves seem to have been used somewhat later. The findings suggest that when the tuff stone sarcophagi became obsolete the stone-built graves came into use, which in turn were followed-up by limestone sarcophagi. By the end of the *templum* phase there were five times more stone-built graves than tuff stone sarcophagi. The stone-built graves alone accounted for 45 per cent of the graves from the *templum* phase. During the *basilica* phase the technique to construct stone-built graves continued to be used. However, only one stone-built grave resembled the graves from the *templum* phase. All other stone-built graves were considerably larger and some of these were trapezoid in shape. Therefore these graves were categorised as a separate category of stone-built tombs. New in the *basilica* phase were trapezoid limestone sarcophagi, which became the predominant grave type during the first phase of the *basilica*.³⁰⁹ In fact the number of limestone sarcophagi excavated at the Servaas church site presently represents the largest concentration of this type of graves in the lower Meuse valley.³¹⁰

The distribution of grave types over the three phases demonstrates that wooden coffins and trench graves were used during the whole period. More labour intensive, and therefore most likely more costly grave types, came into use from the early *templum* phase. The various special grave types seem to have been preferred for shorter periods.

³⁰⁹ The actual number of limestone sarcophagi found at the Servaas church site was higher than mentioned in the table. Several limestone sarcophagi that were reused in later periods were not included.

³¹⁰ Lammers, 1992.

THE CLASSIFICATION OF INDIVIDUALS BY BURIAL STATUS

One of the aims of this study is to analyse any associations between social status and health. Therefore, it is necessary to categorize the burials in status categories. Since specific data concerning the social status of the buried individuals are missing, archaeologists generally have to use indirect indications. Traditionally various components of the burial ritual are seen as valid indicators of social status. For early medieval Western Europe the feasibility of a classification of burials has been extensively discussed.³¹¹ From this discussion it may be concluded that burial rituals do not always straightforwardly reflect the socio-economic status of the deceased. The interpretation of grave goods, in particular weaponry, to categorise individuals by social status has proven complex and often impossible. What has been established is that there is an association between the grave goods and the sex and age of the deceased.³¹² More and more the burial ritual is seen as an expression of what was considered appropriate by the entourage of the deceased. In a sense the burial ritual was adapted to the needs and possibilities of his or her entourage.

It is not only the way the social status of the deceased was expressed in the burial ritual which is poorly understood. Due to the scarcity of written sources our view of what determined a person's social status in the early medieval period is obscured. In other words it is not at all evident what early medieval society looked like in a place like Maastricht. The Germanic penal codes specifically acknowledge the existence of three groups in society: the free (*ingenuus*), the half free (*letus*) and the unfree (*servus*). Written sources indicate there was an elite in society. However, the legal codes do not mention the existence of nobility as a separate category. They do mention that people of low judicial status could move to influential positions in society.³¹³ Apart from their judicial status, people often belonged to various sociological groups, based on dynamic and varying ordering principles, e.g. family structures, religious or secular hierarchies, work-related groups.

At present, the available archaeological data do not allow us to detect the details of this fine framework of social groups and link these to individual burials. The complexity of such a true to life categorisation of individuals is not something that needs to be achieved for this study. That would lead to minute social units that would be too small to allow for comparisons with significant results. Ideally a classification of burials according to social status should be a reflection of the actual stratification of society and still be simple enough to allow for comparison among the categories. By analogy with the early medieval judicial categories it was decided to distribute the inhumations over three categories. These categories are the low status, intermediate and high status category. However, it is important to realise these categories are not identical to the three groups in the legislation. They represent burial status which not necessarily reflects the social status of the buried individual.

³¹¹ For a review of the recent literature see Härke, 1997 and Dickinson, 2002. In combination with more recent literature Steuer's monograph provides an excellent introduction to the topic. Steuer, 1982. Recently Effros has stressed the importance perishable grave goods may have had in the burial ritual. Effros, 2002.

³¹² Halsall, 1995.

³¹³ Staab, 1996; Drew, 1991.

To categorise the graves from the Servaas church site and the Boschstraat site a simple approach was chosen. Criteria for the categorisation of the individuals were the cemetery, the position within the cemetery, the grave type and grave goods. For comparison by status the individuals from the *templum* and *basilica* phases and the Boschstraat site were combined to obtain sample sizes that would allow for meaningful statistical analysis.³¹⁴ In order to combine these samples three assumptions have to be made. Firstly we have to assume that the structure of society was more or less comparable during both the *templum* phase and the *basilica* phase. Although early medieval society underwent considerable changes between the late Roman period and the high Middle Ages, there are no indications of fundamental rearrangements or transitions, like the emergence of large new social groups. The second prerequisite is that general living conditions did not change significantly between 480 and 950 AD. This prerequisite will be tested in chapter eight. The third assumption is that both the *templum* phase and the *basilica* phase samples on the one hand, and the Boschstraat site sample on the other hand, were considered to represent complementary sections of early medieval society in Maastricht. The complementary nature of the early medieval cemeteries of Maastricht will be discussed in chapter seven.

All burials at the Boschstraat cemetery were categorised in the low status category because of the characteristics of this cemetery. The context of this cemetery as a whole and the materialistic data of individual graves differed fundamentally from the contemporary burials at the Servaas church site.³¹⁵ The graves of the Boschstraat site were simple and located in a cemetery that was not associated with a church or the grave of a saint but amidst a settlement of craftsmen. Based on written sources it is difficult to determine the social status of craftsmen. According to Roth the majority of craftsmen were unfree men dependent on secular lords or clerical institutions.³¹⁶ The characteristics of the associated activities on site and the nature of the burials were interpreted as indications that the Boschstraat site served as a cemetery for persons of lower social status.

Because of the assumed presence of the grave of Saint Servatius and the consecutive churches built at the site, the *templum* phase and *basilica* phase burials were regarded as “*ad sanctos*” burials of individuals of intermediate or high status.³¹⁷ Within the cemetery a variety of positions, grave types and grave goods was seen. This seemed to allow for a further division of the burials at this site in an intermediate and a high status category. For this purpose the burials from the *templum* phase and the *basilica* phase at the Servaas site were pooled. Various stories of miraculously moving graves for example in the writings of Gregory of Tours indicate

³¹⁴ The small sample from the *cella* phase was not included in this comparison as it represents the late Roman period; this would mean the inclusion of individuals living under socially and biologically different circumstances. For this sample there were no historical or archaeological data to determine the social status of the individual graves and the burials as a group.

³¹⁵ Secondary inhumations were not categorised into status categories because of the uncertainty of their association with the grave type in which they were found.

³¹⁶ Roth, 1986, p. 128. Roth also describes that some of these craftsmen could rise to high positions, of which the artist-bishop Eligius was the best example.

³¹⁷ Effros, 1997, p. 13.

that the position of the grave within the cemetery was considered an important indicator of the status of the inhumed.³¹⁸ In this study the position of each burial within the cemetery was determined in relation to contemporary buildings and burials. For the beginning of the *templum* phase the point of reference was the *cella memoriae*. Later, after the construction of the first stone church, the church became the point of reference. Assessment of the position within the cemetery was reduced to two categories. Burials inside the church or directly adjacent to the church were categorised as of high status. Burials at a distance of a few meters from the church were categorised as intermediate status graves. Grave-types also provide information on the social structure of the cemetery by taking into account their monumental aspects and economical value. Grave types were graded based on the amount of labour that was invested into the construction of the grave. Categorised as high status graves were sarcophagi (tuff stone or limestone) and stone-built graves (normal and large). Less valuable grave types comprising burials in trench graves and coffins at the Servaas church site were categorised as intermediate status burials.

	Criteria	Interm.	High
Position	In the church / close to the church		X
	Around the church	X	
Grave type	Sarcophagi / stone built graves		X
	Trench / coffin burial	X	
Grave goods	Precious grave goods		X
	No grave goods	X	

TABLE 3-6 Classification scheme for the *templum* and *basilica* phase burials at the Servaas church site. Not classified were disarticulated remains and secondary burials.

In early medieval cemeteries grave goods are generally used to determine the social status of the individual burials.³¹⁹ As grave goods were only found in graves from the *templum* phase and not in *basilica* phase graves their value, as an indicator of status, was problematic. Consequently *templum* phase graves were judged according to an extra parameter. Another factor complicating the categorisation by grave goods is the loss of grave goods due to either intentional grave robbery or accidental disturbances of the grave during later construction and burial activities. Nevertheless, it was decided to use this parameter because of the presence of precious grave goods in some burials that otherwise would not have been rated as high status burials. And since grave goods were used as a parameter, all graves with grave goods from the Servaas church site were categorised as of high status. Burials with simple grave goods were not graded as of intermediate status since these may have been robbed or disturbed graves. Rich graves were generally fitted out with an assemblage of grave goods ranging from common utensils to precious goods. It is known that in robbed graves thieves would leave behind those

³¹⁸ Effros, 1997.

³¹⁹ Steuer, 1982.

goods that were of little value.³²⁰ Therefore, it was decided to place all graves with grave goods in situ in the high status category. This decision will probably cause some graves to be placed in the wrong category. Still, the opposite would also be the case if these graves were categorised in a lower status category, since it is likely that a number of graves with non-precious grave goods represent robbed or disturbed high status graves.

Grave type / Position of the grave		Around church	Close to church	Total
Coffin or trench	N	59	5	64
	%	92%	8%	100%
Sarcophagus or stone built grave	N	16	24	40
	%	40%	60%	100%
Total	N	75	29	104
	%	72%	28%	100%

TABLE 3-7 Grave type by position of the grave. Graves, also including empty graves, are counted.

All graves were scored as intermediate status burials unless one of the parameters, position, grave type or grave goods, complied with the criteria defined for high status burials. At the Servaas church site 104 graves could be assigned to either of the status categories. In order to determine whether the results for the selected parameters were in agreement with each other the associations between the three parameters were tested. The association between grave goods and either position or grave type was poor. This poor association is not easy to explain. Did the loss of grave goods make this parameter a poor indicator for social status during the *templum* phase? Alternatively, were other aspects than position and grave type also important indicators of social status? A highly significant association ($p < 0.0001$) was found between the position within the cemetery and grave type (Table 3-7). This provides some assurance that the parameters may be used as indicators of status.

			Sub-sample			Total
Status			Templum	Basilica	Boschstraat	
Low	N				54	54
	%				100%	35%
Intermediate	N		13	27		40
	%		25%	56%		26%
High	N		40	21		61
	%		75%	44%		39%
Total	N		53	48	54	155

TABLE 3-8 Individuals per status category and per site

³²⁰ See Steuer 1982 on the effect of grave robbery, focussing on the most precious objects.

In total the skeletal remains of 155 individuals were categorised by status. Not all status categories were equally represented. It seems that the high percentage of high social status burials in the sample as a whole was mainly the result of the high percentage of burials from this category in the *templum* phase sample.

4

*Material: survival and
recovery of the human
skeletal remains*

Around 1000 AD emperor Otto III assembled a small group to secretly search and open the grave of Charlemagne in Aachen. To his surprise he found the body of his illustrious and venerated predecessor sitting in his grave as if he had just fallen asleep. According to the account of an eyewitness not only his clothes and personal belongings were well preserved, emperor Charles' body also appeared almost immaculate. Only the tip of his nose had fallen victim to decay. Before he closed the grave, Otto replaced the missing part of the nose with a golden prosthesis; he cut Charles' nails; collected some hair and extracted one tooth, probably with the intention of keeping them in a reliquary.³²¹

Unfortunately the condition of the early medieval human remains excavated in Maastricht never approximated the situation described in this legend. In general only bones were recovered from the graves and even these skeletonised remains were often far from complete. In a paper discussing the problem of incomplete skeletal remains Waldron has argued that variation in the completeness and conservation of recovered skeletons can bias the results of a study of skeletal material.³²² Therefore, assessment of the completeness and state of preservation of the human remains is a necessary prerequisite for osteo-archaeological studies.³²³ As will be discussed below an evaluation of the completeness of the skeletal remains may also extend our knowledge of burial customs and the impact of grave types on the preservation of skeletal remains.

In this chapter, aspects associated with the recovery and preservation of the skeletal remains will be described and discussed. The chapter starts with a description of the recovery procedures on site and preparations for storage and study in the laboratory. The following section addresses matters concerning the completeness of skeletons and bone preservation. This section will focus on both the "completeness rate" of individual skeletons and the "relative survival" of bones and parts of the skeleton at the level of samples and sub-samples. In the following part the completeness rate is used as a parameter to present information on the proportion of the whole skeleton recovered. The relative survival is used to study the selective processes that may have influenced the preservation of various parts of the skeleton. Among the three samples from the Servaas site marked differences in completeness and relative survival of the skeletal material were noticed. To determine the differences between the various groups of skeletons mean completeness rates and recovery percentages were calculated.³²⁴ After a short

³²¹ Althoff, 1996, p. 149-151.

³²² Waldron, 1987, p. 55-64. Also see Hoppa, 1996.

³²³ For documentary sources the investigation of the material aspects of the source can provide insight in the context and informative value of the source. Likewise the study of the completeness and preservation of the skeletal remains can elucidate the informative potential of the sample.

³²⁴ At the time of development of the database for this study the author was not aware of the method used by Waldron to calculate completeness rates. Therefore, only general comparisons with Waldron's results can be made. Waldron, 1987, p. 55-64.

description of the general state of preservation of bone at the two sites this chapter will focus on the factors that influenced the survival of the skeletal material. Finally some of the possible consequences of the variation in relative survival on the anthropological and palaeopathological data will be discussed.

RECOVERY PROCEDURES

Excavation trenches at the Saint Servaas site were completely dug by hand. At the Boschstraat site, a rescue excavation, a dragline was used to remove a top layer of rubble. Further archaeological techniques applied to detect graves, excavate human bones and record circumstantial information were the same at both sites.³²⁵ When the outline of a grave or grave-like feature became visible, its contour was recorded on the site plan (scale 1:20). Details of graves containing grave goods or skeletal material were often mapped out on additional drawings at a scale of 1:20. The filling of the grave was carefully removed. *In situ* measurements of the stature of the individual, from the top of the skull to the base of the calcaneus, were taken in the rare cases when all necessary bones were present and in anatomical position. Any finds in the grave were collected after their position was recorded on a drawing of the grave. In about 25% of the graves a soil sample was taken from the abdominal region. From the sarcophagi and stone-built graves, stone and mortar were sampled respectively.

When necessary, different categories of material collected from the grave were listed under separate numbers. Special items like grave goods also obtained their own number. After the grave and the skeleton had been cleaned, monochrome and colour photographs were made *in situ*. On an archaeological burial registration form all graves and grave finds were described in a standardised way. Additional information was recorded in the excavation journal. Skeletons found at the Boschstraat site were recovered the same day. Within the Saint Servaas church the climatic conditions were very stable. This allowed the archaeologists to incidentally leave some skeletons *in situ* for periods up to a fortnight. Still, most of the skeletons found at that site were collected within one to three days. Once the bones were lifted, they were dried and packed in plastic bags. At the Boschstraat site skeletal remains were generally recovered on the day they were exposed. For every skeleton the skull, the trunk and the right and left limbs were put in separate bags. The procedures for collection and storage of the bones partially met present day requirements.³²⁶ At the time of excavation the research of ancient DNA (aDNA) was still in an early developmental phase and knowledge of the necessary precautions for the analysis of

³²⁵ Both excavations of the Boschstraat site and Servaas church site were carried out by the field team of the archaeological service of the city of Maastricht: B. Emmenes, J. Lebon, M. Roufflard, H. Siebelst, J. Zwakhalen. Field archaeologist was P. Boyens; scientific supervision T. Panhuysen. The author participated for several weeks in the Boschstraat site excavation and for circa 10 weeks in the Servaas church site excavation.

³²⁶ For guidelines concerning the recovery of the human remains the archaeological service of Maastricht had consulted W. Perizonius from the institute for Anthropobiology of Utrecht University. Recovery procedures were largely based on his recommendations. Due to the development of new analytical techniques (trace elements, stable isotopes and ancient DNA) an adaptation of recovery procedures has become imperative. Examples of recent recommendations for the recovery of human skeletal remains can be found

aDNA was not yet available to the archaeologists. Furthermore, the soil from several graves was not sieved. This probably caused the loss of smaller bones, bone fragments and loose teeth.³²⁷ Fortunately soil samples were collected frequently providing the necessary reference samples for future physical and biological analysis.

LABORATORY PROCEDURES

Since the bones had not been cleaned before storage, lumps of dried loam had to be removed with water. In some cases, skeletons had not been dried sufficiently before storage, which led to the growth of fungi on the bone. All washing activities were done over a fine-mesh sieve (2x2 mm) to prevent the loss of small fragments.³²⁸ Fresh water and soft brushes were used to remove the loam. Drying of the bones took place at room temperature (20°C). For storage, the bones were packed in plastic bags, which were not sealed but closed in such a way that air could flow in and out of the bag. Many bones were fragmented and had to be reconstructed. Restoration turned out to be time-consuming. Fragments that did not yield valuable physical anthropological or palaeopathological information were not reconstructed. For those fragments that were reconstructed a glue of water-soluble polyvinyl acetate was used. Only in exceptional cases were bone fragments treated with chemicals to prevent further deterioration. Fragments of the vertebral column and a femur³²⁹ with pathological changes were preserved by immersion in Archeoderm© to forestall further loss of the brittle bone.³³⁰ Assemblages of disarticulated bones of multiple individuals were carefully ordered into smaller groups representing possible individuals. *In situ* photographs, articulation of joints, symmetry, size and morphological differences, dental occlusion, tooth wear, variation in colour and degree of preservation were used to separate the bones per individual skeleton.

On a schematic drawing of the cranial and post-cranial skeleton, the presence of bones was recorded for each individual. Note was also taken of the presence of hyoid bones and auditory ossicles. Furthermore, on a separate form, record was kept of the completeness of the dentition. Cases in which skeletons showed iron oxide and copper oxide staining, the location of the stains was marked on the stylised drawing. All inventory data were stored in a database.

in: Herrmann et al., 1990, p. 15-45; McKinley and Roberts, 1993; Mays, 1998, p. 14-15. Sample preparation for aDNA analysis is discussed in Hummel and Herrmann, 1994.

³²⁷ Mays, 1998, p. 14-15.

³²⁸ The author was involved in the cleaning of all skeletal remains in cooperation with R. Dassen. This proved advantageous for the recovery of small fragments and specific types of small bones like hyoid bones and auditory ossicles. Approximately 70 auditory ossicles were recovered from the sieved remains. In cases where the external auditory meatus was filled with soil, this was left in place to be removed at a later stage with dental instruments. This led to the additional recovery of circa 70 auditory ossicles.

³²⁹ Find 11-04-03 from the Servaas church site.

³³⁰ W. Mulder then at the Anatomy museum, Leiden University, kindly performed preservation of these bones.

FIGURE 4-1 Example of an inventory drawing, displaying the 85 sections used to register presence or absence.

CALCULATION OF COMPLETENESS RATES AND RECOVERY PERCENTAGES

Completeness rates were calculated for all individual skeletons based on the inspection of 85 selected elements of the skeleton (Figure 4-1). Not included in the calculation of the completeness rate were the dentition, the auditory ossicles and the bones of the hyoid.³³¹

Cartilage structures that sometimes ossify, like the cricoid and thyroid, were also not included.

For the combination of inspected parts of the skeleton the range of the completeness rate could

³³¹ Parts of the hyoid bone were recovered in circa 10% of the cases, Bruinjes and Panhuysen, 1994.

vary from 0 (absent) to 1 (complete). These rates were calculated to provide an indication of the research potential of individual skeletons and of groups of skeletons. Included were data on the presence of parts of the skull, the pelvis, the extremities the shoulder girdle, manubrium, sternum and ribs. Larger bones, or bones with large joints were divided in segments, which were separately included in the calculation.³³² Parts of the skeleton were recorded as 'present' in cases in which the part was almost complete on recovery. Functional criteria were applied: enough bone had to be present to ensure that it could be used for a physical anthropological or palaeopathological purpose.³³³

	Number of bones	Number of segments	Percentage of completeness rate
Skull	22	8	9%
Pectoral girdle	4	8	9%
Vertebral column	26	5	6%
Thorax	26	4	5%
Pelvis	2	6	7%
Upper extremity	6	18	21%
Hand	54	6	7%
Lower extremity	8	20	24%
Foot	52	10	12%
Total in completeness rate		85	100%
Auditory ossicles	6	Recorded separately	
Hyoid	1 (5)	Recorded separately	
Dentition	32	Recorded separately	

TABLE 4-1 List of bones of the human skeleton and their representation as segments for the calculation of the completeness rate.

A different recording strategy was chosen for the smaller bones of the hand and foot and for the vertebrae. The bones of the hand and foot were scored per group of bones, namely the carpal and tarsal bones, the metacarpals, the metatarsals and the phalanges of the hand and foot. In the initial inventory these bones were recorded individually. However, the small bones of the wrists, hands and feet add up to hundred and four bones in total. Together they constitute about half the number of bones present in the average human skeleton ($n=206$). If these bones had been included individually in our calculations the (partial) absence of the bones of the wrists, hands and feet would have obscured the other results. By scoring their presence per group of bones the importance of the hands and feet in the formula for the completeness rate is reduced. As a result those parts of the skeleton that often provide basic physical

³³² E.g. the long bones were divided in three segments viz. the proximal end, the shaft, and the distal end and for the pelvis the ischium, the pubis and the ilium were recorded separately

³³³ E.g. a temporal bone of the skull was scored 'present' if enough bone remained to score its sex features, a distal humerus was scored 'present' if scoring the absence or presence of degenerative or other changes was possible.

anthropological and palaeopathological information are of more weight in the calculation of the completeness rate. For the wrists, hands and feet the presence of one bone of each group of bones was sufficient for a score as 'present'.³³⁴ The vertebrae were included in a similar way: the vertebral column was divided in five segments.³³⁵ A segment would be scored as present if at least one third of the facet joints and endplates of a segment were available for inspection. Completeness rates were calculated for each skeleton by dividing the sum of recovered parts by the total number of expected parts, viz. 85. The thus calculated completeness rates per individual were also used to compute mean completeness rates per site, per phase and per grave type.

The examined samples showed a considerable variation in the frequency with which various parts of the skeleton were recovered. To assess the relative bone survival of a specific bone or segment of the skeleton, recovery percentages were established per sub-sample. This percentage expresses how many of the expected parts were in fact recovered. For all inspected parts of the skeleton the following formula was used to calculate the specific recovery percentage³³⁶ (in this example the formula for the right femoral shaft is represented):

$$\text{Recovery percentage femoral shaft (R)} = 100 \times \frac{\text{N femoral shafts(R) recovered}}{\text{N individuals inspected}}$$

Finally to determine the contribution per sub-sample of skeletons to the whole sample proportional percentages (e.g., categorised by period or grave type) were calculated for the 85 parts of the skeleton.

$$\text{Proportional percentage} = 100 \times \frac{\text{N parts recovered per sub - sample}}{\text{Total N parts recovered}}$$

The recovery percentage and the proportional percentage were calculated for sub-samples based on grave types and building phases. Although these percentages were computed for all parts of the skeleton, the results of a selection of eight skeletal parts will be presented in the text below. This set of eight parts comprised a cross section of the available four gross morphological bone types: long bones, short bones, flat bones and irregular bones. The selection also represents bones consisting of one of the two main types of bone architecture: compact bone and cancellous bone.³³⁷ Furthermore, the set encompasses bones that are easily recognisable during excavations and bones that are more unobtrusive and may be overlooked. The eight selected parts of the skeleton were the frontal bone, the right proximal humerus, the right metacarpals, the sternum, the left ilium, the diaphysis of the left femur, the left talus, the phalanges of the right foot. The eight selected parts of the skeleton used in the table above and

³³⁴ E.g., if an os naviculare of the right hand was recovered the carpal bones of the right hand would be recorded as 'present'.

³³⁵ The segments paralleled common anatomical divisions: cervical vertebrae (7), upper thoracic vertebrae (6), lower thoracic vertebrae (6), lumbar vertebrae (5) and the sacrum.

³³⁶ Recovery percentages for left and right bones or bone sections were calculated separately.

³³⁷ Bone characteristics described e.g. by Micozzi, 1993, p.54-55.

following tables proved to be representative for all inspected parts. Both the right and left side of the skeleton were represented in the selection.

FIGURE 4-2 A scatter plot showing the strong correlation between recovery rates based on the 85 inspected element (on the vertical axis) and the rate based on the selection of 8 segments of the skeleton (on the horizontal axis) (Number of inspected individuals is 238)

Both mean recovery rates calculated on the basis of all 85 parts and the recovery rate calculated from 8 selected parts of the skeleton were similar for all sub-samples. As shown in Figure 4-2 there was a linear relationship between the two recovery rates. Computation of Pearson's correlation for the two rates resulted in a highly significant ($p < 0.001$) correlation coefficient of 0.931. This strong correlation indicates that in future studies recovery rates can also be calculated based on this selection of eight segments of the skeleton.

NUMBER OF INDIVIDUALS AND COMPLETENESS

At the Servaas site archaeologists collected the skeletal remains of at least 283 individuals. Of the whole sample 23 individuals could not be dated; 16 individuals were assigned to the period between 950 and 1800 AD and thus fell outside the scope of this study. As a result a total of 244 skeletons was considered to date to the period between circa 350 and 950 AD. In 60 cases the archaeological evidence did not permit more specific dating.

FIGURE 4-3 The bars represent the number of individuals from the Servaas church site and the Boschstraat. The results found for the first the second and the fifth categories (n=99) were not included in this study.

This study focuses on those 184 inhumations that could be specifically assigned to one of the three building phases before 950 AD. At the Boschstraat site 54 skeletons were recovered all dating from the seventh or early eighth century. Therefore, the total number of skeletons analysed within the framework of this study comprised of 238 skeletons. As explained in chapter three the whole sample was divided in four (sub-)samples: viz. the *cella* sample, the *templum* sample, the *basilica* sample and the Boschstraat sample. Below the relevant data concerning the recovery of human skeletal remains will presented per sample.

Sample	Graves	Empty graves	Individuals from graves	Individuals from disturbed burial contexts	Total number of individuals	Completeness rate
Cella	19	0	21	2	23	0.30
Templum	88	35 (39%)	55	25	78	0.13
Basilica	73	24 (33%)	50	33	83	0.26
Boschstraat	50	6 (12%)	44	10	54	0.32
Total	230	65	170	77	238	0.24

TABLE 4-2 An overview of data related to the recovery of human skeletal remains from the four samples that were examined for this study.

A total of 23 skeletons was assigned to the *cella* sample. All 19 graves of this phase contained skeletons. One grave enclosed the articulated skeletons of 3 individuals. Remains of 2 individuals, from disturbed graves, could be added to this collection. Inhumations of the *cella* phase made up 9.7% of the sample examined within the framework of this study. Inhumations from the *cella* sample were the most complete of the three Servaas church site samples, which is evident from a completeness rate of 0.30.

The *templum* sample consisted of 78 skeletons, representing nearly a third of the skeletons in this study (32.8% of the total sample). Fifty-three of the individuals were found in graves. Thirty-five (39.3%) of the 88 graves of this phase were disturbed and contained no human material. Remains of 25 individuals were collected from elevation layers and disturbed graves. In general the skeletons from the *templum* sample were incomplete, resulting in a mean completeness rate of 0.13. More than 80% of the skeletons had a completeness rate of less than 0.25.

The *basilica* sample contained the largest group of skeletons, viz. the skeletal remains of 83 individuals (34.9% of the total sample). About 73 graves were assigned to this phase; 24 (32.9%) of these were empty. In the remaining 49 graves 50 individuals were found. Fragments of 36 skeletons were collected from elevation layers and disturbed graves. The mean percentage of completeness of the skeletons from the *basilica* sample was 0.27. Circa 60% had a completeness rate of less than 0.25.

At the Boschstraat site 54 skeletons were recovered (22.7% of the total sample). Six empty graves were recognised (10%). From 44 graves, skeletons were collected. In addition, skeletal remains of 10 individuals were found in and around the graves. The mean completeness rate was 0.32 and only half of the skeletons were found to have a completeness rate of less than 0.25.

Group 1	Group 2	N	Mean	S.D.	N	Mean	S.D.	p
Cella	Templum	23	0.30	0.26	78	0.13	0.17	<0.001
Templum	Basilica	78	0.13	0.17	83	0.26	0.27	<0.001
Servaas	Boschstraat	184	0.21	0.24	54	0.32	0.25	0.005

TABLE 4-3 Comparison of the mean completeness rates for the four sub-samples and calculated p-values for Student's t-test

Table 4-3 shows comparisons of the mean completeness rates for each sub-sample. As indicated above the highest mean completeness rate was calculated for the inhumations from the Boschstraat sample, closely followed by the *cella* sample, the *basilica* sample ranked third and skeletons from the *templum* sample were the most incomplete. This suggests that time after deposition of the skeletal remains was not an important factor determining the chances of recovery of human skeletal remains at these sites. Statistical analysis showed that the difference in mean completeness rate between the *templum* sample and both the *cella* and *basilica* sample was significant. In general the skeletal remains recovered from the Boschstraat site were significantly more complete than those collected at the Servaas church site.

RELATIVE SURVIVAL AND RECOVERY

Completeness rates per sub-sample

Table 4-4 shows that the recovery pattern of eight selected parts of the skeleton was not the same for each sample. As might be expected, parts of long bones and other bones with a high proportion of compact bone were recovered more frequently than parts with a high proportion of cancellous bone and small bones.³³⁸ For example, recovery percentages found for the femoral shaft and the frontal bone were generally higher than might be expected based on the mean completeness rate. Low percentages were found for bones like the phalanges or the sternum. However, this pattern of relative survival of bones and segments was not identical for each sample. The *templum* sample in particular had a pattern of recovery percentages that differed from the other three samples. In comparison with the mean completeness rate, inhumations from the *templum* sample yielded low recovery percentages for the proximal humerus, the sternum, the ilium, the talus and the phalanges of the foot. This pattern of differential survival was reflected in the proportional percentages.

	Cella	Templum	Basilica	Boschstraat
N individuals	23	78	83	54
Mean completeness rate	0.30	0.13	0.26	0.32
Frontal bone	47.8 %	35.9 %	44.6 %	46.3 %
Prox. humerus R	47.8 %	10.3 %	32.5 %	35.2 %
Metacarpals R	21.7 %	19.2 %	31.3 %	25.9 %
Sternum	13.0 %	3.8 %	14.5 %	5.6 %
Ilium L	30.4 %	14.1 %	33.7 %	57.4 %
Femur shaft L	60.9 %	37.2 %	39.8 %	70.4 %
Talus L	13.0 %	6.4 %	15.7 %	29.6 %
Phalanges foot R	4.3 %	2.6 %	8.4 %	7.4 %

TABLE 4-4 Mean completeness rates calculated for all 85 parts and recovery percentages of eight selected parts of the skeleton per sub-sample

Because of the variation in recovery percentages it was noticed that bones found in above average quantities in specific samples, caused these samples to be comparatively over represented in the total sample and vice versa. If we look for example at the recovery percentage found for the right proximal humerus in Table 4-4, we see a recovery percentage of 47.8% for the *cella* phase and 10.3% for the *templum* phase. As a result we can see in Table 4-5 that 16.9% of the recovered proximal humeri was found in the *cella* phase, while the *templum* phase contributed only 12.3%. Thus the *cella* sample was represented in the total sample by more proximal humeri of the right side than the *templum* sample, despite the fact that the

³³⁸ Differential survival of bones from archaeological and forensic contexts is a common phenomenon. See Micozzi, 1991, p. 54-59 and Hoppa, 1996.

latter sample contributed more than three times the number of individuals to the sample as a whole.

	Cella	Templum	Basilica	Boschstraat	N parts
N individuals	23	78	83	54	
% ind. of total sample	9.7 %	32.8 %	34.9 %	22.7 %	
Frontal bone	10.9 %	27.7 %	36.6 %	24.8 %	103 (100 %)
Prox. humerus R	16.9 %	12.3 %	41.5 %	29.2 %	65 (100 %)
Metacarpals R	8.3 %	25.0 %	43.4 %	23.3 %	60 (100 %)
Sternum	14.3 %	14.3 %	57.1 %	14.3 %	21 (100 %)
Ilium L	9.1 %	14.3 %	36.4 %	40.3 %	77 (100 %)
Femur shaft L	12.3 %	25.4 %	28.9 %	33.3 %	11 (100 %)
Talus L	8.1 %	13.5 %	35.1 %	43.2 %	37 (100 %)
Phalanges foot R	7.1 %	14.3 %	50.0 %	28.6 %	14 (100 %)

TABLE 4-5 Proportional percentage for eight selected parts of the skeleton. In normal distributions the expected proportional percentage for each skeletal segment was expected to be equal to the sample's percentage of the total sample (marked in grey). Percentages marked in bold were more than 25 per cent above the expected percentage for that sample. Those marked in italic were more than 25 per cent below the expected percentage for that sample.

Completeness rates per grave type

Completeness rates calculated for the various grave types also revealed considerable variation. Table 4-6 shows the recovery percentages for the four major grave types at the Servaas and the Boschstraat site. Burials in trenches yielded the highest mean completeness rate (0.34). A slightly lower rate was found for limestone sarcophagi (0.28). The mean rate of circa 0.24 for stone-built graves was not significantly lower than the trench graves and limestone sarcophagi. Only the difference in completeness rate between the trench graves and coffin graves proved to be statistically significant (Student t-test: $p=0.02$).

Group 1	Group 2	N	Mean	S.D.	N	Mean	S.D.	p
Trench	Coffin	89	0.34	0.24	32	0.22	0.24	0.02
Trench	Stone built grave	89	0.34	0.24	20	0.24	0.24	0.10
Trench	Sarcophagus (limestone)	89	0.34	0.24	14	0.28	0.30	0.42
Coffin	Stone built grave	32	0.23	0.24	20	0.24	0.24	0.80
Coffin	Sarcophagus (limestone)	32	0.23	0.24	14	0.28	0.30	0.50
Stone built grave	Sarcophagus (limestone)	20	0.24	0.24	14	0.28	0.30	0.67

TABLE 4-6 Mean completeness rates for four major grave-types and calculated p-values for Student's t-test

	Trench	Coffin	Stone built grave	Sarcophagus (limestone)
N individuals	89	32	20	14
Mean completeness rate	0.34	0.22	0.24	0.28
Frontal bone	56.2 %	40.6 %	50.0 %	28.6 %
Prox. humerus R	40.4 %	28.1 %	25.0 %	28.6 %
Metacarpals R	30.3 %	21.9 %	30.0 %	50.0 %
Sternum	13.5 %	9.4 %	0 %	14.3 %
Ilium L	49.9 %	31.3 %	30.0 %	7.1 %
Femur shaft L	65.2 %	59.4 %	65.0 %	28.6 %
Talus L	20.2 %	12.5 %	10.0 %	14.3 %
Phalanges foot R	2.2 %	6.3 %	5.0 %	28.6 %

TABLE 4-7 Mean completeness rate and recovery percentages of eight selected parts of the skeleton for four major grave types

The recovery percentages in Table 4-7 show the variation in relative survival for the set of eight selected parts of the skeleton. In general the recovery pattern was similar to the situation described above: with higher recovery frequencies for larger bones and bone segments with a large proportion of compact bone. However, between the different grave types some differences in recovery percentages were noticeable. Remains collected from trench graves and limestone sarcophagi in particular showed considerable variation in recovery percentages. In limestone sarcophagi the percentages found for small bones like metacarpals and phalanges of the foot were higher. Whereas larger but flat bones, like the frontal bone and ilium, were recovered less frequently from these sarcophagi. Statistical analysis showed that the low recovery percentages for the left ilium and the left femur shaft from limestone sarcophagi were significantly lower than those found for trench graves.³³⁹ While comparing the same groups the opposite was found for small bones. Although few phalanges could be collected, significantly more phalanges of the right foot were recovered in limestone sarcophagi.³⁴⁰

³³⁹ Chi-square test for the left ilium $p=0.003$ (Fisher's Exact Test) and for the left femur shaft $p=0.016$ (Fisher's Exact Test). Student t-test $p=0.04$ for both comparisons of the mean.

³⁴⁰ Chi-square test for the phalanges of the right foot $p=0.003$ (Fisher's Exact Test)

	Trench	Coffin	Stone built grave	Sarcophagus (limestone)	N parts
N Individuals	89	32	20	14	
% of sample	57.4%	20.6%	12.9%	9.0%	
Frontal bone	64.9%	16.9%	13.0%	5.2%	77 (100 %)
Prox. humerus R	66.7%	16.7%	9.3%	7.4%	54 (100 %)
Metacarpals R	57.4%	14.9%	12.8%	14.9%	47 (100 %)
Sternum	70.6%	17.6%	0.0%	11.8%	17 (100 %)
Ilium L	72.1%	16.4%	9.8%	1.6%	61 (100 %)
Femur shaft L	61.7%	20.2%	13.8%	4.3%	94 (100 %)
Talus L	69.2%	15.4%	7.7%	7.7%	26 (100 %)
Phalanges foot R	22.2%	22.2%	11.1%	44.4%	9 (100 %)

TABLE 4-8 Proportional percentage for eight selected parts of the skeleton calculated for the four major grave types (n=155). For comparison the proportional percentage of each sample based on numbers of individuals is mentioned as "% of sample". Percentages marked in bold were more than 25 per cent above the expected percentage for that sample. Those marked in *italic* were more than 25 per cent below the expected percentage for that sample.

The variation in survival and recovery influenced the composition of the sample available for study. Table 4-8 shows that among the remains from the limestone sarcophagi the frontal bone, the ilium and the femoral shaft were under-represented. Clearly over represented were the metacarpals and the phalanges of the foot. For the trench graves most parts were represented in the sample on a slightly larger scale than might be expected. Bones with a high proportion of cancellous bone, like the sternum, were especially well preserved. In addition, the os ilium was recovered more often from trench graves. Only for the phalanges of the foot did trench graves score well below average.

PRESERVATION OF BONE TISSUE

The state of preservation of bone tissue was inspected macroscopically. Generally the preservation of the skeletal remains was good. Indicative of the favourable conditions was the scarcity of erosive changes on the bone surface. When bones were x-rayed or sawn for various purposes, we often found particles of fine-grained soil had permeated the bone and covered the inner trabecular structure with a thin black layer.

An exception to the general state of preservation was the skeletal material recovered from sarcophagi. These bones were generally less well preserved. In many cases the cortex of many dense bones like the femora and tibiae had disappeared. Bone with a thin cortex like the iliac part of the pelvis had often disintegrated completely. Several fragments of bones were found to be cracked and were covered by crystals. In these cases the biogenic hydroxy-apatite ($\text{Ca}_5(\text{PO}_4)_3\text{OH}$) of the mineral component of the bone had recrystallised as brushite ($\text{CaHPO}_4 \times 2\text{H}_2\text{O}$). Because brushite crystals are larger than hydroxy-apatite their development disrupts the structure of the bone. Being soluble in water, the formation of brushite crystals not only

contributed to the loss of cortex but also to the desintegration of complete bones.³⁴¹ This process occurred predominantly in limestone and tuffstone sarcophagi.

FIGURE 4-4 Grave 101 a trapezoid limestone sarcophagus from the *basilica* phase of the Servaas church site, which was found with the lid of the sarcophagus in place and without a fill of soil. In the sarcophagus the remains of the skull can be recognised in the right corner of the head end. Below the skull in the area of the thorax and abdomen few bones were preserved: visible are a few vertebrae, the bones of the upper extremities were not preserved. The lower extremities were preserved, but only in a very fragile condition (Photograph: City of Maastricht).

Damage of bones due to the activities of scavenging animals was rare at the Servaas church site and absent at the Boschstraat site. At the Servaas church site a few bones displayed signs of possible gnaw marks of small rodents. The possibility that rodents had access to graves at this site was evident. In one of the stone-built graves the skeletal remains of an adult mouse and five to six non-adult mice were found inside a human skull.³⁴²

³⁴¹ Herrmann et al., 1990, p. 8-10 and Farewell, 1993, p. 142.

³⁴² Haglund, 1997.

RELATIVE SURVIVAL AND RECOVERY: RESULTS

A myriad of physical, chemical, biological and cultural factors is known to affect the preservation and survival of human remains. These can be categorised by different principles. From the point of view of the body we can discern intrinsic factors, related to characteristics of the body or skeleton itself, and extrinsic factors, including aspects of the environment and human activities. From a chronological perspective they can be categorised as ante-mortem, peri-mortem, and post depositional. Important determinants are the physical state of the individual, the post-mortem interval before burial, the grave type, the soil type, the type of bone, the depth of burial, the humidity, human activity at the site of burial and the recovery methods.³⁴³ Various studies have shown the importance of the burial location and post-depositional processes.³⁴⁴ The variation in the completeness rates and recovery percentages found for the Servaas and Boschstraat site suggest that human activities at the cemetery and choice of grave type had a significant impact on the composition of the sample available for study.

It is likely that other taphonomical factors, ranging from intrinsic aspects of the body to peri-mortem burial ritual, also influenced the composition of the skeletal sample at the two sites. However, it is difficult to determine the nature and the effect of these factors. Differences in recovery procedures seem to have been no cause for variation, since the same archaeological team excavated all graves in a standardised way. A more plausible option to explain differences in completeness and survival might be the local soil conditions. Although the characteristics of the soil itself did not vary strongly the conditions at the Servaas church site differed considerably from those at the Boschstraat site. At the Servaas church site the burials had been under the roof of the present church for about 950 years, whereas those at the Boschstraat were situated close to the river Meuse and were under a roof for a shorter period of time or in some cases never at all. How this affected the composition of the samples is difficult to establish. In addition little is known concerning important cultural factors like the interval between death and burial and the clothing or wrapping of the body before deposition in the grave.³⁴⁵ We know even less of intrinsic biological factors like the physical condition of the inhumed body.

³⁴³ Henderson, 1987, p. 43-54; Mant, 1987, p. 65-78; Waldron, 1987, p. 55-64; Janaway, 1997; Child, 1995.

³⁴⁴ E.g., in the case of a nineteenth century cemetery Nawrocki found a strong correlation between the depth below surface and the state of preservation of the burial. Nawrocki, 1995, p. 49-66.

³⁴⁵ Generally it is assumed that the deceased were buried between one and three days after death. Ohler, 1990, p. 80-92. E.g. Charlemagne was buried on the day of his death. (1911), p.35. Known exceptions to this general practice were the funerals of other kings and emperors who died in one place and were buried in another. As travelling was time-consuming the interval between death and burial must often have exceeded three days in such cases. See for some early medieval examples. Chélini, 1991, p. 482-483. That the body of the deceased may have been prepared for its last journey can be read in the account of the death of emperor Charles the Bald in 877 AD. Charles died in the south of France. As it was his wish to be buried north of Paris in Saint Denis, his body had to be transported over a considerable distance. The *Annales Bertiniani* describe the unsuccessful attempt to prevent the decay of Charles' body. People belonging to his retinue opened his body, removed the intestines, poured wine into his body and embalmed him with odorous substances. Despite this treatment the body began to smell. Even after they had placed the body in a tarred barrel covered with hides, the stench remained unbearable. Therefore he was buried in his barrel somewhere near Lyon. *Annales Bertiniani*, (1883), p. 137.

What then remains to be analysed within the scope of this study are two cultural factors: the influence of grave type and the effects of human activity at the site. Judged by the completeness rates and percentages calculated for the major grave types and three phases, both factors have influenced the composition of the sample. Still, it must be kept in mind that a complex of confounding factors determined the quantity and quality of the skeletal material available for examination. The two factors discussed below only provide a part of the explanation

TAPHONOMIC PROPERTIES OF GRAVE TYPES

Here some of the taphonomic properties of the major grave types will be described. This will in part help to explain the differences in recovery percentages found for several grave types and be of use for comparison with other early medieval cemeteries. The completeness rates and recovery percentages indicate that of the four major grave-types, the trench grave yielded the most complete skeletons. In general, bones collected from trench graves were also better preserved. Mean completeness rates for coffin graves; limestone sarcophagi and stone-built graves did not vary much. Although coffin graves and trench graves were found in the same areas and both were found in all phases, a significant difference between the mean completeness rates was noted (see Table 4-6). This indicates that generally the graves without traces of wood or coffin fittings were justifiably labelled as a separate category. At the same time it raises the question as to what caused the difference. The comparatively high completeness rates are thought to be the result of specific characteristics of trench graves.³⁴⁶

Mant found that the presence of air and the retention of liquid at the base of a coffin often contributed to increased decomposition of the soft tissue of the body.³⁴⁷ It has been suggested that a rapid rate of decomposition increases the risk of associated bone loss.³⁴⁸ To test if the presence of air and the retention of liquid also affected the chances of survival of skeletal elements at the Servaas church site and the Boschstraat site, the graves were divided in two groups determined by the nature of the grave type. Comparison between graves containing an "open space" or "chamber" at the time of deposition (coffins, limestone and tuff stone sarcophagi, stone-built graves and stone-built tombs) and "filled" grave types, lacking such an

In the first place this narrative informs us about actions taken to prevent decay in specific cases in the early medieval period. It also makes us aware that we may encounter traces of such preparations in the skeletal remains. The opening of the body may have caused recognisable damage to the skeleton, like cut marks on ribs, sternum and pubic symphysis that were found in (15th and sixteenth century) skeletal material that had received a similar treatment. Maat et al., 1997 On the other hand the practice of keeping a human body above the ground in combination with unsuccessful or temporary conservation techniques may possibly have lead to an increased decomposition of the skeletal remains.

³⁴⁶ In trench graves the proportional percentages for metacarpal bones were in accordance with what might be expected. For phalanges of the foot these percentages were less than half what might be expected. Possibly the foot end of trench graves was not always recognised. This may have caused the loss of bones in this area.

³⁴⁷ Mant, 1987, p. 67-68.

³⁴⁸ Gill-King, 1997, p.104-105 and Child, 1995.

open space, like trench graves.³⁴⁹ Below I will use the terms “chamber” and “filled” graves without quotation marks to indicate the two different categories of grave types.

A comparison of chamber and filled graves showed that in Maastricht there was a significant difference in the survival of skeletal parts as expressed in the completeness rate.³⁵⁰ In other studies Henderson found a similar correlation between burial in a wooden coffin and poor preservation of the skeleton.³⁵¹ The underlying reasons for this difference in survival of skeletal parts lay predominantly in two aspects that separate the filled graves from chamber grave types. In filled burials, like trench graves, the body was directly covered with soil at the time of burial. This had two important consequences. First, the access of air and organisms to the decomposing body was limited, preventing scavenging organisms (e.g. insects and snails³⁵²) and certain fungi from reaching the body.³⁵³ At the same time the reduced availability of oxygen created less beneficial circumstances for some types of bacteria and fungi involved in the decomposition process.³⁵⁴ Second, in trench graves the surrounding soil absorbed liquids from the decaying body.

In exhumations of graves of World War II, Mant noticed that putrefactive liquefaction occurred mainly in burials in coffins and caused the formation of a semi-fluid mass of about 5 cm at the base of the coffin. He observed that the retention of water and putrefied tissue was a contributing factor to an increased decomposition of the body.³⁵⁵ At the Servaas site (Figure 4-5) several bones, found in chamber grave types, displayed signs of the presence of liquid levels and a comparatively poorer degree of preservation of bone below the surface lines. This suggests that putrefactive liquefaction not only affected the body but also caused damage to the skeleton.³⁵⁶

Among the various chamber grave types, marked differences were found regarding the recovery percentages of various types of bone. E.g. a significant difference between coffins and trench graves was found for the number of vertebrae that were collected. The mean number of vertebrae recovered from coffin graves was less than half the mean for trench graves ($p=0.001$).³⁵⁷ The architecture of this irregular bone, with a thin cortex and a large proportion of cancellous

³⁴⁹ The division in two types of burials based on the presence of either an “espace vide” or an “espace colmaté” was described by Duday in a study aimed at reconstructing the grave type from the position of the skeletal remains, Duday, 1990. In that study Duday focuses on the interesting aspects of the displacement of bones, he does not discuss possible consequences for the state of preservation.

³⁵⁰ $P = 0.01$

³⁵¹ Henderson, 1987, p. 51.

³⁵² Snail shells were found in numerous graves. However, these snails were not systematically studied

³⁵³ The impact of reduced access to the body is also visible in the difference in decomposition of bodies lying on the surface. Sections of the body that are not covered by clothes are found to decay more rapidly than sections of the body that are protected by clothes.

³⁵⁴ Henderson, 1987, p. 51; Mant, 1987, p. 71-72, for a description of the various stages of decomposition see: Gill-King, 1997.

³⁵⁵ Mant, 1987, p. 67-68. He also mentions that after two years coffin lids were found to be warped, but apparently still in place.

³⁵⁶ The changes in the bone suggest there was a relation between the existence of these fluid levels and the recrystallisation of hydroxyapatite into brushite.

³⁵⁷ Comparison of the mean number of vertebrae: coffin graves: $n=31$, mean=5.29, S.D.=8.81, SE=1.58; trench graves: $n=69$, mean=12.22, S.D.=10.03, SE=1.21; $t=3.312$, $df=98$; $p=0.001$.

FIGURE 4-5 Right part of the skull of a male buried in a trapezoid limestone sarcophagus (find 27-03-03). Changes indicative of the presence of a fluid level in the burial is a fine line of a concentration of a chalk-like substance on the posterior part of the right temporal bone, continuing on the posterior part of the right parietal bone and closing the circle by continuation on the occipital bone. The surface of the bone enclosed by this circle is darker than the bone outside the circle. Similar phenomena were recorded in other graves (photograph: R. Panhuysen).

bone, probably made this part of the skeleton more prone to decay. The fact that the vertebral column was generally positioned at the bottom of the grave will have resulted in exposure of the vertebrae to the putrefactive liquid. This may have been a contributing factor in the increased decomposition of this part of the skeleton.³⁵⁸

It should be noted that generally the open space in wooden coffins disappeared after several years, when the wood decomposed and the coffin collapsed. From that moment on conservational conditions would gradually become equal to those in trench graves. Therefore, if inhumation in coffins had an adverse impact on the preservation of bone, this will have occurred mostly during the first phase after interment. A possible side effect of the collapse of the coffin lid was the chance that large bones, like the skull and pelvis, could break under the sudden pressure of the coffin remains and the soil above the grave. The ensuing fractioning of bones, which was often recorded in the skull and the pelvis, may have contributed to an increased decomposition of bone.

³⁵⁸ Another contributing factor is the fact that the vertebrae were generally located below the thorax and the abdomen, the region of the body where the decomposition process starts. Gill-King, 1997, p.97-98.

In sarcophagi and stone-built graves the presence of air and the retention of liquid at the bottom of the grave also seems to have enhanced the decomposition of bone. Possibly this effect was even stronger as the walls and bottom of these grave types would not decompose and could continue to collect liquids from the decomposing body and from the soil above.³⁵⁹ This was reflected in the completeness rates, which were generally lower in stone-built graves and especially in limestone sarcophagi.³⁶⁰ Some sarcophagi were fitted out with a so-called "seelenloch" a hole in the bottom intended to provide an outlet for liquids from the decaying corpse. Once the sarcophagi were placed in the ground the outlet would have become obstructed by the loamy soil, reducing the outward flow. The prolonged presence of putrefactive liquid may have acted as a factor enhancing decomposition in limestone sarcophagi. As can be seen in Table 4-7, flat bones like the frontal bone and ilium, but even sections of compact bone like femoral shafts were recovered in percentages below the mean.

Despite these unfavourable conditions, the mean completeness rate found for limestone sarcophagi was higher than for wooden coffins and, to a lesser extent, for stone-built graves (Table 4-6). The above average recovery percentages found for the bones of hands and feet seem to have compensated the effect of the above average loss of other parts of the skeleton.³⁶¹ An explanation for this pattern of relative survival might be that it was easier to collect small bones from the well-confined solid bottom of the sarcophagi than from for example trench graves. In other graves these bones were easily overlooked in the dark coloured soil or may have been mistaken for stones or lumps of soil. Recognising them on the solid bottom of the limestone sarcophagi was easier. Besides, many sarcophagi were intact and only filled with a small amount of soil. This also improved the possibilities to recover skeletal material. As mentioned above the bone in limestone sarcophagi was generally poorly preserved.

The completeness rate found for the tuff stone sarcophagi was exceptionally low (0.07, s.d. 0.03). Two of these sarcophagi were found with the covering lid still in place, a third was partially disturbed. Judging by the scarce skeletal remains collected from the closed graves it seems plausible that the same process which affected the flat bones in the limestone sarcophagi also occurred in the tuff stone sarcophagi. Only, in the tuff stone sarcophagi the decomposition processes seems to have been even more destructive.³⁶² The high completeness rates calculated for the three stone-built tombs, containing skeletal remains (mean completeness rate is 0.70, s.d.

³⁵⁹ Not all stone-built graves had a solid floor, in several cases the floor consisted of a dirt floor. The latter will have allowed for more drainage than graves with a solid floor.

³⁶⁰ To evaluate the determination of the sex of the skull and pelvis separate percentages of present characteristics were calculated. These percentages give a more detailed view of the survival of all parts of the skull and pelvis. In comparison to trench graves, a significantly lower mean skull percentage was found for limestone sarcophagi: trench graves: $n=51$, mean=74.2%, S.D.=10.0; limestone sarcophagi: $n=6$, mean=49.3%, S.D.=5.1; Student's $t=2.099$ df=55 $p=0.04$.

³⁶¹ Given the fact that bones lying on the bottom of the grave were poorly preserved and were recovered in small numbers the same would be expected for the small bones of the hands and feet. Nevertheless the proportional percentages for metacarpals and phalanges of the foot were relatively high (Table 4-8). In case of the phalanges of the foot the small number of individuals with phalanges of the right foot probably explains this. For the metacarpals the difference is less marked.

³⁶² Possibly the chemical characteristics of the tuff stone enhanced the decomposition of bone.

0.05) is in contrast with results for other chamber graves. Regarding the discussion above; it seems unlikely that the grave type was a major contributing factor to this high score. Better explanations are the comparatively undisturbed nature of these graves, which belong to the last phase of burials and the extra care with which these "special" graves were excavated.

For the six trench graves with stones found at the Boschstraat site a high mean completeness rate was found (0.57, S.D. 0.25). In comparison to the common trench graves the difference in completeness rates was significant.³⁶³ Trenches with stones were found in the same area as the common trench graves at the Boschstraat site and these graves were not excavated differently from the other graves at this site. Therefore, local soil conditions or recovery procedures cannot account for the marked difference in survival.³⁶⁴ High recovery percentages of almost 70% were found for the majority of skeletal elements. What caused this difference in completeness rates is presently unknown.³⁶⁵

BONE LOSS CAUSED BY HUMAN ACTIVITY

That the circumstances at both sites and during the three phases at the Servaas site were not equal can be inferred from the variation in completeness rates, which cannot be explained solely by the taphonomical properties of the grave types. Among the major factors that had an effect on the survival of skeletal remains was the disturbance of the graves by human activities. The effect of two categories of human activity could be examined at both sites: subsequent burials and actions related to habitation and building. Both activities were not selective in a sense that certain skeletal parts were more prone to disappear. As will be indicated below, they were selective in a way that graves of specific phases or in certain areas were affected more.

For the *cella* burials it was found that later inhumations from the *cella* phase did not disturb the older graves of this phase. Disturbance by graves or buildings of later phases was insignificant. Being inhumed at a lower level probably protected the graves of the first phase of the cemetery better against intercutting by later burials. Building activities associated with the construction of the *magnum templum* were employed in a separate area south of the graves. Because of their position at a lower level, and through coincidence, the *cella* phase cemetery largely escape destruction by later construction works for the *basilica* and the present church. The *cella* phase burials were also protected by the artificial elevation of the site deposited at the time of the building of the *templum* and *basilica* phase edifices.

Graves from the *templum* phase suffered more from disturbances by later burial activities. Even intercutting by graves from the same phase had a negative effect on the mean completeness rate. During the *templum* phase about ten graves disturbed older graves. Building activities accounted for further negative effects. Not only did the demolition of the *magnum*

³⁶³ Comparison between trenches and trenches with stones, found at both sites, by means of Student t-test: trench graves: $n=89$, mean = 0.34, S.D. = 0.23; trenches with stones: $n=6$, mean = 0.57, S.D. = 0.25; $t = -2.307$, $df = 93$, $p = 0.02$.

³⁶⁴ Even if the trench graves lined with stones are compared to the normal trench graves within the Boschstraat site the difference in mean completeness rates is significant (trench graves: $n=35$, mean = 0.34, S.D. = 0.24; trenches with stones: $n=6$, mean = 0.57, S.D. = 0.25; Student $t = -2.220$, $p = 0.03$).

³⁶⁵ Possibly certain aspects of the burial ritual created favourable conditions for the preservation of skeletal remains.

templum and construction work for the *basilica* disrupt the cemetery, it was also damaged due to the replacement of the *basilica* by the present church. This was reflected in a high number of empty graves and a large amount of disarticulated skeletal material collected from elevation layers.

In comparison with the *templum* phase, the conditions for the survival of skeletal material from the *basilica* phase were generally more favourable. Still, several graves were disturbed during the demolition of the *basilica* and the construction of the present church. Intercutting by other graves also reduced the amount of bone that was recovered.

At the Boschstraat site the conditions were apparently the best for the recovery and survival of human skeletal remains. As indicated in Table 4-3 the mean completeness rate calculated for the Boschstraat site was slightly higher than the rate found for the *cella* phase. Although medieval and post-medieval construction works disturbed large areas of the excavated terrain, the level of the burials was largely unaffected. In addition only few graves intersected older graves, generally causing no disturbance of the skeletal remains.

CONSEQUENCES OF VARIATION IN RELATIVE SURVIVAL AND RECOVERY

As mentioned at the beginning of this chapter the differentiated loss of skeletal remains may bias the outcome of the physical anthropological and palaeopathological examination. This could lead to less or less exact demographical data or a lack of precision in palaeopathological diagnoses. The loss of complete burials can cause under representation of specific demographic groups, especially non-adults. To apprehend what the possible biases of the Servaas and Boschstraat sample are, the major implications of differentiated loss will be discussed below.

DIFFERENTIAL LOSS OF NON-ADULT SKELETONS

It is often assumed that post-depositional processes and recovery procedures may act as a selective mechanism causing the under-representation of non-adult skeletons in archaeological skeletal samples.³⁶⁶ The lower percentage of calcified bone in non-adults renders them more vulnerable to decomposition.³⁶⁷ In addition the small size and their shape, unfamiliar to the untrained eye, may often have caused these bones to remain unobserved during excavation. For the samples from the Servaas church site and the Boschstraat site the completeness rates calculated for non-adults were significantly lower than for adults.³⁶⁸ Since less remained of non-adult skeletons, this implies that non-adult skeletal remains were possibly under represented in the sample due to factors relating to differential survival of bone.

One of the causes often suggested for the under representation of non-adult burials is a more superficial position of non-adult graves leading to the complete decomposition of non-adult skeletons. In consequence, burials closer to the surface are often more exposed to the influence

³⁶⁶ Guyot et al., 1997, p.226

³⁶⁷ Crist et al., 1997, p.320-322.

³⁶⁸ Student t-test: non-adult burials: n = 51, mean = 0.10, S.D. = 0.10; adult burials: n = 187, mean = 0.28, S.D. = 0.26; t = 4.918, df = 236, p = 0.00

of (micro-) fauna and bacteria.³⁶⁹ At the Boschstraat cemetery it was possible to test whether non-adult inhumations were buried at a different depth than adult burials. Judged by the mean level of burial the mean depth of non-adult burials was only 5 centimetres above the level of adult burials. This difference was not statistically significant.³⁷⁰ At the Servaas site this was difficult to test because of the relief in the terrain. Still, also for the Servaas site the general impression is that non-adults were buried at the same elevation as adults. At both sites no non-adult graves were found more superficial than adult graves. Therefore, there is no reason to assume that a difference in depth of burial between adults and non-adults was a cause for differential survival favouring adult burials.

As mentioned above the small size and the less calcified state of non-adult bones is a factor leading to differential loss of non-adult individuals in the sample. To what extent this factor biased the composition of the Servaas church site and Boschstraat samples can roughly be assessed by looking at the chances of recovery of parts in the adult skeleton with similar characteristics to non-adult bones and the recovery of child graves without skeletal remains. Fragile and small bones, like hyoid bones, auditory ossicles and tooth germs were collected in considerable numbers, both on site and in the laboratory. The preservation of such bones indicates that soil and environmental conditions generally facilitated the survival of fragile bone. Another indication that non-adult skeletons were not fully decomposed on a large scale was evident from the fact that all non-adult graves contained skeletal remains.³⁷¹

Circa 43% of the non-adult skeletal remains were found outside a burial context. Only 26% of the adult remains were collected without a burial context. The fact that soil from excavation levels was removed by shovel and sieved certainly improved the recovery chances of the bones from adult and non-adult skeletons in layers containing material from disturbed or unrecognised graves. Size and shape of the bones seem to have been important factors in the chances of recovery during this process. The pattern of recovery percentages shows that large and recognisable bones of non-adult individuals were recovered in similar proportions as those of adults.³⁷² However, for most small bones the recovery percentages for non-adults were extremely low. A possible explanation for the relatively high percentage of non-adult skeletal remains without a burial context might be that the excavation team was not familiar with the anatomy of the non-adult skeleton and may not have recognised all non-adult burials.³⁷³ As

³⁶⁹ Rodríguez, 1997, p.460.

³⁷⁰ This was tested for inhumations of adults and non-adults in the same, central, area of the cemetery to exclude bias from spatial variation in the elevation of the terrain. The mean depth of burial for non-adults (n= 23) was 45.40 metres + NAP, s.d. 0.17m and for adults (n= 24) 45.35 metres + NAP, s.d. 0.16m. The small standard deviation showed that there was considerable uniformity regarding the depth of burial.

³⁷¹ As recovered children's graves were found to be adapted to the stature of the deceased most child graves were recognisable by the interior length of the graves.

³⁷² The following selection of non-adult bones was recovered in similar proportions: the frontal bone, the temporal bone, the maxilla and mandible, the scapula, the iliac part of the pelvis and to a lesser extent the shaft of the femur and humerus.

³⁷³ To the untrained eye many bones from a non-adult skeleton do not resemble human bones or even bones at all. This is especially true for the remains of children between birth and circa five years.

indicated above, sieving the soil seems to have compensated for the loss of non-adult burials. Nevertheless, a considerable number of non-adult graves were documented with great care at both sites and the remains collected. All factors together will probably have reduced the chances of survival and recovery of non-adult bones. However, the absence of empty graves of non-adults suggests that the complete loss of non-adult skeletons was rare.

DIFFERENTIAL LOSS OF SKELETAL ELEMENTS

Like in other studies large and dense parts of the skeleton were generally recovered in larger numbers than small parts or elements with a high proportion of cancellous bone.³⁷⁴ A correlation was found between certain grave types and the differential loss of skeletal elements. Theoretically the differential loss of bones may hamper the physical anthropological determination of sex, age and stature. However, many of the features necessary for these determinations can be recorded from either right or left sections of the skeleton and from different parts of the skeleton. Consequently the collection of basic physical anthropological data is possible for the majority of skeletons.

It is more likely that the differential loss of bones had more impact on the palaeopathological analysis. The diagnosis of pathological conditions in the skeleton is generally more specific if more bones can be inspected. For example, the low recovery percentages of phalanges of the hand and feet hindered the classification of arthropathies³⁷⁵ and greatly reduced the possibility to diagnose the presence or absence of leprosy.³⁷⁶ Because the grave type was an important factor influencing the relative survival pattern, it has to be taken into consideration that in certain cases the distribution of pathology may also be biased by grave type.³⁷⁷

CONSEQUENCES FOR FURTHER ANALYSIS

Normally the number of individuals would form the basis to calculate the proportional size of each sample in relation to the total of skeletons included in this study. Based on the completeness rates, corrected sample percentages can be calculated, expressing the proportion of each sub-sample as a proportion of the total sample. For this purpose, the number of individuals in each sample is multiplied by the completeness rate for that sample. Based on the resulting numbers the corrected sample percentage is calculated. Samples with a low completeness rate, like the *templum* sample, will thus be represented with a corrected sample percentage that is lower than might be expected based on the number of individuals in each sample.

The skeletal material of the *cella* phase is characterised by a comparatively high mean completeness rate. This suggests that the bone survival may have partially compensated for the

³⁷⁴ Waldron, 1987, p. 55-64.

³⁷⁵ Waldron, 1987, p. 63.

³⁷⁶ E.g. leprosy can be recognised by characteristic changes of the phalanges and other bones of the hand and foot.

³⁷⁷ Especially when sub-samples are compared by status (a classification partially based on grave type) this possible effect has to be kept in mind.

small size of this sample. The recovery percentages further imply that differential loss of specific skeletal elements was negligible. As indicated in chapter 3 this sample represents just a small fraction of the original late Roman cemetery. Completeness rates and percentages calculated for the *templum* phase predict less favourable conditions for physical anthropological and palaeopathological analysis. This is reflected in the low corrected sample percentage (Figure 4-6). Because of the frequent disturbance of burials and the high number of inhumations in chamber grave types the proportional percentages calculated for smaller skeletal parts were low. The completeness rate calculated for the *basilica* sample was twice as high as than for the *templum* sample. Consequently the *basilica* sample, measured by the corrected sample percentage, was the largest sample in this study. Only the low completeness rate calculated for burials in limestone sarcophagi could have negative consequences for the analysis of who was buried in these sarcophagi. Because of the favourable conditions for bone survival at the Boschstraat site this sample is well represented in the total sample. As is evident from the high corrected sample percentage, the high completeness rate compensated for the smaller size of the Boschstraat sample. The use of trench graves contributed to the high completeness rate at the Boschstraat site.

FIGURE 4-6 Sample percentages based on the number of individuals in each sample and corrected sample percentages based on the number of individuals per sample.

Sample	Status	N	Mean completeness rate	Corrected sample percentage per status category	Corrected sample percentage of all status categories
Boschstraat	Low	54	0.32	100%	37%
Templum	Intermediate	13	0.09	9%	29%
Basilica		27	0.46	91%	
Templum	High	40	0.20	51%	34%
Basilica		21	0.37	49%	

TABLE 4-9 Summary of the number of skeletons, the mean completeness rates and the corrected sample percentages per sample by status

The statistics for completeness rates and corrected sample percentages can also be used to explore the sample repartition by status (Table 4-9). With respect to their burial status all individuals from the Boschstraat site were categorised as low status, which was represented by relatively well-preserved skeletons. The intermediate status sample was largely composed of burials from the *basilica* sample (91%) and only a small proportion from the *templum* sample (9%). To the high status sample the contribution of the *templum* sample was more in balance with the *basilica* sample. As can be deduced from the corrected sample percentages in the last column of Table 4-9 the three status categories were more or less equally represented in the total sample available for analysis.

CONCLUSIONS

The calculation of completeness rates and recovery percentages is a useful tool to analyse the impact of various taphonomical factors on the composition of the samples. A clear difference in completeness rates was found between trench graves and graves consisting of an open space, like in perishable or non-perishable containers, such as a wooden coffin or sarcophagus. This suggests that the presence of air and putrefactive liquid in coffin graves and sarcophagi was a factor that not only enhanced the decomposition of soft tissue but also of bone. The analysis of recovery percentages per sample and per grave type has shown that especially small skeletal elements were often under-represented in the total sample. This is expected to limit the possibilities for detailed palaeopathological analysis. For the burials from the *templum* phase this effect was stronger, because of the increased disturbance of burials during that phase. With respect to palaeopathological analysis, the available numbers and completeness rates indicate that this study should concentrate on general health characteristics and common afflictions. Therefore, this study will focus on general health indicators like life expectancy, stature, Harris' lines, caries, maxillary sinusitis and peripheral osteo-arthritis.³⁷⁸

³⁷⁸ It is obvious that the study of the prevalence of pathological conditions has to be based on afflicted bones in relation to the number of bones available for inspection, instead of counts per number of individuals.

5

Methods

PHYSICAL ANTHROPOLOGICAL METHODS

A uniform investigation of all skeletal remains was executed. To ascertain that all data were collected in a consistent way, a standard set of forms was used. This was a modified version of the Physical Anthropological Report, developed by Maat for the State Service for Archaeological Investigations (R.O.B.).

DETERMINATION OF SEX

The procedures used to determine sex from bones are non-metrical morphological and metrical morphological methods.³⁷⁹ Since differences in most of the inspected and measured features develop during puberty, the use of the methods was limited to adolescents and adults only. Either the dentition or epiphyseal union should indicate that an individual had reached adolescence. Methods, developed specifically to determine the sex of younger individuals, were not applied, as many of the available young skeletons were incomplete and the available methods are not adequate in case of fragmented bones.³⁸⁰

NON-METRICAL MORPHOLOGICAL METHODS

The non-metrical morphological method recommended by the Workshop of European Anthropologists (WEA) was used to determine the sex of the skeletons.³⁸¹ Its criteria were developed on European reference material.³⁸² For this method, ten sex features of the pelvis and fifteen features of the skull have to be examined. All features were scored between -2 and +2, ranging from hyper-feminine to hyper-masculine.³⁸³ Not all of the features are equally indicative for the degree of sexualisation. To correct for this, all scores are to be multiplied with an appropriate weight factor in order to compute a weighted degree of sexualisation. The latter is the sum of the scores multiplied by their weight and subsequently divided by the sum of the used weights only, according to the following formula:

$$\text{Degree of sexualisation} = \frac{\sum wx}{\sum w}$$

x = the score of the individual features
w = the weight applied to the particular features

³⁷⁹ St. Hoyme and Iscan, 1989; Brothwell, 1981, p. 59-63; Ubelaker, 1989, p. 52-60.

³⁸⁰ Introductory literature on the subject of sex determination of subadult skeletons: Saunders, 1992, p. 4-6; Ubelaker, 1989, p. 52-53; Weaver, 1986.

³⁸¹ Workshop of European Anthropologists, 1980, p. 517-518 and p. 523-524.

³⁸² Acsádi and Nemeskéri, 1970, p. 87-97.

³⁸³ There is one exception: the arc composé is scored between -1 and +1.

FIGURE 5-1 Seven of the ten anatomical features of the pelvis that are examined for the non-metrical morphological sex determination

FIGURE 5-2 Six out of fifteen anatomical features of the skull that are examined for the non-metrical morphological sex determination (after Herrmann et al, 1990).

This degree of sexualisation was calculated for both the pelvis and the skull. A so-called power of sex diagnosis was computed by dividing the sum of weights of inspected features by the sum of all possible weights (19 in case of the pelvis and 32 in case of the skull):

$$\text{Power of sex diagnosis} = \frac{\sum W_{\text{observed}}}{\sum W_{\text{all}}}$$

Between various populations marked differences can be found in e.g. the range of the size of the mastoid process or the shape of the mentum. To take into account possible intra-observer variability, scoring of the skulls and pelvises was repeated in a second rally.

Metrical - morphological methods

Skulls or pelvises were not available for every individual. To settle the sex of incomplete skeletons and individuals with ambiguous skulls and pelvises in respect of sex, an additional metrical-morphological method was sought. Because femurs were best represented, measurement of the antero-posterior diameter of the femoral shaft based on MacLaughlin and Bruce's method was chosen.³⁸⁴ Their method combines in one measurement two features that display considerable sexual dimorphism: the diameter of the femoral diaphysis proper and the posterior projection of the linea aspera. With a sliding calliper the maximum antero-posterior femoral shaft diameter (APD) was measured between the inferior margin of the gluteal ridge and the level where the two eminences of the linea aspera diverge. Complete as well as fragmented femora were used. As long as they met the following requirements: the diaphysis had to be intact, femoral growth had completed and pathological changes had to be absent. A sectioning point was calculated from the mean values of individuals sexed by the non-metrical morphological method mentioned above.

ESTIMATION OF AGE AT DEATH

Individuals up to circa 23 years

Assessment of the biological age at death of young individuals was based on indicators related to growth and maturation of the skeleton. The rapid developmental changes of the skeleton during the first 16 to 18 years allowed for relatively exact age estimates, especially when the results of several methods were combined. All possible indicators were assessed and the resulting age indications were integrated in a conclusive age range. A schematic representation of the applicability of the main four indicators used is given in Table 5-1. In the period of overlap (around 23 years of age), between the use of indicators based on changes associated with growth and those on adult ageing effects, (if available) priority was given to the results of the more accurate growth related indicators.

³⁸⁴ MacLaughlin and Bruce, 1985.

Method / Age in years	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Dental development																											
Ossification axial skeleton																											
Length of long bones																											
Epiphyseal union																											

TABLE 5-1 Age range of applicability of the main four age indicators for individuals up to 25 years. The darkest shaded sections represent intervals with a rapid succession of changes, allowing for a precise age determination. Light shaded sections represent intervals allowing for a less precise age determination. Intermediate shaded sections represent intervals without change in the age indicator.

Most of the children were aged by the state of their dental mineralisation and eruption. In the cases where x-rays of the jaws were made these were compared with the diagrams of Ubelaker, based on several studies on dental formation and eruption.³⁸⁵ For individuals up to 12 years this method produced well-limited age ranges. Ossification of the axial skeleton is suitable to assess the age of individuals up to eight years and between 18 and 25 years. Ossification and fusion of various elements of the axial skeleton were interpreted using a scheme compiled by Maat.³⁸⁶ The accuracy of this method improves with the number of features that can be inspected.

If neither the dental development nor the ossification of the axial skeleton could be established, assessment of age by measuring the length of long bones proved to be a valuable method to determine the age of children. Diaphyseal lengths were measured with an osteometric board. To produce the age of the child, the measurements of intact long bones were compared with data from Maresh.³⁸⁷ Because of the difference in mean adult height of the reference population studied by Maresh and our historical population from Maastricht, all measurements were proportionally compensated. The range used from the tables of Maresh was that for girls and boys of the fiftieth percentile.

Age at death for individuals between 14 and 25 years was assessed by evaluating the stage of fusion of epiphyses. The schedule recommended by the Workshop of European Anthropologists was used for this purpose (see figure 5-3).³⁸⁸ If the sex of the individual could be settled, the appropriate age ranges were used. In other cases the ranges of both sexes were applied to deduce a more extensive combined range. Seriation of general bone dimensions was used to estimate the age of incomplete remains missing the above mentioned age indicators. This was only necessary for a few, very young, children. Their bones were compared with those of individuals from the same site whose age could be determined.

³⁸⁵ Ubelaker, 1989, p. 63-65.

³⁸⁶ Maat compiled this scheme on the basis of various methods recommended by the Workshop of European Anthropologists, Workshop of European Anthropologists, 1980, p. 530-531.

³⁸⁷ Maresh, 1955.

³⁸⁸ Workshop of European Anthropologists, 1980, p. 531.

FIGURE 5-3 The intervals of epiphyseal union as compiled for the recommendations for age and sex diagnoses of skeletons by the Workshop of European Anthropologists. Age intervals for males are preceded by the letter "M", those for females by the letter "F" (after Brothwell, 1981 and Workshop of European Anthropologists, 1980).

Adult individuals

The “complex method” developed by Acsádi and Nemeskéri and recommended by the Workshop of European Anthropologists was used to estimate the biological age at death of adult individuals.³⁸⁹ It was named “complex” because it combines the estimates of four age indicators. The symphyseal face is regarded by Acsádi and Nemeskéri as the key indicator. Second in importance are the changes within the proximal femur. The other two criteria are age changes in the proximal humerus and closure of the endocranial sutures. This method gains in accuracy through the combination of inspected indicators. All inspected indicators were classified according to their individual ageing phase. The tables developed by Sjøvold were used to deduce the age or age range from the various age phases of the available indicators.³⁹⁰ For individuals with only one age indicator present, the table from Acsádi and Nemeskéri was used.³⁹¹

FIGURE 5-4 Comparison of the surface of a sawn femoral head (right) with a CT-image (left) of the same intact bone (photograph: R. Panhuysen, CT-image: P. Hofman).

In most cases the “complex method” could be applied according to the guidelines of Acsádi and Nemeskéri and the Workshop of European Anthropologists. However, when the proximal femur or humerus was in a bad condition and could not be sawn, Computerised Tomography (CT) was used to make a scan of the same plane as that of the saw surface. Scans were made with a Somatom Plus CT scanner (Siemens). The femur was placed in the gantry in such a position that the scan plane was perpendicular to the femoral axis through the middle of the head of the femur, collum and the proximal shaft. Empirically a slice thickness of 2 mm was chosen. A full

³⁸⁹ Acsádi and Nemeskéri, 1970, p. 122-135; Workshop of European Anthropologists, 1980, p. 532-534.

³⁹⁰ Workshop of European Anthropologists, 1980, p. 539-549.

³⁹¹ Workshop of European Anthropologists, 1980, p. 135.

sized hardcopy with a wide window setting was used to assess the trabecular structure. The CT-image proved to be an effective replacement.³⁹²

Frequently, because of the fragmentary character of the skeletal remains, only one or two indicators were available. This would result in age ranges of 15 to 40 years. An attempt was made to reduce these ranges to ten-year intervals. Ectocranial suture obliteration and dental attrition were studied to achieve this. Age was estimated from ectocranial suture closure with the help of the schedule of Vallois, as modified by Rösing.³⁹³ Skulls with asymmetrical or atypical suture closure were excluded. Results outside the range deduced by the "complex method" were rejected. The second method used to narrow the results of the "complex method" was seriation based on comparison of dental attrition. Attrition was scored according to the methods of Brothwell and Bouts and Pot.³⁹⁴ For adult individuals whose age could be estimated on the basis of three or four age indicators from the "complex method", the mean attrition rate of the first, second and third molars was calculated, as suggested by Maat and van der Velde.³⁹⁵ Comparison of the degree of attrition of insufficiently aged individuals with the calculated mean scores per age interval made it possible to assign these individuals to one of the age intervals.

STATURE ESTIMATION

For the calculation of living standing height, all long bones of the limbs were measured on an osteometric board. Measurements were taken according to the definitions of Martin and Saller.³⁹⁶ No attempt was made to reconstruct the measurements of bones that lacked the necessary anatomical landmarks. Bones showing traces of fractures or pathological changes which could have had an impact on the length were measured but not used to calculate stature. Stature estimates were computed with the formulas for American Whites as developed by Trotter and Gleser.³⁹⁷ As advised by the authors, the formula with the smallest standard error was chosen. In selected cases the estimated stature of individuals over 30 was corrected for the decrease in stature because of ageing effects. In addition to the widely used formulas of Trotter and Gleser we applied the method conceived by Breiting.³⁹⁸ According to Wurm this method produces more reliable estimates for male individuals of north-western European origin.³⁹⁹

POPULATION VARIABILITY IN NON-METRIC TRAITS

The frequency of a limited number of non-metric traits was assessed. In addition to the long-bone lengths, three dimensions of the skull were measured. Maximum cranial length,

³⁹² Hofman et al., 1995 and Hofman et al., in press.

³⁹³ Knussmann, 1988.

³⁹⁴ Brothwell, 1981, p. 72; Bouts and Pot, 1989. The attrition of incisors, canines and premolars was recorded according to Bouts and Pot but not used for seriation.

³⁹⁵ Maat and Van der Velde, 1987.

³⁹⁶ Martin and Saller, 1957.

³⁹⁷ Trotter and Gleser, 1958.

³⁹⁸ Breiting, 1937.

³⁹⁹ Wurm, 1985, p. 12.

maximum breadth and basi-bregmatic height of skulls were measured with a spreading calliper. Only intact crania, not distorted by post-depositional processes, and successfully restored skulls were evaluated. Non-metric variation was scored as present, normal or indeterminable.

Bilateral traits were checked on both sides and scored separately. The skulls were examined for the presence of thirteen traits: metopism, coronal ossicles, sagittal ossicles, lambdoid ossicles, bregmatic bones, Inca bones, ossicles at lambda, ossicles at asterion, parietal notchbones, mandibular tori, maxillary tori, palatine tori and double condylar facets. The post-cranial skeleton was inspected for the following nine traits: double atlas facets, posterior bridges of the atlas, lateral bridges of the atlas, sacralisation, lumbarisation, spina bifida, sternal foramina, septal apertures.

PALAEOPATHOLOGY

Pathological bone changes in general were studied using gross anatomic examination and radiographic analysis. The latter included standard x-ray as well as computed tomography. All skeletons were first inspected by the author. A committee of specialists in the field of radiology, orthopaedic surgery, pathological anatomy, anatomy and palaeopathology reviewed all pathological cases. During these sessions, the most probable diagnosis was settled.⁴⁰⁰ Special attention was paid to the healing of fractures and the presence of pathology in the axial skeleton and the peripheral joints. The paranasal sinus, the mastoid air cells and the auditory ossicles were inspected for traces of infectious disease.

Another indicator for the health status was the prevalence of Harris lines. Harris-lines are transverse lines that are visible on x-rays as radiopaque lines in the diaphysis and metaphysis of long bones. X-rays were made of all available intact tibiae, because lines are best assessed in that bone. Lines in the distal tibiae were classified and their skeletal age of formation calculated as recommended by Maat.⁴⁰¹ Formation rates, representing the number of lines formed per year of bone growth within the overall population were also computed according to Maat.

DENTITION

The dental remains were recorded with the help of a computer program, developed by Bouts and Pot.⁴⁰² It facilitates the recording of the presence of teeth, alveolar bone and the degree of attrition, caries, exposed pulp cavities and periapical lesions. On a separate form the presence of enamel hypoplasias, specific pathology and anomalies was recorded. The grade of alveolar bone resorption and the formation of calculus were classified according to Brothwell.⁴⁰³

⁴⁰⁰ All cases with possible pathological changes were examined in six sessions. The following persons (in alphabetical order) attended these meetings and contributed to the final diagnoses: Tj.D. Bruintjes, J. Van Engelshoven, P.A.M. Hofman, H.A.M. Janssen, E. van der Linden, G.J.R. Maat, G. Snoep, T. Vermeulen, G.H.I.M. Walenkamp.

⁴⁰¹ Maat, 1984.

⁴⁰² Bouts and Pot, 1989.

⁴⁰³ Brothwell, 1981.

DATA REGISTRATION AND STATISTICAL ANALYSIS

All relevant information concerning the archaeological context and the results from the physical anthropological examination was recorded in a database (MS Access). For analysis of the data a statistical program (SPSS) was used. Prevalence of various features and pathologies is generally expressed in percentages. We did not opt for the possibility to calculate them per 10,000 individuals to avoid the suggestion of large sample sizes. For the statistical analysis the following tests were used, chi-square, chi-square test for trend, Mann-Whitney ranked order, paired t-test. Only the p-value is mentioned in the text or in footnotes. When in cross tabulations the expected number of cases per cell was 5 or less, Fisher's Exact test was used to calculate the probability. Plans showing the distribution of inhumations and various skeletal traits were made with a computer aided design program (AUTOCAD). As a basis for these plans we used a digital map of the city of Maastricht.

6

Results

6 Results

In general the results from the physical anthropological and palaeopathological examination are presented per sample or per status category. For the Servaas site the three samples represent the chronological subdivisions described in chapter three. Therefore, they are named: the *cella* sample, the *templum* sample and the *basilica* sample. The data collected from the human skeletal remains of the Boschstraat site are combined in a fourth sample, labelled the Boschstraat sample. As described in chapter 3, 155 inhumations were categorised by status. The low status sample consisted of all Boschstraat site inhumations. Both the samples of intermediate and high status were composed of a mixture of selected burials from the *templum* and *basilica* sample.

FIGURE 6-1 The four samples examined in this study with their respective chronological intervals

To investigate the presence of diachronic variation the following pairs, representing subsequent periods, were compared: *cella* sample - *templum* sample, *templum* sample - *basilica* sample. Being partially contemporary with the later inhumations from the *templum* sample and the first inhumations from the *basilica* sample, the data found for the Boschstraat sample were compared with these two samples. The inhumations of the *cella* sample and the Boschstraat sample were separated by almost 200 years. An even longer period divided the *cella* sample and the *basilica* sample. Therefore these samples were not systematically compared. Statistical analysis of possible status-related variation occurred by comparison of the following pairs: low status - intermediate status, intermediate status - high status, low status - high status.

DEMOGRAPHY

SEX

The number of individuals in the whole sample population was 238: 184 individuals from the Servaas site and 54 individuals from the Boschstraat site.⁴⁰⁴ Sexualisation degrees for the pelvis, the skull or both could be determined in 122 cases (51%). Non-metrical morphological methods could be used to attribute sex to 92 pelvises (39%) and 100 skulls (42%). In 92 cases (39%) the absence or fragmented state of pelvis, skull and femur or the incomplete development of the inspected features prevented a sex attribution.

FIGURE 6-2 Distribution of the sexualisation degree of the pelvis (n=92) and the skull (n=100) from the Servaas site. Sexualisation degrees below 0 are considered to indicate female sex and sexualisation degrees above 0 are indicative for male sex. Added is a polynomial line for each feature. The height of the columns represents the number of individuals.

Figure 6-2 displays the distribution of the sexualisation degree of the pelvis and skull found for both sites. As is evident from this graph more pelvises and skulls had sexualisation degrees in the female range. Still, both polynomial lines reveal a bimodal curve with the lowest point between the two peaks near to zero. This distribution indicates that the non-metrical morphological method was a reliable tool to assess the sex of this population. In general between 60 to 70 percent of the features, used in the non-metrical morphological method, could be inspected.

⁴⁰⁴ This sample was selected from a sample comprising the skeletal remains of 337 individuals.

	Pelvis			Skull		
	Mean	N	S.D.	Mean	N	S.D.
Male	+0.90	35	0.34	+0.74	44	0.35
Female	-0.87	53	0.38	-0.84	51	0.35

TABLE 6.1 Sexualisation degree calculated for the pelvis and skull by means of the non-metrical morphological method

A total of 53 pelvises was categorised as female which had a mean sexualisation degree of -0.87. The mean calculated for 35 male pelvises was +0.90. For the skulls 51 were female with a mean sexualisation degree of -0.84. Male sex was attributed to 44 skulls with a mean of +0.74. Ambiguous sexualisation degrees (between -0.10 and +0.10) were found in four pelvises (4.3%) and 5 skulls (5%). Four of these cases with an indefinite result for either the pelvis or the skull could be sexed on the basis of a conclusive sexualisation degree for the other part. For five remaining cases this was not possible. As a result, a total of 117 individuals were sexed by means of the non-metrical morphological method. Apart from the five individuals of indeterminate sex, there were 68 adult individuals that could not be sexed by means of the non-metric morphological method.

FIGURE 6-3 Scatter plot of the sexualisation degree of the pelvis and the skull of 70 individuals of the Servaas and Boschstraat site. The vertical axis represents the sexualisation degree of the pelvis; the sexualisation degree of the skull is represented on the horizontal axis

A scatter plot combining the sexualisation degree of the pelvises and the skulls illustrates that in general the results found for the pelvises were corroborated by the sexualisation degrees calculated for the skulls. In two out of 70 cases (less than 3%), from the Servaas and Boschstraat site, did the sexualisation degree of the skull substantially contradict the assessment of the pelvis. As indicated in the fourth chapter, on methods, it was decided that in case of contradicting results the sex determination on the basis of the pelvis would prevail.

Classification by the maximum anterior-posterior femoral diameter (APD) was chosen to extend the possibilities to attribute the sex. The APD could be measured in 105 cases. For 69 of these individuals sex had been determined by means of the non-metrical morphological method. Before criteria were defined to assess sex by APD for the remaining 36 individuals, the variation between left and right bones and by sample was investigated. A paired sample t-test indicated that there was virtually no difference between the right and left femur APD.⁴⁰⁵ Variation between the subsequent phases and sites also proved statistically insignificant. Based on the values found for 40 females and 29 males an additional sex criterion could be defined.

	Mean	S.D.	Minimum	Maximum	N
Male	32.13	2.24	28.25	37.33	29
Female	26.73	2.12	23.25	30.58	40

TABLE 6.2 Statistical data for the maximum femoral anterior-posterior diameter in millimetres of female and male individuals sexed by the non-metrical morphological method

FIGURE 6-4 Distribution of maximum femoral anterior-posterior diameter for male, indeterminate and female individuals (n=105). The vertical position indicates the sex attribution on the basis of the non-metrical morphological method. In the indeterminate group are 36 individuals whose sex could not be determined by means of this method. The outcome of sex attribution by the size of the APD is visualised by the markers. On the left in the middle group are the individuals sexed as female (n=13) because their APD was smaller than the lowest value found for males. In the middle are the individuals with an APD within the range of overlap between the lowest male and the highest female APD. These were categorised as indeterminate (n=7). On the right side are the individuals with a male APD (n=16) as these were larger than the highest value found for females.

A normal symmetric distribution of the values was found for both sexes.⁴⁰⁶ The difference between the mean values for men and women was highly significant.⁴⁰⁷ Between 28.25 mm and 30.58 mm the diameters found for men and women showed an overlap. To lower the risk of misclassification it was decided not to attribute sex to 7 individuals with an APD within this

⁴⁰⁵ N=54 pairs, mean difference 0.04 mm, left larger than right: p=0.75
⁴⁰⁶ Females: skewness: 0.09, standard error: 0.36, males: skewness: 0.31, standard error: 0.41.
⁴⁰⁷ Female APD - male APD: p<0.001.

range of overlap. Thirteen individuals of the indeterminate group had an APD of less than 28.25 mm, these were considered female. Sixteen individuals of this group, with an APD greater than 30.58, were sexed as male.

When the results from the non-metrical morphological method and the metrical morphological sex determinations are combined, sex could be determined in an extra 29 individuals adding up to a total of 146 sexed individuals. Seven individuals were categorised as “indeterminate” because the results of the sex determination by means of the femur APD remained ambiguous.

		Servaas site	Boschstraat site	Total
Male	N	60	6	66
		49%	19%	43%
Female	N	56	24	80
		46%	75%	52%
Indeterminate	N	7	2	9
		6%	6%	6%
Total	N	123	32	155

TABLE 6.3 Number of sexed and unsexed individuals from the Servaas site and the Boschstraat site after sex determination by means of the non-metrical morphological method and the anterior-posterior diameter of the femur

In nine individuals neither the non-metrical morphological method nor the anterior-posterior diameter of the femur provided a conclusive indication of the sex. Therefore, these remained categorised as of indeterminate sex. Thirty-two adults were recovered in conditions that did not allow for determination of sex and were thus categorised as “unsexed”. The impact of the completeness of the skeleton on the feasibility to determine sex is evident. All but one of the unsexed adults were skeletons with recovery rates of less than 0.20.

SEX RATIO

Table 6.4 displays the sex distribution for the four samples. For the whole study a majority of females was found. Marked differences in the distribution over the sexes were visible among various samples of the Servaas site and for the Boschstraat site. None of the samples approximated an equal distribution of males and females. The *cella* sample and *basilica* sample had a slight majority of male burials. Both the *templum* sample and the Boschstraat sample show that female burials predominated. At the Boschstraat site, the number of female burials largely exceeded the male burials.

Calculation of Pearson's chi-square learned that the differences between the consecutive phases at the Servaas site were not statistically significant.⁴⁰⁸ However, the mutual differences

⁴⁰⁸ *Cella* sample - *templum* sample: $p=0.37$ and *templum* sample - *basilica* sample: $p=0.25$.

in sex distribution between both the *templum* sample and the Boschstraat sample and the *basilica* sample and the Boschstraat sample were significant.⁴⁰⁹

	Cella	Templum	Basilica	Boschstraat	Total	Low	Interm.	High
Male	9	20	31	6	66	6	12	22
	60%	44%	55%	20%	45%	20%	38%	55%
Female	6	25	25	24	80	24	20	18
	40%	56%	45%	80%	55%	80%	63%	45%
Total	15	45	56	30	146	30	32	40
M:F	1:0.67	1:1.25	1:0.81	1:4.00	1:1.21	1:4.00	1:1.67	1:0.81

TABLE 6.4 Sex distribution by sample and status

Analysis of the distribution of sex by status yielded a significant result for one comparison. The percentage of females in the sample of low status was markedly higher than in the sample of high status.⁴¹⁰ Like the sample of low status, the sample of intermediate status consisted mostly of women. Variation between these two samples was less evident and not significant.⁴¹¹ Comparison between the intermediate and high status samples showed a majority of female individuals in the intermediate sample and a majority of males in the high status sample. Still, the variation in the distribution of sex between these two groups did not differ significantly.⁴¹²

AGE

The results of the estimation of age at death are generally presented separately for two age categories, viz. non-adults (individuals under the age of circa 20 years) and adults. Not only are different methods used for age estimation of the two categories, separation of the data is also necessary for further physical anthropological and palaeopathological analysis. Determination whether an individual was non-adult or adult was possible for all individuals included in our sample.

Age	Cella	Templum	Basilica	Boschstraat	Total	Low	Interm.	High
Non-adult	6	11	11	23	51	23	6	7
	26%	14%	13%	43%	21%	43%	10%	11%
Adult	17	67	72	31	187	31	26	54
	74%	86%	87%	57%	79%	57%	90%	89%
Total	23	78	83	54	238	54	32	61

TABLE 6.5 Distribution of non-adult and adult individuals by sample

⁴⁰⁹ *Templum* sample - *Boschstraat* site: $p=0.05$; *basilica* sample - *Boschstraat* site: $p=0.003$

⁴¹⁰ Low status - high status: $p=0.004$.

⁴¹¹ Low status - intermediate status: $p=0.17$.

⁴¹² Intermediate status - high status: $p=0.16$.

Circa 21% of all individuals were scored as non-adults. In this respect both excavation sites differed considerably. At the Servaas site 28 individuals (15%) out of 184 were non-adults. The proportion of non-adults found at the Boschstraat site was more than twice as high: 23 (43%) out of 54.⁴¹³ Also within the Servaas site sample the percentage of non-adults varied among the three samples. The *templum* sample and the *basilica* sample had similar proportions of non-adults. However, the percentage of non-adults in the *cella* sample was approximately the double of the percentage found for the *templum* and the *basilica* sample.

When the samples defined by status are compared it is evident from the preceding table that the low status sample (from the Boschstraat site) has a comparatively high proportion of non-adult individuals. For the intermediate and high status samples relatively low percentages, viz. 10% and 11% respectively, of non-adults were found. The chi-square calculated for the distribution of non-adults over the status categories indicated that the variation deviated significantly from expected normal distributions.⁴¹⁴

Non-adults

Of the whole sample 51 individuals were categorised as non-adults. Ossification of the axial skeleton was the ageing method that could be used most, viz. in 70% of these cases. In addition, dental development contributed to the age assessment of 54% of the non-adult individuals. Furthermore, lengths of the long bones and epiphyseal fusion were employed in 42% and 18% of the cases respectively.⁴¹⁵ Thus it was possible to assign 50 non-adults to ten-year age intervals.⁴¹⁶

Age	Cella	Templum	Basilica	Boschstraat	Total	Low	Interm.	High
0-10 yr.	5	5	7	18	35	18	2	5
	83%	50%	64%	78%	70%	78%	67%	71%
10-20 yr.	1	5	4	5	15	5	1	2
	17%	50%	36%	22%	30%	22%	33%	29%
Total	6	10	11	23	50	23	3	7

TABLE 6.6 Non-adult mortality by sample and status

Children who had died between birth and ten years made up the majority of non-adult burials (70%). In comparison with the *templum* sample and *basilica* sample, an even higher percentage of the non-adults from the Boschstraat sample died in the youngest age category. However, the difference between these samples was statistically not significant.⁴¹⁷ Further

⁴¹³ Statistical analysis showed that the difference was highly significant. Servaas site - Boschstraat site: $p < 0.001$.

⁴¹⁴ For Table 6.5: $p < 0.001$.

⁴¹⁵ The total of percentages exceeds one hundred because often more than one method contributed to the age estimation of non-adults.

⁴¹⁶ Various mortality distributions have been calculated for age intervals of one, two and five years. Here only ten-year age intervals are presented. Other distributions will be presented in the discussion.

⁴¹⁷ Templum sample - Boschstraat site: $p = 0.22$; basilica sample - Boschstraat site: $p = 0.43$.

investigation of mortality⁴¹⁸ of 46 non-adults who could be categorised in 5-year age intervals showed that 50% of all non-adult individuals died during the first five years.

Analysis of non-adult mortality by status was possible for only 33 individuals. Most of them belonged to the low status category. Despite their small number the mortality pattern of the individuals from the intermediate and high status samples was similar to that of the low status sample.

Adults

Use of the “complex method” enabled the assessment of age at death for 121 adult individuals. Not all of the four age indicators could be inspected in equal proportions. Most used was endocranial suture obliteration, viz. in 68% of the cases. Inspection of the femoral head was possible in 67% of the individuals. The humeral head could be examined in 47% of the whole sample and the pubic symphysis in 9%. Often only one or two out of four age indicators were available for inspection (in 61% of the cases). Estimation of age at death is more precise when three or four features can be inspected. The remains of 41 individuals allowed for estimation within an age range of 5 or 6 years. For another 80 individuals use of the “complex method” resulted in age ranges of twenty years and more. Seriation on the basis of the ectocranial suture obliteration and dental attrition contributed to a reduction of the age range for 53 of these individuals. Ultimately a total of 94 adults could be assigned to ten-year age intervals (sex could not be assessed for two of these individuals).

Age distribution in intervals

Male and female individuals were not equally distributed over the various age categories. Female mortality was slightly higher in the intervals between 20 to 30 and 30 to 40 years. However, the differences were minor and statistically not significant. In order to create samples of larger size the sample was divided in 20-year age intervals (see tables 6.7 and 6.8).

When arranged by 20-year age intervals, eight more sexed individuals and an additional five unsexed individuals could be included in the analysis. Table 6.8 shows that in 20-year age intervals female mortality is higher than male mortality for the interval between 20 to 40 years. However, the variation in mortality is not statistically significant. Therefore, males and females were combined in further tables presenting mortality in 20-year age intervals.

When analysed per period, significant differences in age distribution were not found. Still, two distribution patterns could be recognised. Both in the *cella* sample and the *basilica* sample the highest number of deaths ranged within the 40 to 60 years interval. In the *templum* and Boschstraat sample most adult individuals died between 20 and 40 years. For the whole sample, mortality in the 20 to 40 years and 40 to 60 years intervals is similar. Furthermore, ages of 60 years or over were comparatively rare. In this respect, it is noteworthy to see that in the Boschstraat sample three individuals reached an age of 60 or more.

⁴¹⁸ Please note that mortality is generally used in osteoarchaeological studies to indicate the absolute number of deaths in a specific age interval. Thus the term is used in a different meaning than in demographical publications dealing with living populations.

Age in yrs.	Male	Female	Total
20-<30	9	11	20
	20%	24%	22%
30-<40	10	12	22
	22%	26%	24%
40-<50	14	13	27
	30%	28%	29%
50-<60	10	5	15
	22%	11%	16%
60-<70	2	5	7
	4%	11%	8%
70-<99	1		1
	2%		1%
Total	46	46	92

Age in yrs.	Male	Female	Total
20-<40	19	29	48
	39%	51%	45%
40-<60	27	23	50
	55%	40%	47%
60-<80	3	5	8
	6%	9%	8%
Total	49	57	106

TABLE 6.7 Distribution of age at death in 20-year age intervals by sex

TABLE 6.8 Age distribution in 10-year age intervals for adults by sex

Age in yrs.	Cella	Templum	Basilica	Boschstraat	Total
20-<40	4	17	17	14	52
	31%	53%	39%	58%	46%
40-<60	7	15	24	7	53
	54%	47%	55%	29%	47%
60-<80	2		3	3	8
	15%		7%	13%	7%
Total	13	32	44	24	113

Low	Interm.	High
14	13	11
58%	46%	35%
7	13	19
23%	46%	61%
2	2	1
13%	7%	3%
24	28	31

TABLE 6.9 Distribution of age at death for adults by sample and status

Age at death could be determined for 83 adults who could be categorised by status. In Table 6.9 the distribution shows that the highest mortality tended to shift from the 20 to 40 years interval, in the low status category, to the 40 to 60 years interval in the high status category. In the group of intermediate status, deaths are equally distributed over the two intervals. For the mere six individuals whose deaths ranged in the age interval of 60 to 80 years the opposite was found. Only when calculated separately for the age categories between 20 to 40 and 40 to 60 years could the trend be substantiated by statistical analysis.⁴¹⁹ When all three age-categories were analysed the reverse trend in the 60 to 80 years category counterbalanced the shift in mortality.

⁴¹⁹ When a Chi-square is tested for trend for the two age categories of 20 to 40 and 40 to 60 years and the three status categories, the outcome indicates significance: $p=0.04$.

Mean age at death

Adult mortality in different samples was also compared by calculation of the mean age at death.⁴²⁰ Mean age at death was first calculated from the ages of individuals whose age could be assessed on the basis of 3 or 4 age indicators of the "complex method". This allowed calculating the mean age at death for a total of 41 individuals.

Sex	Mean	Median	Range	Minimum	Maximum	N
Male	43.7	45.8	40.3	22.0	62.3	20
Female	35.7	43.3	34.5	20.0	54.3	21
Total	39.6	37.0	42.3	20.0	62.3	41

TABLE 6.10 Age at death in years for adult individuals with 3 or 4 age indicators of the complex method inspected

The mean age at death for males was circa 8 years higher than the female mean age at death. Statistical analysis indicated this difference was significant.⁴²¹ Consequently, it was decided to calculate separate means for men and women. The mean age at death was also calculated on the basis of the mid-values of ten-year age intervals. In this way mean ages at death could be calculated for 92 adult individuals.⁴²²

Sex	Mean	Median	Range	Minimum	Maximum	N
Male	42.6	42.5	50	25	75	46
Female	40.9	39.8	40	25	65	46
Total	41.8	41.2	50	25	75	94

TABLE 6.11 Age at death in years for adult individuals, calculated from mid-values of ten-year age intervals⁴²³

Male mean age at death was 1.1 years lower when calculated on the basis of mid-values of ten-year age intervals. Calculation of female mean age at death by the same method resulted in a considerably higher age. Therefore, the difference between male and female mean age at death was reduced to little more than one and a half years. This difference was not statistically significant. However, because of the significant difference between male and female mean age at death described in Table 6.10, it was decided to calculate the mean age at death not only for the whole sample but also separately for males and females

⁴²⁰ The mean age at death was calculated solely for adult individuals. If non-adult ages had been included this would lead to over-representation of non-adults. As it is generally easier to estimate the age of non-adults with precision. In the whole sample about 20% of the individuals were not older than 20 years. In the sample of 82 individuals aged within 6-year ranges the proportion of non-adults was 50%. Not only would this result in underestimation of the mean age at death, it also created the risk that the mean age at death was biased by variations in the proportion of non-adults in the samples

⁴²¹ Male - female: Mann-Whitney: $p=0.02$ (Student t-test: $p=0.02$).

⁴²² As described above 94 adults could be assigned to an age interval of ten years; sex was determined for 92 of these individuals.

⁴²³ Male - female: Mann-Whitney: $p=0.458$ (Student t-test: $p=0.51$).

sex		Cella	Templum	Basilica	Boschstraat	Total	Low	Interm	High
Male	Median	47.5	39.3	43.3	35.0	42.5	35.0	40.0	48.0
	Mean	48.3	38.6	43.1	39.0	42.6	39.0	39.0	47.9
	S.D.	15.8	10.3	11.2	15.2	12.5	15.2	8.4	9.1
	N	9	11	21	5	46	5	10	14
Female	Median	45.0	39.0	41.3	37.0	39.8	37.0	39.0	41.4
	Mean	42.5	38.8	42.1	41.0	40.9	41.0	40.8	41.2
	S.D.	12.6	8.7	13.3	15.9	12.7	15.9	15.1	7.7
	N	4	13	14	15	46	19	12	13
Total	Median	46.4	39.1	43.0	36.4	41.2	36.4	39.6	44.5
	Mean	46.5	38.8	43.1	40.2	41.8	40.2	40.0	44.6
	S.D.	14.6	9.2	11.9	15.0	12.6	15.0	12.2	9.0
	N	13	24	36	21	94	21	22	27

TABLE 6.12 Age at death in years of adults by sample and status, calculated from mid-values of ten-year age intervals

Variation among the mean ages at death calculated for males in the four samples was considerable, viz. a range of almost 10 years. Still, the calculated differences between the samples were not significant. The men from the *templum* sample and the Boschstraat sample generally died at a younger age than those of the *basilica* and *cella* sample. In comparison with the other samples, the high mean age at death for the *cella* sample is remarkable. However, given the wide variation in this sample, expressed in the standard deviation, the differences between the *cella* sample and other samples could not be labelled as statistically significant. Mean age at death of the females varied little; the differences among the four samples did not exceed more than five years; the differences proved to be insignificant. The lowest mean age at death was calculated for the female burials from the *templum* sample. In none of the four samples in table 6.12 was the variation between female and male mortality statistically significant. For the *cella* sample a large discrepancy was found between female and male mean age at death, with a higher age for men. Between the mean age at death of men and women from the *templum* sample the difference was marginal. For the *basilica* sample mean age at death of males exceeded female mean age at death by circa one year. The opposite was found for the Boschstraat sample where female mean age at death surpassed male mean age at death by two years.⁴²⁴

Mean ages at death were equal for the male individuals of low and intermediate status. However, mean age at death of males of high status was more than eight years higher. Statistical analysis indicated the difference between males of intermediate status and high status was significant.⁴²⁵ The variation of female mean age at death among all three status-

⁴²⁴ Male and female ages at death were combined and tested for variation in the mean age at death between the following samples: *cella-templum*, *templum-basilica*, *templum-Boschstraat* and *basilica-Boschstraat*. None of these yielded statistically significant differences

⁴²⁵ Intermediate status male - high status male: Mann-Whitney: $p = 0.03$.

categories was judged insignificant. Comparison between the male and female mean age at death for the high status category also indicates that age at death for males in the high status category was relatively high. Female mean age at death for this category was circa six years lower and when statistically tested the difference missed significance with a small margin.⁴²⁶

POPULATION VARIABILITY

CRANIAL MEASUREMENTS

Cranial measurements are recorded to define the shape of the skull and be able to distinguish variation between populations. Because few crania were recovered intact and few damaged skulls could be sufficiently restored, the number of measurable skulls was limited. Three skull dimensions could be recorded in about a fourth to a sixth of the adult individuals: the maximum cranial length, the maximum cranial breadth and the basi-bregmatic height.

		Male	Female	Total
Maximum cranial length	Mean	192	183	187
	S.D.	5	6	7
	N	23	27	50
Maximum cranial breadth	Mean	143	136	140
	S.D.	5	3	5
	N	17	19	36
Basi-bregmatic height	Mean	131	128	129
	S.D.	7	9	8
	N	14	17	31

TABLE 6.13 Skull measurements in millimetres by sex

All three measurements were tested for sexual dimorphism. Generally male skulls were larger than female skulls. With respect to the maximum cranial length and the maximum cranial breadth the observed differences between males and females were statistically significant.⁴²⁷ Variation for basi-bregmatic height appeared not to be strongly associated with sex. When the mean values for these dimensions were compared by period and status no statistically significant differences between the samples were observed. (Analysis of the maximum cranial length and maximum breadth was carried out separately for male and female individuals.) Based on these measurements three cranial indices were computed: the horizontal cranial index (length-breadth), cranial height-length index and the cranial height-breadth index. No

⁴²⁶ High status male - high status female: Mann-Whitney: $p=0.06$.

⁴²⁷ Maximum cranial length male - maximum cranial length female: $p<0.001$; maximum cranial breadth male - maximum cranial breadth female: $p=0.002$.

significant sexual dimorphism was discerned for any of the three indices. Therefore, these data were not further analysed by sex.

		Cella	Templum	Basilica	Boschstraat	Total
Length-breadth index	Mean	76.3	73.0	75.4	74.7	75.0
	S.D.	2.4	2.4	2.8	3.1	2.8
	N	5	6	16	8	35
Height-breadth index	Mean	92.5	95.4	89.8	96.0	92.4
	S.D.	3.8	6.7	6.8	8.4	6.9
	N	4	5	13	5	27
Height-length index	Mean	70.7	70.8	67.8	71.6	69.6
	S.D.	2.6	3.0	4.2	5.4	4.3
	N	4	5	14	7	30

Low	Interm.	High
74.7	75.3	74.3
3.3	2.9	3.0
8	11	10
96.0	92.3	89.1
8.4	8.0	5.5
5	11	6
71.6	69.4	67.0
5.4	3.8	4.8
7	12	6

TABLE 6.14 Cranial indices by sample and status

Only one of the comparisons of the indices by sample showed a difference that was statistically significant ($p < 0.05$), viz. between the horizontal cranial (length-breadth) index in the *cella* sample and the *templum* sample.⁴²⁸ Judged by the mean horizontal cranial index the individuals of the *templum* sample would be described as clearly dolichocranic (e.g. long-headed, cranial index < 74.9). Whereas the mean found for the *cella* sample was 3.4 higher than the mean of the *templum* sample, which characterises the *cella* sample as mesocranic (e.g. a cranial index between 75 and 79.9). Like the skulls from the *templum* sample, the mean calculated for the skulls of the Boschstraat site matched with the dolichocranic range. Those of the *basilica* sample were on the average mesocranic.

The differences between the various samples by status were marginal. None of the comparisons of the means of the three indices indicated that the differences between the status categories were statistically significant. Besides the calculated means of these indices, the cranial length-breadth index was also studied at the level of individual cases. The distribution of brachyocranic, mesocranic and dolichocranic skulls was inspected by sample and by status category.

Except for one brachyocranic skull from the *basilica* sample, all other skulls were either dolichocranic or mesocranic. Among the skulls from the *basilica* sample and the Boschstraat sample the number of dolichocranic and mesocranic skulls was almost in balance. Deviating distribution patterns were found for the *cella* sample and the *templum* sample. The majority of the *cella* sample skulls were found to be mesocranic, whereas the *templum* sample skulls were mostly dolichocranic. This large proportion of dolichocranic skulls in the *templum* sample may be considered to deviate significantly from the distribution found in the rest of the population.⁴²⁹

⁴²⁸ *Cella* cranial index - *templum* cranial index: $p = 0.046$.

⁴²⁹ *Templum* - rest of the sample: $p = 0.049$; distribution differences between the *Cella* sample and the *templum*: sample and between the *cella* sample and the rest of the sample were not significant. Respectively: $p = 0.08$ and $p = 0.19$.

FIGURE 6-5 Distribution of the cranial types by sample

FIGURE 6-6 Distribution of the cranial types by status

The distribution of cranial types over the various status categories showed that the proportion of dolichocranic skulls increased with status. In the low status category 37.5% of the skulls were dolichocranic, in the intermediate category 45% of the skulls and in the high status category 60% of the skulls were dolichocranic. However, statistical analysis indicated this trend was not statistically significant.

POST-CRANIAL MEASUREMENTS

Many long bones were either damaged or could not be recovered altogether. Therefore, the number of bones that could be measured was low. In 151 adults, for whom sex could be determined, the femur, the humerus and the tibia were the most measured bones. In 43, 38 and 28 percent of the cases measurement of the respective long bone length was possible.

Bone	Male			Female		
	Mean	S.D.	N	Mean	S.D.	N
Humerus (1)	34.5	1.7	30	31.0	1.7	28
Humerus (2)	33.8	1.6	29	30.4	1.6	28
Radius (1)	26.1	1.7	20	23.1	1.6	21
Radius (1b)	25.9	1.7	19	23.0	1.6	18
Ulna (1)	28.2	1.8	15	24.8	1.6	17
Femur (1)	48.2	2.8	29	43.0	2.9	36
Tibia (1)	38.9	2.3	18	34.3	2.7	24
Tibia (1b)	38.6	2.2	18	34.3	2.6	23
Fibula (1)	39.7	2.2	11	33.6	2.2	9

TABLE 6.15 Lengths in centimetres of the long bones of adult male and female individuals. Numbers between brackets behind the names of the bones refer to the numeration of measurements as defined in Martin and Saller 1957.

Sexual dimorphism in the long bone lengths was considerable and statistically significant for all nine dimensions listed in Table 6.15.⁴³⁰ Therefore, female and male long bone lengths were further analysed independently. As measurements within one type of bone display a strong correlation, the mean of only one measurement per bone is presented below.

Lengths by phase or site

Comparison of the four samples showed that variation in the long bone lengths of the upper extremities of the males was marginal. In general the bones from the *basilica* sample were larger than the bones from the *cella* and *templum* samples. Those of the Boschstraat sample were the shortest male individuals. However, the difference between the means of the various samples was never significant. The same was true for the measurements of the lower extremities. In general the mean lengths calculated for the lower extremities of the four samples show the same pattern as was observed for the upper extremities. Again the greatest mean lengths were found for the individuals from the *basilica* sample.

Bone		Cella	Templum	Basilica	Boschstraat	Total
Humerus (1)	Mean	34.0	34.2	35.0	32.7	34.5
	S.D.	1.9	1.1	1.6	2.2	1.7
	N	7	5	16	2	30
Radius (1)	Mean	25.8	25.6	26.7	24.6	26.1
	S.D.	1.7	1.4	1.9	0.5	1.7
	N	4	3	10	3	20
Ulna (1)	Mean	28.0	27.7	28.8	26.4	28.2
	S.D.	1.8	1.5	1.9		1.8
	N	4	3	7	1	15
Femur (1)	Mean	47.5	48.5	48.9	45.9	48.2
	S.D.	2.3	2.1	3.0	2.5	2.8
	N	6	4	15	4	29
Tibia (1)	Mean	37.3	38.0	39.5		38.9
	S.D.	3.1	2.0	1.9		2.3
	N	4	2	12		18
Fibula (1)	Mean	40.8		39.7	38.4	39.7
	S.D.			2.4		2.2
	N	1		9	1	11

TABLE 6.16 Lengths in centimetres of the long bones of adult males by sample

⁴³⁰ For all compared means: $p < 0.001$

Bone		Cella	Templum	Basilica	Boschstraat	Total
Humerus (1)	Mean	29.5	31.3	31.1	31.2	31.0
	S.D.	0.9	1.2	1.6	2.1	1.7
	N	3	4	12	9	28
Radius (1)	Mean	21.7	23.3	23.5	23.1	23.1
	S.D.	0.4	0.7	1.3	2.1	1.6
	N	2	4	6	9	21
Ulna (1)	Mean	23.5	25.1	25.3	24.6	24.8
	S.D.	0.0	1.0	2.5	0.9	1.6
	N	2	3	6	6	17
Femur (1)	Mean	40.6	44.5	42.4	42.9	43.0
	S.D.	0.9	1.7	2.9	3.3	2.9
	N	3	8	9	16	36
Tibia (1)	Mean	32.4	35.7	33.6	34.8	34.3
	S.D.	0.4	2.7	2.9	2.6	2.7
	N	2	3	7	12	24
Fibula (1)	Mean		32.4	33.8	33.7	33.6
	S.D.			2.6	2.0	2.2
	N		1	5	3	9

TABLE 6.17 Lengths in centimetres of the long bones of adult females by sample

Among the females the variation in long bone length of the samples was also limited. All mean dimensions of the long bones of the *cella* sample females were smaller than those of females of the other samples. With regard to the upper extremities for the radius lengths, the difference between the means of two samples was statistically significant. Despite the small number of bones that could be measured, the mean maximum length of the radius for *cella* sample females proved to be substantially shorter than for *templum* sample females.⁴³¹ For the lower extremities, the variation in long bone lengths among the female individuals of the *templum* sample, the *basilica* sample and the Boschstraat sample were statistically insignificant. The mean lengths of the femur and tibia calculated for the *templum* sample and the Boschstraat sample were higher than the means found for the *basilica* sample. All means calculated for the *cella* sample were shorter than the other three samples. In comparison with the mean femur length of the *cella* sample females, the mean found for the *templum* sample females was significantly higher.⁴³²

⁴³¹ Radius length (1); *cella* - *templum*: $p=0.04$, Radius length (1b); *cella* - *templum*: $p=0.03$

⁴³² Maximum femur length (1); *cella* - *templum*: $p=0.05$

Lengths by status

In male individuals the mean lengths for higher status categories all surpass the means found for samples of low or intermediate status. For the upper extremities comparison of the means yielded no statistically significant results. Still, as table Table 6.18 shows there was a consistent increase of the mean length with status. For the lower extremities the same trend could be observed. The means calculated for the high status sample exceeded the means for the intermediate sample. These in turn were higher than the means for the low status sample. When the variance was analysed by means of linear regression analysis it appeared that only in case of the femur this trend was statistically significant.⁴³³

Bone		Low	Interm.	High
Humerus (1)	Mean	32.7	34.3	35.3
	S.D.	2.2	1.7	1.5
	N	2	8	10
Radius (1)	Mean	24.6	25.8	27.0
	S.D.	0.5	1.3	2.1
	N	3	5	7
Ulna (1)	Mean	26.4	27.8	29.0
	S.D.	1.7	2.0	
	N	1	3	6
Femur (1)	Mean	45.9	48.2	50.0
	S.D.	2.5	2.7	2.3
	N	4	8	9
Tibia (1)	Mean	38.6	40.1	
	S.D.	2.0	2.0	
	N	5	7	
Fibula (1)	Mean	38.4	39.3	39.8
	S.D.	1.3	2.7	
	N	1	2	7

TABLE 6.18 Lengths in centimetres of the long bones of adult males by status

Bone		Low	Interm.	High
Humerus (1)	Mean	31.2	31.5	30.5
	S.D.	2.1	1.3	1.7
	N	9	10	6
Radius (1)	Mean	23.1	23.7	23.2
	S.D.	2.1	1.3	0.7
	N	9	5	5
Ulna (1)	Mean	24.6	25.0	24.2
	S.D.	0.9	1.9	2.0
	N	6	5	4
Femur (1)	Mean	42.9	43.9	43.4
	S.D.	3.3	2.4	2.5
	N	16	9	7
Tibia (1)	Mean	34.8	34.0	34.5
	S.D.	2.6	2.9	3.2
	N	12	6	4
Fibula (1)	Mean	33.7	34.6	33.3
	S.D.	2.0	2.0	1.5
	N	3	4	2

TABLE 6.19 Lengths in centimetres of the long bones of adult females by status

Comparison of mean long bone lengths of females showed that the means of the three status categories did not vary much. With respect to the upper extremities of female individuals: the highest means were all found for the category of intermediate status. However, the difference between the mean lengths was marginal. The mean long bone lengths in the lower extremities were distributed in what appeared to be a more random way. Unlike the situation found for the upper extremities, for the lower extremities none of the mean lengths measured for the three status categories was consistently larger than the other.

⁴³³ Maximum femur length (1), low - intermediate - high status: $p=0.01$

Asymmetry

For those individuals with both the left and right bones present the difference in length between the sides was analysed for each type of long bone using a paired sample t-test. Asymmetry in the lower extremities was insubstantial and although the left bones were often longer none of the sides appeared to prevail consistently over the other. Therefore, only the results found for the upper extremities are presented below. When tested to which extent asymmetry correlated with period or site and status category, variation was found to be insignificant.

Bone	Male			Female		
	Mean	S.D.	N	Mean	S.D.	N
Humerus (1) right	34.9	1.8	18	31.2	2.2	13
Humerus (1) left	34.6	2.0	18	30.7	2.1	13
Radius (1) right	26.3	2.0	7	22.9	1.0	9
Radius (1) left	26.1	2.1	7	22.5	1.1	9
Ulna (1) right	28.2	1.8	7	24.6	1.7	4
Ulna (1) left	28.2	1.6	7	24.2	2.0	4

TABLE 6.20 Comparison of mean lengths in centimetres of the right and left humerus, radius and ulna in male and female individuals (only individuals with both right and left bones were included)

In the male sample (table 6.20) the mean lengths for the right humerus and radius were higher than the means for the left side. Only in the humerus proved this size difference to be statistically significant.⁴³⁴ The mean difference between right and left bones was larger in the female sample. In general they also had longer bones on the right side (Table 6.20). Statistical analysis indicated that in the female sample the difference was significant both for the humerus and the radius.⁴³⁵

Sex	Right longest	Equal lengths	Left longest	Total
Male	12	3	3	18
	67%	17%	17%	100%
Female	11	2		13
	85%	15%		100%
Total	23	5	3	31
	74%	16%	10%	100%

TABLE 6.21 Asymmetry in the humerus for males and females

In case of the humerus the asymmetry was further analysed per individual. When categorised by asymmetry it is evident that three out of thirty-one individuals (10%) had longer

⁴³⁴ Maximum humerus length (1); Wilcoxon signed rank-test: $p=0.02$

⁴³⁵ Maximum humerus length (1); Wilcoxon signed rank-test: $p=0.01$, maximum radius length (1); Wilcoxon signed rank-test: $p=0.04$

bones on the left side. All three of these individuals were males. Almost equal lengths of the humeri were found in 16 per cent of the sample. A clear majority of nearly 75 per cent of the inspected individuals had a longer right humerus. The variation between males and females in this distribution was not statistically significant.

STATURE ESTIMATION

The lengths of the long bones of 43 males and 53 females could be used to calculate estimates of stature for 96 individuals. A large difference in mean stature was found between male and female individuals (see table 6.22). This was statistically significant, consequently further analysis of stature occurred separately for males and females.⁴³⁶

Method	Sex	Mean	S.D.	N	Minimum	Maximum
Breitinger 1937	Male	172.8	4.6	43	163.7	183.1
Trotter and Gleser 1958	Male	175.8	6.3	43	162.8	189.1
Trotter 1970	Male	175.2	6.2	43	163.8	187.8
	Female	161.7	6.9	53	149.2	181.7

TABLE 6.22 Stature estimation in centimetres for male and female individuals, according to three selected methods⁴³⁷

The range for male stature extended to circa 25 centimetres, female stature to circa 32 centimetres. Single extreme values are largely responsible for the width of these ranges.⁴³⁸ Comparison of female stature estimated according to Trotter 1970 and male stature estimated according to Breitinger 1937 indicated that the difference between male and female mean stature was circa 11 centimetres.

When analysed by sample, variation in the stature of male individuals was moderate. However, the first three samples (representing subsequent chronological periods) displayed an increase of mean stature with time. Still, when statistically tested this increase did not prove to be significant. Significant differences among the male samples existed between the males from the Boschstraat site and both the *templum* sample and the *basilica* sample.⁴³⁹ Among the female individuals no trend of increasing stature with time was observable. The mean stature

⁴³⁶ Mean male stature estimates calculated according to Breitinger, 1937, Trotter and Gleser, 1958 and Trotter, 1970 exceeded mean female stature calculated according to Trotter and Gleser, 1958, significantly with $p < 0.001$.

⁴³⁷ Included in this table is the mean stature estimated on the basis of the formulas for white males and white females as published by M. Trotter and G. Gleser in 1958. These are presented here to facilitate comparison with older studies. In the subsequent tables the results for males are only based on the revised formulas, published in 1970 by M. Trotter, and the results calculated by means of Breitinger's regression formulas. It should be noted that the formulas for white females published by Trotter in 1970 are identical to the formulas published by Trotter and Gleser in 1958.

⁴³⁸ The stature of the largest female exceeded the stature of the second tallest female with circa seven centimetres. A similar situation was found for the minimum stature for males where the shortest male was seven centimetres shorter than the second shortest male. These estimates were only just outside the range of the double standard deviation for females and within this range for males.

⁴³⁹ Basilica sample male - Boschstraat site male, Breitinger 1937: $p = 0.03$.

Method	Sex		Cella	Templum	Basilica	Boschstraat	Total
Breitinger 1937	Male	Mean	171.8	172.7	174.2	169.1	172.8
		S.D.	4.1	3.1	5.1	3.1	4.6
		N	8	7	22	6	43
Trotter 1970	Male	Mean	172.8	176.0	177.1	170.5	175.2
		S.D.	5.9	4.3	6.5	4.2	6.2
		N	8	7	22	6	43
	Female	Mean	155.9	165.7	161.5	160.5	161.7
		S.D.	3.2	4.4	7.1	7.5	6.9
		N	4	13	17	19	53

TABLE 6.23 Stature estimation in centimetres for male and female individuals by sample

calculated for females from the *templum* sample clearly surpassed the other samples. When mean female stature for the *templum* sample was compared with mean stature calculated for the *cella* sample and the Boschstraat sample the differences proved to be statistically significant.⁴⁴⁰

Another aspect is the variation in sexual dimorphism reflected in the mean difference in stature between the sexes. The difference in stature between males and females for the sample as a whole was circa 11 centimetres. Both for the *cella* sample and the *basilica* sample a greater difference was found viz. 15.9 and 12.7 centimetres respectively. Between the males and females of the *templum* sample and the Boschstraat sample the dimorphism in stature was less prominent. For the *templum* sample the difference in stature between the sexes was only 7.0 centimetres and for the Boschstraat site 8.6 centimetres.

Method	Sex		Low	Interm.	High
Breitinger 1937	Male	Mean	169.1	173.0	174.9
		S.D.	3.1	3.9	5.1
		N	6	10	14
Trotter 1970	Male	Mean	170.5	175.8	178.5
		S.D.	4.2	5.0	6.5
		N	6	10	14
	Female	Mean	160.5	163.5	163.5
		S.D.	7.5	6.1	5.9
		N	19	16	12

TABLE 6.24 Stature estimation in centimetres for male and female individuals by status

Table 6.24 shows different trends in stature by status for males and females. In male individuals mean stature for each category is higher when status is higher. Analysis by means of

⁴⁴⁰ Student's t-test: *cella* sample - *templum* sample female: $p=0.02$ and *templum* sample - *Boschstraat* sample female: $p=0.03$

linear regression indicated this trend in males was statistically significant.⁴⁴¹ For females a larger stature was found for individuals of intermediate status when compared with individuals of low status. However, mean stature calculated for both the intermediate and high status categories was equal.⁴⁴² These deviating trends also dictated the sexual dimorphism in stature. The difference between mean male and female stature increased with status. In the low status category the difference was 8.6 cm; in the intermediate and high status category it was 9.5 and 11.4 centimetres respectively.

NON-METRICAL VARIATION

Six non-metric traits, listed in the table on the next page, could be inspected in sufficient numbers to allow for comparison between various samples. In general no strong correlation was found between observed non-metrical variation and sex. An exception is the prevalence of a septal aperture of the left humerus (*foramen olecrani*). Significantly more females were found with this trait than males.⁴⁴³ Metopism was also found mostly among women. Still, statistical analysis of the distribution of this trait did not indicate there was a significant correlation between metopism and sex.⁴⁴⁴ The results are not displayed separately by sex, because this would lead to too small sample sizes. In case of the prevalence of septal apertures it has to be kept in mind that the proportion of males and females in the samples may bias the percentages presented in the tables.

Variation in the prevalence of non-metric traits among the samples was statistically not significant. Also no evident chronological trends were observable. However, several traits showed considerable variation in their prevalence per sample. For example, both lambdoid ossicles and septal apertures were found more often in the *cella* sample than in any other sample. The individuals from the Boschstraat had the highest percentage of metopism and ossicles at lambda. In the *templum* and *basilica* samples the prevalence of most traits was more or less equal to the prevalence in the sample as a whole.

When the non-metric traits were analysed by status category it could be observed that there was no relation between specific traits and status. The only exceptions were lambdoid ossicles. The prevalence of lambdoid ossicles was higher in the intermediate status category than in the high status category. This difference in prevalence between the two categories was statistically significant.⁴⁴⁵

⁴⁴¹ Linear regression analysis (Pearson correlation) for male stature Breiting 1937 by status: $p=0.004$.

⁴⁴² The correlation between female stature and status was statistically not significant: $p=0.07$.

⁴⁴³ A septal aperture in the right humerus was found in 1 out of 30 males and in 7 out of 40 females. A septal aperture in the left humerus was found in 2 out of 30 males and 9 out of 33 females. In case of the left humerus the prevalence of this trait was significantly higher in females than in males: female - male: $p=0.046$.

⁴⁴⁴ Male - female: $p=0.07$.

⁴⁴⁵ The distribution of lambdoid ossicles in the three status categories differed significantly from a random normal distribution: $p=0.01$. Statistical analysis also indicated that the difference in distribution between the intermediate status and high status was significant: $p=0.03$.

	Cella	Templum	Basilica	Boschstraat	Total	Low	Interm.	High
Metopism	9%	11%	6%	22%	12%	12%	14%	7%
	1/11	3/27	2/35	6/27	12/100	6/27	3/21	2/28
Sagittal ossicle	0%	12%	3%	5%	5%	5%	7%	8%
	0/9	2/17	1/31	1/19	4/76	1/19	1/15	2/24
Lambdoid ossicle	67%	36%	40%	17%	37%	17%	67%	29%
	6/9	4/11	14/35	3/18	27/73	9/18	12/18	6/21
Ossicle at lambda	10%	17%	15%	25%	17%	25%	28%	9%
	1/10	2/12	5/34	5/20	13/76	5/20	4/17	2/22
Ossicle at asterion	14%	30%	10%	19%	16%	19%	3%	15%
	1/7	3/10	3/31	3/16	10/64	3/16	2/16	3/20
Septal aperture R	20%	8%	13%	5%	11%	6%	10%	5%
	2/10	1/13	4/31	1/20	8/74	1/20	4/21	1/21
Septal aperture L	38%	0%	21%	16%	17%	16%	29%	4%
	3/8	0/14	5/24	3/19	11/65	3/19	4/14	1/22

TABLE 6.25 Non-metrical variation by sample and status (percentage and number per inspected individuals)

HEALTH

STRESS MARKERS

Harris lines

The tibiae of 48 adult individuals were complete enough to be inspected for the presence of Harris lines.⁴⁴⁶ Of these 48 individuals 21 were of male sex, 24 female and 3 were of indeterminate sex. Beside type I, II and III lines, remnants of Harris lines were visible on the x-rays. Post-depositional bone loss had damaged 60 lines. Due to the bone loss the length of the lines did not extend halfway into the medullary cavity. Therefore these lines did not comply fully with the criteria defined by Maat for type I, II and III lines.⁴⁴⁷ With respect to their density these incomplete lines were less obtrusive than moderate or strong lines and were considered to represent damaged type I lines. Therefore, these incomplete lines have been included in the counts and calculations as type I lines.⁴⁴⁸ Because only complete tibiae were x-rayed, it was possible to calculate the age of formation for all lines. The results related to the presence of Harris lines will be presented in three forms: counts and percentages of individuals with and without Harris lines, the mean number of lines per individual and the mean formation rate of Harris lines per sample or status category. Statistical analysis indicated that the prevalence of Harris lines in adult individuals was not associated with sex. Also no association with age was

⁴⁴⁶ Definitions and methods are described in chapter 5.

⁴⁴⁷ Maat, 1984.

⁴⁴⁸ Before the damaged Harris lines were added to the type I Harris lines, they were analysed separately. It was found that their age distribution and prevalence was very similar to type I lines.

found. When the 20 to 40 and the 40 to 60 years intervals were compared, the results indicated that no significant difference in the prevalence of Harris lines existed between these age categories.⁴⁴⁹

Presence of Harris lines

Judged by the presence of type I to III lines, 81 per cent of the inspected individuals had one or more Harris lines. Statistical analysis of contingency tables for the presence of the three types of Harris lines showed that only the correlation between the presence of type II and type III lines was statistically significant.⁴⁵⁰

Type I Harris lines	67%
	32/48
Type II Harris lines	31%
	15/48
Type III Harris lines	46%
	22/48
Type I-III Harris lines	81%
	39/48

TABLE 6.26 Various types of Harris lines in 48 adult individuals

With respect to type I lines, inspection of the mean number of lines, the formation rate of lines and the age of formation provided no indication of any correlation of these types of lines with sex, chronological sample or status. Therefore, the data related to type I lines were not presented separately in the tables below. They are included in the calculations for all line types.

	Cella	Templum	Basilica	Boschstraat	Total	Low	Interm	High
Type II Harris lines	20%	38%	47%	13%	31%	13%	38%	47%
	1/5	3/8	9/19	2/16	15/48	2/16	3/8	7/15
Type III Harris lines	40%	50%	53%	38%	46%	38%	38%	53%
	2/5	4/8	10/19	6/16	22/48	6/16	3/8	8/15
Type I-III Harris lines	100%	63%	95%	69%	81%	69%	88%	80%
	5/5	5/8	18/19	11/16	39/48	11/16	7/8	12/15

TABLE 6.27 Harris lines in adult individuals by sample and status

Table 6.27 shows that the number of individuals with type II and type III lines increased from the *cella* phase to the *basilica* phase. However, analysis did not provide support that this trend

⁴⁴⁹ Both the mean number of lines and the mean formation rates were more or less equal. There was also no trend indicating that less Harris lines had persisted in the older age category. All *p*-values were higher than 0.05.

⁴⁵⁰ Type II lines - type III lines: *p*=0.01.

was statistically significant.⁴⁵¹ Judged by the prevalence of individuals with type I to III lines the *basilica* sample appears to be the most affected sample. The comparatively low prevalence of individuals with type II lines in the Boschstraat sample is remarkable. When the *basilica* and Boschstraat samples were compared the number of individuals with type II lines was significantly higher in the *basilica* sample.⁴⁵² For type III lines the variation between the samples was limited.

Status-related variation in the percentage of individuals with Harris lines could be examined in 39 individuals. Generally the highest percentage of individuals with Harris lines was found for the high status category. Comparatively, low percentages were found for the low status category. For type II lines and type I to III lines the trend indicated that the number of individuals with Harris lines increased with status. In case of type II Harris lines this trend proved to be statistically significant.⁴⁵³

Mean number of Harris lines

In total 144 type I to III Harris lines were counted. The mean number of lines per individual was tested for possible influences of sex and age at death. No significant correlation between these factors was found.⁴⁵⁴ Variation in the mean number of lines was also examined for a possible correlation with samples or status. No significant variation in the results was observed. Further comparisons were made on the basis of formation rates.

Sex		Type I	Type II	Type III	All types
Male	Mean	1.71	0.67	0.62	3.00
	S.D.	1.85	1.20	0.59	2.17
	Sum	36	14	13	63
	Nl	21	21	21	21
Female	Mean	2.21	0.25	0.58	3.04
	S.D.	1.91	0.53	0.83	2.24
	Sum	53	6	14	73
	Nl	24	24	24	24
Total	Mean	1.94	0.46	0.60	3.00
	S.D.	1.85	0.90	0.74	2.20
	Sum	93	22	29	144
	Nl	48	48	48	48

TABLE 6.28 Mean number of Harris lines per individual. In the bottom section of the table, "total", numbers are higher because of the inclusion of unsexed individuals

⁴⁵¹ When tested with chi-square for trend for the *cella*, *templum* and *basilica* sample the lowest *p* value was found for the distribution of individuals with type II lines: *p*=0.27.

⁴⁵² *Basilica* sample - Boschstraat site: *p*=0.04.

⁴⁵³ Chi-square test for trend for the presence of type II lines: low-intermediate-high status: *p*=0.04.

⁴⁵⁴ The largest relative difference was observed for the mean number of type II Harris lines per individual. For females the mean number of this type of lines was less than half the mean for males.

Formation rates of Harris lines per year of individual growth

When compared by sample the formation rates did not vary much. For all counts the *cella* sample and the *templum* sample display similar rates. The formation rates found for the *basilica* and the Boschstraat samples were generally higher. The rate calculated for the Boschstraat sample was considerably lower than the rate of the *basilica* sample only for type II lines. There was a tendency for the formation rates of type II lines separately, and for all lines together (type I, II and III), to increase diachronically from the *cella* phase to the *basilica* phase. However, this trend was statistically not significant. With respect to the variation in formation rates by status, minor differences between the categories were also observed. Apart from the rates for type II lines all formation rates were more or less equal for the three status categories. The formation rate for type II lines was found to increase with status. Statistically the correlation between the mean formation rates of type II Harris lines and status was significant.⁴⁵⁵

Type		Cella	Templum	Basilica	Boschstraat	Total	Low	Interm.	High
II	Mean	0.01	0.02	0.04	0.01	0.03	0.01	0.03	0.05
	S.D.	0.02	0.04	0.07	0.02	0.05	0.02	0.05	0.08
	N	5	7	18	15	45	15	8	14
III	Mean	0.02	0.02	0.04	0.04	0.04	0.04	0.04	0.03
	S.D.	0.03	0.03	0.04	0.06	0.04	0.06	0.05	0.03
	N	5	7	18	15	45	15	8	14
All	Mean	0.13	0.15	0.20	0.18	0.18	0.18	0.22	0.18
	S.D.	0.08	0.15	0.12	0.15	0.13	0.15	0.14	0.13
	N	5	7	18	15	45	15	8	14

TABLE 6.29 Formation rate of Harris lines by sample and status

Analysis of the age of formation of Harris lines was based on a database in which all 144 Harris lines were filed as separate entities. Therefore the results in table 6.30 do not represent individuals. The numbers in this table represent individual Harris lines categorised by 1-year age intervals based on their age of formation. Harris lines were found in 39 individuals: 18 males (63 Harris lines), 19 females (73 Harris lines) and 2 unsexed individuals (8 Harris lines). The table shows that there was a difference in predilection of the age of formation of Harris lines between male and female individuals. In females the majority of lines formed from the eighth up to and including the twelfth year. In males the period of increased Harris line formation ranged from the tenth up to and including the fifteenth year.⁴⁵⁶ For both sexes the main period of formation of type III Harris lines seems to have been from birth to the fourth year. The formation of type I and II Harris was found to occur later in the growth period, viz. from the sixth up to and including the fifteenth year of age.

⁴⁵⁵ Linear regression analysis (Pearson correlation) for the formation rate of type II lines by status: $p=0.03$.

⁴⁵⁶ A Kolmogorow-Smirnov test indicates that this difference in age distribution of Harris lines between males and females is significant $p=0.01$.

Type	Sex	Age of formation in 1-year intervals																Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
I	Male	1					1	5	3	2	3	4	2	5	5	4	1	36
	Female	1	1			1	3	2	8	9	8	7	8	4	1			53
II	Male							1	2	1		1	3	2	2	2		14
	Female								1	1	2	2						6
III	Male	3	3	4	1			1							1			13
	Female	1	2	2	1	1		2	1				3	1				14
Total	Male	4	3	4	1		1	7	5	3	3	5	5	8	7	6	1	63
	Female	2	3	2	1	2	3	4	10	10	10	12	9	4	1			73
Total		6	6	7	2	2	4	11	15	13	15	18	16	14	18	6	1	144

TABLE 6.30 Overall distribution of Harris lines per 1-year age interval The intervals for the seventeenth and eighteenth year have not been included in the table as no lines seem to have formed during those intervals.

Harris lines and stature

To investigate a possible correlation between the occurrence of Harris lines and adult stature scatter plots were made, depicting stature and the total number of Harris lines for each individual.

FIGURE 6-7 The left chart displays the correlation between stature and the number of Harris lines for male individuals, the right chart does the same for female individuals. In each diagram a quadratic regression line is drawn. For males R^2 is 0.408 and for females 0.165.⁴⁵⁷

Figure 6-7 illustrates that with respect to the correlation between the number of Harris lines and stature per individual, the trend in females deviates from the trend in males. In males, Harris lines show a positive correlation with stature up to individuals with three Harris lines.

⁴⁵⁷ R -squared is a goodness-of-fit measure for a linear model, in this case the regression line. A small value (the range goes between 0 and 1) indicates that the model line does not fit the data well.

More than three lines were associated with slightly under average stature. Female individuals with a higher number of Harris lines tended to be shorter. This dimorphism was also found when stature was compared between individuals having formation rates of Harris lines lower than the mean and individuals with higher formation rates. The mean stature of females with low formation rates of Harris lines was found to exceed the mean stature calculated for females with higher formation rates. For male stature the opposite was true. Males with an above average formation rate of Harris lines were in general slightly taller.⁴⁵⁸

Enamel hypoplasia

A total of 90 adult individuals were inspected for the presence of enamel hypoplasia. Enamel hypoplasia is a condition representing a period of deficient enamel formation during growth. It is visible as a decrease of the enamel thickness on the crown surface. Most cases of enamel hypoplasia were of the linear type, viz. horizontal grooves around the circumference of the crown.⁴⁵⁹ Two individuals had more serious additional pit-type defects. Plane-type defects, characterised by malformation or complete absence of enamel of large sections of the crown surface, did not occur. In 27 (30 per cent) of the inspected individuals the hypoplastic defects were of a mild to moderate nature. They were difficult to detect macroscopically as the defect was only superficial. Furthermore six individuals (7 per cent) had defects that were more marked, viz. easily detectable lines.⁴⁶⁰ None of the individuals had severe lines with missing enamel. No correlation was found between enamel hypoplasia and sex or age.

	Cella	Templum	Basilica	Boschstraat	Total
No hypoplasia	8 62%	16 61%	22 76%	11 50%	57 63%
Mild to moderate	3 23%	8 31%	5 17%	11 50%	27 30%
Marked hypoplasia	2 15%	2 8%	2 7%		6 7%
Total	13	26	29	22	90

Low	Interm.	High
11 50%	18 90%	12 50%
11 50%	2 10%	10 42%
		2 8%
22	20	24

TABLE 6.31 Enamel hypoplasia in adult individuals by sample and status

Table 6.31 shows the occurrence of individuals with enamel hypoplasia in the four samples. Compared to the other samples the individuals of the *basilica* sample were less affected. For the individuals of the Boschstraat sample the opposite was found. In that sample the percentage of

⁴⁵⁸ Compared are females with a formation rate of less than 0.19 Harris lines per year to females with a formation rate of 0.19 or more Harris lines per year. For the first group stature was 161.7 cm, sd=9.1, n=13. In the second group stature was 159.5 cm, sd=7.1, n=11. For males the following mean statures were found: in males with less than 0.17 Harris lines per year stature was 173.5 cm sd=6.9, n=10. In males with a formation rate of 0.17 or more Harris lines per year stature was 174.2 cm, sd=3.8, n=9.

⁴⁵⁹ Hillson, 1996.

⁴⁶⁰ Mild to moderate lines were difficult to discern macroscopically, marked lines were easily discernible.

individuals with enamel hypoplasia was 13 per cent higher than the mean. Still, this variation was not found to be statistically significant.

Among the three status categories statistically significant variation was found for the distribution of individuals with enamel hypoplasia. In table 6.31 the lowest percentage of individuals with enamel hypoplasia was found for persons of intermediate status. Both in the low and the high status categories significantly more individuals were found to have enamel hypoplasia.⁴⁶¹ When the presence of enamel hypoplasia was tested for correlation with the presence of Harris lines no statistically significant results were obtained.

Cribra orbitalia

The orbital roofs of 102 individuals (non-adults included) were inspected for the presence of cribra orbitalia. Scored as cribra orbitalia were all orbits with multiple pits in the interior-superior surface of the orbit. In the Maastricht sample no cases with expansive new bone formation in the orbits were found. Comparison of the prevalence of cribra orbitalia among the non-adults and the adults showed that the percentage of non-adults with this condition was only slightly higher. Among the non-adults 18 per cent (4/22) had cribra orbitalia, among the adults 14 per cent (11/80).⁴⁶² In Table 6.32 only the data on adult individuals are presented.⁴⁶³ No correlation between sex and cribra orbitalia was found in the sample as a whole, allowing the combination of results for males, females and unsexed individuals in the tables.⁴⁶⁴

FIGURE 6-8 A case of cribra orbitalia, typical for the nature of cribra orbitalia in the samples from Maastricht (photograph: R. Panhuysen)

⁴⁶¹ Low status - intermediate status: $p=0.01$; intermediate status - high status: $p=0.01$.

⁴⁶² Among the adult individuals also no correlation between cribra orbitalia and age was observable.

⁴⁶³ Non-adults were not included because some of the non-adults without cribra might still have developed cribra orbitalia in case they had lived longer. Whereas the prevalence among adults represents in theory the total number of cases developed during the completed growth period. In this respect the percentage of individuals with cribra orbitalia among non-adults is not the same as the percentage calculated for adults.

⁴⁶⁴ Males 16 per cent (6/37) and females 13 per cent (5/40).

	Cella	Templum	Basilica	Boschstraat	Total	Low	Interm.	High
Cribrā orbitalia	10%	17%	15%	7%	14%	7%	5%	22%
	1/10	4/23	5/33	1/14	11/80	1/14	1/20	5/23

TABLE 6.32 Cribrā orbitalia in adult individuals by sample and status

Table 6.32 illustrates that the percentage of individuals with cribrā orbitalia ranged from 17 to 15 per cent for the *templum* and *basilica* samples. For the preceding *cella* sample and the contemporaneous Boschstraat sample lower percentages were calculated. In contrast with the distribution of individuals with cribrā orbitalia by sample the distribution by status category was characterised by larger differences among the groups. When categorised by status, the cases of cribrā orbitalia occurred mostly in the high status category and less in the intermediate status category. Still, calculation of Pearson's chi-square for the intermediate and high status category indicated this deviating distribution pattern was not statistically significant.⁴⁶⁵

PATHOLOGY

The description of pathological conditions is limited to types of pathology found in frequencies that allowed for comparison between the samples. An exception was made for those cases in which the specific type of pathology could yield valuable information on the health situation.

TRAUMA

Fractures

All bones were inspected macroscopically for the presence of fractures. The diagnosis of healed fractures was primarily based on the presence of a change of contour of the bone and deviation of the axis of long bones. Both bones with evident healed fractures and bones for which the presence of a well-healed fracture was suspected were x-rayed. Broken bones displaying no signs of callus formation were also examined to ascertain whether the breakage of the bones had occurred during life or after deposition of the body. No bones were found to display peri-mortem, unhealed fractures. On the basis of the brittle appearance of the edges of the fracture and the direction of the fracture lines all fractures that might possibly be peri-mortem fractures were identified as post-mortem fractures. This diagnosis was further supported by the fact that most unhealed fractures showed a distinctive bright colour of the surface of the fracture (as opposed to the darker coloured surface of the periosteal surface). Therefore, it could be ascertained that many of these post-mortem fractures were the result from damage during the recovery or post-excavation treatment of the skeletal remains.

⁴⁶⁵ Intermediate status – high status: $p=0.12$

FIGURE 6-9 Healed fracture of both the right and left ulna⁴⁶⁶ (photograph: R. Panhuysen).

A total of 24 individuals had contracted fractures during life (circa 10% of all individuals). Six of these individuals had two fractures. In total the number of healed fractures was 30. One of the individuals was younger than 20 years; all others were older.⁴⁶⁷ Male individuals had more fractures than females, viz. 13 males (circa 20% of the males) and 8 females (circa 10% of the females). The percentage of individuals with fractures in the 20 to 40 years interval and the 40 to 60 years interval was more or less the same, viz. 14 and 15 per cent respectively. For the 60 to 80 years interval the percentage of individuals with fractures was much higher, viz. 38 per cent. However, the total number of individuals in this last age interval comprised only eight persons and the variation in prevalence among the age categories was statistically not significant. In the case of healed fractures of long bones the type of fracture was determined in co-operation with consulted specialists. Most fractures were either oblique or transverse fractures (11 and 10 cases respectively). Two cases were diagnosed as spiral fractures. Distribution of the fractures with respect to the side of the body was almost equal, viz. 13 on the right side and 11 on the left side.

⁴⁶⁶ Individual number 1-3-106 a female aged between 34 and 40 years from the Boschstraat site.

⁴⁶⁷ Servaas site 5-09-02, basilica sample, sex unknown, age between 15 and 20 years: fracture of the left ulna.

Bone	Cella		Templum		Basilica		Boschstraat		Total	
	%	N/Ni	%	N/Ni	%	N/Ni	%	N/Ni	%	N/Ni
Mandible		0/13		0/24		0/27	5%	1/21	1%	1/85
Vertebra		0/224	1%	2/202	0.2%	1/539	0.3%	1/367	0.1%	4/1332
Clavicle	7%	1/14	7%	1/14	3%	1/36	10%	3/30	6%	6/94
Scapula		0/25	4%	1/26		0/48		0/28	1%	1/127
Rib		0/13		0/19	10%	3/31		0/4	4%	3/67
Humerus	4%	1/26		0/36	1%	1/69		0/46	1%	2/177
Ulna	5%	1/19		0/26	8%	4/53	7%	3/42	6%	8/140
Radius		0/17	3%	1/30	4%	2/51		0/45	2%	3/143
Hand		0/5		0/18		0/29	6%	1/18	1%	1/70
Femur		0/25		0/55	1%	1/68		0/49	1%	1/197
Tibia		0/22		0/46		0/65		0/48		0/181
Fibula		0/12		0/23	6%	3/49		0/36	1%	3/120
Foot		0/5		0/3		0/21		0/16		0/45
Total		3		5		16		9		33

TABLE 6.33 Frequencies of healed fractures by sample. Bones of the hand and foot are included in the table as an assemblage of bones. Represented are fractured bones or parts of the skeleton as a percentage of the total number of that bone or part of the skeleton inspected in adult individuals. In all cases right and left bones were found in similar quantities.⁴⁶⁸ ("N" is the number of healed fractures and "Ni" is the number of bones or parts of the skeleton that could be inspected.)

The distribution of the fractures within the skeleton was analysed on the basis of all 33 fractures found in adult individuals. With 14 fractures (48 per cent) the bones of the upper extremities were most often affected. Second came the shoulder girdle with seven fractures (24 per cent). Both the lower extremities and the trunk were involved four times (14 per cent each). One fracture was found to have affected the skull (3 per cent). When the distribution per type of bone is considered, most fractures occurred in the long bones, viz. 17 fractures. Three individuals had fractured ribs and another three had a fracture of the vertebral arch. The other fractures were contracted in the spinal process of a thoracic vertebra, the glenoid cavity of a scapula, a mandibular condyle and the os capitata of the right hand. No statistically significant correlation was found between the type of bone that was fractured and the sample or status category. Still, fractures of the ribs as well as fractures in the lower extremities were found exclusively in individuals from the *basilica* sample. With a total of seven, these fractures made up almost half the total number of fractures found in the *basilica* sample. Fractures of the lower extremities and ribs were found almost exclusively among male individuals: six out of seven fractures were seen in five male individuals and one in an unsexed individual.

⁴⁶⁸ Right and left bones were counted separately and in case of the ribs, hands and feet the percentage was not calculated on the basis of individual bones but on cases in which ribs or bones of the hand and feet could be inspected.

	Cella	Templum	Basilica	Boschstraat	Total	Low	Interm.	High
Fractures per inspected bone	1.6% 2/122	0.5% 1/216	3.1% 11/355	1.1% 3/266	1.8% 17/959	1.1% 3/266	1.2% 3/241	2.9% 8/272
Individuals with fracture	18% 3/17	4% 3/67	17% 12/72	19% 6/31	13% 24/187	19% 6/31	14% 5/36	17% 9/54

TABLE 6.34 Prevalence of fractures in adults by sample and status (per inspected long bones and per individual)

The percentage of individuals with one or more fractures in the *templum* sample was significantly lower than in the *basilica* and Boschstraat samples.⁴⁶⁹ As indicated above, there was a marked variation in recovery rates between the samples. In order to circumvent possible bias due to the variation in recovery rates, the frequency of fractures in the long bones was calculated as a percentage of the number of inspected long bones. Distribution of the fractures per inspected long bone also displayed a statistically significant difference between the *templum* and the *basilica* samples, but not between the *templum* and the Boschstraat samples or between the *basilica* and the Boschstraat samples.⁴⁷⁰

Comparison of the prevalence of fractures per individual and the prevalence calculated per inspected long bone presented no indication for a correlation with status. As stated above, there was a specific pattern of fracture distribution in the *basilica* sample. Fractures in the lower extremities and ribs only occurred in this sample. With regard to status this pattern was less consistent.

Fracture healing and secondary osteoarthritis

Fracture healing was investigated by inspecting the alignment of the fragments of each fractured bone for angulation, rotation and dislocation (ad latus and ad axis). Complete consolidation had occurred in all fractures. In six cases (21 per cent of the adult individuals with fractures) the fracture had healed almost completely in anatomical position. Less optimal healing was found for 22 fractures (76 per cent). In these cases marginal angulation, displacement, rotation or a combination of these was found. The outcome of the assessment of the quality of healing after consultation with specialists was that in case of these fractures permanent functional impairment was unlikely. Only one individual had a fracture of the femur that at first sight seemed to be poorly healed. In this case the fracture had caused some permanent functional impairment. Nevertheless, given the difficulties associated with this type of fracture it had healed reasonably well.⁴⁷¹ Another factor that was taken into account for an assessment of the healing of the fractures was the presence of secondary osteoarthritis. Secondary osteoarthritis was defined as the occurrence of osteoarthritis at joints that are biomechanically related to the fractured bone. In five individuals with fractures osteoarthritic changes were diagnosed as secondary to the fracture. None of these cases of secondary

⁴⁶⁹ *Templum* – *basilica*: $p=0.047$ (Fisher's Exact test); *templum* – Boschstraat: $p=0.03$ (Fisher's Exact test)

⁴⁷⁰ *Templum* – *basilica*: $p=0.04$ (Fisher's Exact test)

⁴⁷¹ For examples of less well healed femur fractures see Czarnetzki, 1996, p.174-179 and Czarnetzki et al., 1989, p.52.

osteoarthritis occurred in the group with fractures with near to optimal fracture healing. Secondary osteoarthritis was found four times in individuals with less optimal fracture healing and the fifth individual was the person with the poorly healed fracture of the femur. All fractures were consolidated and displayed remodelling of the permanent callus. This suggests all fractures had occurred well before the time of death. Estimates of the moment of fracture varied between one and five years before the time of death.

FIGURE 6-10 Diaphyseal fracture of the femur, with angulation of the diaphysis, exorotation and shortening ⁴⁷² (photograph: R. Panhuysen).

Spondylolysis

Spondylolysis is a separation mostly occurring at the site of the pars interarticularis of the neural arch of the vertebra. As a result the dorsal part of the vertebral arch, consisting of the laminae, spinous process and inferior process, is separated from the rest of the vertebra. The aetiology of spondylolysis was a matter of debate. Traditionally it was considered a congenital abnormality. Recent studies show that spondylolysis is the result of a stress fracture that has not (completely) healed. ⁴⁷³

⁴⁷² Individual (number 11-04-03) from the basilica sample, male, aged between 52 and 61 years who was categorised to be of high status. By means of macroscopical inspection and x-rays a spiral fracture was diagnosed. Apart from angulation and exorotation the bone had healed reasonably well with a shortening of the bone of circa 25 millimetres (in comparison to the right femur).

⁴⁷³ Aufderheide and Rodriguez-Martin, 1998, p. 63-64.

FIGURE 6-11 A case of spondylolysis of the fifth lumbar vertebra (photograph: R. Panhuysen).

In 71 individuals one or more lumbar vertebrae could be inspected. Three individuals were found with spondylolysis (4 per cent). All three cases of spondylolysis concerned the fifth lumbar vertebra. Individual 05-08-08 was a case in which spondylolysis was found in the fifth lumbar vertebrae in combination with partial fusion of the fifth lumbar vertebra to the upper part of the sacrum (hemisacralisation).

Number	Sample	Status	Sex	Age	Vertebra
04-03-01/2	Templum		?	Adult	5th lumbar vertebra
05-08-08	Basilica	Intermediate	Female	23-40	5th lumbar vertebra
05-11-02	Templum	High	Male	31-37	5th lumbar vertebra

TABLE 6.35 Individuals with spondylolysis

Injuries by sharp bladed and pointed objects

Nine individuals were found to be injured either by cuts of sharp bladed objects or by pointed objects. Traumatic changes caused by a sharp bladed object were found in six individuals. In five of these cases the skull was the part of the body that was injured.

Number	Sample	Status	Sex	Age (yr.)	Bone	Object	State of trauma
01-02-03	<i>Basillica</i>	High	Male	43-49	Tibia	Sharp bladed	Remodelled
03-06-04	<i>Templum</i>	High	Male	31-40	Skull: frontal bone	Sharp bladed	Remodelled
04-03-01	<i>Templum</i>		Male	20-29	Skull: atlas, axis and hand	Sharp bladed	Peri-mortem
05-08-12	<i>Basillica</i>	Intermediate	Male	34-40	Skull: left parietal bone	Sharp bladed	Peri-mortem
06-05-06	<i>Basillica</i>	High	Male	49-55	Skull: frontal bone	Sharp bladed	Remodelled
06-06-01/2	<i>Basillica</i>		Male	30-39	Skull: left parietal bone	Sharp bladed	Peri-mortem
01-05-07	<i>Basillica</i>	Intermediate	Male	43-49	Skull: right orbit	Pointed	Remodelled
13-07-02	<i>Cella</i>		Male	48-54	Skull: right side frontal bone	Pointed	Remodelled
15-03-01	<i>Cella</i>		Male	31-37	Skull: right orbit	Pointed	Remodelled

TABLE 6.36 Individuals with injuries caused by sharp bladed and pointed objects

Apart from one individual all skulls displayed signs of only one cut. In one of these five cases not just the skull was injured but cuts were also observed on the atlas, axis and carpal bones. On the skull of this individual traces of at least seven cuts with a sharp bladed object could be observed. The sixth case was an individual with an oblique cut-mark on the tibia. In three of the individuals with sharp bladed injuries signs of healing could be recognised. In the other three cases no indications for healing were found. Because of the typical fracture pattern surrounding the cut bone and the uniform colour of both the edges of the cuts and the periosteal surface it was possible to classify the latter traumata as a result of peri-mortem incidents.

Traumatic changes caused by sharp pointed objects were observed in three individuals. Each of these injuries was found on the right side of the frontal bone, in or around the orbits. In all three cases some form of bone reaction had taken place around these traumata. This suggests that some time had passed between the moment these individuals had been injured and their death.

All injuries by sharp bladed or pointed objects were found in male individuals; only adult individuals were affected. Two injuries had occurred in the *cella* sample (both by pointed objects), two in the *templum* sample (both by sharp bladed objects) and five in the *basilica* sample (one by a pointed object and four by sharp bladed objects). No traces of such injuries were found among the individuals from the Boschstraat. When distributed by status category two traumata were found in the intermediate category and three traumata in the high status category. A combination of fractures and injuries caused by sharp bladed or pointed objects was found in two individuals. One individual had a healed fracture of the right humerus and an injury on the skull, caused by a pointed object.⁴⁷⁴ The other individual combined a healed fracture of the left clavicle with cuts of the skull.⁴⁷⁵

⁴⁷⁴ Individual 13-07-02.

⁴⁷⁵ Individual 06-05-06.

FIGURE 6-12 Frontal bone of a male who died between 31 to 40 years. Left of centre a longitudinal depression is visible, representing a healed trauma from a sharp bladed object. To the left of this trauma post mortem damage of the skull is visible (Servaas church, 3-6-4, photograph: R. Panhuysen).

FIGURE 6-13 Illustration: trauma of the lateral surface of the right half of the frontal bone, probably caused by a sharp pointed object: 1-5-7 (photograph: R. Panhuysen).

FIGURE 6-14 A detail of two cuts by a sharp bladed object in the skull of individual 04-03-01 of the saint Servaas site. The first cut is visible in the middle of the photograph (1), the second cut (2) intersects at an angle with the first cut.

FIGURE 6-15 Another detail of trauma due to injury with a sharp bladed object in individual 04-03-01 of the saint Servaas site (Servaas church site, 4-3-1, both photographs: R. Panhuysen).

Osteochondritis dissecans

In palaeopathology osteochondritis dissecans is a condition in which the bone below the cartilaginous surface of a joint is damaged. The most likely cause for this damage is a constitutional vascular anomaly combined with some form of trauma. Two cases of osteochondritis dissecans were found. In both cases the knee joint was affected. When counted as a percentage of the total number of knee joints inspected the prevalence of osteochondritis dissecans was one per cent. One of the individuals was female between 40 to 60 years of age from the *basilica* sample. The other individual, from the Boschstraat sample, was an adult male.

ARTHROPATHIES

Arthropathies are diseases affecting the joints. The following arthropathies were examined systematically in this study: osteoarthritis or osteoarthritis, degenerative disc disease and seronegative spondylarthropathies. Arthropathies in the peripheral joints were scored as percentages from the total number of that joint that could be inspected. For the study of arthropathies in the vertebral column the spine was divided in five segments: the cervical vertebrae (n=7), the upper thoracic vertebrae (n=6), the lower thoracic vertebrae (n=6) the lumbar vertebrae (n=5) and the sacrum (n=1). Only those cervical, thoracic and lumbar vertebrae were included for which the joint surfaces and endplates of two or more vertebrae were present in a segment. The presence of one segment was sufficient for an individual to be counted in the tables.

	Mean	S. D.
Cervical vertebrae	3,8	2,7
Thoracic vertebrae 1 to 6	4,3	2,2
Thoracic vertebrae 7 to 12	5,0	1,8
Lumbar vertebrae	4,4	1,1
Total number of vertebrae	18,0	6,1

TABLE 6.37 Mean number of recovered vertebrae in 74 adult individuals with vertebrae

In 74 adult individuals the vertebral column could be inspected. In most cases two or more of the segments of the vertebral column and a substantial number of vertebrae could be examined. The sacrum was available for inspection in 58 of the 74 adult individuals. Below the results are not presented per segment of the vertebral column but per individual. In cases where there was considerable variation in the distribution of pathological changes in the vertebral column this will be mentioned in the text.

Osteoarthritis

Osteoarthritis or osteoarthritis (OA) includes pathological changes of both peripheral and vertebral synovial joints. The presence of arthrosis was scored in accordance with the criteria

published by Rogers and Waldron in 1995.⁴⁷⁶ In line with practice in (palaeo-) pathological literature these degenerative changes are further referred to as “osteoarthritis” (OA). Changes in the peripheral synovial joints are indicated as peripheral osteoarthritis (POA), similar changes in the synovial facet joints of the vertebral column are labelled as vertebral osteoarthritis (VOA). Scored as cases of osteoarthritis, were joints displaying either eburnation or a combination of at least two of the following types of changes: marginal osteophytes, pitting on the joint surface and subchondral cysts.⁴⁷⁷ Excluded from the analysis of the prevalence of osteoarthritis were five cases in which osteoarthritis was considered to be secondary to a fracture and four individuals affected by a seronegative spondylarthropathy. The data on temporomandibular joint osteoarthritis will be presented in a separate paragraph.

Osteoarthritis of the peripheral joints

Seven individuals (6 per cent of all examined individuals) were diagnosed with peripheral osteoarthritis, in four individuals multiple joints were involved. Eleven peripheral joints displayed osteoarthritic changes. Males were more often affected than females: five males (10 per cent of all males) as opposed to two females (3 per cent of all females). Six individuals with peripheral osteoarthritis could be categorised in an age at death interval. For all six the estimated age at death varied between 40 and 60 years. The small number of individuals produced little variation in the distribution of individuals with peripheral osteoarthritis over the four samples: two in the *cella* sample, three in the *templum* sample, one in the *basilica* sample and one in the Boschstraat sample. Four individuals with peripheral osteoarthritis could be categorised by status: one each in the low and intermediate status category and two in the high status category.

With regard to the distribution of osteoarthritic joints within the body it was noted that both the upper and lower extremities were involved in almost equal percentages. Six joints of the upper extremities and five joints of the lower extremities had osteoarthritic changes. Osteoarthritis in the lower extremities was most frequent in the knee joint; viz. three individuals had four joints affected.

⁴⁷⁶ Rogers and Waldron, 1995, p. 43-44. These definitions are based on an earlier publication Rogers et al., 1987.

⁴⁷⁷ Criteria summarised after Rogers and Waldron, 1995, p. 43-44. A record was kept of cases affected by either marginal osteophytosis or subchondral cysts. Analysis of these data suggested a uniform distribution of these changes over the various samples and status categories.

Joint	Cella		Templum		Basilica		Boschstraat		Total	
	%	N/Ni	%	N/Ni	%	N/Ni	%	N/Ni	%	N/Ni
Shoulder (right)		0/13		0/13		0/29	5%	1/21	1%	1/76
Shoulder (left)	8%	1/12		0/13		0/19	6%	1/18	3%	2/62
Elbow (right)		0/11		0/14		0/33		0/18		0/76
Elbow (left)		0/11	7%	1/14		0/28		0/16	1%	1/69
Wrist (right)		0/3		0/8	5%	1/22		0/12	2%	1/45
Wrist (left)		0/7		0/8	5%	1/19		0/13	2%	1/47
Hand (right)		0/5		0/6		0/15		0/14		0/40
Hand (left)		0/5		0/5		0/17		0/14		0/41
Hip (right)		0/10	6%	1/18		0/28		0/23	1%	1/79
Hip (left)		0/11		0/17		0/25		0/25		0/78
Knee (right)	10%	1/10	11%	2/19		0/33		0/21	4%	3/83
Knee (left)		0/10	7%	1/15		0/29		0/22	1%	1/76
Ankle (right)		0/6		0/12		0/27		0/18		0/63
Ankle (left)		0/6		0/7		0/24		0/18		0/55
Foot (right)		0/5		0/3		0/15		0/14		0/37
Foot (left)		0/4		0/2		0/16		0/14		0/36

TABLE 6.38 Distribution of peripheral osteoarthritis by sample in adult individuals. Presented are the numbers of joints with and without osteoarthritis. ("N" is the number of joints displaying signs of osteoarthritis and "Ni" is the number of joints that could be inspected.)

Temporomandibular joint osteoarthritis

In 99 adult individuals the temporomandibular joint could be inspected for the presence of osteoarthritis. Seven females (14 per cent) had osteoarthritis of the temporomandibular joint. Only one male was affected by this condition (2 per cent). This asymmetric distribution over the sexes was close to statistical significance.⁴⁷⁸ Relatively speaking most cases of temporomandibular joint osteoarthritis were recorded in the age categories of 60 years and older. The increase of temporomandibular joint osteoarthritis from 5 per cent in the age group from 20 to 40 years to 37.5 per cent in the age group of 60 years or more represented a trend that was statistically significant.⁴⁷⁹ In one case osteoarthritis of the temporomandibular joint appeared to have been secondary to a fracture of the neck of the mandibular condyle. No association existed with arthritic changes in the other peripheral or vertebral joints. Generally high rates of dental attrition were found in combination with temporomandibular joint osteoarthritis.

⁴⁷⁸ Males - Females: $p=0.06$ (Fisher's Exact test).

⁴⁷⁹ For the three twenty year intervals between 20 and 80 years of age the following percentages were found 5 per cent ($n=40$), 7 per cent ($n=45$) and 37 per cent ($n=8$). Chi-square test for trend for 20-40, 40-60 and 60-80 years: $p=0.03$.

Cella	Templum	Basilica	Boschstraat	Total	Low	Interm	High
8%	7%	6%	14%	8%	16%	10%	7%
1/13	2/29	2/36	3/21	8/99	3/21	2/21	2/28

TABLE 6.39 Temporomandibular joint osteoarthritis (TMJOA) by sample and status

Among the various samples the variation in frequency of temporomandibular joint osteoarthritis was limited. The frequency was highest in the Boschstraat sample. In the *cella*, *templum* and *basilica* samples the prevalence of temporomandibular joint osteoarthritis was more or less equal. With increased status there was a decrease in the prevalence of temporomandibular joint osteoarthritis. Analysis of this trend indicated that it was statistically not significant.

Vertebral osteoarthritis

The presence of vertebral osteoarthritis was recorded systematically for two synovial joints: the apophyseal facet joints and costo-vertebral joints. As indicated above, the same diagnostic criteria were applied that were used for the peripheral joints. In 74 individuals the presence of vertebral osteoarthritis could be inspected.⁴⁸⁰ No significant difference was found for the prevalence of vertebral osteoarthritis between male and female individuals. Within the consecutive twenty-year age categories a marked rise in the prevalence of vertebral osteoarthritis was recorded. Between the cohort of 20 to 40 years and 40 to 60 years the prevalence increased from 6 per cent to 25 per cent.⁴⁸¹ Due to the small number of individuals in the age category of 60 years or older it was not possible to determine if this trend continued. The majority of changes diagnosed as vertebral osteoarthritis was found in the apophyseal facet joints.

Age	Cella	Templum	Basilica	Boschstraat	Total	Low	Interm	High
20-<40 yr.	0%	17%	9%	0%	7%	0%	13%	17%
	0/3	1/6	1/11	0/10	2/30	0/10	1/8	1/6
40-<60 yr.	0%	43%	31%	20%	27%	20%	20%	46%
	0/6	3/7	5/16	1/5	9/34	1/5	2/10	6/13
All	0%	31%	23%	11%	18%	11%	18%	40%
	0/10	4/13	7/31	2/18	13/72	2/18	3/22	8/20

TABLE 6.40 Vertebral osteoarthritis among adult individuals by sample and status

In the *cella* sample none of the individuals was found to have suffered from vertebral osteoarthritis. In the *templum* and *basilica* samples the prevalence of vertebral osteoarthritis was similar. Among the adults of the Boschstraat site the percentage was lower. Overall the

⁴⁸⁰ Excluded from the inspected sample were individuals displaying changes associated with seronegative spondylarthropathies.

⁴⁸¹ 20-40 years - 40-60 years: $p=0.049$ (Fisher's Exact test).

variation in prevalence of vertebral osteoarthritis was not significant: neither among the consecutive samples at the Servaas site nor between the *templum* and Boschstraat sample.

In comparison to the low and intermediate status categories the high status category was characterised by a higher prevalence of vertebral osteoarthritis. This increase in the prevalence of vertebral osteoarthritis with status was statistically significant.⁴⁸² Looking at the distribution of osteoarthritic changes within the segments of the vertebral column it was evident that predominantly the cervical and lumbar vertebrae were affected. When checked for distribution patterns with significant differences in prevalence per segment of the vertebral column one significant result was found. The lumbar vertebrae of individuals from the high status category were more often affected by vertebral osteoarthritis than were those of the low and intermediate status categories.⁴⁸³

Degenerative disc disease

Degenerative disc disease (DDD) is a term used to describe changes in the discovertebral joint that are considered to be caused by degeneration. Two types of pathological changes in the spine are thought to be indicative of degenerative disc disease: osteophytes along the margin of the vertebral endplate, and Schmorl's nodes in the central part of the endplate. Both vertebral osteophytes and Schmorl's nodes are considered to be the result of displacement of material from the intervertebral disc.⁴⁸⁴ Various types of osteophytes may be formed on or close to the margin of the vertebral body. Vertebral osteophytes that are limited to the margin of the discovertebral junction and do not extend on the anterior surface of the vertebral body were recorded as signs of degenerative disc disease.⁴⁸⁵ Scored as Schmorl's nodes were blunt indentations in the surface of the superior or inferior vertebral endplates.

In 74 adult individuals the presence of degenerative disc disease could be examined; 77 per cent of the cases displayed signs of degenerative disc disease. More males (81 per cent, $n=32$) than females (74 per cent, $n=42$) were affected. The difference was not statistically significant. An increase in the incidence of degenerative disc disease with age was found. Among the individuals between twenty to forty years circa 67 per cent displayed signs. For the category of individuals between forty and sixty years an increase of 19 per cent to a total of 86 per cent was found.⁴⁸⁶

	Cella	Templum	Basilica	Boschstraat	Total	Low	Interm.	High
Degenerative disc disease	90% 9/10	69% 9/13	87% 27/31	60% 12/20	77% 57/74	60% 12/20	77% 27/22	90% 18/20

TABLE 6.41 Degenerative disc disease among adult individuals by sample and status

⁴⁸² Chi-square test for trend: $p=0.03$.

⁴⁸³ Chi-square test for trend for low ($n=1$, $n_i=16$), intermediate ($n=1$, $n_i=22$) and high status categories ($n=5$, $n_i=17$): $p=0.04$.

⁴⁸⁴ Resnick, 1996 p.356.

⁴⁸⁵ Resnick, 1996 p.261.

⁴⁸⁶ 20-40 years – 40-60 years: $p=0.08$ (Fisher's Exact test)

The results indicate that in the *templum* and Boschstraat samples the prevalence of degenerative disc disease was lower than in the preceding *cella* sample and the later *basilica* sample. Analysis of the data, comparing the combined largely Merovingian samples of the *templum* phase and the Boschstraat with the *basilica* sample from the Carolingian period, indicated that the difference between the two periods was statistically significant.⁴⁸⁷

Comparison of the prevalence of degenerative disc disease in the three status categories indicated that the percentage of affected individuals increased with status. This trend was statistically significant.⁴⁸⁸ At the level of the lower thoracic vertebrae this trend was most manifest. Among the individuals with a lower thoracic spine available for inspection the percentages of individuals with degenerative disc disease were 42 per cent, 60 per cent and 100 per cent for the low, intermediate and high status categories respectively.⁴⁸⁹

Distribution of the prevalence of degenerative disc disease in the segments of the vertebral column revealed minor differences between males and females. In the samples from Maastricht the prevalence of degenerative disc disease in the cervical and upper thoracic vertebrae was higher in females than in males. In the upper thoracic vertebrae this asymmetric distribution over the sexes was statistically significant.⁴⁹⁰ At the level of the lower thoracic vertebrae the prevalence of degenerative disc disease was similar for both sexes. For the lumbar vertebrae the percentages for degenerative disc disease were higher in males than in females. It was also noted that the increase in degenerative disc disease with age was not of equal proportion in all five segments of the spine.⁴⁹¹ The prevalence of degenerative disc disease at the different levels of the spine was not equal for all samples. The *templum* sample in particular was characterised by a relatively high prevalence of degenerative disc disease in the upper thoracic vertebrae. Despite the small number of individuals, analysis comparing the *templum* and *basilica* sample indicated that the variation in distribution was statistically significant.⁴⁹² At the level of the lower thoracic vertebrae the prevalence of degenerative disc disease was considerably higher in the *templum* sample and significantly lower in the Boschstraat sample.⁴⁹³

⁴⁸⁷ *Templum* and Boschstraat sample – *basilica* sample: $p=0.04$ (Fisher's Exact test); Odds ratio = 0.259, 95% confidence interval: 0.059–1.049.

⁴⁸⁸ Chi-square test for trend for low, intermediate and high status categories: $p=0.03$.

⁴⁸⁹ Distribution: low status (8/19), intermediate status (12/20), high status (17/17). Chi-square test for trend for low, intermediate and high status categories: $p<0.001$. There was a discrepancy between the prevalence of 100 per cent DDD in the high status category for the lower thoracic vertebrae and a prevalence of 86 per cent when calculated per individual. When the percentage is calculated per individual, six more individuals are included for which the lower thoracic vertebrae were not or incompletely recovered.

⁴⁹⁰ DDD in the upper thoracic vertebrae of: males – females: $p=0.04$ (Fisher's Exact test); Odds ratio 3.562, 95% confidence interval: 1.188 – 10.678.

⁴⁹¹ When the prevalence of DDD in the three twenty years age intervals was analysed per segment of the vertebral column the cross-tabulations for the cervical vertebrae and the lumbar vertebrae yielded statistically significant results. For the increase of DDD in cervical vertebrae with age: $p=0.03$ (Fisher's Exact test). Increase of DDD in lumbar vertebrae with age in twenty year intervals: $p=0.03$ (Fisher's Exact test).

⁴⁹² *Templum* sample – *basilica* sample: $p=0.02$ (Fisher's Exact test); Odds ratio 0.105, 95% confidence interval: 0.017 – 0.633.

⁴⁹³ *Templum* sample – Boschstraat sample: $p=0.004$ (Fisher's Exact test); Odds ratio 2.125, 95% confidence interval: 1.283 – 3.518.

	Cella	Templum	Basilica	Boschstraat	Total
Cervical vertebrae	33%	50%	33%	36%	36%
	3/9	4/8	7/21	5/14	19/52
Upper thoracic vertebrae	40%	78%	27%	38%	39%
	4/10	7/9	7/26	6/16	24/61
Lower thoracic vertebrae	80%	100%	72%	42%	69%
	8/10	9/9	21/29	8/19	46/67
Lumbar vertebrae	60%	58%	59%	50%	57%
	6/10	7/12	17/29	9/18	39/69

TABLE 6.42 Distribution of degenerative disc disease in the segments of the vertebral column in adult individuals by sample

Seronegative spondylarthropathies

In four cases a combination of pathological changes was found which were thought to be indicative of seronegative spondylarthropathy. The term seronegative spondylarthropathy is used to describe a group of diseases that may affect the joints in ways similar to rheumatoid arthritis but differs from the latter because of the absence of rheumatoid factor in the blood. The three major seronegative spondylarthropathies are ankylosing spondylitis, psoriatic arthritis and Reiter's syndrome. In palaeopathology the diagnosis is generally based on specific changes in the joint and the characteristic distribution of these changes over the various joints. Clinically four conditions are considered relevant for the diagnosis of seronegative spondylarthropathy: spondylitis, sacroiliitis, enthesopathies and asymmetric synovitis.^{49a} The first three can also be used for the diagnosis of seronegative spondylarthropathy in palaeopathological studies. Spondylitis is an inflammation of one or more of the vertebrae. In palaeopathological specimens seronegative spondylitis can be recognised through the presence of syndesmophytes, since the erosions are difficult to distinguish from post-mortem changes. Syndesmophytes are bony outgrowths extending vertically from the edge of one vertebral body to the next. The presence of sacroiliitis is apparent from marked erosion of the sacro-iliac joint or intra-articular bony ankylosis of the same joint. Enthesopathies are hypo- or hyperplastic bone transformations occurring at the site of insertion of muscle tendons and ligaments. In seronegative spondylarthropathies the enthesopathies are hyperplastic.

In all four cases of seronegative spondylarthropathy we found ossification of ligaments and erosion of the sacroiliac joint, with or without intra-articular bony ankylosis. All individuals had syndesmophytes sometimes in combination with signs of "calcification" of the intervertebral disc. Enthesopathies were also found in all four individuals.

^{49a} Dougados et al., 1991.

Number	Sample	Status	Sex	Age (yr.)	Sacroiliitis	Spondylitis	Enthesopathies
01-07-03	<i>Cella</i>		Male	70-80	Bilateral, asymmetric	Yes	Yes
02-06-07	<i>Cella</i>		Male	43-50	Unilateral	Yes	Yes
05-11-02	<i>Templum</i>	High	Male	31-37	Unilateral	Yes	Yes
11-04-03	<i>Basilica</i>	High	Male	52-61	Bilateral, asymmetric	Yes	Yes

TABLE 6.43 Individuals with seronegative spondylarthropathy

All individuals with seronegative spondylarthropathy were males. Two cases were found in the small *cella* sample. In the *templum* and *basilica* samples there was one individual with seronegative spondylarthropathy in each sample of the Servaas site, none in the Boschstraat sample. In the case of number 11-04-03 the skeleton was sufficiently complete and the nature of the bone changes and their distribution was sufficiently distinct to allow for a more detailed diagnosis. The bilateral asymmetric sacroiliitis, in combination with limited joint changes in the hands and feet in contrast to the serious changes in the large joints and widespread syndesmophytes with para-vertebral ossification best fit with a diagnosis of reactive arthritis also known as Reiter's syndrome.⁴⁹⁵

DIFFUSE IDIOPATHIC SKELETAL HYPEROSTOSIS

Diffuse Idiopathic Skeletal Hyperostosis (DISH) is a skeletal disorder characterised by the ossification of ligaments, muscular attachments and cartilage.⁴⁹⁶ The ossification is most marked along the vertebral column. Especially on the right anterolateral aspect of the thoracic spine laminated ossification of the anterior longitudinal ligament progressively appears with age. This may occur at various consecutive vertebral bodies and often continues across the intervertebral disc resulting in flowing anterior ossification (FAO). Apart from the aforementioned changes in the vertebral column, ossification of entheses at extra spinal sites like the crista iliaca and the insertion of the Achilles tendon are also considered characteristic for DISH.⁴⁹⁷

The palaeopathological diagnosis of DISH is generally based on the clinical description of DISH.⁴⁹⁸ However, when these criteria are strictly applied to incomplete skeletons a large number of individuals with changes associated with DISH would not be included in the analysis. Since a statistically significant correlation was found between flowing anterior ossification in the spine and ossification of extra-spinal entheses, the presence of the combination of these conditions was scored as DISH and analysed in separate tables.⁴⁹⁹

⁴⁹⁵ Bruintjes and Panhuysen, 1995, Resnick, 1996, p.273-279.

⁴⁹⁶ Also known as Forrester's disease.

⁴⁹⁷ Resnick, 1996, p.378 and Rogers and Waldron, 1995, p. 47-54

⁴⁹⁸ Rogers and Waldron, 1995, p. 51

⁴⁹⁹ Flowing anterior ossification – ossification of extraspinal entheses: $p < 0.001$ (Fisher's Exact test); Odds ratio 14.063, 95% confidence interval 4.197 – 47.115.

Number	Sample	Status	Sex	Age	FAO	Enthesopathies
01-02-03	<i>Basilica</i>	High	Male	43-60 yr.	T3-T9	Symmetrical, diffuse
03-08-01	<i>Cella</i>		Male	40-48 yr.	C4-C5, T5-T9	Symmetrical, diffuse
11-04-05	<i>Basilica</i>	High	Male	59-70 yr.	T9-T12	Symmetrical, diffuse
11-08-15	<i>Templum</i>	High	Female	42-48 yr.	T8-T11	Symmetrical, diffuse

TABLE 6.44 Individuals with DISH, FAO indicates which vertebrae are affected by flowing anterior ossification (C= cervical, T= thoracic, the numbers indicate the number of the vertebra)

When the classic strict criteria for DISH were applied, i.e. ankylosis of 4 consecutive thoracic vertebrae and extra spinal enthesopathies, DISH was diagnosed in 1 out of 74 cases (1 per cent). In individual 01-02-03 the ossification of the anterior ligament led to fusion of vertebrae with the characteristic “candle-wax” appearance. Three other cases were still included in the table because of flowing anterior ossifications, which did not fuse completely but were in close contact.

When the count of cases of DISH was based on the presence of flowing anterior ossification in at least two vertebrae in combination with ossification of entheses at extra-spinal sites then 15 out of 74 individuals were diagnosed with DISH (20 per cent). Significantly more males than females had DISH, viz. 31 per cent of the males (n=32) in comparison to 12 per cent of the females (n=42).⁵⁰⁰ The prevalence of DISH increased with age. Between 20 to 40 years 10 per cent (n=30) had DISH, between 40 to 60 years: 26 per cent (n=35) and in the category of 60 years or more: 50 per cent (n=6). Analysis indicated this trend was statistically significant.⁵⁰¹

Age	Cella	Templum	Basilica	Boschstraat	Total	Low	Interm.	High
20-40 yr.	0%	17%	18%	0%	10%	0%	22%	17%
	0/3	1/6	2/11	0/10	3/30	0/10	2/9	1/6
40-60 yr.	33%	14%	31%	17%	26%	17%	20%	30%
	2/6	1/7	5/16	1/6	9/35	1/6	2/10	4/13
All	30%	15%	26%	10%	20%	10%	16%	30%
	3/10	2/13	8/31	2/20	15/74	2/20	4/22	6/20

TABLE 6.45 Cases of DISH in adult individuals by sample and status

The prevalence of DISH was highest in the *cella* and *basilica* samples. In the *templum* sample the prevalence was lower. Therefore, there was no unidirectional diachronic trend among the three samples representing consecutive phases at the Servaas site. Overall the variation in prevalence of DISH was statistically not significant. With respect to the distribution of DISH

⁵⁰⁰ Males – females: $p=0.048$ (Fisher's Exact test); Odds ratio 0.297, 95% confidence interval: 0.090 - 0.983.

⁵⁰¹ Chi-square test for trend for 20-40, 40-60 and 60-80 years: $p=0.02$.

over the three status categories the data indicate that the prevalence increased with status. However, this trend was not statistically significant.⁵⁰²

INFECTIOUS DISEASE

Although infectious diseases generally affect soft tissue, chronic infectious diseases may lead to skeletal lesions. Skeletal lesions caused by infectious disease were found in long bones, in the maxillary and mastoid sinus and around the tip of the roots of dental elements. Infectious disease associated with the dentition will be analysed separately in the section on dentition. This section presents the data related to periostitis, osteomyelitis, chronic maxillary sinusitis, mastoiditis and pleuritis.⁵⁰³

Periostitis and osteomyelitis

In palaeopathology the term periostitis is used to indicate that new bone has been formed by the periosteum. In such cases the inner layer of the periosteum forms woven bone on the surface of the cortex in reaction to various types of insults of which infection is by far the main cause. In palaeopathology this bone can either be woven bone, thought to represent fresh bone formation, or sclerotic, suggesting the periosteal lesion has stabilised. Two important causes for periostitis are haematogenous infection and trauma.⁵⁰⁴ In this study the data on periostitis are based on inspection of adult individuals with at least two of the long bones of the lower extremities present. Periostitis was considered present when either fine-pitted bone well distinguishable from the underlying cortical bone or a thickened surface of remodelled bone fixed to the underlying cortex were found.

The long bones of 94 individuals were inspected. In 19 individuals periosteal new bone formation was found (20 per cent). Periostitis was most frequent in the tibia, fibula and femur (in order of declining frequency); usually at the level of the diaphysis. Significantly more males had periostitis than females.⁵⁰⁵ Among 42 males 13 (31 per cent) were diagnosed with periostitis. Among 48 females 5 cases (10 per cent) of periostitis were found. No significant association was found between the prevalence of periostitis and age.

Between the *templum*, *basilica* and Boschstraat samples the variation in prevalence of periostitis is small, ranging between 17 and 26 per cent. The three samples from consecutive phases at the Servaas site (*cella*, *templum*, and *basilica*) indicated that the percentage of cases of periostitis increased with time. However, analysis using Chi-square test for trend demonstrates that this was not statistically significant.

⁵⁰² Chi-square test for trend for low, intermediate and high status: $p=0.11$.

⁵⁰³ The occurrence of new bone formation on the endocranial surface of the skull may be the result of infectious disease as well. However, as the aetiology of this endocranial new bone formation is still controversial these data will be presented in a separate section below.

⁵⁰⁴ Ortner, 2003, p. 208.

⁵⁰⁵ Males – females: $p=0.02$ (Fisher's Exact test); Odds ratio 0.259, 95% confidence interval: 0.083 – 0.806.

	Cella	Templum	Basilica	Boschstraat	Total
Male	12%	44%	38%	0%	31%
	1/8	4/9	8/21	0/4	13/42
Female	0%	0%	8%	20%	10%
	0/5	0/12	1/13	4/20	5/50
All	8%	22%	26%	17%	20%
	1/13	5/23	9/34	4/24	19/94

Low	Interm	High
0%	13%	60%
0/4	1/8	9/15
0/0	0/1	3/4
4/20	1/4	1/11
1/7	4/11	4/14
4/24	1/3	11/27

TABLE 6.46 Adult individuals with periostitis by sample and status

Among the three status categories there was a strong variation in the prevalence of periostitis. In the category of intermediate status a low percentage of cases of periostitis was found, whereas the high status category contained a comparatively high number of cases. There was no unidirectional trend indicating an increase or decrease associated with status. A Chi-square test of the data presented in Table 6.46 indicated that the distribution as a whole varied significantly from expected distributions.⁵⁰⁶

In three of the individuals with periostitis the infection was part of an osteomyelitis. Osteomyelitis is an infection of the entire bone, including the endosteal surface inside the bone. In all three individuals osteomyelitis had affected one of the long bones of the lower extremities. In one of these cases the osteomyelitis was most likely secondary to a fracture of the femur. All cases were found in the *basilica* sample. Two individuals with osteomyelitis could be categorised as being of high status.

Number	Sample	Status	Sex	Age (yr.)	Infectious disease	Bone
06-05-04	Basilica	High	Female	31-37	Osteomyelitis	Tibia
06-06-01/II	Basilica	-	Male	30-40	Osteomyelitis	Fibula
11-04-03	Basilica	High	Male	52-61	Osteomyelitis	Femur

TABLE 6.47 Cases of osteomyelitis

Chronic maxillary sinusitis and mastoiditis

During chronic infection of the maxillary sinus irritation of the periosteum induces new bone formation, which can be recognised as spicules of bone or a bone plaque. Causes for chronic maxillary sinusitis are infections of the nasal cavity, periapical dental abscess or extraction of (pre-) molars, allergy and septum deviation. In 64 individuals one or both maxillary sinuses were inspected macroscopically, if necessary an endoscope was used. In 29 individuals (45 per cent) signs of chronic maxillary sinusitis were present. Chronic maxillary sinusitis was found in 40 per cent of the males and 50 per cent of the females. Comparison of the prevalence in the age

⁵⁰⁶ $P=0.01$ (Fisher's Exact test)

category of 20 to 40 years and 40 to 60 years shows a significant increase with progressing age from respectively 31 per cent to 59 per cent.⁵⁰⁷

	Cella	Templum	Basilica	Boschstraat	Total	Low	Intermediate	High
Sinusitis	44%	54%	48%	37%	45%	37%	50%	50%
	4/9	7/13	11/23	7/19	29/64	7/19	8/16	8/16

TABLE 6.48 Adult individuals with chronic maxillary sinusitis by sample and status

There was little variation in the prevalence of chronic maxillary sinusitis in the four samples. Both the highest percentage and the lowest percentage were recorded in the *templum* and the Boschstraat sample respectively.

Distribution of the cases of chronic maxillary sinusitis over the three status categories indicated that the prevalence was lowest in the low status category and was equally high in the intermediate and high status category. The difference in prevalence among these categories was not statistically significant.

Number	Sample	Status	Sex	Age (yr.)	Infectious disease	Bone
01-05-06	Basilica	Intermediate	Female	37-46	Mastoiditis	Temporal bone
27-03-03	Basilica	High	Male	34-40	Mastoiditis	Temporal bone

TABLE 6.49 Cases of mastoiditis

Mastoiditis is an infection inside the mastoid process, which can be recognised by the presence of a fistula originating in an abscess in the mastoid cellulae and opening on the exterior surface of the mastoid process. Two cases of mastoiditis were found one male and one female, both from the *basilica* sample.

Pleuritis

One individual was diagnosed with changes due to pleuritis. In this individual the interior surface of three ribs had been affected by periosteal new bone formation. This was interpreted as the result of an infection of the pleura.

Number	Sample	Status	Sex	Age (yr.)	Infectious disease	Bone
05-08-05	Basilica	Intermediate	Female	25-34 yr	Pleuritis	Ribs (3)

TABLE 6.50 Case of pleuritis

⁵⁰⁷ Age interval 20 to 40 years – 40 to 60 years: $p=0.04$ (Fisher's Exact test); Odds ratio 3.288 95% confidence interval: 1.104 – 9.795.

Endocranial new bone formation

In some individuals it was observed that periosteal bone had formed on the interior surface of the skull. The palaeopathological interpretation of this endocranial new bone formation (ENBF) is under debate. According to one hypothesis the new bone formation is the result of meningitis, another hypothesis suggests the bone formation may be caused by a subdural or an epidural haematoma. This condition was only found in non-adult individuals. The interior surface of the skull of 26 non-adult individuals was inspected. Five individuals (19 per cent) had new bone formation on the interior surface of the skull.

Number	Sample	Status	Age (yr.)	Bones involved	Distribution	Lytic
01-0A-02	<i>Cella</i>		2-4	Frontal, parietal	Symmetrical	No
04-10-04	<i>Basilica</i>	Intermediate	1-2	Frontal, temporal	Incomplete skull	No
01-03-109/A	Boschstraat	Low	0-3	Temporal	Symmetrical	No
02-04-007/1	Boschstraat	Low	1-2	Frontal, temporal	Incomplete skull	No
02-04-007/2	Boschstraat	Low	12-18	Temporal	Incomplete skull	No

TABLE 6.51 Cases of endocranial new bone formation

With respect to the age of the individuals 4 out of 5 were four years or younger. The distribution over the samples was highly variable. One of the inspected non-adults of the *cella* sample had endocranial new bone formation. From the consecutive *templum* phase none of the 5 inspected individuals showed signs of endocranial new bone formation. In the *basilica* sample endocranial new bone formation was found in 1 of the 5 inspected individuals. For the Boschstraat sample the score was 3 individuals with endocranial new bone formation out of 14 individuals (21 per cent).

NEOPLASIA: OSTEOMA

A neoplasm is defined as a mass of abnormal tissue that grows by cellular proliferation more rapidly than normal and continues to grow after the stimuli that initiated the new growth cease.⁵⁰⁸ Only one type of neoplasm was found in the population, viz. osteomata. Osteomata are benign, bone-forming lesions that are generally found on the outer surface of the neurocranium, but they can also form on the facial bones of the skull or in the postcranial skeleton.⁵⁰⁹ Twelve individuals had one or more osteomata (6 per cent of the adult individuals). Osteomata were more common in males than in females, 12 per cent versus 5 per cent respectively.⁵¹⁰ The prevalence of osteomata was not associated with the age of the individuals. All osteomata were equally distributed over the four samples and there was no evident association with status.

⁵⁰⁸ Stedman, 1990, p. 1030.

⁵⁰⁹ Aufderheide and Rodriguez-Martin, 1998, p. 375.

⁵¹⁰ Statistically this difference in prevalence was not significant.

CONGENITAL ANOMALIES: SPINA BIFIDA OCCULTA

Spina bifida occulta is a limited defect occurring in the spinal column characterised by the (partial) absence of the vertebral arch. The adjective 'occulta' is used for cases in which this defect has not resulted in exposure of the spinal cord or its membranes. In the examined population there were 7 adult cases of spina bifida occulta; one in the atlas of a female from the *basilica* sample (11-04-04) and six in the sacrum. The latter were all cases of partial spina bifida occulta. In these cases the neural arch of the second, third and fourth sacral vertebra were incomplete.

Of the six cases with spina bifida occulta four were females and two males. The small number of individuals results in a distribution over the samples that is largely influenced by chance.

	Cella	Templum	Basilica	Boschstraat	Total
Spina bifida occulta	1/4	0/7	3/17	2/15	6/43 (14%)

TABLE 6.52 Adult individuals with partial spina bifida occulta in the sacrum

ENTHESOPATHIES: CORTICAL DEFECTS

An enthesopathy is a hypo- or hyperplastic bone transformation occurring at the site of insertion of muscle tendons and ligaments into bones or joint capsules. Apart from the bone forming enthesopathies associated with DISH two types of enthesopathies were found in relatively large numbers. Most common were cortical defects at the site of insertion of the costoclavicular ligament on the clavicle. Also on the crest of the greater tubercle on the humerus, the insertion site for the pectoralis major muscle, similar cortical defects were found. Cortical defects are changes in the surface of the cortex ranging from marked porosity to deep oval or oblong pits. Clinical studies indicate that cortical defects are caused by repeated pulling stress at the site of insertion.⁵¹¹ In palaeopathology enthesopathies like cortical defects are known as biomechanical musculo-skeletal stress markers. The cortical defects at the site of insertion of the costoclavicular ligament are also named rhomboid fossae.

All cases were found in adult individuals. Therefore, the prevalence of cortical defects is calculated in ratio to the adult part of the sample. In 58 individuals the medial half of one or both clavicles was available for inspection, the proximal part of one or both the humeral shafts could be inspected in 98 individuals. Both clavicles and humeri could be examined in 58 individuals. About 34 per cent of the inspected individuals had a cortical defect on the clavicle. The humerus was available for inspection in a larger number; the prevalence of cortical defects was lower, viz. 10 per cent. When both clavicles and humeri were available for inspection (n=58) the prevalence of cortical defects was also 10 per cent. The presence of a cortical defect on the humerus was strongly associated with the presence of cortical defects on the clavicle. In the 58 individuals where both clavicles and humeri could be examined, all six cases of cortical defects on the humerus were found in individuals who also had cortical defects on the clavicle.⁵¹²

⁵¹¹ Brower, 1977; Panhuysen et al., 1994; Panhuysen et al., in press; Shauffer and Collins, 1966 and Stirland, 2000, p.131-132.

⁵¹² Cortical defect in the humerus - cortical defect in the clavicle: $p=0.001$ (Fisher's Exact test).

Cortical defects, independent of the bone affected, were found significantly more often in males than in females.⁵¹³ There was no association between age and the prevalence of cortical defects.

	Cella	Templum	Basilica	Boschstraat	Total	Low	Interm	High
Clavicle	33%	45%	38%	23%	34%	23%	40%	33%
	3/9	5/11	8/21	4/17	20/58	4/17	6/15	5/15
Humerus	7%	18%	11%	4%	10%	4%	17%	12%
	1/15	4/22	4/37	1/24	10/98	1/24	4/24	3/25
Clavicle and humerus	11%	18%	9%	6%	10%	6%	13%	7%
	1/9	2/11	2/21	1/17	6/58	1/17	2/15	1/15

TABLE 6.53 Number of adults with cortical defects by sample and status

The distribution of cases of cortical defects over the samples did not vary significantly. The highest prevalence was found for the sample from the *templum* phase, the lowest for the Boschstraat. In general the percentage of cortical defects in the clavicle was three times as high as the percentage of cortical defects in the humerus. When the distribution of cortical defects was analysed by status no significant variation was recorded. The intermediate status category scored the highest prevalence of cortical defects.

HYPEROSTOSIS FRONTALIS INTERNA

Hyperostosis frontalis interna is abnormal deposition of bone on the inner aspect of the frontal bone and in some cases on the parietal bone. It is found almost exclusively in females, of whom most are 30 years or older.⁵¹⁴ A hormonal disorder is mostly proposed to be the cause of hyperostosis frontalis.⁵¹⁵

	Number	Sample	Status	Sex	Age (yr.)
Hyperostosis frontalis interna	03-07-10	Basilica	Intermediate	Female	48-63
	04-10-01	Basilica	Intermediate	Female	31-37
	05-07-02	Basilica	Intermediate	Female	31-37
	07-09-02	Basilica	Intermediate	Female	23-40
	17-03-05/2	Templum	-	Female	23-40
	01-04-011	Boschstraat	Low	Female	60-65

TABLE 6.54 Individuals with hyperostosis frontalis interna

⁵¹³ Cortical defect Males-Females, $p=0.02$ (Fisher's Exact test), Odds ratio 0.279 95% confidence interval 0.104-0.747. Data per bone: clavicle: males 50% ($n=26$) - females 19% ($n=31$) Humerus: males 20% ($n=39$) - females 4% ($n=50$) and both in the clavicle and humerus: males 23% ($n=26$) - females 0% ($n=31$).

⁵¹⁴ Hershkovitz et al., 1999, p. 310.

⁵¹⁵ Stedman, 1990, p.737, Aufderheide and Rodriguez-Martin, 1998, p. 419.

Out of 79 skulls that were inspected 6 (8 per cent) had hyperostosis frontalis interna. All six individuals were females, which means that 15 per cent of the females (n=40) had hyperostosis frontalis interna. Two thirds of all cases came from the *basilica* sample.

DENTITION

The dentition could be inspected in 99 adult individuals and 18 non-adult individuals. Because the non-adult sample is composed of individuals with different degrees of dental development the description and analysis of dental data will focus on the adult individuals with 28 or more erupted permanent teeth. Recorded were the total number of erupted elements, the total number of inspected positions in the jaw, post-mortem loss of elements, ante-mortem loss of elements and elements with caries. Furthermore the degree of attrition was scored and the presence of calculus, alveolar atrophy, periapical abscesses and fistulas was documented.⁵¹⁶

	Cella	Templum	Basilica	Boschstraat	Total
N Individuals	13	28	32	26	99
N erupted elements and alveoli	407	894	1016	795	3112
N Inspected positions	300	439	576	492	1807
N Inspected elements	260 (64%)	382 (43%)	476 (47%)	419 (53%)	1537 (49%)
Mean Inspected elements per individual	20.0	13.6	14.9	16.1	15.5
Std. Deviation Inspected elements	8.7	9.6	9.6	8.9	9.4
Post-mortem tooth loss	105	453	423	347	1328
Mean PM loss per individual	8.1	16.2	13.2	13.3	13.4
Std. Deviation PM loss	7.8	9.4	8.4	8.7	8.9

TABLE 6.55 Number of inspected elements, inspected positions and post-mortem tooth loss in individuals with 28 or more permanent teeth

⁵¹⁶ Various indexes and ratios exist that combine the number of teeth affected by ante-mortem loss and caries. The purpose of calculating these indexes is to express and compare the caries experience of a population. (Hillson, 1996, p. 280) Best known is the DMF index, derived from modern dentistry and recording the number of Decayed, Missing and Filled teeth. This and other indexes have been adapted and devised for archaeological material. See for example (Costa, 1980, Caselitz, 1998.) No DMF indexes or other ratios were presented here because these ratios wrongly imply that every tooth that was lost before death was affected by caries. Ante-mortem tooth loss can just as commonly be caused by periodontal disease. (Hillson, 1996, p. 280.) Calculation of such indexes for comparison with other populations is further hindered by the fact that post-mortem tooth loss will bias the caries rates. Incisors, canines and premolars are lost more often than the molars, whereas molars are more often affected by caries. Thus samples with large numbers of post-mortem tooth loss will often have inflated caries rates. Therefore, Hillson recommends calculating caries rates and DMF indexes or ratios per type of tooth. (Hillson, 1996, Hillson, 2001) As this is hitherto not common practice in osteoarchaeology this would reduce the chances of finding comparable data in osteoarchaeological studies of contemporaneous populations. Therefore, we have chosen to present the data here as undifferentiated counts of affected teeth. Data were collected per tooth and for future studies it will be possible to present these data per type of tooth. However, to allow for meaningful comparisons it would be necessary to increase the number of inspected teeth.

Table 6.55 lists the number of elements available for inspection in each sample. Apart from the number of erupted elements and ante-mortem tooth loss (see below) this number was largely determined by the rate of post-mortem tooth loss. The mean post-mortem tooth loss in the *templum* sample was twice as high as in the *cella* sample. Post-mortem tooth loss in the *basilica* and the Boschstraat samples ranged between the values found for the *cella* and *templum* samples.

INSPECTED DENTITIONS

FIGURE 6-16 Detailed view of the left anterior part of the mandible. Because of post-depositional bone loss part of the crown and root of an impacted canine are visible (see arrow). All molars and premolars were absent due to ante-mortem tooth loss (Boschstraat: 1-4-11 a female of low status aged between 60 to 65 years, photograph: R. Panhuysen).

In humans the regular number of erupted elements in the permanent dentition is 32. This number may be increased due to the formation of supernumerary teeth or it can be reduced as a result of agenesis or impaction of dental elements. Supernumerary elements, extra teeth, were not found in the examined samples. Agenesis and impaction were both present in the population. Congenitally absent teeth are teeth that have not formed at all (agenesis). The third molars are the teeth that are most frequently missing because of agenesis.⁵¹⁷ An impacted tooth is a tooth that has remained inside the jaw. Third molars and upper canines are generally the most commonly impacted teeth.⁵¹⁸ With respect to the eruption of the third molars it is difficult to distinguish between agenesis and impaction. In case a dental element had not erupted it was generally scored as congenitally absent. Only in case part of the element was visible in the jaw either macroscopically or on radiographs, it was scored as a case of impaction.⁵¹⁹

⁵¹⁷ Hillson, 1996, p. 113.

⁵¹⁸ Hillson, 1996, p. 113.

⁵¹⁹ Radiographs of the dentition were only made in exceptional cases.

N erupted elements	Cella	Templum	Basilica	Boschstraat	Total
28	1				1 (1%)
30	2	1	3	3	9 (9%)
31	1		2	1	4 (4%)
32	9 (69%)	27 (96%)	27 (84%)	22 (85%)	85 (86%)
N individuals	13	28	32	26	99
Total N erupted	407	894	1016	795	3112

TABLE 6.56 The number of erupted elements in adult individuals by sample

Impaction was found in one individual from the Boschstraat sample. In this case a mandibular canine had remained inside the jaw. In 13 individuals the absence of third molars was scored as a case of congenitally absent teeth. The third molars of both the upper and lower jaw were absent in one individual. Nine individuals were found with missing both third molars in either the upper or lower jaw. In addition, three individuals missed only one of the third molars. Most individuals, however, had 32 erupted elements, viz. 86 per cent.

FIGURE 6-17 Mandibula seen from above. The left and right third molars are absent. Both the first and second molars show an advanced rate of attrition of the occlusal surface. Due to the abrasion of the enamel (white in the photograph) the dentine (grey in the photograph) is exposed in all dental elements (Servaas church: 1-6-7 a male from the *cella* sample aged between 50 to 59 years, (photograph: R. Panhuysen).

ATTRITION

To determine the rate of attrition or tooth-wear the molars of all 99 individuals with 28 or more erupted elements of the permanent dentition were inspected. However, in order to be included in the data set the dentition of an individual had to be unaffected by ante-mortem tooth loss or other pathological conditions that might affect the rate of attrition. Application of these criteria

resulted in a reduction of the number of individuals available for inspection to 50. The average rate of attrition of the first molars could be recorded in 40 individuals, of the second molars this was possible for 41 individuals and the third molars could be inspected in 30 individuals. In all three types of molars the rate of attrition was slightly higher in males than in females. However, this difference was not statistically significant.

	10-20 yr.			20-30 yr.			30-40 yr.			40-50 yr.			50-60 yr.			60-70 yr.		
	M1	M2	M3	M1	M2	M3	M1	M2	M3	M1	M2	M3	M1	M2	M3	M1	M2	M3
Sample																		
Cella				2.67	2.33	1.33	5.00	3.33	3.00	4.00	3.33	-	4.67	4.00	-	4.00	3.00	2.00
N	0	0	0	1	1	1	1	1	1	1	1	0	1	1	0	1	1	1
Templum	2.33	1.67	-	2.93	2.07	1.34	3.42	2.84	2.45	3.22	2.67	2.17	-	-	-	-	-	-
N	1	1	0	5	5	4	4	4	3	3	3	2	0	0	0	0	0	0
Basilica				2.92	2.17	1.42	3.83	3.00	2.17	3.67	2.67	2.33	-	-	-	5.33	4.33	3.33
N	0	0	0	4	4	4	2	2	2	1	1	1	0	0	0	1	1	1
Bosch	2.77	1.99	-	2.83	2.27	1.40	5.16	3.44	2.83	-	-	-	4.33	3.00	2.00	5.00	4.33	-
N	3	2	0	4	5	5	2	3	2	0	0	0	1	1	1	1	1	0
Total	2.68	1.89	-	2.88	2.18	1.38	4.07	3.10	2.54	3.47	2.80	2.22	4.50	3.50	2.00	4.78	3.89	2.66
N	4	3	0	14	15	14	9	10	8	5	5	3	2	2	1	3	3	2
Low	2.77	1.99	-	2.83	2.27	1.40	5.16	3.44	2.83	-	-	-	4.33	3.00	2.00	5.00	4.33	-
N	3	2	0	4	5	5	2	3	2	0	0	0	1	1	1	1	1	0
Interm.				2.93	2.07	1.42	3.83	3.00	2.17	3.50	2.67	2.33	-	-	-	-	-	-
N	0	0	0	5	5	4	2	2	2	2	2	1	0	0	0	0	0	0
High				2.67	1.67	1.00	3.65	3.00	2.33	3.16	2.66	2.17	-	-	-	5.33	4.33	3.33
N	0	0	0	1	1	1	2	2	2	2	2	2	0	0	0	1	1	1

TABLE 6.57 mean attrition rate of the first second and third molar by sample and status category for ten-year age intervals. Not all individuals for which the degree of attrition could be determined could be categorised in one of the ten-year age intervals. This was possible for 37 first molars, 38 second molars and 29 third molars.

With advancing age the degree of attrition increased. This correlation between age and degree of attrition proved to be statistically significant for all three types of molars.⁵²⁰ Still, the general increase of the attrition rate with age was not constant. As can be seen in Table 6.57 the attrition rate scored for individuals in the 30 to 40 years age interval was higher than in the following ten-year age interval. The variation in the degree of attrition among the four samples was generally limited. The small number of individuals hindered comparison of the degree of attrition, among the three status categories. Also in this comparison the 30 to 40 years age interval was characterised by higher attrition rates than for the following ten-year age interval.

⁵²⁰ Calculated was the Pearson Correlation Coefficient for the relation between the attrition rate for the first, second and third molars on one side and the age as represented by the ten-year age intervals on the other side. For first molars the Pearson Correlation Coefficient was 0.702, $P < 0.001$ and $N = 37$. For second molars the Pearson Correlation Coefficient was 0.741, $P < 0.001$ and $N = 38$. For third molars the Pearson Correlation Coefficient was 0.559, $P = 0.002$ and $N = 29$.

CARIES

Dental caries is the destruction of enamel, with or without the involvement of dentine and cement due to the acid production by bacteria present in dental plaque. Caries can be recognised as cavities in the crown or on the surface of the root.⁵²¹ Of the 99 individuals with 28 or more erupted elements of the permanent dentition two individuals lacked all teeth due to ante-mortem and post-mortem tooth loss, leaving 97 individuals for inspection of the presence of carious lesions. In 56 individuals (58%) caries was found. Out of 1537 dental elements that could be inspected 166 (11%) were affected by caries. In general the carious lesions were found to be occlusal caries, viz. in the pits and fissures of the crowns of the teeth. A considerable number of elements had carious lesions on the approximal surface of the crown. Caries on the root just below the cement-enamel junction, the neck, was rare.⁵²² Females were relatively more often affected by caries than males, viz. 42% and 37% respectively.⁵²³ There was an evident but not statistically significant increase in the number of individuals with caries with advancing age. Among the individuals in the age category between 20 to 40 about 52% had at least one element with caries (n=40), in the category from 40 to 60 years this percentage increased to 71% (n=41).⁵²⁴ The following tables on caries data presented as a percentage express the proportion of carious teeth as a percentage of the number of inspected elements. In addition the percentages of individuals with caries are listed.

	Cella	Templum	Basilica	Boschstraat	Total	Low	Interm.	High
Teeth	12%	8%	12%	11%	11%	11%	10%	10%
	31/260	30/382	58/476	47/419	166/1537	47/419	39/365	39/382
Individuals	85%	48%	61%	50%	58%	50%	57%	56%
	11/13	13/27	19/31	13/26	56/97	13/26	12/21	14/25

TABLE 6.58 Caries by sample and status. First the data are presented concerning the number of elements with carious lesions as a fraction of the number of inspected teeth. Secondly the data are presented concerning the number of individuals with carious teeth as a fraction of the number of individuals.

The variation in the prevalence of carious elements in the four samples was moderate. A relatively low proportion of carious elements (8 per cent) was found for the *templum* sample. In the other three samples the percentages of carious elements were higher (11 to 12 per cent). Statistical analysis of the prevalence of carious elements in these samples indicated that only the difference between the *templum* sample and the *basilica* sample was significant.⁵²⁵ The data for the three status categories indicated there was little variation in the prevalence of carious

⁵²¹ Hillson, 1996, p. 269.

⁵²² It was recorded which elements were affected by caries. However, these data are not presented here because a breakdown of the information into teeth categories and type of caries would lead to very small samples.

⁵²³ Males - females: $p=0.67$ (Fisher's Exact test).

⁵²⁴ 20 to 40 years - 40 to 60 years: $p=0.09$ (Fisher's Exact test).

⁵²⁵ Percentage of carious elements: *templum* vs. *basilica*: $p=0.04$ (Fisher's Exact test).

lesions. The percentage of affected elements was marginally higher in the low status category, whereas the proportion of individuals with caries was slightly lower than in the intermediate and high status groups.

ANTE-MORTEM TOOTH LOSS

Ante-mortem tooth loss is the loss of permanent dental elements during life. Teeth may be lost during life either passively because of pathological conditions or through extraction. Advanced caries or attrition followed by secondary eruption and periodontal disease may cause the loss of teeth during life. Ante-mortem tooth loss was determined by inspecting the alveoli or tooth sockets. The criteria for scoring ante-mortem tooth loss were, besides the absence of a dental element, clearly remodelled margins of the tooth socket or complete disappearance of the tooth socket due to advanced remodelling of the jaw. Without traces of remodelling of the tooth socket it was assumed that the tooth had been lost due to post-depositional factors. Ante-mortem tooth loss was found in 49 individuals (49%) out of a total of 99 individuals. A total of 255 teeth (14%) out of 1807 inspected tooth positions were found to have been lost during life. Both males and females were affected in equal proportions.⁵²⁶ A strong and statistically significant association existed between the age of individuals and the prevalence of ante-mortem tooth loss.⁵²⁷ Of the 40 individuals who died between 20 to 40 years 10 individuals (25%) had ante-mortem tooth loss. In comparison to the 20 to 40 year age interval ante-mortem tooth loss tripled to 31 (76%) among the 41 individuals who died between 40 to 60 years. Therefore, the data on ante-mortem tooth loss are presented separately for the two age categories of 20 to 40 years and 40 to 60 years. In addition to the data on the proportion of teeth lost, the data on individuals with ante-mortem tooth loss are also presented to facilitate comparison of the data with other sites.

For the age category between 20 to 40 years the differences in ante-mortem tooth loss were minimal. An exception was the comparatively high value for the sample from the *cella* phase (12 per cent as opposed to 5 per cent in the other three samples). A different distribution was found for the 40 to 60 year category. This age category showed an increase in ante-mortem tooth loss from the *cella* sample to the *basilica* sample. Statistical analysis of these rising percentages in the three subsequent samples from the Servaas site indicated that this diachronic increase was statistically significant.⁵²⁸ With circa 19 per cent ante-mortem tooth loss, the individuals from the Boschstraat had an equal percentage of ante-mortem tooth loss as the individuals from the *cella* sample. The prevalence of ante-mortem tooth loss in the three status categories could be analysed in 74 individuals with 1379 observable alveoli, tooth positions. Both in the age category between 20 to 40 years and for the sample as a whole the highest rate of ante-mortem tooth loss

⁵²⁶ Among 40 males 21 had ante-mortem tooth loss (52%), a similar percentage was calculated for 27 out of 52 females (52%).

⁵²⁷ For the age category 20 to 40 years versus 40 to 60 years: $p < 0.001$ (Fisher's Exact test); odds ratio = 9.300, 95% confidence interval = 3.052 - 29.432.

⁵²⁸ Chi-square test for trend *cella* - *templum* - *basilica*: $p = 0.04$.

	Age	Cella	Templum	Basilica	Boschstraat	Total	Low	Interm	High
Alveoli	20-40 yr.	12%	5%	5%	5%	6%	5%	1%	13%
		10/86	14/258	11/223	12/239	47/806	12/239	2/225	22/173
	40-60 yr.	19%	23%	28%	18%	23%	18%	30%	21%
		28/146	35/152	82/295	26/141	171/734	26/141	44/149	57/267
Individuals	All	13%	13%	17%	12%	14%	12%	12%	19%
		40/300	57/439	99/576	59/492	255/1807	59/492	52/418	87/669
	20-40 yr.	33%	15%	33%	25%	25%	25%	10%	50%
		1/3	2/13	4/12	3/12	10/40	3/12	1/10	4/8
	40-60 yr.	71%	70%	82%	71%	76%	71%	67%	81%
		5/7	7/10	14/17	5/7	31/41	5/7	6/9	13/16
	All	62%	39%	62%	38%	49%	38%	43%	70%
		8/13	11/28	20/32	10/26	49/99	10/26	9/21	19/27

TABLE 6.59 Ante-mortem tooth loss by sample and by status, percentages represent the number of alveoli with evident signs of ante-mortem tooth loss as a percentage of the total number of alveoli that could be inspected.

was found for the high status category.⁵²⁹ In the 40 to 60 years interval the differences between the status categories were not statistically significant and displayed no trend to increase or decrease with status.

ABSCESSSES

Periapical abscesses are alveolar abscesses located around the apex of the tooth root. They are the result of bone resorption caused by periapical periodontitis from micro organisms. All 99 individuals with a completely erupted permanent dentition were inspected macroscopically for the presence of periapical abscesses. When possible teeth were removed from the jaw in order to inspect the socket. The tooth sockets were not examined radiographically. Therefore, not all periapical abscesses will have been detected. The presence of a cavity with (partially) remodelled bone around the root of a tooth was considered diagnostic evidence for periapical abscesses. In 45 individuals (45 per cent) periapical abscesses were found. A total of 120 (7 per cent) abscesses was recognised while inspecting 1807 alveoli. Males and females were evenly affected. A strong increase in the prevalence of periapical abscesses with advancing age at death was found.⁵³⁰ As a consequence the data are presented separately for the 20 to 40 and 40 to 60 year age categories and for all individuals with almost completely erupted permanent dentitions.

⁵²⁹ Low and intermediate status combined – high status: $p=0.002$ (Fisher's Exact test); odds ratio = 0.621, 95% confidence interval= 0.452 – 0.853.

⁵³⁰ For the inspected alveoli in the age category of 20 to 40 years versus 40 to 60 years: $p<0.001$; odds ratio = 4.961, 95% confidence interval= 2.977 – 8.339.

FIGURE 6-18 Inferior surface of the right half of the maxilla. Visible (1) is the hole of a fistula that drained the periapical abscess at the root of the first molar (solid arrow). Also note (2) the carious lesion on the interproximal surface of the first molar (outlined arrow) (Servaas church: 5-8-3 a female aged between 44 to 50 years from the *basilica* sample and of high status, photograph: R. Panhuysen).

	Age	Cella	Templum	Basilica	Boschstraat	Total	Low	Interm	High
Alveoli	20-40 yr.	5%	1%	3%	3%	3%	3%	2%	1%
		4/86	2/258	7/223	8/239	21/806	8/230	7/225	2/179
	40-60 yr.	8%	12%	15%	8%	12%	8%	12%	14%
		12/146	19/152	44/295	11/141	86/734	10/111	18/149	53/387
	All	7%	5%	9%	4%	7%	4%	6%	8%
		22/300	22/439	55/576	21/492	120/1807	21/492	26/418	35/469
Individuals	20-40 yr.	67%	8%	33%	25%	25%	24%	20%	17%
		2/3	1/13	4/12	3/12	10/40	9/12	2/10	1/8
	40-60 yr.	86%	60%	65%	71%	68%	71%	78%	56%
		6/7	6/10	11/17	5/7	28/41	5/7	7/9	9/16
	All	77%	29%	53%	38%	45%	38%	52%	41%
		10/13	8/28	17/32	10/26	45/99	10/26	11/21	11/27

TABLE 6.60 Periapical abscesses by sample and by status

In the 40 to 60 years age interval the prevalence of periapical abscesses was found to increase diachronically. It rose from about 8 per cent in the *cella* sample to 12 per cent in the *templum* sample and in the last period, viz. the *basilica* phase, abscesses were present in 15 per cent of the inspected tooth-sockets. This trend was statistically significant.⁵³¹ When the presence of abscesses in individuals of all age categories was compared a similar trend was not present. Looking at the number of individuals (not alveoli) with periapical abscesses no evident trends could be recognised. However comparison of the high number of individuals with abscesses in the *cella* sample with the low number in the *templum* sample indicated that the difference between these samples was statistically significant.⁵³² This high number of individuals with abscesses in the *cella* sample contrasts with the trend of the increase of affected alveoli over time. The increase of the number of abscesses in the inspected alveoli from the low to the high status categories indicated that the prevalence of periapical abscesses was associated with status.⁵³³ Again at the level of counts of individuals with abscesses no significant trends could be recognised.

CALCULUS

Dental calculus is mineralised plaque and exists in two types, viz. supra-gingival and sub-gingival calculus. Supra-gingival calculus is found as a deposit in the shape of a band on the enamel of the cervical crown. Sub-gingival calculus is formed on the root of the tooth. Only the presence of supra-gingival calculus was recorded systematically in this study. With advancing age there was a relative increase in the number of individuals with calculus. However, statistical analysis indicated this trend was not significant. Calculus distribution over males and females showed that significantly more males than females had calculus.⁵³⁴ Therefore, data concerning males and females are presented in separate rows in Table 6.61.

	Cella	Templum	Basilica	Boschstraat	Total	Low	Interm.	High
Males	100%	100%	88%	75%	92%	75%	100%	93%
	8/8	11/11	15/17	3/4	37/40	3/4	8/8	13/14
Females	40%	43%	86%	81%	67%	41%	85%	50%
	2/5	6/14	12/14	13/16	33/49	13/16	11/13	6/12
All	77%	70%	87%	75%	78%	75%	91%	73%
	10/13	19/27	18/32	18/24	75/96	18/24	19/21	9/26

TABLE 6.61 Individuals with calculus by sample and by status

⁵³¹ Chi-square test for trend *cella* - *templum* - *basilica*: $p=0.049$.

⁵³² For the *cella* sample versus the *templum* sample: $p=0.01$ (Fisher's Exact test); odds ratio = 8.333, 95% confidence interval= 1.512 - 56.341. The variation in the prevalence of periapical abscesses between the *templum* sample and the *basilica* and *Boschstraat* samples was not significant with p -values of 0.07 and 0.57 respectively.

⁵³³ Chi-square test for trend low - intermediate - high status: $p=0.03$.

⁵³⁴ For males versus females: $p=0.01$ (Fisher's Exact test); odds ratio = 0.167, 95% confidence interval= 0.035 - 0.691.

Regarding the prevalence of supra-gingival calculus among the combined male and female samples there is little variation between the four samples or the three status categories. The largest variation in the prevalence of calculus was found for females in the various samples. In the *cella* and *templum* samples the prevalence of calculus was comparatively low, whereas it was approximately twice as high among the females of the *basilica* and Boschstraat samples. The difference in prevalence between the *templum* and *basilica* females was found to be statistically significant.⁵³⁵ Although the prevalence of calculus was evidently lower among females of high status, the difference was not statistically significant. Considerable fluctuations in the difference in prevalence of calculus between males and females were found in the four samples and three status categories. In the *cella* and *templum* samples calculus was much less common in females than in males. Almost equal percentages in males and females were found for the *basilica* and Boschstraat samples. Comparison of the sexes in the three status categories showed marginal differences in the groups of low and intermediate status. In the high status category almost all males had calculus, whereas half of the females were affected. This association of calculus by sex in the high status category is statistically significant.⁵³⁶

ALVEOLAR ATROPHY

Alveolar atrophy is the retraction of the supportive tissues of the teeth. In osteo-archaeological studies this is recorded by describing the recession of the alveolar bone. The occurrence of alveolar atrophy was found to be associated with age. In the 20 to 40 year category circa 60 per cent of the individuals had evident atrophy. This increased to 90 per cent in the 40 to 60 years category. This correlation with age is statistically significant.⁵³⁷

	Cella	Templum	Basilica	Boschstraat	Total	Low	Interm.	High
20-40 years	67%	27%	75%	75%	61%	75%	56%	71%
	2/3	3/11	9/12	9/12	23/38	9/12	5/9	5/7
40-60 years	86%	89%	88%	100%	90%	100%	88%	87%
	6/7	8/9	15/17	6/6	35/39	6/6	8/9	13/15
All	77%	52%	84%	71%	71%	71%	75%	84%
	10/13	13/25	27/32	17/24	67/94	17/24	15/20	21/25

TABLE 6.62 Individuals with alveolar atrophy by sample and status

⁵³⁵ For *templum* versus *basilica*: $p=0.046$ (Fisher's Exact test); odds ratio = 8.000, 95% confidence interval= 0.611 – 92.656. Comparison for *templum* versus Boschstraat missed statistical significance $p=0.056$ (Fisher's Exact test); odds ratio = 0.173, 95% confidence interval= 0.023 – 1.119.

⁵³⁶ For males versus females: $p=0.03$ (Fisher's Exact test); odds ratio = 13.000, 95% confidence interval= 1.067 – 641.913.

⁵³⁷ For the age category of 20 to 40 year versus 40 to 60 years: $p=0.01$ (Fisher's Exact test); odds ratio = 5.707, 95% confidence interval= 1.501 – 23.534.

In general the various samples showed little variation in the prevalence of alveolar atrophy. An exception was the low prevalence in the 20 to 40 year age category in the *templum* sample. The difference with the higher prevalence in both the *basilica* and Boschstraat samples proved to be statistically significant.⁵³⁸ Among the status categories there was little variation in the prevalence of alveolar atrophy.

⁵³⁸ For *templum* versus *basilica* or Boschstraat in the 20 to 40 year age category: $p=0.04$ (Fisher's Exact test), odds ratio = 0.125, 95% confidence interval= 0.013 – 1.061.

7

Discussion

INTRODUCTION

It is the aim of this study to use human skeletal remains from two sites as a source of information concerning the living conditions in early medieval Maastricht. In addition, this study seeks to contribute to the interpretation of the archaeological findings relating for example to the layout of the cemetery of each chronological phase and to diachronic changes at the cemeteries. With these goals in mind the following analysis of the collected data is divided into an introduction, a review of the parameters used in this study and a main section discussing the results in their chronological and topographical context.⁵³⁹

The extent to which historical events can be described largely depends on the available sources. With respect to the description of living conditions in the late Roman and early medieval period, the information depends mainly on the quality and quantity of human remains. Thus the reliability of the available information will be determined by the presence of an adequate number of individuals and whether statistical methods can validate the trends encountered in the material.⁵⁴⁰ It is worth reiterating that osteo-archaeology is generally confronted with limitations in its scientific approach. Osteo-archaeological knowledge is largely acquired from unilateral observations in uncontrolled circumstances. Unlike physical anthropological and medical studies of living individuals, which can rely on experimental studies under controlled circumstances, osteo-archaeological studies have to rely on observations and attempts to interpret these observations in their context.

GENERAL CHARACTERISTICS OF PHYSICAL ANTHROPOLOGICAL AND PALAEOPATHOLOGICAL DATA

Before we can discuss the results of the physical anthropological and palaeopathological examination it is necessary to review the parameters that are used to obtain an image of the living conditions in late Roman and early medieval Maastricht. It is not the purpose of this study to extensively evaluate all methods applied in collecting data, as this would require a series of separate studies. The review is aimed at providing a concise description of methodological aspects that have an impact on the validity of the results and the way the data may be interpreted.

⁵³⁹ Topics concerning questions and developments transcending the separate phases and samples will be addressed in chapter eight.

⁵⁴⁰ As a result not all data collected and presented in the previous chapter will be discussed here.

SEX

It is generally recognized that the methods for the determination of sex in adult individuals based on the inspection of the pelvis and skull generate reliable results.⁵⁴¹ As Acsádi and Nemeskéri have indicated in the description of their method, it is necessary to test whether the method can be applied correctly in the sample under study.⁵⁴² An indication that this non-metrical morphological method was appropriate to determine sex for the Maastricht population is evident from figure 6.2 in the previous chapter. The anterior-posterior femoral diameter was used as an additional indicator of sex. This metrical morphological indicator was applied only in cases with unambiguous values, in order to reduce the chance of incorrect determinations. With respect to a possible bias in the determination of sex in cemetery samples, Walker has indicated that in some cases females may be underrepresented in excavated samples.⁵⁴³ One of the reasons for female underrepresentation is the more gracile nature of female bones, which increases the susceptibility to age-related bone loss in females. This may have a negative effect on the preservation of female skeletal remains. In our samples the recovery rate of male skeletal remains was indeed slightly higher than in females. However, the difference in survival of male and female bones was not statistically significant.⁵⁴⁴ Therefore, it is unlikely that this effect had a noteworthy impact on the representation of females in the examined samples. Another source of bias in sexing skeletal remains mentioned by Walker is the ongoing development of male cranial features in young males up to the age of 30 years. In theory this trend could lead to the erroneous attribution of female sex to young males. Walker further signalled a tendency to develop more "male" cranial features in females of 45 years and older.⁵⁴⁵ Since the determination of sex was primarily based on the sexualisation degree of the pelvis it is unlikely that these age related changes in the cranium have significantly biased our results. Furthermore, the limited effect of this age related masculinisation of elderly females is evident from the high correlation between sex determinations for pelvis and skulls (see the scatter plot in figure 6.3).

Data on the distribution of the sexes can provide valuable information on the composition of the cemetery population.⁵⁴⁶ Generally the number of males and females is expected to be in balance in a population. Overrepresentation of either males or females in a cemetery sample can be the result of an existing imbalance in the composition of the living population. However, it can also be a consequence of gender based selective mechanisms in the burial customs. For example an overrepresentation of male burials might be an indication of the foundation of a monastic or canonical community or it could be a result of a tendency to bury males and females at different cemeteries. The determination of sex will also be used to plot the distribution of the sexes in plans of the cemetery. This will help to determine whether there

⁵⁴¹ See for example Brothwell, 1981 p. 59-63, St. Hovme and Iscan, 1989 p. 76 (pelvis) and p. 69-74 (skull) and Mays and Cox, 2000 p. 118-120

⁵⁴² Acsádi and Nemeskéri, 1970, p. 91-97.

⁵⁴³ Walker et al., 1988 and Walker, 1995, p. 35.

⁵⁴⁴ The mean recovery rate for males (n=66) was 0.34 and for females (n=88) 0.33.

⁵⁴⁵ Walker, 1995, p. 36-40 and Weiss, 1972.

⁵⁴⁶ It is noted that the cemetery population only in rare cases (e.g. natural disasters or epidemics) reflects the living population

were concentrations of burials of either males or females or whether they were buried in the same areas. Another line of research is the analysis of the possible association between grave goods and sex. In recent years, especially since the study of Halsall,⁵⁴⁷ this topic has become a focus of study.⁵⁴⁸

AGE AT DEATH

The available methods for estimation of age at death for non-adults are considered quite reliable. Estimation of age at death of adult skeletal remains is not undisputed. For both age categories it should be recalled here that all methods lead to estimates of the biological age, based on an assessment of various ageing processes in the skeleton. It is known that there is considerable variation in the progress of these ageing processes. Therefore, on the individual level there may be a discrepancy between the estimated biological age and the actual calendar age. Within larger samples of skeletons the effect of individual discrepancies between biological age and the calendar age are generally considered to be levelled out, namely the number of individuals with a biological age younger than their calendar age is expected to equal the number of individuals with a biological age older than their calendar age. However, any bias introduced by the method of age determination will not be reduced by an increase of the sample size. To the contrary, the incorporation of the tendency to either underage or overage in a method will affect the whole sample. Furthermore, it is recalled here that it is not possible to reconstruct precise life tables based on osteo-archaeological data, since the mortality distributions and graphic representations all illustrate the number of deaths in certain age intervals, not the number of living individuals in that age category.⁵⁴⁹ Because of the nature of the examined samples it was decided not to include mortality tables in this chapter but to use bar charts for the illustration of mortality patterns.

AGE OF NON-ADULTS

From a methodological point of view estimation of age at death for non-adults is fairly accurate. In individuals up to 20 years the ongoing development of multiple skeletal and dental elements and the rapid growth of long bones generally allows for precise and reliable age estimations. On the basis of these results it is possible to acquire a detailed picture of mortality among the non-adult population. However, comparison of these data with other studies is often hindered by the

⁵⁴⁷ Halsall, 1995.

⁵⁴⁸ An example of the analysis of this association can be found in Stoodley, 1999. This development has raised interest among archaeologists and historians for the reliability of the methods to determine sex from the skeletal remains. Effros has suggested the increased use of aDNA analysis for this purpose, Effros, 2000. However, given the problems surrounding the conservation of ancient DNA, the risk of contamination with modern DNA and the costs of DNA analysis it is not to be expected that aDNA analysis will be applied on a large scale. Still, as Effros stated it can be very useful to test other physical anthropological methods and to determine the sex of non-adult individuals. For the time being morphological sex determination will be the most frequently applied method providing reliable results.

⁵⁴⁹ Waldron, 1994, p. 16-21.

large variety of age categories used in the literature.⁵⁵⁰ And it has to be taken into account that attribution to these age categories is determined by osteological and dental age characteristics or the desire to create age categories of an equal number of years for statistical purposes. Often these age intervals do not correlate with the biological and pathological developments that affect the morbidity and mortality risks in the individual. For example an approach categorising children in ten-year age intervals will group children between birth and two years with a high mortality risk with children from 5 to 10 years who generally have a lower mortality risk. Furthermore, it should be noted that the socio-cultural classification of individuals in age categories seldom corresponds with the categories used in physical anthropology.⁵⁵¹ It is evident that osteological criteria, like the fusion of the epiphyses of the clavicle, did not determine when an individual was culturally considered an adult. Written sources indicate that in early medieval Europe the cultural transition from childhood to adulthood took place quite early in life, around 12 to 14 years.⁵⁵² That is well before growth has completed.

With respect to non-adult mortality methodological aspects pose no obstacle to the use and interpretation of the physical anthropological data. Still, other factors may hinder the use of these data. The proportion of non-adult individuals in the excavated population may be reduced due to a higher susceptibility to decomposition processes of the bones of younger children.⁵⁵³ In addition, the number of non-adults in a cemetery may also be increased or decreased as a consequence of specific burial customs.⁵⁵⁴ When it can be ruled out that the recovery of non-adult skeletal remains is seriously affected by differential preservation or preferential burial the data can be used to calculate non-adult mortality. This is considered to be a reflection of general strain on the population and to be determined by the living conditions as well as the demographic developments and the pathological load. It is not just the proportion of non-adults versus adults in a population which is of interest, but also the distribution of non-adult mortality during the first two decades of life may yield information on general living conditions. For example a high mortality in the first two years after birth is considered to be indicative of poor living conditions, often in combination with population growth.⁵⁵⁵

⁵⁵⁰ Examples of frequently used age classifications: five year intervals (0-<5 yr, 5-<10 yr etc.); ten year intervals (0-<10 yr, 10-<20 yr etc.) A much used classification system uses Latin terminology for the various age categories: *infans I* (0-6 yr), *infans II* (6-12 yr), *juvenis* (13-20 yr). Herrmann et al., 1990, p. 52.

⁵⁵¹ Lohrke, 2004, p. 17-18.

⁵⁵² This age corresponds with a biological phenomenon: the start of the reproductive period of females. According to Lejan girls married at a young age and remarried if they became widows at an early age. Boys seem to have married at a later age. Lejan, 1995, p. 345-347.

⁵⁵³ Guy et al., 1997.

⁵⁵⁴ Some post-Carolingian cemeteries, like the cemetery of Saint Hilaire in Namur (Belgium) were specially designated to bury children. In other cemeteries like the cemeteries of monasteries, children are sometimes lacking because they were underrepresented in the community.

⁵⁵⁵ Examples of studies stressing the importance of a detailed analysis of non-adult mortality profiles: Brothwell, 1987, Hühne-Osterloh and Grupe, 1989, Molleson, 1991 and Zink, 1999.

AGE OF ADULTS

Estimation of age at death for adults is generally considered less precise and known to be less reliable than for non-adults.⁵⁵⁶ Age assessment of adult individuals is hampered by inter-individual variation and is often considered to be problematic in older individuals.⁵⁵⁷ For this study estimation of age at death was done by means of the “complex method”. When necessary this method was used in combination with ectocranial suture obliteration and molar attrition. Like all methods to estimate age at death the “complex method” is certainly not without flaws. Molleson and Cox described that for the individuals with a known age at death in the Spitalfields population (London, UK) the “complex method” tended to overestimate age at death for individuals younger than 40 years and underestimate age for individuals of 70 years or more.⁵⁵⁸ Baetsen studied a population of 151 adult individuals of known age from Alkmaar (NL) and found similar trends. However, in the Alkmaar study the age estimates based on the “complex method” were found to be more in agreement with the actual ages at death than in the Spitalfields study.⁵⁵⁹ This difference between the two studies may partially be explained by the way the “complex method” was applied. In the Spitalfields study the proximal humerus and femur were not sawn for inspection of the trabecular structure; in the Alkmaar study these bones were sawn according to the instructions by Acsádi and Nemeskéri.⁵⁶⁰ Despite the aforementioned disadvantages of the method, the “complex method” was chosen as the basis for the estimation of age at death for adults in our population because it is a method using multiple indicators that may limit the effect of bias encountered in single indicator methods.⁵⁶¹ Furthermore, it was developed on the basis of a European population, reducing the chance of bias due to inter-population differences. The widespread use of the method in Europe and the Netherlands was also a factor in the selection of this method as the basis for ageing in this study, since this would allow the data to be compared with other studies.

The estimates of the age at death for adults were used to calculate mean ages at death. Generally, mean variation in mean ages at death of different populations is difficult to interpret, since the mean age at death does not take into account the distribution of mortality over the consecutive age intervals. Furthermore, comparison of the mean age at death from different populations may be biased by the use of different methods, or when the same method is used, they may be influenced by inter-observer variation. In this study comparison of the mean ages at death among the samples is feasible because the same investigator collected all age estimations, using a fixed set of methods. To ascertain whether the general distribution of mortality is comparable the overall distribution of mortality in the compared samples will be examined. Mean ages at death will be used to determine whether there were diachronic changes in the age at death and whether there was a correlation between age at death and

⁵⁵⁶ Kemkes-Grottenthaler, 2002

⁵⁵⁷ Iscan and Loth, 1989 p. 36-37; Molleson and Cox, 1993, p. 169; Ortner, 2003 p. 38-39.

⁵⁵⁸ Molleson and Cox, 1993, p. 169.

⁵⁵⁹ Baetsen, 2001, p. 31-33.

⁵⁶⁰ Molleson and Cox, 1993, p. 169

⁵⁶¹ Maat, 1987.

status. The distribution of mortality will also be studied by means of bar charts representing the mortality profiles. In principle the distribution of mortality over ten-year age intervals may provide more detailed information on the risk of dying at certain ages. However, it must be kept in mind that this is not only a function of the risks of dying in the consecutive ten-year age intervals, but possibly was also determined by selective mechanisms in the burial customs.

STATURE

Comparison of standing living height between various samples was done by calculating stature estimates from standardised measurements of long bones. For this purpose long bones were measured to the nearest millimetre.⁵⁶² From these measurements stature was calculated separately for males and females. The regression formulas used to calculate stature are devised from series of long bone measurements from individuals of known stature and sex. The result, a mean stature in centimetres for males and females, is appealing since it allows us to visualise the average standing height of males and females in a population. More importantly it facilitates comparison with archaeological, historical and modern data on stature. However, the existence and use of different regression formula also introduces some distortion in the data on stature.⁵⁶³ For example for the skeletal remains from Maastricht the formulas from Trotter⁵⁶⁴ and from Trotter and Gleser⁵⁶⁵ yield structurally higher statures than the formulas developed by Breitingner⁵⁶⁶. These differences are largely the result of differences in proportions of the bones in the upper and lower extremities, spine and skull in the populations for which various authors developed their regression formulas. The use of different regression formulas also hinders comparison of the results presented in older studies applying other methods and regression formulas, e.g. the formulas developed by Pearson and Olivier.⁵⁶⁷ Therefore, in this study it was decided to present both the calculated stature and the mean lengths of the long bones for adult males and females.

Adult stature is dependent on genetic factors and various aspects of living conditions, like the quality and quantity of nutrition, physical stress and disease load.⁵⁶⁸ Therefore, stature is considered a valuable indicator for the general living conditions and socio-economic situation. Because multiple factors can have an effect on growth, stature is a non-specific indicator of general living conditions. In order to study the impact of socio-economic factors we have to determine whether the ethnic composition of the population was more or less stable during the period under study. With respect to the *cella* phase in Maastricht and the transition to the

⁵⁶² As is customary in physical anthropology the error of measurement was not formally examined. As a means of informal control all measurements of single bones were repeated.

⁵⁶³ Wurm and Leimeister, 1986.

⁵⁶⁴ Trotter, 1970.

⁵⁶⁵ Trotter and Gleser, 1958.

⁵⁶⁶ Breitingner, 1937.

⁵⁶⁷ Pearson, 1898 and Olivier, 1963.

⁵⁶⁸ Tanner, 1978, p. 117-153.

templum phase it is hitherto unknown whether the ethnic background of the population changed. As mentioned in chapter two there are indications for a "Germanization" of local culture in the Merovingian period, roughly coinciding with the *templum* phase. The historical and archaeological sources do not indicate whether this "Germanization" process was accompanied by the influx of considerable numbers of individuals who differed genetically from the Gallo-Roman population. For the *templum* phase and the *basilica* phase we have no reason to assume large changes in the genetic composition of the population. Therefore, the analysis of differences in long bone growth and stature may provide information on possible differences in living conditions for the *templum* and *basilica* phase.

Socio-economic factors are assumed to influence adult stature by means of status-related differences in access to quantitatively and qualitatively sufficient nutrition and other elements of living conditions.⁵⁶⁹ In several studies Wurm has shown studies that high status was associated with above average stature.⁵⁷⁰ Changes in stature may also provide information on general changes in living conditions. An increase in stature over time within a more or less stable population may be interpreted as an indication for improvements in living conditions. Male and female stature is affected differently by changes in the living conditions. Therefore, attention is also paid to changes in the dimorphism in stature.⁵⁷¹

METRIC AND NON-METRIC VARIATION

It was mentioned before that because of the often-fragmentary nature and incompleteness of the skeletal remains only the presence of a select number of non-metric skeletal traits was scored. For the same reason no more than three measurements of the cranium were taken.⁵⁷² Although non-metric traits have been studied since the nineteenth century the interpretation of the data on non-metric or epigenetic variation of skeletal traits is not at all straightforward. As the presence of most traits depends on multiple genes their occurrence is explained by means of a threshold model, developed by Falconer.⁵⁷³ According to this model the development of a trait depends on whether the gene load in an individual surpasses a threshold. A polygenetic distribution is considered to have an additive positive or negative effect on the development of a trait. Internal and external environmental factors may also contribute to the development of non-metric traits. Factors like parity, maternal age, sex and nutrition may either push an individual over the threshold or prevent the development of a trait. The occurrence of some of

⁵⁶⁹ Early evidence for the relation between access to nutrition and stature is found in an article from 1861 by J. Zeeman. In his publication Zeeman describes that fluctuations in the price of rye were associated with fluctuations in the percentages of undersized conscripts. A high price of rye resulted after an interval of 1 year in a large percentage of undersized 18-year-olds. Zeeman, 1861 cited from Wieringen, 1972, p. 116. There is a vast amount of literature on the topic of the association between socio-economic status and stature. Introductions to this topic are: Wieringen, 1972 and Floud et al., 1990.

⁵⁷⁰ Wurm, 1985.

⁵⁷¹ Valenzuela, 1983.

⁵⁷² Martin and Saller, 1957.

⁵⁷³ Hauser and De Stefano, 1989, p. 6-7.

these traits may also be influenced by the age of the individual, as several traits are thought to appear or disappear with advancing age. Some non-metric traits are also considered indicators of ontogenic stress or poor health conditions during pregnancy.⁵⁷⁴

In this study one non-metric trait, viz. lambdoid ossicles, displayed considerable variation between the separate phases in the sample. The spatial distribution of individuals with lambdoid ossicles in the cemetery is studied to establish whether this trait was evenly distributed or whether it was found to be concentrated in clusters of individuals. A clustered distribution might indicate that the individuals buried in these clusters were genetically related.⁵⁷⁵ However, since the development of this type of non-metric trait depends of genetic and environmental factors it is difficult to determine to what extent its occurrence is the result of genetic relationships.⁵⁷⁶ Still, this topic deserves some attention, as family relations may have been an important factor in the selection of the burial location.⁵⁷⁷ With respect to metric variation in the sample, few data could be collected and analysis of these data did not indicate that metric variation was clearly associated with period or status. Therefore, metric data will not be discussed below.

THE EFFECT OF STRESS AND DISEASE

Osseous changes, like Harris lines and cribra orbitalia, and dental changes, like enamel hypoplasia, may all be induced by various forms of systemic stress. Both physical stress, e.g. disease, nutritional deficiencies, heavy labour and intoxication are possible causes. Therefore the data on stress indicators are combined in the analysis to provide insight in the presence of stress.

However, the presence of stress-related changes in the skeleton cannot be used as an unequivocal sign of poor health. Markers of physical stress in the skeleton can be seen both as a negative phenomenon, viz. evidence for the exposure to stress, and as a positive phenomenon, namely the ability to react to pathological conditions. In recent years osteo-archaeologists have realised that there is no straightforward relation between the presence of stress indicators or signs of disease and poor living conditions. In many cases the skeletal reaction may be interpreted as proof that the individual temporarily survived or overcame the strain on its health. The ability to survive and overcome disease and stress will often have been attributed to good health. Individuals with less resistance to stress and disease may have died before the skeleton could react. This notion that the presence of osseous changes due to stress and disease may in certain samples be associated with good health is named the "osteological paradox".⁵⁷⁸

⁵⁷⁴ For a brief but recent overview of the literature on the interpretation of accessory ossicles see Hanihara and Ishida, 2001, Barnes, 1994 provides examples for the interpretation of non-metric variation in the axial skeleton as developmental defects

⁵⁷⁵ Sutural structures like lambdoid ossicles are genetically determined, but they are dependent of environmental factors. Moderate heritability estimates were found for sutural bones. Hauser and De Stefano, 1989, p. 84-97.

⁵⁷⁶ Hanihara and Ishida, 2001 and O'Loughlin, 2004.

⁵⁷⁷ On the options for burial that may have existed in the early medieval period see for example: Theuvs, 1998, p. 344-346

⁵⁷⁸ Wood et al., 1992; Larsen, 1997, p. 336-337; Wright and Yoder, 2003.

The study of various health indicators in relation to each other and in the context of the historical and archaeological data on living conditions will contribute to reaching valid interpretations. For example an increase in the prevalence of Harris lines and enamel hypoplasia in combination with a temporary decrease in mean age at death might together be interpreted as indicators of a deterioration of living conditions.

HARRIS LINES, ENAMEL HYPOPLASIA AND CRIBRA ORBITALIA

As described in chapter 5 a Harris line or growth arrest line is a small layer of bone formed during a period of delayed bone growth. In adult individuals they can be seen in the marrow cavity as a thin layer of trabecular bone. On radiographs of the long bones of non-adults and adults Harris lines are visible as transverse radio-opaque lines indicating the presence of increased bone density.⁵⁷⁹ There is little doubt that Harris lines are associated with periods of delayed or arrested growth. However, because such growth insults can be caused by a variety of conditions, Harris lines are considered to be a non-specific stress indicator. Possible causes of growth insults that might possibly lead to the formation of Harris lines are: quantitative or qualitative deficiencies in nutrition, exposure to toxic substances, disease, and physical strain. In present day clinical practice Harris lines are also encountered in individuals who did not experience notable physical stress.⁵⁸⁰

Due to limited access to x-ray facilities examination of Harris lines is not a standard procedure in osteoarchaeological studies, which reduces the availability of comparable data. The possibility to compare data of different studies is further reduced due to the fact that there is considerable variation in the methods used to study Harris lines. The applied methods vary in the selection of bones for examination and the definition of Harris lines.

Enamel hypoplasia is also considered to be an indicator of physical stress interfering with proper growth of dental enamel.⁵⁸¹ Like Harris lines it is a non-specific indicator. The recording of these defects in the enamel surface was done by macroscopic inspection. As most enamel defects were in the shape of horizontal lines and not very marked the classification of hypoplasia was rather straightforwardly recorded as present or absent.⁵⁸² Unfortunately not all osteoarchaeological studies include results for this stress indicator in the data set. This limits the possibility of comparing data with contemporaneous or otherwise interesting populations.

Cribra orbitalia are more specific as an indicator of physical stress. These osseous changes of the roof of the eye orbits are associated with iron deficiency anaemia. Although this considerably limits the range of causes for this phenomenon, a large variety of conditions, like dietary insufficiencies, low birth weight, chronic diarrhoea, parasitic infection and genetic diseases, may cause this condition.⁵⁸³ Although cribra orbitalia are often categorised according

⁵⁷⁹ Maat, 1984.

⁵⁸⁰ Already in 1933 Harris published a radiograph of the distal tibia of a "normal" healthy child displaying, beside a marked Harris line of a severe influenza, several faint lines ascribed to mild infections with common childhood illnesses, Harris, 1933, p. 15.

⁵⁸¹ Skinner and Goodman, 1992, p. 160-162; Lukacs, 1989, p. 267

⁵⁸² In addition the age of formation was recorded.

⁵⁸³ Larsen, 1997, p. 29-30

to different descriptive systems, many studies present data on the prevalence of *cribra orbitalia*. This has led to a situation where data for comparisons on a population level are available.

PATHOLOGY

As indicated in the chapter on methods a panel of medical specialists and physical anthropologists reviewed all pathological cases. Pseudopathology⁵⁸⁴, normal variants and mild degenerative changes were either excluded beforehand or during sessions of the paleopathology panel. The panel assisted in diagnosing the disease and the assessment of the impact of various pathologies on the life of the affected individual. With respect to peripheral osteoarthritis and degenerative changes in the spine the application of the criteria developed by Rogers and Waldron⁵⁸⁵ in combination with the clinical experience of the panel members lead to the use of conservative standards for the scoring of these conditions. Various pathological conditions can provide information on the health conditions in Maastricht. Fractures can inform us about occupational risks and medical treatment, arthropathies and musculo-skeletal stress markers may inform us about physical activities.⁵⁸⁶ The frequency of sharp bladed injuries is an indicator of the amount of violence. In some instances signs of healing may shed some light on the availability of medical care. The prevalence of a condition like DISH is often interpreted as a sign of an affluent diet.⁵⁸⁷ Other more specifically diet-related information can be obtained from the study of carious lesions, peri-apical abscesses, ante-mortem tooth loss and calculus.

CONSIDERATIONS REGARDING THE REPRESENTATIVENESS OF THE SKELETAL REMAINS

The assumption that skeletal remains collected at an archaeological site represent the whole population of a settlement during a specific time frame is generally to be refuted.⁵⁸⁸ A basic inventory of the composition of the examined sample in relation to the living population may provide insight into the informative value of the data. Such an assessment should take into account three major factors that determine the composition of the sample under study: the biological filter, the cultural filter and the effect of post-depositional processes. Generally these factors cause a reduction or bias of the information that is contained in the human remains. The

⁵⁸⁴ Pseudopathology is the common denominator for changes in the skeleton that resemble pathological bone changes, while these changes are the result of peri-mortem or post-mortem damage of the skeletal remains.

⁵⁸⁵ Rogers et al., 1987, Rogers and Waldron, 1995.

⁵⁸⁶ The interpretation of musculo-skeletal stress markers is less straightforward as was previously thought. E.g. Weiss has shown that the manifestation (occurrence and size) of musculo-skeletal stress markers is largely dependent of age of the individuals instead of physical activities, Weiss, 2003.

⁵⁸⁷ Waldron, 1985, Rogers and Waldron, 2001 and Weinfeld et al., 1997.

⁵⁸⁸ Problems related to sample size, completeness and representativeness are discussed by e.g. Hoppa, 1996, Waldron, 1994, p. 12-16; Saunders and Herring, 1995; Buchet and Lorren, 1975.

biological filter consists of environmental conditions and subsistence strategies which determine the demographical composition, health status and mortality pattern of the original population. The cultural filter is defined by burial customs determining who was buried at a cemetery and whether the place of burial was selected on social and demographic grounds. The possibility of selective burial on the basis of demographic or social characteristics will be discussed below in the sections on sex and age distribution. In chapter four the limiting effect of some post-depositional processes was described. It is recalled here that the cemetery at the Servaas site was not completely excavated and that the inhumations from the *templum* phase in particular had suffered from the intense building and burial activities. The cemetery at the Boschstraat site was almost completely excavated and at that site few graves had been disturbed by later human interference.

FIGURE 7-1 A flow chart representing the reduction and bias of information collected from human skeletal remains (after: Hoppa, 1996, p.52).

THE COMPOSITION OF THE ORIGINAL POPULATION

Little is known about the provenance of the population interred at the early medieval cemeteries of Maastricht. In general people buried at a cemetery are expected to have lived in the nearest settlement or in surrounding settlements. For the cemeteries of Maastricht such peripheral settlements may have been situated in the valley of the River Meuse up to a distance of several

kilometres from Maastricht. In the case of the cemetery of the Sint Servaas complex it seems plausible that the assumed presence of the grave of Servatius also attracted the burial of persons from further away.⁵⁸⁹ Early medieval histories describe the transport of deceased kings and bishops over large distances to be buried at important locations.⁵⁹⁰ On a local or regional scale this practice may have been followed and resulted in the burial of non-local people at the Servaas cemetery. For the cemetery at the Boschstraat site we have no information on whether people from neighbouring settlements also used this cemetery. The close association between the graves and the traces of habitation and occupation at the same site suggest it was mainly used to bury people who lived in the vicinity of the burial area.

At present there are no reliable data concerning the size of the population and the demographic development of Maastricht in the first millennium AD. As stated in chapter two the expansion of the habitation area and an increase in the number of settlements in the Meuse valley suggest that the population in the region expanded from the seventh century on. Nevertheless, we are ill informed regarding the population growth and density and the size of the total habitation area of Maastricht. An important factor in the demographic analysis of the inhumed populations is the possibility of migration to and from Maastricht. The influx of migrants or the departure of inhabitants may have altered the demographic make-up of the population considerably. Five developments in the region may have instigated the migration of individuals and groups to Maastricht. For the late Roman period it is assumed that there was a shift in secular and religious authority possibly associated with a migration of people from Tongeren to Maastricht. At the same time there was a decline in the population of the rural settlements. This trend may have been tied in with the concentration of people in and around defensible places like Maastricht. The following seizure of authority by Frankish nobility most likely also led to migration. Because of its functions as a central place it is possible that members of the Frankish nobility and their retinue settled in or around Maastricht. The religious community, which formed around the grave of Saint Servatius, may also have attracted some immigrants. Furthermore a passage in the *miraculae* by Einhard mentions that Maastricht had "many inhabitants, mostly merchants".⁵⁹¹ This informs us of the temporary or permanent influx of merchants. Little is known about the emigration of inhabitants from Maastricht. The general impression is that the surrounding countryside was repopulated and that new lands were cultivated from the Carolingian period on.⁵⁹² It is possible that similar developments led to migration from Maastricht. In general we may assume that during the 600 year focus of this study the population of Maastricht was not stable nor isolated.

⁵⁸⁹ Theuvs presents a review of burial options for the population of a settlement in the Meuse-Demer-Scheldt region in the late Merovingian period. Theuvs, 1998.

⁵⁹⁰ Ohler cites how king Pippin, the father of Charlemagne feels that his end is near and travels to the church of Saint Denis to die there. Ohler, 1990, p. 53. See also an overview of the transferral of bodies to their place of burial in the eighth and ninth centuries published by Chélini, 1991, p. 483.

⁵⁹¹ "...estque habitantium et praecipue negotiarum multitudine frequentissimus." Einhard, 1887, p. 261.

⁵⁹² For an overview of the development of new settlements in the Meuse-Demer-Scheldt region see Theuvs, 1998.

Since we cannot make reliable estimates of the population size of Maastricht and settlements nearby, it is not possible to determine what proportion of the original population was examined for this study. It is evident that the sample of 238 individuals only represents a fraction of the total number of individuals that lived in Maastricht during the late Roman and early medieval period. As indicated above the skeletons examined for this study come from two cemeteries out of a constellation of at least ten early medieval cemeteries in and around Maastricht. Additional cemeteries from this period may still lay hidden in the subsoil. The examined samples in this study seem to represent sections of the Servaas cemetery and a more or less complete cemetery from the Boschstraat.

THE CELLA PHASE

The *cella* sample consists of skeletal remains of 23 individuals found in 20 graves from the Servaas church site. The graves of this phase were attributed to the late Roman period (350 and 480 AD). Only a small section of the total late Roman cemetery fell within the boundaries of the Servaas church excavation. The centre of the late Roman cemetery lay to the north, closer to the Roman road. Burials from what is expected to be the centre of the cemetery were excavated at the Servaas Pandhof site, just north of the Servaas church site. Two features characterise the *cella* phase cemetery. Firstly there is an area with small clusters of graves in the northernmost excavation trenches. A second important feature is a rectangular building found south of the late Roman graves. As indicated in chapter three this rectangular building is considered to have been a *cella memoriae*, a burial chapel. No graves from the late Roman period were identified further south of this structure. It is not clear what the absence of late Roman graves in this area implies. The structure stood possibly at the border of the cemetery, since most of the excavation trenches reached the lowest elevation associated with late Roman activities. Therefore, it seems plausible that late Roman burials did not extend further to the south and that the area excavated within the Servaas church site represented the southern fringe of the late Roman cemetery.⁵⁹³

Because of its position at the margin of the cemetery the *cella* sub-sample may not be representative for the late Roman cemetery as a whole. The chances are that the sample has been biased with respect to sex, age and status of the individuals. Still, these skeletons are the largest series of human remains from late Roman Maastricht that have been examined so far. In anticipation of further research of the Servaas Pandhof burials this sample is the best source of information concerning living conditions in late Roman Maastricht.

⁵⁹³ If we assume that the late Roman cemetery developed from a central core and expanded over time by adding burials at the fringes then it is possible that the burials included in this study date from the last part of this phase.

FIGURE 7-2 Plan of the *cella* phase cemetery.

REFERENCE DATA

No recent published physical anthropological and palaeopathological studies from late Roman cemeteries in the region were available. Therefore, one Dutch study of an older Roman cemetery and studies of more distant late Roman cemeteries were used for comparison: Valkenburg (NL)⁵⁹⁴, Poundbury (UK)⁵⁹⁵, Cirencester (UK)⁵⁹⁶, Saint-Martin-de-Fontenay (F)⁵⁹⁷, and Linz (AU)⁵⁹⁸. In addition to these studies of skeletal remains demographic data collected from gravestones found at two cemeteries in Trier (D)⁵⁹⁹ were also included for comparison. Comparison with the data presented in this study was generally only possible for demographic data. Data relating to the palaeopathological condition were often treated in a casuistic and not in an epidemiological way or were recorded in ways that barred comparison with the *cella* data. Only the physical anthropological examination of the Valkenburg remains largely resembled the approach used in this study. The inhumation graves at this site dated from the second half of the first century to the beginning of the third century. These graves were considered to be the graves of a local population living and working near a Roman castellum. H. Lonnée studied the remains of 47 juvenile and adult individuals from this site in a way similar to this study, which

⁵⁹⁴ Lonnée and Maat, 1998.

⁵⁹⁵ Farwell, 1993.

⁵⁹⁶ McWhirr et al., 1982.

⁵⁹⁷ Pilet, 1994.

⁵⁹⁸ Wiltshcke-Schrotta and Teschler-Nicola, 1991.

⁵⁹⁹ Gauthier, 1975.

allows for comparison of some of the palaeopathological data.⁶⁰⁰ Molleson examined six late Roman cemeteries of Poundbury, Southwest England. These combined cemeteries date from the fourth and early fifth century and were positioned between a hill fort and the Roman town of Durnovaria. Over 1400 inhumation graves were collected from these cemeteries.⁶⁰¹ The Bath gate cemetery excavated in Cirencester, South England, dated from the fourth and fifth centuries. About 405 individuals were recovered and studied by Calvin Wells. The cemetery appears to be a late Roman city cemetery used by all age categories and both sexes.⁶⁰² The cemetery of Saint-Martin de Fontenay was used from the Iron Age to the end of the seventh century; 38 inhumations were dated to the late Roman period. This cemetery was situated in the northwest of France and studied under the direction of Pilet. It does not seem to be associated with a Roman urban centre but is situated in a more rural setting.⁶⁰³ The cemetery of Linz-Tiefer Graben in Austria was associated with a late Roman urban centre. Wiltchke-Schrotta and Teschler-Nicola studied 39 individuals from this cemetery. Because of the high frequencies of pathological changes in the skeleton the authors suggest that the cemetery was used to bury individuals from some sort of hospital.⁶⁰⁴ Data collected from the texts on late Roman gravestones from two cemeteries, St. Matthias and St. Paulinus, also represent a population buried in an urban context. Trier is located circa 170 kilometres from Maastricht in Germany close to the border with Luxemburg. The texts on the gravestones only provide comparative data on the sex and age distribution in the cemetery.⁶⁰⁵

PHYSICAL ANTHROPOLOGY AND PALAEOPATHOLOGY

The skeletal remains from the *cella* sample were relatively well preserved and with respect to the completeness of the material this sample scored the highest recovery rate (0.31) of the three samples excavated at the Servaas church site. This had a positive effect on the collection of physical anthropological and palaeopathological data.⁶⁰⁶

In comparison to some other late Roman samples the *cella* sample comprised a large proportion of non-adult burials, viz. 26 per cent. The cemeteries of Cirencester, St. Martin de Fontenay and Linz all have lower percentages of non-adults. Possible explanations for this phenomenon may vary per cemetery. Only at Poundbury and in the gravestones from Trier percentages of non-adults were higher than in the *cella* sample. A high mortality around birth and in the first few years is often considered to be a sign that non-adult mortality in a cemetery population represents the actual mortality in society.⁶⁰⁷ Of the six non-adult individuals in the

⁶⁰⁰ Lonnée and Maat, 1998.

⁶⁰¹ Farwell and Molleson, 1993.

⁶⁰² McWhirr et al., 1982.

⁶⁰³ Pilet, 1994.

⁶⁰⁴ Wiltchke-Schrotta and Teschler-Nicola, 1991, p. 188.

⁶⁰⁵ Gauthier, 1975.

⁶⁰⁶ As a consequence the relatively small sample contributed comparatively many data to the analysis. E.g. in the total sample the percentage of left proximal femora available for inspection of the *cella* sample was equal to the percentage for the *templum* sample.

⁶⁰⁷ Molleson, 1991.

cella sample five died before reaching the age of five.⁶⁰⁸ For the Roman Empire Parkin estimates that infant and child mortality was circa 300 per 1000 live births.⁶⁰⁹ However, since figures on fertility are lacking it is difficult to use this estimate to calculate a percentage of non-adult mortality in Roman cemeteries.⁶¹⁰ In general the proportion of non-adult burials and the fact that most of these children in the *cella* sample died before the age of five comply with general notions concerning infant and child mortality in the late Roman period.

Site	N	Non-adults	Male : Female	Mean age		Stature	
				Male	Female	Male	Female
<i>Cella</i>	23	25%	60% : 40%	48.3 yr	42.5 yrs	172.8 cm	155.9 cm
Valkenburg	47		84% : 16%			175.9 cm	159.3 cm
Poundbury		42%	53% : 47%			166.2 cm	160.9 cm
Cirencester	405	17%	69% : 31%	40.8 yr	37.8 yr	169.1 cm	157.9 cm
St. Martin de Fontenay	26	15%	53% : 47%		31.5 yr		
Linz	39	13%	50% : 50%		42.7 yr	166.6 cm	159.9 cm
Trier	128	47%	51% : 49%	43.8 yr	36.1 yr		

TABLE 7-1 Demographic data for the *cella* sample and six other late Roman cemeteries (N represents the number of individuals included in the study, not all characteristics like age and sex could be determined for all individuals.)

The demographic composition of the *cella* sample shows a minor imbalance with respect to the distribution of the sexes. Males slightly outnumbered females in the *cella* sample.⁶¹¹ For Roman period cemeteries such uneven distributions are often interpreted as the result of military presence. Because of the small sample size no conclusions can be drawn from the slight overrepresentation of males in the *cella* sample. Apart from Valkenburg and Cirencester the other cemeteries all appeared to be used by a balanced number of males and females. The marked overrepresentation of males in the Valkenburg population is perhaps caused by the burial of locally recruited male labourers.⁶¹² In most sites males and females were buried in the same areas of the cemetery.

Mean age at death calculated for the adult individuals (≥ 20 year) of the *cella* sample was 48.3 years for males and 42.5 years for females. The difference between males and females with respect to their mean age at death was remarkable but not statistically significant. In comparison to the data published for Cirencester and Trier mean age at death for *cella* sample

⁶⁰⁸ In this respect it is interesting to remember that several of the Christian gravestones found on and around the late Roman cemetery refer to deceased children. Boppert, 1986.

⁶⁰⁹ Parkin, 1992, p. 92-93.

⁶¹⁰ For Roman Gaul Coulon mentions two child mortality percentages. 25 per cent for a second century cemetery and 10 per cent for a late Roman cemetery as an example for differences within the Roman period, Coulon, 1994, p. 139-140.

⁶¹¹ Males 9 (60%) and females 6 (40%)

⁶¹² Lonnée and Maat, 1998, p. 14.

males and females was high. This suggests that the living conditions of the population buried at the *cella* phase cemetery were relatively favourable.

FIGURE 7-3 Distribution of mortality among adult individuals of the *cella* sample (n=13).

These relatively favourable living conditions also seem to have been reflected in the stature of males which was high in comparison to other late Roman cemeteries. Only at the Valkenburg site was a higher stature noted. However, it should be mentioned that stature for the Valkenburg sample was calculated on the basis of the regression formulas of Trotter and Gleser published in 1958. These are known to yield higher stature values than the formulas of Breiteringer used for the *cella* sample.⁶¹³ The data regarding the mean femur length from the Valkenburg site and the *cella* sample are not conclusive, but these seem to confirm that the males from the Valkenburg site were most likely taller than the males from the *cella* site (Valkenburg: 50.4 centimetres, n=3; *cella*: 47.5 centimetres n=6). Male stature in the *cella* sample further exceeds the means calculated for Poundbury, Cirencester and Linz. Oddly enough there was a large difference between male and female stature in the *cella* sample. As a result female stature in the *cella* sample was considerably lower than in the reference cemeteries. Regarding stature a significant difference between males and females is normal. In the case of the *cella* sample the dimorphism exceeded expectations.⁶¹⁴ Generally males are circa 10 to 11 centimetres taller than females.⁶¹⁵ In late Roman Maastricht the difference in stature was 15.9 centimetres. In the *cella*

⁶¹³ For the *cella* sample we also calculated stature using the 1970 revised formulas of Trotter, in which case mean stature was 172.8 centimetres. These formulas also generally produce lower values for stature than the Trotter and Gleser formulas of 1958.

⁶¹⁴ Stature of males from the *cella* sample (171.8 centimetres) was slightly lower than the mean stature calculated for the four combined samples. The mean stature of females (155.9 centimetres) however, was almost 6 centimetres below the mean calculated for the whole female population.

⁶¹⁵ Wieringen, 1972, p. 175.

sample male stature was 110 per cent of female stature. This value exceeds the percentages found for male stature in modern populations (circa 107 per cent). The late Roman populations from Poundbury, Cirencester and Linz do not show similarly large differences between male and female stature (Poundbury 103%, Cirencester 107% and Linz 104%) Possible ethnic differences between males and females were a factor contributing to the dimorphism in the *cella* sample.⁶¹⁶ Consequently, as an indicator of socio-economic circumstances the dimorphism in the *cella* sample produces a mixed signal. Male stature suggests that living conditions were relatively favourable, whereas female stature indicates less favourable conditions. However, the small sample size provides no assurance that this effect was not the result of chance. Therefore, it was decided to refrain from further interpretation of this phenomenon until it is either refuted or confirmed by the ongoing examination of late Roman burials from the Pandhof site.⁶¹⁷

Cranial non-metric data could be compared to the data acquired from the Valkenburg and Cirencester populations. Out of eleven skulls one displayed a metopic suture (circa 9 per cent), which was comparable to the prevalence calculated for Valkenburg and Cirencester (14 and 8 per cent respectively). Lambdoid ossicles were common in the *cella* sample (67 per cent) and the Cirencester population (62 per cent) and less common in the Valkenburg population (40 per cent).

Site	N	Cribra orbitalia	Enamel hypoplasia	Formation rate of Harris lines
<i>Cella</i>	23	10%	38%	0.13
Valkenburg	47	45%	43%	
Templum	78	17%	39%	0.15
Roman Britain	4773/2808	10%	13%	

TABLE 7-2 Prevalence of cribra orbitalia and enamel hypoplasia and the formation rate of Harris lines in the *cella* sample, two reference populations and in Romano British data.

The prevalence of cribra orbitalia suggests the *cella* sample and the Valkenburg population differed in general health conditions. Cribra orbitalia were found four times more often in the Valkenburg population than in the *cella* sample. The prevalence rate calculated for the *cella* sample corresponded with the crude prevalence calculated for 4773 individuals from 29 British sites dated between 43 and 410 AD.⁶¹⁸ The relatively high prevalence of cribra orbitalia in the Valkenburg population is in contrast with the relatively high stature calculated for this population. Enamel hypoplasia was also more common in the Valkenburg population but this difference was not very marked. The pooled data of 2808 individuals from 25 British sites from the Roman period showed a much lower prevalence of enamel hypoplasia, viz. 13%. The

⁶¹⁶ Assuming the burials represent the latest phase of the late Roman cemetery the males may have been of Germanic descent and the females of Gallo-Roman descent.

⁶¹⁷ It is assumed that the excavations at the Pandhof site have uncovered a considerable number of burials from the late Roman period. At the time of writing the results of this excavation are analysed and the human remains are studied within the framework of the Saint Servatius project.

⁶¹⁸ Roberts and Cox, 2003, p. 140-141.

formation rate of Harris lines could only be compared to other samples within the framework of this study. A formation rate of 0.13 Harris lines recorded for the *cella* sample represents the lowest formation rate of the samples included in this study. However, the difference with the *templum* samples was indistinct.

Condition	%	N
Fractures per inspected long bone	1.6%	(2/122)
Individuals with temporomandibular joint osteoarthritis	8%	(1/13)
Individuals with vertebral osteoarthritis	0%	(0/10)
Individuals with degenerative disc disease	90%	(9/10)
Individuals with DISH	30%	(3/10)
Individuals with periostitis	8%	(1/13)
Individuals with chronic maxillary sinusitis	44%	(4/9)

TABLE 7-3 Selected palaeopathological results for adult individuals in the *cella* sample

In general the parameters presenting information on the health of the *cella* sample show no signs of extreme pathological conditions. Given the small number of (adult) individuals in the sample it is difficult to compare the results to percentages calculated from larger samples. Two fractures in 122 inspected long bones correspond with the mean number of fractures in the whole sample examined. Further trauma were single injuries found in two skulls caused by a pointed object. Trauma due to sharp bladed objects was not encountered in the *cella* sample. The prevalence of degenerative disc disease in the sample was high (90 per cent), which makes it a common condition among adult individuals. Surprisingly, the high mean age at death and the high prevalence of degenerative disc disease was not accompanied by a high prevalence of vertebral osteoarthritis. To the contrary none of the inspected individuals had changes caused by vertebral osteoarthritis. The prevalence of DISH (30%) was the highest of the four samples in this study. The selected reference samples provide few data for the prevalence of DISH. In Roman Britain DISH was relatively rare: viz. 23 cases (0.4% of the total burials).⁶¹⁹ A relatively small number of individuals of the *cella* sample showed signs of periostitis (8%). Chronic maxillary sinusitis was present in almost half the number of adult individuals, a prevalence that tallied with the mean found for the whole sample.

⁶¹⁹ Roberts and Cox, 2003, p. 138.

Site	N	Caries	Abscesses	AM loss
Cella	23	12%	7%	13%
Valkenburg	47	6%	-	4%
Templum	78	8%	5%	13%
Roman Britain ⁶²⁰	5046/3372/3319	7%	4%	14%

TABLE 7-4 Prevalence of caries, peri-apical abscesses and ante-mortem tooth loss (all calculated per inspected element or position) in the *basilica* sample and reference populations

The prevalence of caries, periapical abscesses and ante-mortem tooth loss corresponded with the mean found for the examined population as a whole. In comparison with data from Roman Britain the percentages for caries and abscesses were relatively high. The frequencies in the *cella* sample were also high in comparison with the Valkenburg population. Most likely this was the result of differences in diet. The *cella* population may have consumed more sticky carbohydrates. Furthermore, a peculiar dimorphism in the distribution of calculus in males and females was found. All inspected males (n=8) had calculus, whereas 40 per cent of the females (n=5) had formed calculus deposits in their dentition. A similar trend was visible in the pooled data of 21 Roman cemeteries from Britain presented by Roberts and Cox. Although fewer individuals had dental calculus (27%), calculus was found 1.7 times more often in males than in females.⁶²⁰ A difference between calculus in males and females was further found in the *templum* sample. In the *basilica* and Boschstraat samples there was no such difference. This disparity suggests there may have been a difference in diet and dental hygiene between males and females.

ANALYSIS OF THE OSTEOLOGICAL DATA IN CONTEXT

Graves of males and females were almost evenly distributed over the cemetery (see figure 7-4). Two groups of graves were arranged in ways that merit some attention. First, four graves lying northwest of the remains of the *cella* memoriae were roughly arranged in pairs. In both pairs the burial to the south contained the skeletal remains of a female and next to this on the north side a male burial. This arrangement of graves (Figure 7-4) suggests a relation existed between the male and female individual burials. A second group with a remarkable arrangement was lying more to the east and consisted of two burials of females that were each accompanied by associated child graves. It is tempting to speculate about the possible relation between these burials. Possibly the children buried close to the two females may have been their offspring. This would infer the presence of a genetic relation that could be examined by means of ancient DNA-analysis. In a preliminary study of ancient DNA from skeletal remains excavated at the site it has hitherto proven difficult to extract ancient DNA of sufficient quality and quantity to examine a possible relation between the female and the children.⁶²¹

⁶²⁰ Roberts and Cox, 2003, p. 131-132. In total 255 males and 150 females had dental calculus

⁶²¹ Gijn, 1996.

FIGURE 7-4 Plan of the distribution of burials of males and females at the *cella* phase cemetery. The large numbers I to IV designate clusters of graves in the cemetery 1 = female, 2 = male, 3 = non-adult, 4 = adult individual of undetermined sex.

FIGURE 7-5 Plan of the distribution of individuals by age at the *cella* phase cemetery

The distribution of the individuals by age category shows that all individuals under the age of ten years were found in the eastern part of the cemetery. If we dichotomise this and compare the eastern concentration of burials with the more dispersed burials in the west no statistically significant difference between the two sections was found.⁶²² With respect to the adult individuals no apparent age-related distribution pattern was recognized. The paired male and female graves in the northwest and the female graves accompanied by child graves seem to indicate that family relationships in part determined the position where an individual was buried at the cemetery.

CONCLUSION

As was discussed in chapter three the historical sources and the gravestones associated with the late Roman cemetery along the road to Tongeren all imply the cemetery was used to bury Christian inhabitants of Maastricht and surroundings. The small section of this cemetery examined within the framework of this study indicates that all demographical categories were present in the *cella* sample. Non-adults, males and females of all age categories were found in small heterogeneous clusters of burials. The combination of sexes and age categories in these clusters suggests they possibly consisted of burials of related individuals, belonging to one or more families. The considerable proportion of non-adult individuals in the sample might imply that infants and young children were not underrepresented in this section of the cemetery. Other remarkable demographic characteristics of the sample are the relatively high mean age at death calculated for male individuals, the above average sexual dimorphism in stature and the difference in prevalence of dental calculus between males and females. The combined evidence suggests living conditions may have been different for the sexes. Mean age at death and stature both suggest that the conditions were more favourable for males. The inspection for various pathological conditions provides no indication for the presence of extreme physical or pathological stress during this phase. Harris lines, enamel hypoplasia and cribra orbitalia were present but the prevalence of these conditions never exceeded the mean values calculated for the combined samples. Ninety per cent of all individuals had degenerative disc disease. This relatively high prevalence may in part be influenced by the relatively high age at death. As will be discussed below the relatively high prevalence of DISH is not considered as an indicator of poor living conditions. To the contrary the prevalence of DISH in the *cella* sample may probably be interpreted as a sign that at least some individuals in the sample had consumed an affluent diet.⁶²³

⁶²² Among the western burials no individuals in the age category between 0 to 10 years ($n=6$) were found. Among the eastern burials 5 out of 12 individuals fell in that age category ($p = 0.1141$).

⁶²³ Waldron, 1985; Rogers and Waldron, 2001.

THE *TEMPLUM* PHASE

After the *cella* phase the site of the present-day Servaas church became a desirable place of burial for the Merovingian elite. A clear indication for this development is the use of impressive tuff stone sarcophagi and precious grave goods found in several graves. The presence of graves that were less costly and contained no grave goods or only simple objects suggests that individuals of somewhat lower status were also buried at this cemetery, albeit generally at a larger distance from the church. Early on in the *templum* phase there was no stone church at the site and most burials were located in the same area as the burials from the *cella* phase. Only after the construction of a stone-built church was the cemetery area extended towards the south and the west. This was accompanied by a shift in grave types. The tuff stone sarcophagi are all associated with the early *templum* phase. During the later *templum* phase composite stone coffins replaced the tuff stone sarcophagi. Generally, the graves seem to be distributed in small clusters, with vacant zones in between. There seems to be no formal organisation of the graves in rows, although in some areas the distribution of the graves appears to reflect the presence of paths or other constructions that provided orientation points for the alignment of graves.

FIGURE 7-6 Plan of the burials associated with the *templum* phase.

Based on the present knowledge of the chronological developments the *templum* phase roughly spans a period of 220 years between 480 and circa 650 to 700 AD.⁶²⁴ Circa 88 graves were associated with this phase. The skeletal remains of 78 individuals were available for study. Only

⁶²⁴ T. Panhuysen 1990 and chapter 3 of this study

a section of the original cemetery of this phase was included within the boundaries of the excavation trenches inside the Servaas church. Within the excavated part of the cemetery a considerable proportion of graves had been lost due to building and burial activities. Unfortunately the subsoil of the church building from the *templum*-phase itself could not be studied because it was largely disturbed as a consequence of the construction of crypts for later church buildings. Therefore, the sample from the *templum* phase represents a selection of the persons buried around the church. As discussed in chapter three this selection most likely consisted of persons of high and intermediate status.

REFERENCE DATA

Despite the large number of Merovingian cemeteries been excavated, there are relatively few published studies on the physical anthropology and palaeopathology of comparable populations in the region. Additional reference data were obtained from studies of cemeteries located as far away from Maastricht as Normandy. Besides comparison with data from the Boschstraat site which may have been partially contemporaneous with the *templum* phase, four other cemeteries were selected: Rosmeer (B), Tournai (B), St. Martin de Fontenay (F) and Saffig (D). The Merovingian cemetery of Rosmeer was situated circa 10 kilometres west from Maastricht and was excavated by H. Roosens. The cemetery was situated in a rural setting and comprised 118 graves; several graves were fitted out with costly grave goods. The graves in the cemetery date from the second half of the sixth century to the end of the seventh century.⁶²⁵ P. Janssens studied the human skeletal remains from those 48 graves. The distribution of the sexes and the age structure were calculated from the published data collected by P. Janssens.⁶²⁶ Mean age at death was calculated as a mean of the midvalues of ten-year age intervals. Roosens presented information regarding the stature of males and females buried in Rosmeer.⁶²⁷ A second cemetery included here for comparison was the Merovingian cemetery of the Saint Brice quarter in Tournai, circa 205 kilometres west of Maastricht. This cemetery was situated around the site that is thought to be the burial place of king Childeric (who died circa 481 AD). Tournai was a late Roman urban centre. In the sixth century it was probably not large in size but a place of some significance given the frequent visits of the Merovingian aristocracy.⁶²⁸ The 91 graves excavated to the north of this grave represent only a part of the original population of this cemetery. Here too some graves were fitted out with precious grave goods. The presence of King Childeric's grave, probably positioned at the centre of this cemetery, suggests that the St. Brice cemetery was a cemetery for individuals of high status. The mean values and percentages for Saint Brice were calculated by the author based on the data published in a catalogue by A.

⁶²⁵ Roosens et al., 1976, p.42 and Roosens, 1989.

⁶²⁶ Roosens et al., 1976, p.60-72.

⁶²⁷ The publication does not mention which formulas were applied for the calculation of stature. Roosens et al., 1976, p.60-72. However, in other publications Janssens stated that he generally used the formulas of Dupertuis and Hadden; Dupertuis and Hadden, 1951.

⁶²⁸ Pycke, 1990.

D'Hulst.⁶²⁹ Further west, in the French Calvados region, a third cemetery was situated at a distance of circa 570 kilometres. This cemetery, mainly of Merovingian date, from Saint-Martin-de-Fontenay in Normandy was excavated and studied under the direction of Pilet.⁶³⁰ Its setting was more rural in nature than the cemeteries of Saint Brice and the Saint Servaas. Both elaborate grave types and precious grave goods were found as well as more plain variants. The fourth cemetery was situated near Saffig in the Mayen-Koblenz district, 170 kilometres southeast of Maastricht. This cemetery, also in a rural setting, was in use from the first half of the sixth century to the end of the seventh century. During that period the associated settlement probably almost tripled in size from circa 35/40 to at least 110 inhabitants. Generally the skeletal remains were poorly preserved; as a consequence only a few physical anthropological data were available and published by W. Melzer.⁶³¹

PHYSICAL ANTHROPOLOGY AND PALAEOPATHOLOGY

The various activities that disturbed the graves of the *templum* phase had a negative effect on the recovery rate of the skeletal remains of the *templum* sample. Thirty-five of the 88 graves were empty. The skeletal remains of a total of 78 individuals were recovered from the remaining 53 graves and from well-dated contexts. As a consequence of the disruption of many graves the sample had a recovery rate of 0.13. This indicates that in most of the burials from the *templum* sample a large proportion of bones was missing.

Site	N	Non-adults	Male : Female	Mean age		Stature	
				Male	Female	Male	Female
Templum	78	14%	64% : 56%	38.6 yr	38.8 yr	172.7 cm	165.7 cm
Boschstraat	54	43%	20% : 80%	39.0 yr	41.0 yr	169.1 cm	160.5 cm
Rosmeer	48	29%	50% : 50%	38.3 yr	35.0 yr	178.0 cm	161.0 cm
Tournai, St. Brice	91	13%	65% : 35%	36.2 yr	33.3 yr	170.9 cm	159.7 cm
St. Martin 6th cent.	248	22%	52% : 48%	21.5 yr		166.7 cm	154.3 cm
St. Martin 7th cent.	404	32%	40% : 60%			167.0 cm	155.1 cm
Saffig	280	33%	58% : 42%				

TABLE 7-5 Demographic data for the *templum* sample, the Boschstraat sample and four Merovingian cemeteries

In comparison to the Boschstraat sample and the cemeteries of Rosmeer, St. Martin-de-Fontenay and Saffig the proportion of non-adults in the *templum* sample was low. Only at the other high status cemetery from an urban context, St. Brice, a similar percentage of non-adults was found. It is unlikely that this low proportion represents the actual mortality among non-

⁶²⁹ D' Hulst, 1990. This has the advantage that the same methods could be applied as for the data presented for Maastricht. Stature was recalculated on the basis of the recorded long bone measurements according to Breiting, 1937 for males and Trotter, 1970 for females.

⁶³⁰ Pilet, 1994. It should be noted that in this study stature was estimated by use of the tables developed by Manouvrier, Manouvrier, 1893.

⁶³¹ Melzer, 1993.

adults. Apparently specific characteristics of the *templum* phase and St. Brice cemeteries had an impact on the demographic composition of the cemetery population. We can only speculate about the alternative burial location for non-adult individuals, missing at the *templum* phase cemetery. However, it is striking to see that the percentage of non-adult burials was relatively high at the Boschstraat cemetery. Within the *templum* sample females were marginally more numerous than males. However, the under representation of males is too small to assume that during the *templum* phase females structurally outnumbered the males. We have to take into account that large sections of the cemetery have been disturbed completely and other previously excavated skeletal remains from this cemetery can only be studied when the previous excavations of 1953-54 and 1969-70 have been analysed. At most reference cemeteries small imbalances in the number of males and females were recorded. The only exception among the reference populations is the Boschstraat sample. At that site females clearly outnumbered the males.

FIGURE 7-7 Distribution of mortality among adult individuals from the *templum* sample (n=24).

There was little difference in the mean age at death between *templum* phase males and females. This tendency was also found at the Boschstraat cemetery. In the reference cemeteries the difference between male and female mean age at death was larger. At Rosmeer and St. Brice the mean age at death of females was roughly three years below male mean age at death. Unfortunately no comparable data were available for St. Martin-de-Fontenay and Saffig. For the cemetery of Saffig the graphical data also suggest that female mortality was higher before the age of circa 30 years, whereas male mortality was much higher around the age of forty. In comparison to Rosmeer mean age at death was slightly higher in the *templum* sub-sample. A larger difference, ranging from about two years in males to more than five years in females, existed between the *templum* sub-sample and St. Brice.

With respect to the distribution of mortality among adults it was found that mortality steadily increased from the 20 to 30 years age interval to a peak in the 40 to 50 years age interval,

leaving only a few survivors whose death occurred in the 50 to 60 years interval. This age distribution deviates from what is generally seen in historical populations. In such populations the mortality curve seldom displays such a marked difference in mortality between the last two ten-year age intervals. Usually a more gradual decrease in mortality is seen, representing a slowly declining number of survivors.⁶³² This mortality distribution could partially be the result of random effects occurring in small sample sizes. Still, it is not likely that this can completely explain the mortality curve.

FIGURE 7-8 Adult mortality in ten year age intervals for the *templum* and Boschstraat samples and the cemeteries of Rosmeer and Saint Brice. The number of individuals mentioned in the legend refers to the number of individuals for whom age at death could be estimated within ten-year age intervals.

Comparison of the *templum* mortality distribution with three of the reference populations in Figure 7-8 illustrates that in the *templum* sample mortality for the 40 to 50 years age interval was considerably higher than in the reference populations. Also in these reference populations small sample size might limit the representativeness of the results. Still the difference is considerable and it seems to represent two different trends.

In order to hypothesize on the biological and cultural formation processes of the Servaas cemetery during the *templum* phase we assume that this mortality distribution is representative for the actual age distribution of individuals buried in this section of the cemetery. Factors which might explain this age distribution were an increased mortality risk for

⁶³² E.g. Melzer, 1993, p. 99; Waldron, 1994, p. 16-19 and Sirianni and Higgins, 1995.

this age category⁶³³, an uneven distribution of age categories within the Servaas cemetery or preferential burial. On the basis of the present data it is assumed that cultural factors determining the distribution of burials among and within cemeteries had a large impact on the age and sex distribution in various sections of the cemetery.

A possible explanation might be that local living conditions were such that the mortality risk was higher for the 40 to 50 years age interval and that only few individuals survived to later intervals. However, there are no indications that disease, occupational hazards or violence put both males and females in this age category under more strain than other age categories.⁶³⁴

Two factors seem to have had an impact on the age and sex distribution in the sample. These were the custom to bury individuals of high status in separate sections in and around a church, and the practice of preferential burial of individuals in the Servaas cemetery from elsewhere. Since the examined section of the cemetery was situated close to the assumed grave of Saint Servatius, this area would have been considered a prestigious location for burial. Generally such *ad sanctos* burial locations were reserved for high status secular and clerical individuals.⁶³⁵ Possibly high status individuals buried at this cemetery may have been older because it took individuals time to acquire a social position that was associated with an *ad sanctos* burial. At present it is not possible to determine whether these high status individuals were living locally or whether they came from places in the region.⁶³⁶ Only two sections of this large Merovingian cemetery have been excavated and only one of the uncovered samples of skeletal remains has hitherto been examined. Therefore, it is difficult to determine whether the atypical representation of older individuals is a consequence of an uneven spatial distribution of these age categories within the Saint Servatius cemetery or whether this was the result of preferential burial. Preferential burial is defined here as the practice of burying a deceased person at a different cemetery than the cemetery where the majority of the individuals of his or her local community is buried. In that case the high number of burials in the 40 to 50 years category may partially have been caused by preferential burial of individuals who had acquired sufficient status to be buried near Saint Servatius.

The notion that the individuals buried in this section of the cemetery were of high status seems to be supported by the data on the stature of these individuals. The mean male stature of 172.7 centimetres was only exceeded by the stature calculated for the males buried at the cemetery of Rosmeer. According to the data, males at Rosmeer were more than 5 centimetres

⁶³³ Theoretically it is also possible that the new groups grasping control over Maastricht and its environs consisted initially of a higher proportion of individuals between 40-50 years. This "founder population" may have influenced the mortality distribution in this section of the Servaas cemetery.

⁶³⁴ The fact that both males and females were equally well represented in the 40 to 50 years age interval indicates that gender-related occupational hazards were an unlikely explanation for this phenomenon. In that case the differentiation in male and female activities would most likely have lead to sexual dimorphism in occupation related pathologies and mortality.

⁶³⁵ See for example Treffort, 1996, p. 147 and Hassenpflug for an analysis of areas in and around a church that were a focus for high status burials Hassenpflug, 1999, p.227-228.

⁶³⁶ Provenance studies based on isotope analysis, may in the near future provide means to acquire more information about the origin of separate individuals in the cemetery.

taller. This larger stature at Rosmeer might partially be a consequence of the application of different regression formulas for the calculation of stature.⁶³⁷ However, the difference is large enough to assume that the males at Rosmeer were relatively tall for the Merovingian period. Other reference cemeteries indicate that male stature was generally below the mean calculated for the *templum* sample. Mean stature of the females from the *templum* sample was at least more than 4 centimetres above the mean calculated for females in all reference cemeteries. This suggests that the females from the *templum* sample grew relatively tall and most lived in more favourable living conditions. In contrast to the situation in the *cella* sample, within the *templum* sample the difference between mean male and female stature was relatively small, viz. 7 centimetres. (Male stature was circa 104 per cent of female stature.) Overall, the stature of males and females in the *templum* sample seems to indicate that living conditions were relatively good during that phase. This corroborates the data concerning mortality in the *templum* sample, which also suggested that in this respect the inhabitants of Maastricht fared reasonably well.

Site	N	Cribra	Enamel hypoplasia	Formation rate of Harris lines
Templum	78	17%	39%	0.15
Basilica	83	15%	24%	0.20
Boschstraat	54	7%	50%	0.18
Saint Martin de Fontenay 6th cent.	248	14%	-	-
Saint Martin de Fontenay 7th cent.	404	19%	-	-

TABLE 7-6 Prevalence of cribra orbitalia and enamel hypoplasia and the formation rate of Harris lines in the *templum* sample and reference populations

With respect to cribra orbitalia the prevalence in the *templum* sample was 17 per cent, comparable values were found for the two phases at the Saint-Martin-de-Fontenay cemetery. At two other Merovingian cemeteries from Normandy, Saint Martin and le Martray, both in the community of Giberville, the prevalence of cribra orbitalia was 14 and 31 per cent respectively.⁶³⁸ Considerable variation is found in the prevalence of cribra orbitalia. Although the presence of this alteration of the roof of the orbits is generally considered an indication for iron-deficiency anaemia, often in association with inadequacies in nutrition and a variety of health problems, dissimilarities in prevalence are difficult to interpret.⁶³⁹ Possible causes for variation in the prevalence of cribra orbitalia in the Merovingian period might be the consumption of different diets or the prevalence of infectious disease and the occurrence of chronic diarrhoea. No significant differences in the prevalence were found between males and females. The

⁶³⁷ Wurm has published tables comparing various methods to calculate stature, which indicate that the formulas of Dupertuis and Hadden (that Janssen probably used for the Rosmeer population) yields higher stature estimates than the formulas used in this study. Wurm and Leimeister, 1986.

⁶³⁸ Pilet et al., 1990, p. 57-58 and p. 75.

⁶³⁹ Larsen, 1997, p. 29-40.

prevalence of enamel hypoplasia was similar to the prevalence in the *cella* sample. In the *basilica* sample fewer individuals showed signs of enamel hypoplasia. This would suggest that in this respect living conditions in the *templum* phase were less favourable. However, enamel hypoplasia is not a very specific indicator of stress which makes it difficult to explain this high prevalence in combination with other health indicators that suggest the living conditions were relatively good. For Harris lines, the differences between the samples were too small to draw any conclusions on differences in living conditions.

Condition	%	N
Fractures per inspected long bone	0.5%	(1/216)
Individuals with temporomandibular joint osteoarthritis	6.9%	(2/29)
Individuals with vertebral osteoarthritis	30.7%	(4/13)
Individuals with degenerative disc disease	69.2%	(9/13)
Individuals with DISH	15.4%	(2/13)
Individuals with periostitis	21.7%	(5/23)
Individuals with chronic maxillary sinusitis	53.8%	(7/13)

TABLE 7-7 Selected palaeopathological results for the *templum* sample

Most parameters providing information relating to the pathological conditions in the *templum* sample give reason to believe that the population was not exposed to a high level of pathological strain or excessive occupational hazards. In comparison to the preceding *cella* phase cemetery an increase in the prevalence of three conditions was noted: vertebral osteoarthritis (VOA), periostitis and chronic maxillary sinusitis. When compared with the subsequent *basilica* phase cemetery no significant changes in the pathology were recorded. Only one fracture was found in the *templum* sample. The prevalence of DISH in the *templum* sample was lower than the *cella* and the *basilica* sample.

One uncommon form of pathology was found in the *templum* phase population. Two male individuals had injuries of the skull caused by sharp bladed objects. Both individuals were buried close to each other a few meters north of the northern wall. Similar injuries were not found in the *cella* sample or at the Boschstraat cemetery. Also at the cemetery of Saint-Martin-de-Fontenay none of the individuals had injuries caused by sharp bladed objects.⁶⁴⁰ One male individual from a contemporaneous cemetery in Borgharen had a comparable injury of the skull.⁶⁴¹ And in the *basilica* sample four males had sharp bladed injuries. In the early medieval period injuries caused by a sharp bladed object are generally the result of a blow with a sword or axe. In Maastricht the characteristics of the cutting injuries indicate that these were the result of wounds inflicted by a sword.⁶⁴² These injuries provide evidence on the presence of

⁶⁴⁰ Pilet, 1994.

⁶⁴¹ R. Panhuysen, 2000 and R. Panhuysen, 2002

⁶⁴² The absence of radiating fracture lines, the length of the cuts, the pattern of chipping of bone and the line pattern of damascened iron on several cut surfaces all suggest the injuries had been inflicted by a sword. R. Panhuysen, 2002.

violence in society. In this respect one of the two individuals is especially of interest. The skeletal remains of this male with an age between 20 to 29 years showed the individual had suffered at least seven blows with a sword.⁶⁴³ Not only was the skull hacked to pieces, cuts on the atlas and axis indicated that the individual was also wounded at the throat to the extent that the skull was almost severed from the rest of the body. Injuries to the bones of the wrist suggest that the victim tried to protect himself during the attack. Both the blows to the skull and the cut to the throat were independently lethal. The combination of cut wounds implies that after this individual was killed the body was further mutilated.⁶⁴⁴ Cases with multiple injuries were also found in the Towton study of fifteenth century casualties of a battle between two armies.⁶⁴⁵ It is difficult to determine under what circumstances the skeleton received the series of blows to the skull and hands. Because of the similarity of the pattern of injuries with the cases in the Towton study it seems plausible that these injuries were inflicted during armed combat. However, it cannot be excluded that the injuries were the result of local violence or the consequences of an execution.

Site	N	Caries	Abscesses	Ante mortem tooth loss
Templum	78	8%	5%	13%
Basilica	83	12%	9%	17%
Boschstraat	54	11%	4%	12%
St. Martin 6th cent.	248	8%	-	12%
St. Martin 7th cent.	404	7%	-	11%

TABLE 7-8 Prevalence of caries, abscesses and ante mortem tooth loss in the *templum* sample and reference populations

The percentage of teeth affected by caries was comparable to the percentages found at Saint-Martin-de-Fontenay. For the *basilica* and the Boschstraat sample the caries percentage was considerably higher. Frequencies of caries are for a large part determined by diet, especially the consumption of easily fermentable carbohydrates and the consumption of food high in sugar content.⁶⁴⁶ The difference in the frequency of caries between the *templum* sample and the *basilica* and Boschstraat sample suggests a general change in the diet may have occurred. The individuals from the last two samples possibly consumed more carbohydrates and sugars. Sugars in various forms had been available at least from the Roman period; honey especially

⁶⁴³ Unfortunately the skeletal remains were not found in a primary burial. The bones were found in the fill of a stone-built grave, together with the skeletal remains of two individuals.

⁶⁴⁴ The high number of injuries might indicate that the assailant was in some sort of rage when the victim was killed or that the opponent intended to prevent identification of the victim.

⁶⁴⁵ Novak, 2000, p 91-92. In individuals with injuries of the skull caused by sharp bladed objects the mean number of injuries per skull was 2.7. In a sample of 28 crania with injuries 9 crania had received 4 or more blows by a sharp bladed object.

⁶⁴⁶ Larsen, 1997, p. 65-66

seems to have been a common foodstuff.⁶⁴⁷ The number of peri-apical abscesses and ante-mortem tooth loss in the *templum* sample was similar to that in the Boschstraat sample. Also at Saint Martin-de-Fontenay similar percentages of ante-mortem tooth loss were noted. The general impression is that oral health in the *templum* sample was better than in the *basilica* sample. Like in the *cella* sample calculus was more common in males (100 per cent, n=11) than in females (43 per cent, n=14). The most plausible explanation would be that this was the consequence of a difference in diet or oral hygiene between males and females. However, other aspects of dental health do not show such marked differences between males and females.

SPATIAL DISTRIBUTION

On the basis of the physical anthropological information two out of four clusters in the *templum* cemetery (described in chapter 3, see figure 7-9 on the next page) comprised only female skeletal remains, viz. in cluster I and cluster II.⁶⁴⁸ The other clusters contained burials of both sexes.⁶⁴⁹ Both clusters 1 and 2 were lying west of the western wall of the *templum*. Because two clusters could be recognised, with a space of circa 7 metres in between, the two are described as separate entities. Still, these clusters may together have formed one zone reserved for the burial of females.

Cluster	Male	Female	Non-adult	Unknown
1	0	4	2	4
2	0	5	0	2
3	2	6	0	1
4	8	7	2	4

TABLE 7-9 The distribution of the number of male, female, non-adult individuals in the 4 clusters; the last column mentions the number of remains adult individuals for which sex could not be determined.

Cluster I was found circa 25 metres to the west of the western wall of the *templum*. This cluster consisted of at least 9 graves, viz. coffins and trench graves. We are in the dark concerning the confines of this cluster as it was delimited on three sides by the boundaries of the excavation trench. Only the eastern limit, consisting of a void space, could be established in the neighbouring excavation trench. Among the skeletal remains found in this cluster were two non-adults and four females. Cluster II was lying at a shorter distance from the church.

⁶⁴⁷ Hagen, 1995, p. 150-159; Toussaint-Samat, 1994, p. 15-37.

⁶⁴⁸ As a cautionary note it should be mentioned here that skeletal remains were not found in all graves in these zones. And not all skeletal remains could be sexed. Therefore, it cannot be ruled out that males were buried in these zones. Still, the disarticulated bone in these zones also seems to indicate that females were mostly buried here

⁶⁴⁹ About 8 graves were dated to the first phase of the *templum* cemetery, before the construction of the stone-built church. For four of these graves sex could be determined and these were all of female sex. In those graves that were contemporary with the stone-built church males and females occur in roughly equal proportions. The four female graves were distributed over clusters two and three. In theory this may have biased the sex distribution in these clusters.

FIGURE 7-9 Plan of the distribution of burials of males and females at the *templum* phase cemetery. The large numbers I to IV designate clusters of graves in the cemetery. 1 = female, 2 = male, 3 = non-adult, 4 = adult individual of undetermined sex.

It comprised about 14 graves lying at circa 15 metres from the western wall of the *templum* in the direction west-northwest. This cluster of tuff stone sarcophagi, stone-built tombs, trench graves and wooden coffins extended over a length of at least ten metres from north to south. In the east and west the limits of the cluster were recognisable as space void of inhumations. Our view of the northern and southern limits is obscured by the boundaries of the excavation trenches. These graves contained the skeletal remains of 6 females and 2 individuals for whom sex could not be determined.

Clusters III and IV consisted both of male and female burials. Still, the majority of graves in the third cluster contained female burials. Due to the construction of a crypt for the Romanesque church no information could be collected for possible inhumations in the interior of the church building from *templum* phase. Therefore, it is not possible to determine whether people were buried inside the church during the *templum* phase. Likewise we cannot test whether this space was more reserved for male burials as is generally assumed.⁶⁵⁰ One grave, viz. grave 137, appears to have been positioned inside the stone-built church of the *templum* phase. The skeletal remains found in this grave did not allow for the determination of sex. In this case

⁶⁵⁰ In a study from Swiss churches from the early medieval period to the nineteenth century Ulrich-Bochsler found that inside churches female burials were underrepresented; Ulrich-Bochsler, 1997.

grave goods (including a sword and a small silver cross found at the bottom of the grave) indicate the primary burial in this grave was a male.⁶⁵¹

FIGURE 7-10 Plan of the distribution of individuals by age at the *templum* phase cemetery.

As stated earlier the poor state of conservation seriously hampered the possibilities to estimate age at death for many burials of the *templum* sample. This is reflected in the map above, showing few individuals that could be assigned to ten-year age intervals. Most individuals for whom more specific information could be collected were concentrated in the eastern excavation trenches. In that area the *templum* phase graves were probably better protected from disturbances because they were covered by ground deposited to elevate the terrain. No definite concentrations of specific age categories could be recognised. Only a few younger individuals were found dispersed over the cemetery. In general the spatial distribution of graves seems to have altered only slightly from the situation in the *cella* phase of the cemetery. One divergent aspect in the cemetery was the absence of pairs of containing the remains of juxtaposed males and females. Still, the presence of both sexes and various age categories in most clusters of burials suggests that these clusters were not composed of members of specific social groups like monks or canons. More likely the individuals buried in

⁶⁵¹ Unfortunately the contents of the grave were disturbed. The skeletal remains of at least 3 individuals had been deposited in the grave. This suggests that graves in the area were dismantled during construction works. Human remains found in these graves were then collected in grave 137. Similarly the grave goods of these displaced burials may also have been deposited in grave 137. Still, the nature of the grave goods indicates that the graves in this section of the cemetery were most likely of male individuals.

these clusters were members of separate families.⁶⁵² At this stage it is difficult to hypothesize about the two clusters in which only female burials were found. An explanation might be that these females belonged to some form of a religious congregation. Or possibly the cemetery became a burial place for the women of one or more intermediate to high status families. A glimpse of possible kinship relations could be obtained by examining the distribution of non-metric variation. Most of the conditions like lambdoid ossicles were found predominantly in the area north of the church. Cortical defects, a musculoskeletal stress marker, and individuals with *cribra orbitalia* also were found mostly in that area. This would suggest that the group buried in this area had a shared genetic background and similar living conditions. Still, this is also the section of the cemetery with the best-preserved remains and it cannot be excluded that the distribution of these conditions is the product of a disparity in the availability of data.

Several special grave types were used for burials during the *templum* phase. The most remarkable graves used at the beginning of the *templum* phase were seven tuff stone sarcophagi. Only three of these contained human skeletal remains. In two of these cases sex could not be determined. The third case was the grave of the "rich lady". For this richly furnished grave the physical anthropological data confirmed the determination of sex deduced from the grave goods; her age at death fell in the range between 20 to 40 years. As mentioned in chapter three another special type of grave was constructed during a later stage of the *templum* phase. Four composite stone coffins were built in pairs as "twin graves". Similar graves were also found in other cemeteries from the Merovingian period.⁶⁵³ M. Colardelle suggests these twin graves were graves of members of the same family who were successively buried next to each other.⁶⁵⁴ Unfortunately at the Servaas church site no skeletal remains in situ were recovered from these graves. Therefore, the physical anthropological data cannot contribute to the interpretation of this special grave type.

Recent studies have pointed to the existence of an association between sex and age of the deceased and the grave goods a person received at the time of burial.⁶⁵⁵ This association could also be studied in the *templum* phase cemetery. However, at the time of study several grave goods were still under examination and no complete overview was available. Due to the effect of post-depositional disturbances on the graves and the loss of grave goods this only allows for some general observations. At the *templum* cemetery grave goods were more frequent in the graves of older individuals. Most objects were found in graves from individuals between 40 to 50 years. It is recalled here that this was the age category that seemed to be overrepresented in

⁶⁵² E.g. Pilet et al. interpreted similar findings in the cemetery of "Le Martray, Giberville" also as an indication for the grouped burial of individuals who were related, being members of a family, Pilet et al., 1990, p. 65. Also Treffort has described that a grouped burial of members of a family had a long history, Treffort, 1996, p. 170-172.

⁶⁵³ E.g. three pairs of double or "twin" graves were excavated at Saint-Julien-en-Genevois (France) Colardelle, 1983, p. 71. See also the distribution map of ten examples of twin graves in Merovingian France on page 374 of the same publication.

⁶⁵⁴ Colardelle, 1983, p. 370. This hypothesis is supported by physical anthropological evidence as indicated by M.R. Sauter in a contribution to Colardelle's study, p. 422.

⁶⁵⁵ E.g. Halsall, 1995, *passim*.

this section of the cemetery. Another age category associated with many grave goods was between 10 to 20 years. The majority of grave goods was found in the graves of females.

CONCLUSION

The transition from the *cella* phase to the *templum* phase appears at first to have been a process of gradual change. Before the construction of the stone-built church a few individuals were buried in the area that was already used during the *cella* phase. The placement of seven tuff stone sarcophagi in this initial phase marks the moment that this zone became a burial area for individuals of a high status. Only later in the phase, towards the end of the sixth century, the burial area expanded, probably after the construction of a church. With the construction of a church at this location this section of the cemetery was no longer positioned at the periphery; it became the central area. This shift in focus of the cemetery also caused an increase in the number of inhumations in the area. Further associated with this shift was a change in the demographical composition of the population buried at this section of the cemetery. Non-adult individuals were underrepresented and females were slightly overrepresented. Indicators like the prevalence of lambdoid ossicles, cribra orbitalia and cortical defects, suggest that the individuals buried north of the church were possibly genetically related and may have lived under similar conditions.

In comparison with various contemporaneous populations, the demographical parameters suggest that during the *templum* phase living conditions in Maastricht were generally above average for those individuals buried in the examined section of the Servaas cemetery. Mean age at death, and male and female stature were relatively high. Health conditions were difficult to compare. However, the palaeopathological examination provided no evidence for a poor state of health. Two individuals with injuries to the skull caused by blows with a sword provide an indication for the probable involvement of inhabitants of Merovingian Maastricht in armed conflict.

THE BASILICA PHASE

The construction of a large *basilica*, at some time between 670 and 750 AD, must have resulted in a dramatic change in the external appearance of the religious complex. Echoes of these changes are recognisable in the layout of the cemetery. After the construction of the *basilica* the arrangement of the graves was more orderly in most areas of the cemetery, e.g. in the area in the corner formed by the north wall of the choir and east of the northern extension. Furthermore an increase in the burial density was noted south of the church. This is remarkable since there appears to be enough space to bury north of the church. Burial in the north was possibly restricted, or new developments south of the church may have made that area more attractive as a place of burial. However, in the area south of the church the layout of the graves appeared to be less orderly. In contrast to the imprecise east-west orientation of the graves in the previous phases the *basilica* phase graves closely followed the orientation of the church. Inside the church a large concentration of limestone sarcophagi was found arranged around the cancella.

Most of the nave and aisles were not used for burial purposes. In the eastern part of the church six graves were placed against the interior wall of the *basilica* and in the annexes and extensions. More limestone sarcophagi were buried outside along the walls of the church. Together with those positioned inside the church around the *cancellae*, a considerable number of limestone sarcophagi were found. The recurrent use of this costly type of grave indicated that also during the *basilica* phase individuals of above-average status were frequently buried at the heart of the Servaas cemetery.

FIGURE 7-11 Plan of the building and burials associated with the *basilica* phase.

Consisting of 83 individuals, the sample from the *basilica* phase was slightly larger than the *templum* phase sample. Included in the sample were all burials that could be associated with the *basilica*, dating between circa 670 and 950 AD. After the ninth century little burial activity was noted in the area. Only a small section of the original cemetery was represented in our sample as only the area inside the church and a small strip around the outside walls of the *basilica* fell within the perimeter of the excavation trenches. This selection of graves is considered to represent burials of individuals of intermediate to high status because of the nearness to the assumed location of the grave of Saint Servatius and the frequent use of limestone sarcophagi. The margins of this cemetery have hitherto not been determined. In four other excavations near the present church, sections of the same cemetery were found. A large section of the cemetery was excavated at the Pandhof site, inside the courtyard adjacent to the Saint Servaas church. Close to the eastern end of this church a considerable number of graves were excavated in trench two of the Vrijthof excavation. The early medieval graves found at the

FIGURE 7-12 the top half of the photograph shows the limestone sarcophagi as they were positioned against the outer wall of the *basilica* (see upward arrow). On the right side, inside the *basilica*, (see arrow pointing right) is one sarcophagus with a lid still in place.

lower levels of the Stiftskapel site were also a part of the cemetery, although for this location we have no indication whether it was used for burial during the *basilica* phase. Finally the graves excavated at the Servaasklooster site probably also belonged to the same cemetery spreading out around the Servaas church. It seems plausible that the area from the Saint Servaas church site to the Roman road was continuously used as a burial ground from the late Roman period up to the nineteenth century. However, after the ninth century the number of burials inside the present church decreases drastically. Between the tenth and the nineteenth century only a few provosts and members of the aristocracy were buried inside the Saint Servatius church.

REFERENCE POPULATIONS

Recently published physical anthropological reference data from Carolingian cemeteries from the region of Maastricht are scarce. Seven reference populations were selected. Two regional cemetery samples, from Namur (Belgium) and Susteren (The Netherlands), were used as reference populations despite the fact that the chronology of these cemeteries extended 50 to 200 years after the end date of the *basilica* sample. The cemetery from the Chapelle Saint Hilaire site in Namur (Belgium) comprised of burials from the Carolingian period and the subsequent early Ottonian period.⁶⁵⁶ This sample consisted of 22 adult burials recovered in and around an

⁶⁵⁶ Personal communication J Plumier

early medieval chapel dedicated to Saint Hilaire.⁶⁵⁷ Because of the burial inside and close to a church we assume that these individuals were of intermediate to high status. The cemetery excavated at the Salvator Square in Susteren also consisted at least partially of burials of intermediate to high status.⁶⁵⁸ S. Baetsen studied a total of circa 43 burials from this excavation. A third sample used for comparison was excavated at Rijsburg, in the west of the Netherlands near the coast.⁶⁵⁹ These burials were positioned in a late Carolingian cemetery which preceded the construction of a Romanesque church. G. Maat examined a total of 16 individuals, dating between circa 875 and 1133 AD.⁶⁶⁰ In addition, data from geographically distant sites ranging from Haithabu (Germany) in the north to San Vincenzo al Volturno (Italy) in the south were used for comparison. The cemetery from Haithabu contained burials from the ninth century and belonged to a large settlement focused on trade and manufacture.⁶⁶¹ U. Schaeffer studied the skeletal remains of 100 individuals from this site. V. Higgins examined the human remains of 276 individuals from a cemetery excavated at the site of the monastery of San Vincenzo al Volturno.⁶⁶² These skeletal remains were recovered from various burial areas around the monastery. Although as a whole the collected samples consisted of burials from the late Roman period to the end of the Carolingian period, most of the graves dated from the eighth and ninth centuries. High status burials, burials of intermediate status and lower status individuals from the local population living in the vicinity of the monastery were represented in the sample. In addition, a cemetery from France and one from Switzerland were used as a reference population, viz. Villiers-le-Sec (France)⁶⁶³ and Satigny-Genève (Switzerland). The cemetery of Villiers-le-Sec was a small village cemetery north of Saint Denis, France, from which 48 individuals were recovered and examined by G. Auboire.⁶⁶⁴ Villiers-le-Sec was a village that was part of the property of the monastery of Saint Denis. Because of its association with a small settlement with agricultural functions it is assumed that predominantly individuals of low to intermediate status used this cemetery. Simon and Leemans studied the cemetery excavated in Satigny-Genève.⁶⁶⁵ This population represents 103 Carolingian burials from a larger cemetery in use from the sixth to the thirteenth centuries. The cemetery was associated with a church and priory in a rural setting not far from Geneva. Generally the publications of the above mentioned

⁶⁵⁷ R. Panhuysen, 2005c. All non-adult individuals were examined by Ms M. Vandenbruaene from the Flemish Institute for Archaeological Heritage, Brussels, several early medieval inhumations excavated nearby also at the site of le Grognon were examined by Ms A. Malevez, DGATLP, Service de l'Archéologie, Liège.

⁶⁵⁸ Baetsen, 1998.

⁶⁵⁹ Cordfunke et al., 1998.

⁶⁶⁰ Cordfunke et al., 1998. The dating of the burials is based on several ¹⁴C-dates and stratigraphical analysis, personal communication by M.F.P. Dijkstra who is preparing a doctoral thesis on the Rijsburg site.

⁶⁶¹ Schaeffer, 1963).

⁶⁶² Used for comparison in our tables were the data kindly provided by Ms V. Higgins. Recently the results of the osteoarchaeological examination of these skeletal remains were published. Higgins, 2002).

⁶⁶³ Distance from Maastricht circa 400 km.

⁶⁶⁴ Auboire, 1988).

⁶⁶⁵ Simon and Leemans, 1991).

populations provided general demographic data. Specific health related data are often lacking or unsuitable for comparison due to the variation in methodology.

PHYSICAL ANTHROPOLOGY AND PALAEOPATHOLOGY

Although some graves were damaged in the eleventh century during the construction of the present church, the skeletal remains in the *basilica* sample were considerably more complete (recovery rate: 0.27) than those of the *templum* sample (recovery rate: 0.13). As a result more information could be gained from this sample. Generally the preservation of the skeletal remains was good, however the inhumations deposited in limestone sarcophagi were poorly preserved. Many of these remains showed signs of the presence of levels of putrefactive fluid in the graves. Those parts of the skeleton that were exposed to these fluids were often poorly preserved, ranging from loss of cortical bone to complete dissolution of bone tissue.

Site	N	Non-adults	Male : Female	Mean age		Mean stature	
				Male	Female	Male	Female
<i>basilica</i>	83	13%	58% : 45%	43.9 yr	42.1 yr	174.2 cm	167.5 cm
Namur (750-1000 AD)	22		41% : 59%	42.5 yr	33.6 yr	174.1 cm	161.0 cm
Susteren (800-1150 AD)	43					172.5 cm	162.9 cm
Rijnsburg (875-1133 AD)	16	6%	80% : 20%	39.1 yr		173.0 cm	165.0 cm
Haithabu (800-1200 AD)	100	23%	62% : 38%			169.1 cm	157.5 cm
San Vincenzo (350-1000 AD)	276	12-21%	47% : 53%	33.6 yr	28.9 yr		
Villiers-le-Sec (600-1000 AD)	48	42%				165.5 cm	156.2 cm
Satigny (Carolingian)	103	22%	61% : 39%			170.9 cm	155.0 cm

TABLE 7.10 Demographic data for the *basilica* sample and five reference cemeteries.

The low percentage of non-adult burials in the *basilica* sample suggests that this age category was underrepresented in the sample. This is corroborated by the distribution of non-adult mortality in five-year age intervals which shows a relatively low number of deaths in the first five years of life (4/11), and a relatively high number of deaths between 15 to 20 years (4/11) an interval that is normally characterised by low mortality. This suggests that selection by age was a factor determining whether individuals were buried in the examined part of the *basilica* cemetery. Similar distributions of non-adult mortality were found in other cemeteries. At the site of San Vincenzo al Volturno, Higgins found low to moderate percentages of non-adult burials for the Carolingian period ranging from 12 to 21 per cent for different burial areas. This phenomenon was explained by the fact that in general moderate to high status burial areas were examined. At the sites in Haithabu and Satigny non-adult mortality was slightly above 20 per cent. However, a considerably higher percentage was found for the rural cemetery of Villiers-le-Sec, where over 40 per cent of the individuals died before reaching adulthood.

In the *basilica* sample and the cemeteries of Namur and San Vincenzo the number of males and females was approximately in balance. At Haithabu the males outnumbered the females, which might be a result of the (temporary) influx of male traders and craftsmen in this

settlement, serving as a port of trade. Both in the cemeteries of Satigny and Rijsburg more males were buried. For Satigny this was considered the result of the presence of a community of monks at the priory. The same was possibly true for the Rijsburg burials.

Little variation in mean age at death was found between males and females of the *basilica* sample, viz. 43.1 and 42.1 year respectively. In comparison to other Carolingian cemeteries and populations from other periods a difference of one year is small since in many historical populations mean age at death for females was about five to ten years lower. Generally, the mean age at death calculated for males and females of the *basilica* sample was relatively high in comparison to contemporary samples. The males from Namur almost reached the same mean age at death (42.5 years), but there the females seem to have died earlier (33.6 years). Both the males and females of San Vincenzo generally died at a younger age, resulting in lower mean ages at death.

FIGURE 7-13 Distribution of mortality among adult individuals of the *basilica* sample (n=35)

Unlike the *templum* sample, the distribution of adult mortality in the *basilica* sample was in agreement with mortality distributions commonly found for adult individuals in pre-industrial populations (compare Figure 7-7 and Figure 7-13). This was noticeable in the higher proportion of mortality in the 50 to 60 and 60 to 70 year age intervals. Again the highest number of deaths was found for the 40 to 50 year age interval. Up to and including the 40 to 50 years interval females were almost equally represented. The two last intervals showed fluctuations in the representation of the sexes. This may just as well reflect actual changes in the proportions of male and female mortality or be a consequence of the small number of individuals.

Stature of both males and females was relatively high. The stature of males from the *basilica* sample was not exceeded in any of the reference populations. Both males and females in Namur were generally as tall as those of Maastricht. The males in the Susteren population were less than 2 centimetres shorter. At the sites of Satigny and Haithabu mean male stature was

respectively circa 3 and 4 centimetres lower and the difference with males from the village population of Villiers-le-Sec was more than 8 centimetres. For females, the same ranking according to mean stature was found among the reference populations, with the exception of the females of Susteren, whose mean stature exceeded the mean calculated for the *basilica* sample by 1.4 centimetres and the females of Satigny who generally were shorter than the females in all other reference populations. The two populations that were geographically nearest to Maastricht, viz. Namur and Susteren, have mean statures for males and females that were much closer to the *basilica* sample than the other reference populations. For the *basilica* sample male stature was circa 108 per cent of female stature, which is marginally larger than the difference generally found between males and females.

With respect to other health related characteristics few data could be collected from the reference studies. Therefore, the data from the *templum* and Boschstraat samples were included in the comparison of the prevalence of cribra orbitalia, enamel hypoplasia and Harris lines.

Site	N	Cribra	Enamel hypoplasia	Formation rate of Harris lines
Templum	78	17%	39%	0.15
Basilica	83	15%	24%	0.20
Boschstraat	54	7%	50%	0.18
Blossac Saint-Hilaire ¹⁶	19	0%	—	—

TABLE 7-11 Prevalence of cribra orbitalia and enamel hypoplasia and the formation rate of Harris lines in the *basilica* sample and reference populations

The prevalence of cribra orbitalia was only slightly lower than in the *templum* sample and twice as high as in the Boschstraat sample. In Blossac Saint-Hilaire a Carolingian cemetery in Poitiers (F) none of the inspected skulls (n=19) had cribra orbitalia. It should be noted here that the cases of cribra orbitalia from the *basilica* sample were generally individuals with rather superficial changes of the orbita. None of these cases had proliferative new bone formation in the orbits or evident signs of porotic hyperostosis of the skull. With respect to the health conditions related to the formation of cribra orbitalia the situation for the *basilica* sample appears to have been similar to the situation for the individuals of the *templum* sample. Almost a quarter (24 per cent) of the individuals from the *basilica* sample showed signs of linear enamel hypoplasia. The formation rate of Harris lines does not show much variation between the samples from Maastricht. Therefore, no additional information on physical childhood stress can be deduced from these data. Given the relatively moderate nature of these cases of hypoplasia and their low prevalence in combination with the relatively high mean stature, it seems unlikely that individuals from the sample experienced substantial physical stress during childhood.

At first sight some of the palaeopathological parameters presented below might suggest that the individuals of the *basilica* sample were on average not living under favourable health conditions. However, for several of these parameters longevity resulted in an increased risk of

acquiring these pathological conditions, rendering it less likely that they were the result of poor living circumstances.

Condition	%	N
Individuals with vertebral osteoarthritis	23%	(7/31)
Individuals with degenerative disc disease	87%	(27/31)
Individuals with DISH	26%	(8/31)
Individuals with periostitis	26%	(9/34)
Individuals with chronic maxillary sinusitis	48%	(11/23)

TABLE 7-12 Selected palaeopathological results for the *basilica* sample

An example of the possible impact of increased longevity is the prevalence of vertebral osteoarthritis (VOA) and degenerative disc disease (DDD), which was relatively high. Both conditions are known to increase with age. This trend was also observed in the pooled samples of this study. Consequently it is likely that the comparatively high mean age at death in the *basilica* sample was an important cause of the elevated percentages of degenerative disc pathology in the spine.⁶⁶⁶ The high prevalence of DISH, almost twice the prevalence calculated for the *templum* sample, can partially be explained by the increased longevity.⁶⁶⁷ A factor further contributing to this high prevalence of DISH could be a change in general living conditions, in particular the diet. As indicated above DISH is often associated with an affluent diet and the lifestyle of high status members of religious communities.⁶⁶⁸ Janssen found changes associated with DISH in practically all the skeletal remains of eleventh to sixteenth century canons buried in the "Stiftskapel" (n=17).⁶⁶⁹ The association of DISH with the lifestyle of high status members of religious communities is of particular interest in the *basilica* sample. It is expected that a proportion of the *basilica* burials were either canons or monks. The increased prevalence of DISH may therefore be associated with the burial of members of a religious community or individuals with a similar life style. Rouche and Pearson have pointed out that people in the Carolingian period may have theoretically had access to sufficient quantities of food, as suggested by various written sources. Whether quantitatively and qualitatively sufficient diets were available to all social groups remains debatable.⁶⁷⁰ Rouche indicates various early medieval members of monastic communities may have received abundant diets.⁶⁷¹

⁶⁶⁶ In larger samples this assumption can be tested by calculating the prevalence per age category. Unfortunately in this study sample sizes were too small.

⁶⁶⁷ In a large study of two hospital populations Weinfeld and co-workers found a strong correlation between age and prevalence of DISH. Weinfeld et al., 1997.

⁶⁶⁸ Waldron, 1985, Rogers et al., 1987, Weinfeld et al., 1997, Janssen and Maat, 1999, Rogers and Waldron, 2001.

⁶⁶⁹ Janssen and Maat, 1999 p. 24.

⁶⁷⁰ Rouche, 1973 and Kathy L. Pearson, 1997.

⁶⁷¹ Rouche, 1973.

With respect to parameters that provide an indication of the exposure to infectious diseases it is noted that both chronic maxillary sinusitis and reactive new bone formation on the long bones of the lower extremities were found in a relatively high percentage of the inspected individuals. The prevalence of chronic maxillary sinusitis was slightly lower than the prevalence in the *templum* sample. In the skeletal remains inspected for this study and in another sample from Maastricht the prevalence of chronic maxillary sinusitis was found to increase with advancing age, largely due to the increase of dental pathology in older individuals.⁶⁷² So the relatively high prevalence of chronic maxillary sinusitis in the *basilica* sample might also be a consequence of the high proportion of individuals dying at a more advanced age. Another cause for chronic maxillary sinusitis may be rhinogenous sinusitis, which is thought to be strongly influenced by living conditions.⁶⁷³ Since little is known about living conditions, especially housing conditions, it is not possible to interpret this aspect of the prevalence of chronic maxillary sinusitis.

At present there is no satisfactory explanation for the relatively high prevalence of reactive periosteal new bone formation (in palaeopathology this is diagnosed as periostitis) in the long bones of the lower extremities (26%). This was about 5 per cent more than in the *templum* sample. Some of these cases of reactive new bone formation were possibly infections secondary to oral pathology. However, in the four combined samples periosteal new bone formation was not found to increase with advancing age. This suggests that it is unlikely that the age composition of the *basilica* sample can explain the relatively high prevalence of periosteal new bone formation.

Bone changes due to trauma were found in considerable numbers in the *basilica* sample. Two types of trauma may provide clues concerning the living conditions of the individuals from the *basilica* sample, viz. healed fractures and intentional injuries caused by sharp bladed objects. Of all inspected long bones 3.1 per cent displayed changes caused by fractures and the ensuing healing process. This is the highest prevalence of fractures per inspected number of bones in all four samples in this study. As was stated in chapter 6 the increase of fractures from the *templum* to the *basilica* phase was statistically significant. Since fractures were more common in males than in females, part of this increase may be explained as a result of the higher proportion of male burials in the excavated section of the cemetery. In comparison to a study by Judd focussing on trauma from medieval and later medieval populations from Britain, the percentage of bones with fractures in the *basilica* sample is higher than the percentage found for a leper hospital cemetery from Chichester (2.6 per cent). This is surprising, since the percentage of fractured long bones found for this hospital population was already considerably higher than the percentages calculated for three medieval cemeteries that were used for comparison in the same study.⁶⁷⁴ Therefore, we may conclude that the lifestyle of the individuals from the *basilica* sample was associated with an increased risk of fractures.

⁶⁷² Panhuysen et al., 1997. In a study by Merrett and Pfeiffer 2000 the prevalence of chronic maxillary sinusitis was also found to increase with advancing age, Merret and Pfeiffer, 2000, p. 310-311.

⁶⁷³ Boocock et al., 1995.

⁶⁷⁴ Judd and Roberts, 1998, p.51.

The distribution of the fractures in the body may shed some light on what caused the fractures. Fractures of the upper extremities were the predominant type of fracture and their distribution was similar to the distribution in the other three samples. It is recalled here that only four healed fractures were found in the bones of the lower extremities of the four samples in this study. All four of these were individuals from the *basilica* sample. The fractures of the lower extremities (one in the femur and three in the fibula) may be particularly indicative of a shift in lifestyle or occupational risks. Such fractures are often caused by a fall from a height and may have been the result of equestrian accidents or construction work and other activities on scaffolds.⁶⁷⁵ Apart from the fractured femur the other fractures in the upper and lower extremities had healed well, with no indication for serious functional complications. Although there is no unequivocal evidence for the presence of medical care it seems likely that fracture treatment included the use of splints and adequate rest. Regarding the femur fracture the consolidation of the bone suggests traction was applied.⁶⁷⁶ The study of complications in fracture healing, like secondary osteoarthritis, suggests that most fractures were treated successfully.⁶⁷⁷ Secondary osteoarthritis was found in association with circa 27 per cent of the healed long bone fractures. In general, the treatment of fractures seems to have been effective in preventing functional impairment and other complications.

Also of interest in determining the hazards to which the population was exposed was the analysis of injuries caused by sharp bladed objects. As discussed above these injuries were considered to be inflicted by weapons, most likely swords. Four cases of sharp bladed injuries were noted in the skeletal remains from the *basilica* sample. All cases were adult male individuals. In three individuals the head was injured and in one individual the tibia. Two of the injuries were (partially) healed and two showed no sign of healing and were consequently considered peri-mortem injuries. About 21 male skulls were recovered with 50 per cent or more of the skull intact. Sharp bladed injuries were found in 3 (14 per cent) of these skulls. In all skulls the left side was affected.⁶⁷⁸ Sharp bladed injuries were documented in other Carolingian and medieval cemetery populations like Haithabu, Arras and a collection of cemeteries from Baden Württemberg.⁶⁷⁹ With respect to the quantification and distribution of the injuries inflicted by

⁶⁷⁵ Other explanations would imply serious changes in the surrounding terrain or housing and labour conditions. Since there is no indication that the terrain became more mountainous or that there was a dramatic change in housing and labour conditions an increase in horse riding activities among the individuals buried in and around the *basilica* might be a plausible explanation for the changing prevalence and distribution of fractures.

⁶⁷⁶ In a treatise from the sixth century Paul Aegineta describes how a fractured femur should be treated. Treatment included the application of some form of traction by using ligatures and the assistance of two individuals to extend the leg. Adams, 1843, p. 443-444.

⁶⁷⁷ Siraisi, 1990.

⁶⁷⁸ Viz 5.6 per cent of 18 frontal bones, 14.3 per cent of 14 left parietal bones and 7.1 per cent of 14 inspected left tibiae.

⁶⁷⁹ Haithabu two cases of sharp bladed injuries Schaeffer, 1963, p. 204; Arras one case of sharp bladed injuries in a female Blondiaux et al., 1991; a selection of six cases among 2095 individuals from 8 early medieval cemeteries (sixth to the eighth century) Czarnetzki et al., 1989, p. 45-50; similar examples of healed and unhealed sharp bladed injuries of the skull from the twelfth to the fourteenth centuries are mentioned in Czarnetzki, 1996, p. 188-195.

sharp bladed objects we may compare our data with similar results from a survey by Weber and Czarnetzki.⁶⁸⁰ These authors found that circa 10 per cent of 304 early medieval skulls displayed signs of either sharp- or blunt force trauma. They also noted that these traumas were predominantly found in males. Another similarity to the trauma pattern in our study is that most traumas involved the left half of the frontal bone or the left parietal bones. Generally it is argued that in case of combat with swords, right-handed assailants in a frontal attack will inflict most damage to the left side of their opponent.

The spatial distribution of individuals with sharp bladed injuries within the *basilica* phase cemetery was not random. One individual with a healed injury of the tibia was found north of the northern transept in a monumental grave. All three individuals with sharp bladed injuries to the skull were found in burials south of the choir of the *basilica*. In fact they were found within a stretch of 6 by 1 metres, parallel to the axis of the church.⁶⁸¹ This concentration of sharp bladed injuries in burials is peculiar and will be discussed below. Overall, we may conclude that both the prevalence of fractures and the distribution of sharp bladed injuries in this sample indicated that males buried around the *basilica* in particular had a lifestyle that exposed them to considerable risks of breaking bones or getting injured in armed conflict.

Site	N	Caries	Abscesses	AM loss
Templum	78	8%	5%	13%
Basilica	83	12%	9%	17%
Boschstraat	54	11%	4%	12%
Blossac Saint-Hilaire ¹⁷	19	9%	-	-
Haithabu	100	1%	-	3%

TABLE 7-13 Prevalence of caries, peri-apical abscesses and ante-mortem tooth loss (all calculated per inspected element or position) in the *basilica* sample and reference populations

A considerable number of dental elements from the *basilica* sample were affected by caries. With a prevalence of 12 per cent this was considerably higher than in the *templum* sample (8 per cent) and slightly higher than in the Boschstraat population (11 per cent). The prevalence of ante-mortem tooth loss (17 per cent) was higher than in any of the three other samples presented in this study. Both caries and ante-mortem tooth loss are known to increase with increased consumption of carbohydrates (especially sugars)⁶⁸², advancing age and the consumption of more refined foodstuffs. It is possible that the increased longevity of the individuals of the *basilica* sample may partially explain the higher prevalence of caries and ante-mortem tooth loss. From the eighth century on sugar may have been available in Western Europe, however, it is not likely sugar became obtainable in large quantities before the eleventh

⁶⁸⁰ Weber and Czarnetzki, 2001.

⁶⁸¹ It is recalled here that the two individuals with sharp bladed injuries from the *templum* sample were also buried close to each other.

⁶⁸² Hillson, 1996, p. 278.

century and it long remained an expensive product.⁶⁸³ Therefore, it is more likely that an increased consumption of other sugars may have contributed to the increased caries prevalence. In comparison to the Boschstraat sample, which had a similar percentage of carious elements, the *basilica* sample had a higher prevalence of dental abscesses and ante-mortem tooth loss. This might be an indication that the two samples differed in the consumption of abrasive foodstuffs.⁶⁸⁴ The *basilica* sample individuals might have consumed more refined foodstuffs. This may have allowed for the occurrence of more caries lesions on the occlusal surface of the dentition, leading to more peri-apical abscesses and ante-mortem tooth loss.⁶⁸⁵ In that case a change in diet was responsible for the relatively high rates of caries and ante-mortem tooth loss. With respect to the formation of calculus no difference between males (88 per cent) and females (86 per cent) was noted (in contrast to the situation in the *cella* and *templum* samples).

SPATIAL DISTRIBUTION

Outside the *basilica* all burial areas were used for both male and female burials. No systematic pattern could be recognised in the positioning of male and female burials. The burials outside the church were generally a mix of male, female and non-adult burials. This indicates that these areas were not exclusively used to bury individuals from a clerical community. It is possible that the area around the *basilica* was used as an *ad sanctos* burial ground by some families of high social status. Non-adult burials were not evenly distributed outside the church: most non-adults were buried south of the choir and the southern annexe. In this part of the cemetery the graves were placed close together. The difference in spatial organisation between the northern graves and the southern graves suggests that these areas were used for burials of two different groups. The fragmentary condition of the skeletal remains recovered from inside the *basilica* did not allow for the determination of sex in the majority of cases. Therefore, the absence of female burials inside the nave of the church cannot simply be regarded as evidence that females were not buried inside the church. Only one grave inside the church containing female skeletal remains was found in an annexe south of the eastern corner of the southern aisle. This female burial was found in the only grave that was positioned on the same spot as two previous graves.⁶⁸⁶ No evidence for the presence of a permanent demarcation of the grave was found. The fact that the consecutive burials caused marked disturbance of the previous burials indicates the three individuals were not buried at the same time. Still, the relatively precise superposition of the graves suggests that the burials were placed intentionally at the same spot and that some form of grave marker must have been present. We can only guess the reason why these

⁶⁸³ Hagen, 1995, p. 183 and Toussaint-Samat, 1994, p. 552-555.

⁶⁸⁴ Possibly the extraction of teeth may also have contributed to the elevated number of ante-mortem tooth loss.

⁶⁸⁵ Maat and van der Velde, 1987.

⁶⁸⁶ The first and deepest grave (grave 76, 06-05-08) was of a male aged between 40 to 55 years who was buried in a coffin. A second coffin (grave 75, 06-05-07) was placed on top of the first burial. In the process the first grave was partially disturbed. In the second grave the remains of a child between 6 and 7 years were found. At the same spot the third grave (grave 73, 06-05-04) was positioned, disturbing the child's grave below. The top grave was a trench grave, containing the remains of a female aged between 31 and 37 years.

FIGURE 7-14 Plan of the distribution of burials of males and females at the *basilica* phase cemetery. 1 = female, 2 = male, 3 = non-adult, 4 = adult individual of undetermined sex.

three individuals were buried in the same spot. Possibly they were members of the same family. The annexe may in that case have been a small funerary chapel for a family.

With respect to the distribution of the sexes by grave type there was no evidence of primary burials of females in sarcophagi. A total of 35 limestone sarcophagi were excavated within the confinements of the Servatius church excavation. Only 14 of these contained human remains. In 6 of these the human remains were not lying in situ. Most likely these remains represented secondary depositions.

In 8 sarcophagi a primary burial was found: 7 were males and one was an individual of unknown sex, aged between 6 to 10 years. This might implicate that limestone sarcophagi were predominantly or even exclusively used for the interment of males. Regarding similar sarcophagi found in Liège in the middle and to the south of the Saint Lambert church, Otten assumes that these were used to bury clerics.⁶⁸⁷ However, due to the absence of primary inhumations in the other 27 sarcophagi it remains unknown whether the use of these sarcophagi in Maastricht was reserved for the burial of clerics.

⁶⁸⁷ Otten, 2003, p.107.

FIGURE 7-15 Sarcophagi positioned in the centre of the *basilica*.

Analysis of the distribution pattern of individuals by age indicated that burials of adult individuals were dispersed evenly over the excavated section of the cemetery and not clustered by age. As mentioned above, non-adults were found mostly outside the *basilica* in the south-eastern part of the excavated area and to a lesser extent in the north-eastern part. Very young children were clearly underrepresented in the excavated section. The absence of normal proportions of children dying between birth and up to 5 years will be discussed in more detail below. The underrepresentation of this age category and the low proportion of non-adult burials between 5 to 20 years in this sample both imply that burial in this section of the cemetery was predominantly reserved for adult individuals.

The clustered distribution of individuals with lambdoid ossicles in the various sections of the cemetery suggests that genetic relations may have determined the place of burial within the cemetery. Other factors are known to have an effect on the formation of lambdoid ossicles, and the interpretation of this epigenetic trait as an indicator is not without discussion. Still, the distribution of individuals with and without this trait might provide an opening to determine genetic relations within the cemetery. In the future this may possibly be tested by means of ancient DNA analysis.⁶⁸⁸ Skulls could only be inspected in individuals buried outside the church or in the southern annexe. Therefore the analysis of the spatial distribution of this epigenetic trait is limited to these parts of the cemetery. Overall the *basilica* sample comprised a relatively large number of individuals with lambdoid ossicles (viz. 14 out of 35, 40 per cent).

⁶⁸⁸ For an example of a study focusing on the genetic relations in cemeteries by means of aDNA analysis see Gerstenberger, 2002.

FIGURE 7-16 Plan of the distribution of individuals by age at the *basilica* phase cemetery

FIGURE 7-17 Distribution of skulls in the *basilica* phase cemetery 1 skulls without lambdoid ossicles, 2 skulls with lambdoid ossicles, and 3 individuals with trauma by sharp bladed objects. The absence of a symbol indicates no skull remains were found.

Cluster	N inspected	Lambdoid ossicles	Males	Females
N-E	9	4 (44%)	4/4	0/5
S-E	9	8 (89%)	3/3	5/6

TABLE 7-14 Distribution of lambdoid ossicles in the two main clusters

All individuals with lambdoid ossicles were either buried in the northeast cluster (4 out of 9, 44 per cent) or the southeast cluster (8 out of 9, 89 per cent) or the southern annexe (1 out of 4 in situ burials, 25 per cent). No lambdoid ossicles were found in any of the individuals buried along the walls of the *basilica* (8 individuals with skulls). In the northeast cluster there was a clear division between the males and females regarding the presence of lambdoid ossicles. All four male skulls had one or more lambdoid ossicles, while none of the five female skulls had any lambdoid ossicles.⁶⁸⁹ In the southeast cluster almost all males and females had lambdoid ossicles, only one female skull had none. Since the presence of lambdoid ossicles is thought to be determined both by genetic and environmental factors⁶⁹⁰, it seems plausible to interpret the specific distribution of this trait as an indication that relatives, possibly members of the same family, were buried together in private areas of the cemetery. In this respect it is of interest to note that lambdoid ossicles were present in all males of both the northeast and the southeast clusters. It is tempting to consider that the males were genetically related and were members of one or two families exerting hereditary rights to be buried in close proximity to Saint Servatius. Whether there was a genetic relation between the two clusters cannot be determined on the basis of the present evidence. The difference in the layout of these two clusters of graves, one organised in formal rows, the other in partially intersecting graves, suggests that at least two different groups used these separate areas of burial.⁶⁹¹ In this context it is also noted that the individuals with trauma caused by sharp bladed objects were also found exclusively among the burials in clusters with individuals with lambdoid ossicles. Three individuals with such trauma were buried close to each other in the southeast cluster and the southern annexe.

Burial close to the choir inside a church was often reserved for secular and clerical individuals of high standing.⁶⁹² It is assumed that burial outside the church, near the main altar and choir, was still a prestigious burial location for laypersons.⁶⁹³ Therefore, the combined results concerning spatial distribution by sex, age, presence of lambdoid ossicles and sharp-bladed trauma support the hypothesis that the areas north and south of the eastern choir were

⁶⁸⁹ The occurrence of lambdoid ossicles in the males of the north-eastern cluster could be interpreted as an indication that genetically related males from one family were buried here together with females from other families. This could be interpreted as the burial of a male line of descendants with spouses who came from other families.

⁶⁹⁰ Hauser and De Stefano, 1989, p. 5-11; Barnes, 1994, p. 140-141; Najjar and McWilliams, 1978, p. 129-131.

⁶⁹¹ When it can be established that the two burial clusters were not contemporaneous it is also possible that the difference in layout was the result of changing views concerning the spatial organisation of graves. However, at present there is no indication that the burials in the clusters were not contemporaneous.

⁶⁹² See for example the situation in the monastic church of Reichenau (Germany), Hassenpflug, 1999, p. 73 and p. 227-228.

⁶⁹³ Ariès, 1977; Chélini, 1991 and Effros, 1994.

predominantly used as a burial ground for adult members of two or more families of above average socio-economic status. The traumas by sharp bladed objects found in some of the males buried in these sections of the cemetery suggest that these families or groups may have been involved in armed conflict.⁶⁹⁴

CONCLUSION

The construction of a new church building in the *basilica* phase was accompanied by a change in the layout of the cemetery. At the time of the construction of the *basilica* and shortly thereafter there was a short phase where a group of 18 limestone sarcophagi was buried inside the church around the cancella. These changes tied in with changes in the demographic composition of the population buried in this section of the cemetery. After the *templum* phase, during which females slightly outnumbered males, the *basilica* phase cemetery is characterised by a reversal of this situation. Males outnumbered the females by 10 per cent. Mean age at death slightly increased both for males and females with circa 4 to 3 years respectively. As a result mean age at death was slightly lower for females. With respect to stature, a more significant dichotomous development was noted. Mean male stature slightly increased to 174.2 centimetres, whereas the mean female stature decreased 4 centimetres to 161.5 centimetres. It is not clear whether this change in average stature is associated with changes in the living conditions of males and females respectively or the selection of females from another ethnic or socio-economic background. Another possibility might be that the proportion of females of high status in this area of the cemetery decreased due to burial elsewhere at the Servaas cemetery or in other cemeteries. Other general health indicators do not indicate that living conditions declined during the *basilica* phase. The prevalence of some pathological conditions probably increased due to the overall rise in longevity. In part this may also explain the relatively high prevalence of DISH. However, it seems likely that this was associated with improving living conditions, especially regarding the diet of these individuals. The increase in the number of teeth affected by caries could be considered a development in support of the notion that diet changed. Although part of the caries increase was a consequence of the higher mean age at death. The higher prevalence in caries and especially peri-apical abscesses will have contributed to the relatively high prevalence of chronic maxillary sinusitis. Whether fractures were also a sign of increased longevity is difficult to determine. The relative high number of fractures and injuries by sharp bladed objects suggests that males especially had a lifestyle that may have exposed them to a higher risk of contracting traumas than females. The distribution of sharp bladed trauma within the *basilica* phase cemetery indicates that certain groups of males within society were evidently at risk from being wounded or killed in armed conflict since all cases of sharp bladed trauma were found in groups of individuals with lambdoid ossicles buried in prestigious areas of the cemetery. It is possible that several of the males with cuts were

⁶⁹⁴ Le Jan describes how the gift of arms played a role in the life of aristocratic families: in Carolingian times young men, between circa 13 to 15 years of age, received their arms from their father or other relatives. Often members of the aristocracy received at that occasion or sometime thereafter the complete set of weaponry of a heavily armed cavalryman. Lejan, 1995, p.64 and 78.

genetically related. These burials were possibly associated with the ruling families in the region who were involved in armed conflict against internal and external adversaries.⁶⁹⁵

THE BOSCHSTRAAT CEMETERY

The Boschstraat area appears to have been inhabited for a relatively short period of time during the seventh and the early eighth centuries. As described in chapter three the Boschstraat sample consists of two types of inhumations found at this site: inhumations concentrated in a cemetery and burials dispersed over the excavated area in three clusters of two to five graves. The largest group of 45 inhumations was concentrated at the site of a small cemetery. Since very

FIGURE 7-18 Overview of burials at the Boschstraat cemetery. As explained in chapter 3 the three frames at the left side of the figure represent burial clusters found dispersed in the excavated area. The right section of the figure represents the cemetery

little of this section of the site was lost due to latter disturbances, this cemetery was excavated and recovered almost completely. The three dispersed clusters of graves consisted of 9 burials. Possibly there were more small clusters of inhumations in the areas that were not recovered. These separate clusters of burials were presumably graves positioned in the yards of houses. Unfortunately no house plans and only vague indications of yards could be recognised at the time of excavation. As a result little is known concerning the exact relations between the burials and the buildings and yards. All 54 individuals at this site were buried in trench graves. Six of

⁶⁹⁵ Maybe in the future the hypothesis that these individuals were genetically related can be tested by means of ancient DNA analysis.

these trench graves had a few stones at the head and/or foot end. Only in three graves were plain grave goods found in the graves. Because of the distribution of the graves among the remains of a settlement and areas used for the manufacture of various objects, we assume that the cemetery was used to bury the dead of the surrounding settlement. At the same time the simple grave types in combination with the manufacturing activities in the settlement were reasons to assume that the individuals buried at the Boschstraat site were of low status.

REFERENCE POPULATIONS

Since the burials and other archaeological features were dated to the end of the seventh and the early eighth centuries, the physical anthropological and palaeopathological results are compared with both the *templum* and *basilica* phase sample. Further comparisons were made with three populations used in the section on the *templum* sample that were also mainly dated to the seventh century: Rosmeer, a selection of the Saint Martin de Fontenay cemetery and the Saffig cemetery. None of the reference samples used for comparison with the *basilica* sample were used since these samples often consisted of a majority of ninth or tenth century burials.

Site	N	Non-adults	Male : Female	Mean age		Stature	
				Male	Female	Male	Female
Templum	78	14%	44% : 56%	38.6 yr	38.8 yr	172.7 cm	165.7 cm
Boschstraat	54	43%	20% : 80%	39.0 yr	42.0 yr	169.1 cm	160.5 cm
Basilica	83	13%	55% : 45%	43.1 yr	42.1 yr	174.2 cm	161.5 cm
Rosmeer	48	29%	50% : 50%	38.3 yr	35.0 yr	178.0 cm	161.0 cm
St. Martin 7th cent.	404	32%	40% : 60%			167.0 cm	155.1 cm
Saffig	280	33%	58% : 42%				

TABLE 7-15 Demographic data for the Boschstraat sample and five reference populations

PHYSICAL ANTHROPOLOGY AND PALAEOPATHOLOGY

In total 50 graves were excavated at the Boschstraat site. In six of these no human remains were present. The remaining 44 graves yielded the skeletal remains of 44 individuals. The remains of 10 individuals were additionally collected near these graves. The latter were recovered as articulated skeletal remains, lacking a recognisable burial context, close to the other burials. Because of the undisturbed nature of the cemetery and the burial in trench graves the mean recovery rate was relatively high: 0.32. This is the highest recovery rate calculated for the four samples in this study.

The Boschstraat cemetery was characterised by two phenomena: in comparison to the *templum* and *basilica* samples there was a relatively high percentage of burials in the non-adult category and an exceptionally high proportion of female burials. In particular, the high proportion of female burials is an indicator that the Boschstraat cemetery is different from other early medieval cemeteries. Because of this it will be difficult to analyse the demographical and pathological data from the Boschstraat cemetery. Below, the proportion of non-adult burials will be reviewed first, and secondly the unequal distribution of males and females will be discussed.

The burials of non-adults at the Boschstraat cemetery were partially clustered within the central cemetery. As this cemetery was more or less completely excavated, the concentration of children will not have biased the end-results. No further special cemeteries for children were found at this site. In addition, no child burials were recorded in the three dispersed clusters of burials. Non-adults were buried in the same type of graves. In contrast to what is sometimes expected⁶⁹⁶, non-adults were also buried at the same depth as adults. Therefore, it is unlikely that factors like grave type and depth of burial had a negative effect on the possibility to recover skeletal remains of non-adults. This seems to be supported by the fact that larger bones like the frontal bone of the skull, the os ileum or the femoral shaft were recovered in more or less the same percentages in non-adults and adults. Overall there are no indications that the proportion of non-adult burials was considerably biased due to factors related to the excavation strategy, burial ritual or differential decay. Nevertheless, it cannot be determined whether the number of non-adult burials reflects the actual number of deaths of non-adults in the settlement associated with the cemetery. If we neglect the uneven proportions of males and females in the cemetery the percentage of individuals dying before the age of 20 was 43 per cent. This is circa 10 per cent higher than the non-adult proportion in the reference samples from Rosmeer, Saint Martin de Fontenay and Saffig. Although non-adult mortality at the Boschstraat is within the margins found or expected for other early medieval cemeteries it is relatively high for a population that is further characterised by a high mean age at death and an average mean stature.⁶⁹⁷

FIGURE 7-19 The distribution of non-adult individuals from the Boschstraat by five-year age intervals (n=21)

⁶⁹⁶ Acsádi and Nemeskéri, 1970, p.239.

⁶⁹⁷ E.g. Zink, 1999.

Looking at the data presented below the relatively high number of non-adult burials was not the result of poor health conditions of the Boschstraat population. The distribution of non-adult deaths shows that the majority of children died between birth and five years of age. However, only two to three of these children died during the first year after birth. Generally the highest mortality is expected in the first year of life. Various authors consider this as an indication that individuals dying around birth and during the first year of life are missing from the sample and often they propose to correct for this deficit.⁶⁹⁸ However, Brothwell has reasoned that much of the mortality variation may still reflect demographic fact.⁶⁹⁹ He suggests that changes in the occurrence of specific diseases and fluctuations in environmental stress were the principal causes of differences in child death group composition.⁷⁰⁰ In addition Molleson has argued that demographic trends like slow population growth and small family size may also have contributed to low mortality rates for children between birth and two years.⁷⁰¹ Recently Kölbl indicated that infant mortality in early medieval cemeteries was for a large part determined by fertility.⁷⁰² She has elaborated on the notion that for a high number of infants in a cemetery population, one not only assumes a high rate of infant mortality but also a high number of births. According to palaeodemographical literature, the observed fertility was low in early medieval Europe because the early medieval population in Western Europe was growing at a slow rate.⁷⁰³ A possible factor contributing to this low fertility rate was discussed by Riddle, who presented evidence that some forms of birth control applied in the late Roman and medieval period may have been effective.⁷⁰⁴ For the Maastricht population there are no reasons to assume that the growth rate was higher than in contemporary places and that likewise the birth rate was low.

From a palaeopathological point of view there is no evidence that children born in Maastricht were relatively more exposed to physical stress and a high disease load. The skeletal remains of non-adults and adults from the Boschstraat show no signs of elevated pathological strain during the growth period.⁷⁰⁵ A study of the age at weaning of individuals excavated at the Pandhof site suggests that weaning in early medieval Maastricht occurred at two to four years of age.⁷⁰⁶ Late weaning is considered to result in a lower death rate during the first year of life.⁷⁰⁷ These weaning practices possibly contributed to the survival of a higher proportion of infants and so to a low infant mortality rate.

⁶⁹⁸ Bocquet-Appel and Masset, 1982; Guy et al., 1997; Zink, 1999, p. 53;

⁶⁹⁹ Brothwell, 1987, p. 136.

⁷⁰⁰ Brothwell, 1987, p. 135.

⁷⁰¹ Molleson, 1991.

⁷⁰² Kölbl, 2004.

⁷⁰³ In written sources Le Jan signals an increase of the number of children surviving into adulthood from 3.4 in the seventh century to 4.3 in the tenth century, Le Jan, 1995, p. 339-340.

⁷⁰⁴ Riddle, 1994.

⁷⁰⁵ Low rates of *cribra orbitalia*, rickets, enamel hypoplasia and infectious disease.

⁷⁰⁶ Merckx and Panhuysen, 2004.

⁷⁰⁷ Hühne-Osterloh and Grupe, 1989; and Dupras et al., 2001.

It must be acknowledged that it cannot be ruled out that some burials of very young children (between birth to 1 year of age) were not preserved or not recovered.⁷⁰⁸ However, because of the archaeological circumstances and the demographical and pathological conditions we may assume that the excavated number of non-adults at the Boschstraat was largely representative for the number of non-adult burials at this cemetery. Whether the proportion of non-adult burials at the cemetery was representative for the proportion of non-adult deaths in comparison to adult deaths is less evident. Comparison with non-adult mortality figures from other sites is hampered by the uncertainty about the representation of adults in the cemetery. For an evaluation of non-adult mortality in relation to the situation at other sites we first have to examine the representativeness of adult burials in the cemetery.

The nature of adult mortality can be studied by looking at the male-female ratio. As is visible in Table 7-15 the sexes were not in balance in this cemetery. This is in contrast with other rural early medieval cemeteries. In an extensive study of funerary customs in the northern part of the French Alps, Colardelle found that the number of males and females was generally in balance (mostly at rural cemeteries) or that males outnumbered females (mostly when a church was present).⁷⁰⁹ There seem to be three plausible explanations for the fact that female burials outnumbered male burials (6 males and 24 females). This could be the result of an actual overrepresentation of females in the living population. Other explanations would be: a predilection for burying females from other settlements at the Boschstraat cemetery, or "large-scale" burial of males from the Boschstraat settlement in another cemetery. We could formulate these explanations as: female overrepresentation at the site, funerary immigration of females and funerary emigration of males. Combinations of these processes may have occurred too. The available evidence suggests that the funerary emigration of males provides the best explanation for the male-female ratio.

Regarding the nature of the site there was no indication that structurally more women than men inhabited the settlement. Apart from monastic sites there are few communities with a similar preponderance of female burials. Given the context of the cemetery it is unlikely that the Boschstraat settlement was associated with a nunnery. The various remains of the manufacture of bone, metal and glass objects suggest that activities associated with males occurred at the site. There is no reason to assume these males did not live in this settlement. Concerning the possibility of preferential burial of females at the Boschstraat cemetery there is no independent evidence for such a trend. It is unlikely that a low status cemetery like the one at the Boschstraat site would be selected for preferential burial of females from elsewhere. It is also implausible that the high number of females in the cemetery was solely the result of preferential burial of females from other settlements at the Boschstraat cemetery. In that case the expected number of males would have been larger than the number of non-adults. In my view a considerable number of males from this community were not buried at the Boschstraat

⁷⁰⁸ Several authors have noted that during many years of archaeological research few to none alternative burial locations for newborn infants have been recovered, Kölbl, 2004.

⁷⁰⁹ Colardelle, 1983, p. 138; Buchet and Olive, 1983, p. 421 and Young, 1999, p. 81.

cemetery. Since none of the examined early medieval burial sites in Maastricht was characterised by overrepresentation of males it is unknown where these males were buried.⁷¹⁰

Whatever the causes of the skewed sex ratio and its effect on the proportion of non-adult burials the fact remains that the composition of the Boschstraat cemetery population differed considerably from all reference populations. It is possible this also affected the mean age at death and mortality profiles. Despite the small sample size, male mean age at death was four years lower in comparison to the *basilica* sample, but in comparison to the *templum* sample and the Rosmeer cemetery the difference was negligible. Female mean age at death was relatively high and showed more variation among the reference populations, viz. the females from the Boschstraat sample lived on average about one year less than the females from the *basilica* sample (table 7-16). They lived about two years longer than the females from the *templum* sample and six years longer than the females buried at Rosmeer. The difference with Rosmeer is surprising since several of the graves at this site contained more prestigious grave goods than were found at the Boschstraat cemetery.⁷¹¹

FIGURE 7-20 Bar chart of adult mortality (n=20) in the Boschstraat sample. Columns represent the number of deaths in the respective ten-year age intervals.

The mortality profile of the Boschstraat sample differs in two aspects from common mortality profiles. Firstly there was a high mortality in the age interval between 20 to 30 years and secondly there was the low mortality in the 40 to 50 years age interval. Small sample size will have contributed to the peculiarities of this mortality profile and the following suggestions

⁷¹⁰ Two possible explanations for burial in other cemeteries might be: preferential burial at other cemeteries in the vicinity for reasons in the social and cultural domain and migration of males to other sites. At present there are no data available which support or refute either of these explanations.

⁷¹¹ Roosens et al., 1976.

should be considered as hypothetical. Burial customs may have determined the composition of the cemetery population. Unlike the situation in the Boschstraat sample, elsewhere mortality is often low in the 20 to 30 year age-interval. Explanations for the large number of deaths in this category include preferential burial at this cemetery for individuals dying in this age interval or preferential burial elsewhere of individuals dying in all other intervals, and especially in the 40 to 50 year age interval.

Mean stature of the five males from the Boschstraat sample was considerably lower than in the *templum* and *basilica* samples.⁷¹² This suggests that the males from the Boschstraat sample had less favourable living conditions during growth than the males from the *templum* and *basilica* sample. Males from Saint-Martin de Fontenay were slightly less tall; those from Rosmeer were almost 10 centimetres taller.⁷¹³ Mean female stature for the Boschstraat, the *basilica* and Rosmeer samples all ranged within one centimetre. Females at Saint Martin de Fontenay were on average 5 centimetres shorter; those of the *templum* sample were 5 centimetres taller than the females from the Boschstraat. Mean stature for females from the Boschstraat, the *basilica* sample and Rosmeer does not indicate that among these samples there were considerable differences in living conditions during growth. However, the females of the *templum* sample were significantly larger, which suggests that the females buried at the Boschstraat cemetery were raised under less privileged conditions than those of the *templum* sample. The rank order for mean female stature among the reference populations differs from the rank order for mean age at death. Stature is an indicator of living conditions during growth, whereas mean age at death is more likely to be determined by circumstances during the whole life span. Therefore, the variation in rank orders by mean stature and mean age at death may have been the result of shifts in living conditions from youth to adulthood. Given the short period of use of the settlement and its cemetery it should be taken into consideration that "demographic founder effects" had an impact on the composition and the characteristics of the population. When the population settled at the Boschstraat site it possibly consisted of a number of adult females who lived under less favourable conditions during youth but enjoyed better living conditions during their adult life. As a result their age at death would have been higher, but their stature would have been lower.⁷¹⁴

HEALTH

When we compare the results for *cribra orbitalia* with the results for stature in the Boschstraat sample and three reference samples, these health indicators do not indicate that one single trend might explain the variation between the parameters. The prevalence for *cribra orbitalia* in the Boschstraat sample was lower than in the *templum* and the *basilica* samples.

⁷¹² As mentioned in chapter six this difference was statistically significant despite the small sample sizes.

⁷¹³ However, it is recalled here that the large difference between the Boschstraat sample and the Rosmeer sample may be partially a result from the application of different regression formulas to calculate stature.

⁷¹⁴ However, the atypical composition of the buried population may have contributed to the occurrence of this discrepancy.

Site	N	Cribra orbitalia	Enamel hypoplasia	Formation rate of Harris lines
Templum	78	17%	39%	0.15
Boschstraat	54	7%	50%	0.18
Basilica	83	15%	24%	0.20
St. Martin 7th cent.	404	19%		

TABLE 7-17 Prevalence of cribra orbitalia and enamel hypoplasia and the formation rate of Harris lines in the Boschstraat sample and reference populations

This suggests that with respect to conditions associated with anaemia the living conditions during growth were more favourable for the Boschstraat population than for the *templum* and *basilica* samples. However, this might not have been the case for all aspects of health during growth, as seems to be evident from the higher mean adult stature of the females in the *templum* and *basilica* samples. If we take two other parameters into account the general image of health during growth does not become clearer. Slightly more individuals at the Boschstraat site had linear enamel hypoplasia, but all cases were light to moderate. Moreover, both the percentage of individuals with Harris lines and the formation rates of Harris lines were lower than in the *basilica* sample and slightly higher than in the *templum* sample. In the cemetery of Saint-Martin de Fontenay the general health situation appears to have been less favourable. Not only did relatively more individuals at this cemetery have cribra orbitalia, they also had a lower mean stature for males and females.

Fractures per inspected long bone	1% (3/266)
Individuals with temporomandibular joint osteoarthritis	14% (3/21)
Individuals with vertebral osteoarthritis	11% (2/18)
Individuals with degenerative disc disease	60% (12/20)
Individuals with diffuse idiopathic skeletal hyperostosis	10% (2/20)
Individuals with periostitis	17% (4/24)
Individuals with chronic maxillary sinusitis	37% (7/19)

TABLE 7-18 Selected palaeopathological results for the Boschstraat sample

As in the *templum* sample, fractures were an uncommon finding at the Boschstraat site. There were no fractures in the lower extremities. All three fractures of the long bones were found in the ulna. Six other fractures were found in the hand, the mandible, a vertebra and three fractures in the clavicle. Overall the frequency and the distribution of the fractures were more similar to the *templum* sample than to the *basilica* sample. Injuries due to cuts with sharp bladed objects or injuries from piercing objects were not found in this cemetery. Of interest might be the relatively high prevalence of temporo-mandibular joint osteoarthritis (TMJOA). In comparison to the *templum* and *basilica* samples this condition was found twice as often in the Boschstraat population. The sample size is too small to draw any definite conclusions, but it is tempting to consider the nature of the diet as a possible factor contributing to this prevalence. The

prevalence of vertebral osteoarthritis (VOA) and degenerative disc disease (DDD) was low in comparison to the *templum* and *basilica* samples. For vertebral osteoarthritis this was also the case when the prevalence was compared per age category. This renders it unlikely that the prevalence of vertebral osteoarthritis was low because of a lower mean age at death. At present we have no explanation for the low prevalence of these two conditions. Apparently some aspects of the activities and diet of the Boschstraat populations had a mitigating effect. Also for DISH the Boschstraat population was characterised by a relatively low prevalence. For a population which we assume was of low status this was not surprising since DISH is generally associated with the lifestyle and diet of individuals of high social status. The prevalence of periostitis (17 per cent) was just below the prevalence found for the *templum* sample. An explanation for the variation in prevalence between the samples is presently lacking. Chronic maxillary sinusitis was found to be less common (37 per cent) than in the *templum* and the *basilica* samples. For a great part this will have been a consequence of the relatively low frequencies found for peri-apical abscesses and ante-mortem tooth loss.⁷¹⁵

Site	N	Caries	Abscesses	AM loss
<i>Templum</i>	78	8%	5%	13%
<i>Boschstraat</i>	54	11%	4%	12%
<i>Basilica</i>	83	12%	9%	17%
<i>St. Martin 7th cent.</i>	404	7%		11%

TABLE 7-19 Prevalence of caries, peri-apical abscesses and ante-mortem tooth loss (all calculated per inspected element or position) in the Boschstraat sample and reference populations

As discussed above the caries percentage in the Boschstraat sample was almost as high as that of the *basilica* sample, whereas the percentage of ante-mortem tooth loss was relatively low which was more in line with the results for the *templum* sample. The results suggest the diet consumed by the Boschstraat site population created a risk of developing caries and may have been similar to the diet of the *basilica* sample. This would still leave the lower prevalence of peri-apical abscesses and ante-mortem tooth loss unexplained. Usually a higher caries rate also results in a higher rate of ante-mortem tooth loss.⁷¹⁶ The fact that fewer carious teeth seemed to have caused periapical abscesses in the Boschstraat population may have been related to the consumption of more abrasive foodstuffs. The consumption of less refined food possibly caused more attrition on the occlusal surface of the dentition and prevented the development of carious lesions on this surface.⁷¹⁷ Fewer carious lesions in the occlusal surface probably lead to

⁷¹⁵ If housing conditions and exposure to polluted air were an important factor, then the Boschstraat population with their manufacturing activities would have been expected to have an above average prevalence of chronic maxillary sinusitis.

⁷¹⁶ In the Saint-Martin de Fontenay cemetery both caries and ante-mortem tooth loss were lower.

⁷¹⁷ For a description of this process see Maat and Van der Velde, 1987.

fewer peri-apical abscesses and less ante-mortem tooth loss.⁷¹⁸ As a result of the lower rate of infections of the jaw fewer infections of the maxilla occurred and therefore, fewer cases of odontogenic chronic maxillary sinusitis. The caries prevalence was not the only characteristic of the dentition shared by the Boschstraat population and the *basilica* sample. Also the prevalence of calculus in both populations was similar. And unlike the *cella* and the *templum* samples the prevalence of calculus in males and females was in balance in the Boschstraat population as well as in the *basilica* sample.⁷¹⁹

SPATIAL DISTRIBUTION

The spatial distribution of males and females in the cemetery shows that the few males buried at this cemetery were fairly evenly distributed. Two were found in the dispersed clusters, four others were lying in the cemetery. One of the male skeletons was positioned in a trench lined with some stones. This burial was surrounded by at least six graves of non-adult individuals.

FIGURE 7-21 Plan of the distribution of burials of males and females at the Boschstraat cemetery. 1 = female, 2 = male, 3 = non-adult, 4 = adult individual of undetermined sex.

⁷¹⁸ The distribution of carious lesions is expected to be different between the Boschstraat sample and the *basilica* sample. The data on the exact position of carious lesions will be analysed at a later stage when the results of more individuals are available, after conclusion of the study of the Pandhof and Vrijthof samples.

⁷¹⁹ Boschstraat sample: males 75 per cent – females 81 per cent; *basilica* sample: males 88 per cent – females 86 per cent.

These graves were surrounded by a vacant zone of circa 7 metres and seemed to form a separate cluster north west of the nucleus of the small cemetery. More non-adult graves were found in the rest of the cemetery. In four instances young children were buried at the foot end of an adult female. It is tempting to assume there was a genetic relation between the adult females and the non-adult buried in or near their grave. In the future this might be examined by means of aDNA analysis.

FIGURE 7-22 Plan of the distribution of individuals by age at the Boschstraat cemetery

The spatial distribution by age shows that in the dispersed burial clusters both young children and adults up to old age were represented. In the cemetery it is apparent that the small cluster of non-adults surrounding the grave of a young adult male consisted only of children under the age of ten years. In the rest of the cemetery no concentrations of specific age groups were recognised. The two north-south orientated graves contained the in situ remains of a female and an individual of indeterminate sex. The spatial distribution by sex and age provides no clues aiding in the explanation of their unusual orientation. These graves, together with an empty grave and some disarticulated remains; appear to be surrounded by a vacant area. This area was possibly empty because of the presence of a structure on top of the grave. In that case we could think of some sort of founder grave covered by an earthen mound, which was not uncommon in rural cemeteries.

CONCLUSION

The most striking characteristic of the Boschstraat sample is the overrepresentation of females in the sample which may have been the result of preferential burial of a considerable number of males at one or more other cemeteries. Both the dispersed clusters of burials and the central cemetery show no evident differences regarding distribution by sex and age. In many general health aspects the Boschstraat cemetery population resembled the skeletons from the *basilica* sample. However, with respect to important health parameters like mean adult age at death and stature the Boschstraat population scored slightly lower.

PREFERENTIAL BURIAL AND FUNERARY MIGRATION

In the following section of this chapter some of the results and findings that transcend the discussion of separate phases or samples will be reviewed. As indicated above, in some instances the demographical data from the samples seem to represent a selection of the living population. Obviously it was not expected that the cemetery population was a direct reflection of the complete living population of early medieval Maastricht. For example Waldron and Hoppa have stressed the fact that cemetery populations consist of the non-survivors of a living population. Several factors, varying from burial customs to procedures of excavation (and treatment) of skeletal remains, are known to reduce the possibilities of gaining knowledge about the living population.⁷²⁰ In addition we know from contemporary written sources that preferential burial may have resulted in the burial of individuals in cemeteries at some distance from the place where they lived and died. As referred to above, this was not unusual for royal burials and has been considered a possibility for other high status burials as well.⁷²¹ An example of this practice related to Maastricht is the burial of bishop Lambertus of Maastricht. After Lambertus was murdered in Liège, an event that is thought to have taken place around 700 AD, Lambertus was buried in Maastricht. And later his successor transferred his remains to Liège. Sometimes testaments from the Carolingian nobility provided detailed instructions concerning the place of burial. Treffort mentions an example of far-reaching provisions to assure that they would be buried at a preferred location. In 876 AD count Heccard from Autun indicated in his will that he wanted to be buried at the monastery of Fleury-sur-Loire. The count even provided for the possibility that his body could not be transferred to the monastery. In his will he requests that in that case his bones should be transferred to the monastery "when the right time had come".⁷²² The custom to bury selected persons at specific burial sites was thought to occur on a small scale at sites like important churches and monasteries. In addition, various elite families built and owned private churches or were involved in the administration and funding of monasteries. As a consequence, members of the elite were often buried in or near these churches or monasteries.⁷²³ Written sources provide no evidence that individuals of low social

⁷²⁰ E.g. Waldron, 1994, p.12-21; Hoppa, 1996 *passim*.

⁷²¹ Chélini, 1991, p.483.

⁷²² Cited after Treffort, 1996, p. 176 note 54: "quando oportunitatem tempus venerit".

⁷²³ See various passages in Treffort, 1996 and Hassenpflug, 1999.

status were buried at other burial sites than the local cemetery. Various normative sources like the resolutions from church councils and instructions for parish priests indicate that people should be buried at the cemetery of their parish. In the same texts it was decreed that only members of the clergy and some very privileged persons could be buried inside a church. Other areas outside the church were also reserved for high status burials. These were locations like the *atrium*, the *portico* or along the walls of the church (*sub stilicido*).⁷²⁴

Hitherto, few medieval cemeteries from one conurbation have been studied and published in a way that allows conclusions on the selection of burial sites by the deceased or their next of kin. Both in Lund (Sweden) and York (Great Britain) physical anthropological and palaeopathological data from several medieval cemeteries were collected. For medieval Lund (990-1536 AD) Arcini found that in the examined cemeteries the age and sex distribution did not vary between the cemeteries.⁷²⁵ In medieval York the mortality profiles and sex ratios of the examined medieval cemeteries did not imply that large groups of individuals were buried at cemeteries outside their parish, or in the case of monks and Jews, at cemeteries other than those associated with their communities.⁷²⁶ In York variation in burial location for groups by social status appeared to have occurred predominantly within the cemetery. In at least one cemetery in York it was possible to discern areas that were used by groups differing in social status.⁷²⁷

Based on early medieval written sources it was expected that burial preferences of high social status groups would have played a role in the layout and composition of the Servaas and the Boschstraat cemeteries. This was especially true for the Servaas cemetery, since this cemetery was situated at the spot where the local population and religious institutions assumed Saint Servatius was buried. At least since the sixth century the veneration of this saint brought about the construction of a church and this site became the focus for an increasing number of *ad sanctos* burials, generally a privilege for individuals of high social status. The use of expensive tuff stone sarcophagi, limestone sarcophagi and precious grave-goods in some graves are considered reflections of the high social status of the burials. In our samples the demographical data of the *templum* and *basilica* phase cemeteries and the Boschstraat cemetery differed from the data cited for various reference cemeteries.⁷²⁸ Differences were

⁷²⁴ Chélini, 1991, p. 484-485 and Treffort, 1996 p. 147-148. See also Hassenpflug, 1999, *passim*, Effros, 1997.

⁷²⁵ Arcini, 1999

⁷²⁶ Publications of medieval cemeteries from York are: the parish cemetery of St. Helen-on-the-Walls Dawes and Magilton, 1980; the Jewish burial place Jewbury Lilley et al., 1994 and the cemetery at St. Andrew Fishergate used to bury monks and lay people Stroud and Kemp, 1993. All of these cemeteries appear to be used to bury predominantly the dead of communities associated with these cemeteries. For the Jewbury burial place it is noted that members of the Jewish communities from York, Lincoln and possibly two other places were buried at this cemetery in the thirteenth century.

⁷²⁷ For a study of social status groups within the St. Helen-on-the-Walls cemetery see Dawes and Magilton, 1980, Grauer, 1989 and recently Sullivan, 2004.

⁷²⁸ The burials from the *cella* phase were not included in this discussion because of the small number of graves. The available data, e.g. the burial of males and females in pairs of graves, were not suggestive of preferential burial of either males or females or of individuals from specific age categories. Furthermore, a considerable proportion of the cemetery population consisted of non-adult burials (26 per cent of 23 individuals) during this phase. Given the context and the position of this section at the margins of the late

observed for three demographical parameters: the male-female ratio, the percentage of non-adults in the cemetery and the general mortality distribution. Furthermore, the clustering of individuals by sex and the non-random distribution of certain trauma at the Servaas church site suggest burial preferences may have had an impact on the structure of the cemetery.

THE SERVAAS CHURCH SITE

During the *templum* phase (circa 480-700 AD) the area covered by the excavation trenches became the centre of the cemetery. For this phase the demographical data differ from what might be expected if a cross-section of the population had been buried in this part of the cemetery. Slightly more females than males (25 females and 20 males) and relatively few non-adults (14 per cent of 78 individuals) were buried here. The low proportion of graves of children under the age of two years in particular suggests that the non-adult age category was under-represented in the sample and that the area around the church was predominantly reserved for adult burials.⁷²⁹ The preliminary results of the physical anthropological examination of the skeletal remains from another section of the Servaas cemetery (viz. the Pandhof site) indicate that in this section a larger proportion of non-adults was buried.⁷³⁰ This might compensate the low proportion of non-adult burials in the centre of the cemetery. In that case preferential burial within the cemetery also affected the demographical composition of samples from different areas within the cemetery. Another aspect of the mortality distribution in the *templum* sample was the slight under-representation of individuals dying at an older age (50 years and more). This could be an indication that, like very young individuals, older individuals did not receive high status burials as often as individuals between 30 to 50 years.⁷³¹ A comparable phenomenon was recognised in the distribution of grave-goods in contemporary cemeteries from the region of Metz. Halsall found that in that region individuals of 50 years or more received fewer and less prestigious grave-goods.⁷³² In this view it might be noteworthy that during the *templum* phase slightly more females than males were buried in prominent locations, in expensive grave types and with precious grave-goods. However, the numerical difference between male and female burials was small and we do not know the male-female ratio in other sections of the Servaas

Roman cemetery we assume that the cella sample consisted of inhumations from local Christians and that preferential burial was not manifest in this cemetery.

⁷²⁹ Ulrich-Bochsler described a similar trend in a collection of skeletal samples from church excavations from the Bern area. She found that during the early medieval period, burials of children dying between birth and the first year were under-represented. After 1000 AD she noted an increase of the burial of fetuses and newborn infants in and close to a church. Ulrich-Bochsler, 1997p. 143-144

⁷³⁰ This statement is based on the preliminary results from the physical anthropological examination of human skeletal remains from the Pandhof site. At the time of writing this study is carried out within the framework of the Saint Servatius project by E. Smits and R. G.A.M. Panhuysen. Detailed percentages are at the time of writing not yet available since no concluding information on the exact dating of individual graves is available. After analysis of about 200 individuals, non-adult mortality was circa 40 per cent

⁷³¹ It is recalled here that at the Boschstraat cemetery the proportion of deaths in the age categories above 50 years was higher than might be expected.

⁷³² For the association between grave-goods and age in the region of Metz during the Merovingian period see Halsall, 1995, p. 83-86, *passim* and 254.

cemetery or inside the church. For preferential burial in different areas *within* the Servaas cemetery there was unambiguous evidence: the under-representation of non-adults in the area close to the church in combination with the higher proportion of non-adult burials in the area covered by the Pandhof site and the presence of two concentrations of female burials in the *templum* phase cemetery. As described above the area close to the church is known to be a high status burial location. The age and sex distribution in this section of the cemetery indicate that age and sex of the deceased were important criteria whether an individual would be buried at this location.

During the *basilica* phase (circa 700-950 AD) the cemetery was also characterised by an under-representation of non-adults (13 per cent of 83 individuals). As indicated for the *templum* phase this may have been compensated by burial of non-adults in other sections of the Servatius cemetery. The distribution of adult mortality did not indicate that specific age categories were under-represented. Unlike the situation in the *templum* phase, males slightly outnumbered females during the *basilica* phase (31 males and 25 females). Perhaps this was the result of the inclusion in the sample of burials from inside the church. Burial in the church was even more esteemed than burial close to the church, since the right to be buried inside the church was reserved for clerics and select laymen.⁷³³ Corroborating evidence for the high status of burials in- and outside the church was the frequent use of special grave types. At least 35 limestone sarcophagi and 7 stone-built tombs were utilized at the Servaas church site during the *basilica* phase. The available data suggest that females were rarely buried in limestone sarcophagi or inside the church. Evidence for the occurrence of preferential burial in the *basilica* phase cemetery thus consisted of the under-representation of non-adults in the area around the church and the possible absence of female burials inside the church.

In conclusion, preferential burial within the Servaas church site samples was not documented in the *cella* phase. However, the archaeological and demographical data indicate that in the *templum* and *basilica* phase samples preferential burial seems to have been an important factor. What could not be established is whether there was an actual influx of burials from individuals outside the local community and to what extent this may have affected the demographical composition of the cemetery. As mentioned before, written sources indicate that monasteries and important ecclesiastical centres were appealing sites to be buried. Therefore, it seems plausible that the Servaas cemetery also attracted high status burials from members of the elite living in the Meuse Valley or possibly even further away. Detailed genetic and provenance studies using ancient DNA and stable isotope analysis may in the future provide more information on this matter.

THE BOSCHSTRAAT SITE

With respect to the sex ratio, the Boschstraat cemetery differed considerably from what was expected. Since this cemetery is thought to have been associated with a community of low status craftsmen and their families it was presumed that the proportion of males and females in the cemetery would be in balance. Instead, males were considerably under-represented in the

⁷³³ Hassenpflug, 1999 and Treffort, 1996.

sample: in comparison to a balanced representation about 75 per cent of the males (circa $n=18$) were missing from this cemetery. Not one of the reference populations in chapter 7 or any of the six rural and urban cemeteries from Normandy and Poitiers (fourth to tenth centuries) displayed similar disparate sex ratios.⁷³⁴ As discussed above it is assumed that the missing males were systematically buried at another cemetery in Maastricht or its surroundings. At the Boschstraat cemetery the proportion of males buried at another cemetery exceeded the scale of preferential burial on an individual basis and resembled a type of funerary migration. Other explanations for the absence of a proportion of male burials could be that this was the result of selective migration of males during life, a disproportionate susceptibility to epidemic disease of females or the death elsewhere of male combatants in armed conflict. All three alternative explanations cannot be disqualified categorically, but there are reasons to consider some as less probable. Least plausible is the hypothesis that the cemetery represents the victims of an epidemic disease. The layout of the Boschstraat cemetery does not suggest that it was created in a single short episode. In case of an epidemic disease, we might expect more collective burials and contemporaneous graves sharing the same orientation. In addition, epidemics are rarely so selective that they cause such marked differences in male and female mortality.⁷³⁵ The traces of activities associated with the manufacture of glass, metal and antler objects in the Boschstraat settlement argue against the long-term absence of males due to migration. Written sources indicate that most of the activities related to early medieval craftsmanship seem to have been carried out by males.⁷³⁶ The activities related to crafts in the Boschstraat site area may therefore be seen as an indication of the presence of males in the community living at this site. Death in armed conflict or during occupational activities away from the settlement might be a plausible explanation for male under-representation on a small scale. However, so many males are missing from the cemetery that this becomes a less probable explanation, especially given the fact that armed conflict was mostly between individuals of intermediate and high social status.⁷³⁷ What then caused this funerary migration is unknown; neither do we know precisely what the alternative locations for burial were. As indicated in chapter three the existence of a considerable number of early medieval cemeteries in Maastricht is known through historical records, isolated finds and excavations. Until now none of the excavated cemeteries indicate overrepresentation of adult males. The data from the Boschstraat cemetery suggest that burial outside the local cemetery was not only a privilege for a small number of individuals of above average status. Apparently this practice may also have been part of the burial ritual in individuals of lower status.

⁷³⁴ Alduc-le Bagousse and Sansilbano-Collilieux, 1991, p.89.

⁷³⁵ On the susceptibility and resistance to six common infectious diseases see Cliff et al., 1998 p.95-96. Analysis of epidemiological data on these diseases show no difference in susceptibility and resistance between males and females.

⁷³⁶ This is not explicitly stated in contemporary sources, however those accounts mentioning names or gender of craftsmen indicate these were males. See Roth, 1986 *passim*.

⁷³⁷ For to bear a sword and to partake in armed conflict a person generally had to be a free man and have sufficient means to have weapons, armour and horses. Le Jan, 2000, p. 282.

COMPLEMENTARY CEMETERIES IN MAASTRICHT

As described above the cemetery population of the Boschstraat site showed differences in the demographical composition that suggest that this cemetery did not include all deaths in the population and did not represent a cross section of mortality in the local population. On the basis of the present indications for preferential burial and funerary migration a system of complementary cemeteries in early medieval Maastricht and surroundings may have existed.⁷³⁸ The distribution of grave-goods could be taken as a lead, how to interpret this burial practice. Grave-goods are no longer exclusively seen as personal belongings of an individual. The interpretation of grave-goods has become more complex. It is recognised that they can be the expression of a variety of burial customs and in addition may be statements of the relatives of the deceased. Although the grave type and the location of the grave are less often interpreted within the same contextual framework, these aspects too are a reflection of burial customs and statements of the deceased. In an article on settlement patterns and burial practices Theuws has argued that the relatives of a deceased had in some cases a range of options for the location of the burial.⁷³⁹ Possible burial places in rural settlements during the late Merovingian period were: isolated graves or small clusters in the farmyard, rural cemeteries without a church, cemeteries originating around early churches in the region or important cult centres outside the region.

For the groups living in and around Maastricht similar options for burial existed. At the Boschstraat site we see both small clusters of burials in the yard and burial at a settlement cemetery. Cemeteries like those of nearby Rosmeer and Borgharen may also have belonged to a system of complementary cemeteries in and around Maastricht. The cemeteries of Rosmeer and Borgharen may have been associated with an estate or one or more rural settlements. The main Vrijthof cemetery is more difficult to categorise since this cemetery partially resembles a cemetery like those frequently found in rural contexts. In case of the Vrijthof cemetery, the vicinity of the Sint Servaas church and its surrounding Servatius cemetery may have affected its use.⁷⁴⁰ The cemetery at the Lage Kanaaldijk may have been an example of a cemetery which evolved into a cemetery with a church, and may well have been in the possession of a local aristocratic family. This could explain the large number of otherwise rare limestone sarcophagi at this cemetery. As indicated above, the Servatius cemetery became an *ad sanctos* cemetery; at least from the sixth century when the first stone-built church was constructed. Since that time it probably attracted both burials from the local community as well as from high status individuals from the region of Maastricht or further away. This study has provided data that suggest that these cemeteries may have functioned in a system of complementary cemeteries. The most manifest effect that could be recognised in the demography of these cemeteries was the under-representation of male graves in the Boschstraat cemetery. The under-representation

⁷³⁸ R. Panhuysen, 1999.

⁷³⁹ Theuws, 1998, p.345-355.

⁷⁴⁰ Preliminary results of a study of this cemetery by Theuws suggest that at this cemetery at least one section was used rather intensively with superimposed graves and intercutting of burial pits. These are phenomena which are rarely encountered at rural cemeteries.

of individuals of 50 years and older in the *templum* and *basilica* samples and the underrepresentation of individuals of 40 to 50 years at the cemeteries of Rosmeer and the Boschstraat were possibly also a result of burial preferences. This might reflect a trend to reserve high status burials for individuals who died between circa 15 and 50 years. The presence of a constellation of complementary cemeteries would provide the most plausible explanation for the skewed demographic profiles found at the Boschstraat cemetery and the age distribution at the Servaas church cemetery, the Boschstraat cemetery and Rosmeer. Most cemeteries were used to bury a population living nearby. Some individuals or sometimes groups of individuals were buried at another cemetery. We do not know exactly what criteria were used to select the place of burials for these individuals. What we do know is that these criteria included or were associated with age and sex of the deceased. In addition status will have been a factor determining the burial place. Analysis of data collected in the ongoing Saint Servatius project will allow us to test this hypothesis and provide more insight in what factors determined the selection of the burial location.⁷⁴¹ In conclusion it is evident that burial customs in the early medieval period lead to the concentration of individuals within and among cemeteries according to social conventions. Judged by the demographic profiles of the cemeteries and the clusters within these cemeteries, sex and age were important in the determination of an individual's position in society; at least at the time of burial. The impact of these decisions are not always as manifest as the significant absence of males in the Boschstraat cemetery. Nevertheless, it is essential to consider the possible impact of such a process on the composition of early medieval cemetery samples. Finally we may conclude that the populations examined in this study were not representative of a cross-section of the local population. The samples examined for this study represent various groups in early medieval society. Some of these groups we can identify as representatives of the elite. Others, like the clustered female burials at the *templum* phase cemetery, cannot be identified. Nevertheless the data collected in this study are prosopographical observations.

DIACHRONIC CHANGES IN LIFE CONDITIONS AT THE SERVATIUS CEMETERY IN MAASTRICHT

The human remains from the Sint Servaas church site were attributed to three consecutive phases. This provides the opportunity to analyse the osteo-archaeological data for the presence of diachronic trends at one and the same site. The data from the Boschstraat sample were not included in the diachronic analysis because these data are from the time of the transition from

⁷⁴¹ It is possible that the complementary nature of the cemeteries in Maastricht was reduced later in the Carolingian era. In the ninth century the church appeared to extend its control of the burial ritual. At that time instructions to the parish priests clearly state that people should be buried in the parish cemetery. This resulted in the abandonment of rural cemeteries without churches and the dissolution of the custom to bury in farmyards. From that time on the burial of individuals at cemeteries other than their parish cemetery became more and more a privilege of individuals of high status. There is no indication that preferential burial at privileged areas within cemeteries was reduced at the same time. The fact that the burial of laypersons inside the church was authorised in well-described cases and was repeatedly mentioned might be considered an indication that the practice of preferential burial within cemeteries may even have increased.

the *templum* to the *basilica* phase. For this site no specific information concerning the dating was available per grave, which makes it impossible to fit the Boschstraat burials in either the *templum* or *basilica* samples. Being from another type of cemetery could make it more difficult to interpret the results. For the remaining three samples it should be noted that relatively small data sets were available. Therefore, the results of the diachronic comparison of these data are preliminary conclusions. As discussed above the demographical composition of the *templum* and *basilica* samples is probably biased by the use of the cemetery by groups of intermediate and high status and this may have had an impact on other osteo-archaeological results.

	Cella (N=23)	Templum (N=78)	Basilica (N=83)	Significance
Male/female ratio	1.0.67	1.1.25	1.0.81	
Non-adult percentage	26%	14%	13%	P<0.05
Mean age (adult) males	48.3	38.6	43.1	
Mean age (adult) females	42.5	38.8	42.1	
Stature males in cm	171.8	172.7	174.2	
Stature females in cm	155.9	165.7	161.5	P<0.05
Cribra orbitalia	10%	17%	15%	
Enamel hypoplasia	38%	39%	24%	
Formation rate of Harris lines	0.13	0.15	0.20	
Fractures per inspected long bone	1.6%	0.5%	3.1%	P<0.05
Periostitis (bilateral)	8%	22%	26%	
Chronic maxillary sinusitis	44%	54%	48%	
DISH	30%	15%	26%	P<0.05
Caries (% per inspected element)	12%	8%	12%	
Abscesses (% per inspected alveole)	7%	5%	9%	
AM tooth loss (% per inspected position)	13%	13%	17%	
Calculus in males (% per individual)	100%	100%	88%	
Calculus in females (% per individual)	40%	43%	86%	

TABLE 7-20 An overview of selected data available for analysis of possible diachronic trends. All data are presented in detail in chapter six. The number of individuals mentioned for each phase represents the total number of individuals in each sample. It is reminded here that means and percentages in the table could generally be calculated for smaller numbers of individuals from these samples. Comparisons yielding statistically significant results are represented by light and darker grey shading. In some cases two phases were compared in others a comparison was made between one phase on one side and the combined results of two phases on the other side.

Probably the early medieval cemetery does not provide an overview of the life conditions of a cross-section of the population of Maastricht. It is expected to represent the life conditions of individuals of specific groups of intermediate and high status. The samples were compared for a selection of parameters listed in the table below. These parameters were expected to provide

information on the general health condition during growth (stature, cribra orbitalia, enamel hypoplasia and Harris lines), the prevalence of long bone fractures, DISH (diffuse idiopathic skeletal hyperostosis) and infectious disease (periostitis and chronic maxillary sinusitis) and dental health and diet (caries, peri-apical abscesses, ante mortem tooth-loss and calculus). Changes in these parameters are described for the transition between the *cella* and *templum* phase and between the *templum* and *basilica* phase.

THE CELLA-TEMPLUM TRANSITION

The transition from the *cella* phase to the *templum* phase was dated to the second half of the fifth century AD. The transition between these phases is considered to represent possible changes in life conditions between the late Roman and the Merovingian period.⁷⁴² Based on osteological data documenting a parallel situation in Italy, the transition from the late Roman to the early medieval period was expected to show a marked decline in general life conditions.⁷⁴³ When the various parameters of the three phases in the Servatius cemetery were compared no uniform trend of an evident deterioration of life conditions in the *templum* phase was noticeable. The decrease in mean age at death for males and females did fit with expectations. However, this decrease was not statistically significant and not supported by similar trends in other parameters. A reliable indicator of life conditions that contradicts the results for mean age at death is adult stature. Both male and female stature showed an increase. The remarkable increase in female stature from the *cella* phase to the *templum* phase was statistically significant. Several indicators of general health during growth display no marked changes. For the prevalence of cribra orbitalia a moderate increase was noted. This might suggest that anaemia, presumably caused by poor nutritional conditions or chronic infections, may have been more prevalent in Merovingian Maastricht than before. Is this in contradiction with the increase in stature? An explanation might be that a high prevalence of individuals with cribra orbitalia indicates that a larger number of individuals overcame anaemia during childhood and survived into adulthood. With respect to the occurrence of fractures, the *templum* phase population seems to have had a lower risk to fracture any of the long bones of the upper extremities.⁷⁴⁴ Most likely this was the result of a difference in the daily activities of these individuals. It is tempting to interpret the lower prevalence of fractures as an indication that, being individuals of intermediate and high status, the *templum* phase sample population was less involved in manual labour. Another striking difference between the *cella* phase and the *templum* phase was the high prevalence of DISH in the *cella* phase sample. As discussed in the previous chapter DISH is often associated with an affluent diet. A decline in the prevalence of DISH might thus be an indication for a more restrained diet during the *templum* phase. This would be in accordance with the decrease in caries and peri-apical abscesses. Ante-mortem

⁷⁴² It should be taken into account that the phase represented by the *cella* sample was already a phase characterised by changes. During this phase Roman control of the northwestern provinces was already declining and the settlement of people of Germanic ethnicity was in progress.

⁷⁴³ Manzi et al., 1999.

⁷⁴⁴ Fractures of the lower extremities were only found in the sample from the *basilica* phase.

tooth loss did not decline but stayed at the same level. Also the imbalanced distribution of calculus, with male prevalence more than twice the female prevalence, remained unchanged. Together the change in caries rates and prevalence of peri-apical abscesses suggest there was a difference in diet between the *cella* and *templum* phase cemetery populations. This is not reflected in the archaeobotanical evidence, which indicates that in Maastricht many staple crops remained the same from the Roman period throughout the first Millennium AD.⁷⁴⁵ The only major change seems to have been the introduction of rye. However, spelt wheat remained an important crop.⁷⁴⁶ Instructions for the managing of royal domains indicate that orchards also remained in use after the Roman period.⁷⁴⁷ Early medieval law codes contain a detailed description of fines for the theft of beehives, indicating the importance of beekeeping in early medieval times.⁷⁴⁸ We may therefore assume that honey was available as a sweetener and thus was a contributing factor in the development of caries. Altogether the situation concerning the staple crops and the continuity in the availability of several other components of the diet was stable. Therefore, it is not likely that the decrease in caries was caused by changes in the absolute presence or absence of cariogenic components in the diet. Most likely the effect of the diet on caries and related abscesses was a consequence of changes in food processing, the proportion of cariogenic components or of cultural factors.

Overall, the transition from the late Roman period to the Merovingian period shows no uniform effect on the parameters listed in Table 7-20. In a large British study comparing data from a series of Roman and early medieval populations Ch. Roberts and M. Cox also found contradictory trends for various health parameters. After the Roman era the British data also show an increase in mean adult stature.⁷⁴⁹ Claims for a sharp decline in life conditions in Maastricht after the late Roman period seem to be refuted by the data presented in this study. In fact the increasing stature suggests that the Merovingian population of Maastricht experienced better life conditions than the late Roman population.

It should be noted that least two factors may have influenced the outcome of the comparison of the *cella* and the *templum* phase samples. The first factor was the general status of the group buried at the section of the cemetery during each phase. As indicated in the first section of this chapter the *templum* sample most likely consisted of a large number of high status burials. It is discussed below that these groups may have enjoyed better circumstances during growth and adult life than individuals with a lower status. Therefore, the studied *templum* sample may not be representative for the whole population in Merovingian Maastricht. On the other hand we also do not know what the social position of the individuals in the *cella* sample was. In fact the relatively high prevalence of DISH in this sample might be an indication for a relatively high position in society. A high prevalence of DISH suggests constant access to an affluent diet which is often a privilege of high status individuals. Another factor that might partially have biased the

⁷⁴⁵ Bakels and Dijkman, 2000

⁷⁴⁶ Staple crops are crops of cereals that form the principal components in the diet.

⁷⁴⁷ Bakels and Dijkman, 2000

⁷⁴⁸ See e.g. Drew, 1991, p.72-73 and p. 213-214.

⁷⁴⁹ Roberts and Cox, 2003, 164-220 and 390.

differences between the *cella* and *templum* was a possible change in the genetic constitution of the population, due to the presumed arrival of an elite of Frankish origin. An indication for possible changes in the genetic composition of the *templum* sample may have been the abrupt and statistically significant change of the mean horizontal cranial index, which shifted from mesocranial to dolichocranial ($p < 0.05$). Whether craniometric data are good indicators of genetic affiliation is a matter of discussion.⁷⁵⁰ Given the political and social changes in Maastricht it is plausible that there was an influx of high status individuals of a different genetic background. However, it is not known when the Gallo-Roman population changed by the arrival of groups of Germanic origin. The available data do not tell us whether this already started in the third or fourth century, at the time of the arrival of the first wave of troops and farmers of Germanic origin, or in the fifth century when Germanic culture became dominant.⁷⁵¹

THE TEMPLUM-BASILICA TRANSITION

The *templum* and *basilica* phases are dated between the second half of the fifth and the end of the tenth centuries. Based on the carbon 14 data listed in chapter three we assume that the transition from the *templum* to the *basilica* phase took place between the last quarter of the seventh and the first quarter of the eighth centuries. Regarding the transition from the *templum* to the *basilica* phase we studied general differences between the Merovingian and Carolingian period. Written sources provide little indication that life conditions changed from the Merovingian to the Carolingian period. Given the above-mentioned stability in the food situation, with possible beneficial influences due to climate changes and improvement of agricultural techniques, it was assumed that the various parameters for the health situation would show little change, and possibly even some improvement in health. Because the site was used predominantly for the burial of individuals of intermediate and high status in both phases no status-related health changes were expected. These expectations were largely corroborated by the osteo-archaeological data. Mean age at death of males and females increased slightly. Male stature increased while female stature decreased. This contradictory development of stature may partially have been a result of the sample selection. In the *basilica* phase the proportion of high status burials of males with a high stature increased. One of the general health indicators, enamel hypoplasia, showed a decrease in prevalence from the *templum* to the *basilica* phase. Fractures were more frequently found in the *basilica* phase. Fractures of the lower extremities were recorded only for this sample. The *basilica* sample showed a higher prevalence of DISH. Like all of the mentioned changes this increase was statistically not significant. But similar to the high prevalence of DISH in the *cella* sample this was accompanied by a higher prevalence of carious teeth and peri-apical abscesses. The percentage of ante-

⁷⁵⁰ Recently J. Gerstenberger completed an ancient DNA study on the genetic variation in the Merovingian cemetery of Weingarten. In that study the aDNA results contradicted the previously assumed association between social status and anthropometric data in this cemetery. Overall Gerstenberger found that the Merovingian population was rather homogenic and genetic relations between individuals showed no association with social status. Gerstenberger, 2002.

⁷⁵¹ This process could be further studied on the basis of larger datasets and especially with a combination of ancient DNA and stable isotopes analyses.

mortem tooth loss was also higher than in the preceding phase. Together these data suggest the individuals in the *basilica* sample consumed a diet with negative impact on dental health, which may have been more affluent than in the *templum* phase. The sharp increase in calculus among females ($p < 0.05$) may also be a result of changes in diet.⁷⁵²

Often it is implicitly assumed that in contrast to the Roman period no proficient health care was available in the early medieval period and that the available medical care was inadequate. This is in contrast with the historical sources like penal codes that make provisions for the reimbursement of the costs of medical care in case individuals were wounded in the context of domestic violence for example.⁷⁵³ The institution of leper houses and other care for the sick was taken up by the ecclesiastical institutions at least from the sixth century on and is for example reflected in the plan of Saint Gall, a design for an ideal monastery. This plan reserved space for medicinal herb gardens and an infirmary. At present the only way to study the effects of medical care in early medieval Maastricht is via the study of fracture healing. As mentioned above most fractures from the *templum* and *basilica* sample had healed without serious complications. In some cases the healed condition of a complicated fracture suggested that the persons that treated the fracture must have had experience in this field.⁷⁵⁴

Regarding the general diachronic trend no decline in health conditions was found for the transition from the *cella* phase to the *templum* phase in the Sint Servaas church samples. The increase in adult stature suggests certain aspects of life conditions may even have improved. However, this may also be a consequence of the burial of high status females in the sampled area. Comparison of the *templum* phase sample and the *basilica* phase sample also did not reveal any large changes.

STATUS RELATED DIFFERENCES IN HEALTH

Analysis of the relation between social status and life conditions is generally awkward. Several problems have to be solved and various premises have to be fulfilled.⁷⁵⁵ Often parameters like general stress indicators and degenerative changes lead to ambiguous interpretations. Knowledge of social status and its possible effects in past societies is frequently incomplete. Despite these obstacles an attempt was made to study the association between burial status and life conditions in early medieval Maastricht. This was considered important since the early

⁷⁵² Some authors consider a high consumption of proteins as a possible cause for a high prevalence of calculus in a population, Roberts and Cox, 2003.

⁷⁵³ Drew, 1991.

⁷⁵⁴ Note juxtaposing written sources on medical treatment and notion by Dumoulin and data by Lovell. Preliminary conclusion: without (optimal) medical treatment many fractures may still heal without serious complications. However, in case of major fractures of the humerus, femur and tibia healing without complications is often dependent of medical treatment.

⁷⁵⁵ To mention a few: one needs knowledge of the social stratification during the period under examination. The nature of this stratification should be such that it had an effect on osteo-archaeological parameters. Different social categories need to be recognisable by specific elements in the burial ritual. Examples of studies focussing on status-related variation health conditions are: Powell, 1988; Grauer, 1989; Robb et al., 2001

medieval period is a formative period for the social structure in Western Europe.⁷⁵⁶ After the Roman period a new social organisation seems to develop with new authorities like the church and an emerging aristocracy claiming a leading role in society. Analysis of the impact of status on life conditions could provide insight in the nature of social stratification between the fifth and the tenth centuries.⁷⁵⁷ This study is based on 155 selected individuals for whom burial status could be determined from their archaeological context. As indicated in chapter three burial status was defined by the cemetery, position within the cemetery, grave type and grave goods. It is worth reiterating here that burial status is not a straightforward reflection of the social status of the buried individual. The low status category (n=54) was represented by the burials from the Boschstraat cemetery, and was considered to belong to a population of possibly unfree craftsmen and their families. Both the intermediate status (n=40) and high status (n=61) categories consisted of burials at the Sint Servaas church cemetery. Like for the diachronic comparison all osteo-archaeological parameters included in this study were analysed for changes associated with burial status (see chapter 6). Table 7-21, on the next page, shows an overview of the results, which will be discussed below.

The male-female ratios in the three status categories were a reflection of the burial customs at the two cemeteries. This also implies that low status males were only marginally represented in the comparison, which has an impact on the results for the low status category. At present there is no way to compensate for these effects or to estimate this bias. When the data for the low and intermediate status males were grouped their mean age at death was significantly lower than of the males in the high status category. For females no significant differences in mean age at death were found. The difference in mean age at death between males and females in the high status category was considerable. In the context of this cemetery this might be an indication that a considerable proportion of male burials consisted of male individuals leading a sheltered life, like monks or canons.⁷⁵⁸ Regarding adult stature the males of intermediate status resembled more the males of high status. Surprisingly the prevalence rates for *cribra orbitalia* were lower for low and intermediate status individuals than for high status individuals. In reference to the osteological paradox this could be interpreted as an indication for better chances of overcoming anaemic conditions during growth for individuals in the high

⁷⁵⁶ The samples from Maastricht have the advantage that they come from one location, were contemporaneous, their context was reasonably well known and the burial ritual included sufficient elements that allowed for a classification according to status. Several problems regarding status determination and the interpretation of its interaction with biological status remain unsolved. E.g. it is not clear whether status displayed in burial context was exactly the same as the status of an individual. And during the later Carolingian period simplicity is rediscovered as a virtue for high status clerics, this will have obscured our view and may have caused us to place such burials in the wrong status category.

⁷⁵⁷ E.g. were the life conditions of high status individuals better and did this result in an above average stature and mean age at death? Or did the easy access of free farmers of intermediate status to agricultural products allow them to achieve the same biological status as high social status individuals?

⁷⁵⁸ Janssen has shown that the canons associated with the Servaas monastery who were buried at the Stiftskapel site reached a mean age at death of circa 56 years, acquired a mean stature of 174 centimetre and all displayed signs of DISH. This suggests that the canons from the high and late middle ages lived under above average life conditions, Janssen and Maat, 1999.

status sample. The prevalence of enamel hypoplasia was distributed quite erratically; it was high in both the low and high status categories and significantly lower in the intermediate status category.

	Low (N=54)	Interm. (N=40)	High (N=61)	Significance
Male/female ratio	1.4.00	1.1.67	1.0.81	
Non-adult percentage	43%	10%	11%	
Mean age (adult) males	39.0	39.0	47.9	P<0.05
Mean age (adult) females	41.0	40.8	41.2	
Stature males in cm (Breitinger 1937)	169.1	173.0	174.9	
Stature females in cm (Trotter 1970)	160.5	163.5	163.5	
Cribra orbitalia	7%	5%	22%	
Enamel hypoplasia	50%	10%	50%	
Formation rate of Harris lines	0.18	0.22	0.18	
Fractures per inspected long bone	1.1%	1.2%	2.9%	
VOA	11%	14%	40%	P<0.05
DDD	60%	77%	90%	P<0.05
Periostitis	17%	4%	41%	
Chronic maxillary sinusitis	37%	50%	50%	
DISH	10%	18%	30%	
Caries (% per inspected element)	11%	10%	10%	
Abscesses (% per inspected alveole)	4%	6%	8%	P<0.05
AM tooth loss (% per inspected position)	12%	12%	19%	
Calculus in males (% per individual)	75%	100%	93%	
Calculus in females (% per individual)	81%	85%	50%	P<0.05

TABLE 7-21 A resume of selected data available for analysis of possible relations between status and health. All data are presented in detail in chapter six. The number of individuals mentioned for each phase represents the total number of individuals in each sample. It is reminded here that means and percentages in the table could generally be calculated for smaller numbers of individuals from these samples. Comparisons yielding statistically significant results are represented by light and darker grey shading. In some cases two phases were compared in others a comparison was made between one phase on one side and the combined results of two phases on the other side.

The prevalence of long bone fractures and their distribution within the skeleton indicated that the low and intermediate status groups were both characterised by a lower prevalence of fractures than the high status group. This suggests that the high status individuals were involved in activities associated with an increased risk of fractures. With respect to further parameters related to adult health and occupational activities it was noteworthy that vertebral osteoarthritis (VOA) was found significantly more often in individuals of high status than in individuals of low or intermediate status. This was most marked for the lumbar vertebrae. In

part both the elevated number of long bone fractures and the prevalence of vertebral osteoarthritis may have been a consequence of the increased longevity of males in this category, but it may also have been linked to occupational activities or horse riding. For degenerative disc disease (DDD) the increase with status was found to be statistically significant. This trend was most manifest in the lower thoracic vertebrae. This may also have been associated with occupational activities or the constitution of the individuals in each category.⁷⁵⁹ The data on DISH show a clear increase with status, however this trend was not statistically significant.

The equal distribution of caries in the three status categories would suggest that access to cariogenic foodstuffs was not linked to status. Oddly enough the prevalence of peri-apical abscesses increased with status.⁷⁶⁰ This trend was statistically significant ($p=0.0263$). For ante-mortem tooth loss the low and intermediate status categories scored an equal prevalence rate, while high status individuals had lost more teeth prior to death. The higher prevalence of ante-mortem tooth loss may have been a result of the higher prevalence of peri-apical abscesses and was possibly linked to the increased longevity recorded for the males in this category. The difference between males and females in mean age at death in the high status category was not the only health-related difference between the sexes. High status males had significantly more dental calculus than females ($p=0.026$). The prevalence of calculus was considerably lower than among females of low or intermediate status.

The interpretation of the differences between the three status categories is quite complex and open to debate. Several of the examined parameters for health show no consistent differences between the status categories. Similar results were found in other studies focussing on the relation between burial status and health conditions.⁷⁶¹ Because of the skewed proportion of adults at the Boschstraat cemetery the association between non-adult mortality and status can only be studied for the intermediate and high status categories. In this respect it is evident that non-adults were underrepresented in these groups. Several parameters displayed little disparity between the three status categories: female mean age at death, the formation rate of Harris lines and the prevalence of caries. Overall there seems to be some similarity between the low and intermediate status categories, especially for cribra orbitalia, fractures of the long bones and vertebral osteoarthritis. For female stature, chronic maxillary sinusitis and calculus in males the intermediate category was more similar to the high status group. The high status category was characterised by a high prevalence in cribra orbitalia, fractures, degenerative disc disease, DISH and periostitis. For dental abscesses and degenerative disc disease a trend was recorded that indicated that the increase in prevalence

⁷⁵⁹ Robb et al., 2001 also found a similar increase of the occurrence of Schmorl's nodes with status for Italian Iron Age samples.

⁷⁶⁰ Most likely this high number of individuals with abscesses is partially the result of the high mean age at death (as we saw a clear increase of abscesses with age) found for the cella sample and the contrast is increased by the incompleteness of many of the skeletons from the templum sample. It could also indicate that in the cella phase many individuals had a few abscesses whereas later a few individuals had many abscesses.

⁷⁶¹ E.g. Grauer, 1989 and Robb et al., 2001 found no relation between enamel hypoplasia and social status.

with status was statistically significant. The most plausible explanation would be that this was a result of the increased longevity in the high status sample.

The above mentioned significant associations between status and the selected parameters indicate that there was a correlation between status and health conditions. The males in the high status sample in particular may have had a special position in society. High status males not only seem to have been taller and reached an older age but they also had a higher risk of fractures. As a group the high status individuals also had more vertebral osteoarthritis, degenerative disc disease, DISH and peri-apical abscesses. Of these the higher risk of fractures, vertebral osteoarthritis and degenerative disc disease may have been associated with occupational or equestrian activities. High status females were in key parameters (mean age at death and stature) more similar to females of intermediate status. This suggests that females did not benefit from the advantages or did not suffer from the disadvantages of a higher status category for hitherto unknown cultural or biological reasons.

Returning to the general similarity between the health status of low and intermediate status categories as opposed to the high status category might help in interpreting who was buried at the cemeteries of Maastricht. The similarity between the two status categories might be an indication that these consisted largely of a local population. If so this local population had the option of burying at settlement cemeteries like the Boschstraat cemetery or if their status permitted at the Servatius cemetery. In line with what written sources suggest, the high social status group was then probably buried at the prestigious areas of the Servatius cemetery, a space they probably had to share with regional aristocracy. As a result the high status category of the Servaas church site would consist of a heterogeneous group of local and regional individuals. This phenomenon might provide an explanation for the differences in cemetery layout that can be recognised during the *basilica* phase. In the Carolingian period the group of high status burials may in part have been associated with the monastery or chapter of canons that was linked to Saint Servatius.

8

Conclusion

8 | Conclusion

This study presents the results of a physical anthropological and palaeopathological analysis of the skeletal remains of 238 individuals excavated at the Servaas church and Boschstraat sites from Maastricht. The cemetery excavated at the Servaas church site represents a section of the large Servaas cemetery; the Boschstraat site contained, among others, a cemetery of circa 40 graves and several dispersed graves. The Servaas cemetery was in use from the late Roman period to the nineteenth century. Most of the graves at this cemetery date from the early medieval period. At the Boschstraat site all graves were early medieval. During the late Roman and early medieval period Maastricht became an important central place in the Meuse valley. Reviewing the data listed and discussed in the previous chapters, the question arises what do the various osteoarchaeological data add to our knowledge of early medieval Maastricht? The study of the skeletal remains has provided insight in the demography and health of the individuals buried at the two cemeteries. This study has further shown that the analysis of these data within their historical and archaeological context may provide information on local historical developments. Analysis of sex, age and stature of the human remains, in association with the distribution of their graves, showed that at the Servaas church site diachronic changes in the layout of the cemetery and variation in grave type were associated with changes in the use of the cemetery. Archaeological finds indicate that during the late Roman and early medieval period the Servaas cemetery was used by a variety of groups in society. Since historical and archaeological sources provide little information on the composition of these groups, our knowledge of the burial practice in Maastricht is limited. Physical anthropological and palaeopathological data may provide some clues about the composition of these groups. In general the Servaas church site was the section of the Servaas cemetery, positioned in and around the consecutive churches, that was used to bury individuals of intermediate and high social status. The Boschstraat cemetery was found amidst remnants of a late seventh to early 8th century settlement that was involved in the production of objects of metal, antler and glass. Given the main activities employed at the site and the simple graves the population of the cemetery was probably of low social status.

At the Servaas church site all burials could be categorised in one of three consecutive phases: the *cella* phase, the *templum* phase and the *basilica* phase. During the *cella* phase (circa 350-480 AD) the burials at the late Roman cemetery seem to represent graves of males, females and children in small clusters, who were possibly family members. We assume that these individuals were inhabitants of Maastricht of intermediate social status. The individuals buried during the *templum* phase (circa 480-700 AD) showed more diversity in grave type and distribution patterns in the cemetery. The wealth represented by the prestigious grave types and precious grave goods are considered indicative for the burial of high status individuals, probably members of the emerging Frankish aristocracy. As is evident from the use of tuff stone sarcophagi in the middle of the sixth century, the site attracted high status burials even before a stone-built church was constructed. Possibly, this may have encouraged bishop Monulphus to construct a church, the

magnum templum, at this site. Around or at least shortly after the construction of this church the cemetery developed into an *ad sanctos* burial place. In the cemetery, separate areas and clusters were recognised. One cluster consisted of female burials and another of a combination of females and non-adults. Other areas were composed of a mixture of male and female burials. Non-adults were underrepresented in the *templum* phase sample. The first results of the physical anthropological examination of burials from another section of the Servaas cemetery suggest non-adult burials may have been concentrated in a less prestigious area of the cemetery.

The *basilica* phase cemetery (circa 700-950 AD) was characterised by an expansion of the buildings of the church and monastery. This coincided with changes in the layout of the cemetery that suggest that the organisation of the cemetery changed. In some areas burials seem to be placed in a well-ordered manner, other areas of the cemetery show a continuation of the seemingly unordered juxtaposition and superposition of graves. Possibly this was a reflection of the increasing control over the burial ritual by churches and monasteries. A series of graves from the *basilica* phase was located inside the church, in particular a group of limestone sarcophagi in the centre of the church. Many of these sarcophagi contained no, or poorly preserved skeletal remains. Therefore, the information collected from these graves was fragmentary. All graves inside the church, for which sex could be determined, indicated that males were buried there. Evidence that females were buried inside the main sections of the church was lacking. It is tempting to consider the concentration of limestone sarcophagi at a central place inside the church as evidence for the presence of a community of monks or canons. This implies that such a community existed at the time of construction of the *basilica*. The area around the church seems to have been used to bury both males and females and a small number of non-adults. Because of their position close to the church, and the assumed location of the grave of Saint Servatius, these graves most likely were also used to bury individuals of high social status.

The Boschstraat cemetery (circa end seventh early eighth century) differed in many aspects from the Servaas cemetery. Its position in relation to the inhabited areas of Maastricht was more peripheral and closely associated with a separate settlement. Regarding the demographical composition of the cemetery population this site was most unusual. Females largely outnumbered males in this cemetery, which is thought to be the result of burial of males at another cemetery in the area. This odd male-female ratio in the Boschstraat cemetery is the main argument for the assumption that the cemeteries in and around Maastricht formed a constellation of complementary cemeteries. In this constellation various burial places provided a resting place for individuals and groups, which suited their social status, lineage, membership of a group or other characteristics.

Regarding diachronic changes in health from the late Roman period to the end of the Carolingian period, the data collected for Maastricht indicate that changes occurred. From the late Roman period to the Merovingian period there was no deterioration of living conditions. This fits the notion that the transition from the Roman period to the Merovingian period was a gradual process, characterised by continuity in many aspects of daily life. Male stature, generally considered a good indicator of socio-economic circumstances, even increased during

the whole period. The differences in health between the *templum* phase and the *basilica* phase were small. For males, living conditions seemed to have improved, whereas a decrease in female stature suggested that their situation may have deteriorated. A comparison between a selection of early medieval cemeteries suggested that the population of Maastricht on average may have enjoyed better health conditions than in other areas of the Frankish territories.

Based on the location of the grave, the grave type and the presence of grave goods, all early medieval individuals were categorised in status categories. Three status categories were defined: low social status, intermediate social status and high social status. Normally social stratification is associated with noticeable differences in health between groups in society. Comparison of the health conditions of the individuals in these status categories on average showed minor differences in health. Since negative and positive health indicators were not uniformly distributed over the three status categories, the differences were difficult to interpret. Differences between individuals of low and intermediate status were generally insignificant. Only for high status males noticeable beneficial effects on health could be observed. It seems plausible that the overall low population density and the beneficial circumstances concerning the food supply in Maastricht reduced the effect of social stratification on health.

As we have seen in the previous chapter, various groups in society used the Boschstraat cemetery and the Servaas cemetery as a burial place. Since only a small section of the cemeteries of early medieval Maastricht has been examined we can only obtain a vague notion of these groups. As a result, these first prosopographical observations are incomplete. However, physical anthropological and palaeopathological data have allowed us to discern clusters of female burials in the *templum* phase cemetery and to notice the absence of male burials at the Boschstraat. Because of these data, we could look for evidence for the presence of complementary cemeteries. Without the osteoarchaeological data, we would be ignorant of the relatively favorable living conditions in early medieval Maastricht. Ongoing studies of more sections of the Servaas cemetery and other early medieval cemeteries in Maastricht will in the near future provide additional physical anthropological and palaeopathological data from which we can learn more about the various groups in early medieval Maastricht. The combination of traditional physical anthropological data and aDNA and isotope analysis may even allow us to study the relations between individuals and groups buried in different locations in Maastricht.

9

Bibliography

8 | Bibliography

- (1883) *Annales Bertiniani*, In *Monumenta Germaniae historica, Scriptores in usum scholarum separatim editi*, Vol. 5 (Ed. Waitz, G.) Hannover.
- (1891) *Annales Fuldenses*, In *Monumenta Germaniae historica, Scriptores in usum scholarum*, Vol. 7 (Ed. Kurze, F.) Hannover.
- (1913) *Vita Landiberti episcopi Traiectensis vetustissima*, In *Monumenta Germaniae historica, Scriptores rerum merovingicarum*, Vol. 6 (Ed. Krusch, B.) Hannover-Leipzig, p. 353-384.
- (1936) *Gesta sanctorum patrum Fontanellensis coenobii*, (Eds. Lohier, F. and Laporte, J.) Rouen-Paris.
- (1980) *Annales Bertiniani*, In *Quellen zur karolingischen Reichsgeschichte*, Vol. 2 (Ed. Rau, R.) Darmstadt, p. 11-287.
- Acsádi, G. and Nemeskéri, J. (1970) *History of human life span and mortality*, Akadémiai Kiadó, Budapest.
- Adams, F. (Ed.) (1843) *The seven books of Paulus Aegineta*, London.
- Aitken, M. J. (2000) Radiocarbon dating In *Archaeological method and theory: An encyclopedia* (Ed. Ellis, L.) Garland Publishing, New York, p. 505-509.
- Alduc-le Bagousse, A. (1994) Maturation osseuse - majorité légale: la place des adolescentes en paléanthropologie In *La femme pendant le moyen âge et l'époque moderne*, Vol. 17 (Ed. Buchet, L.) CNRS Éditions, Paris, p. 31-39.
- Alduc-le Bagousse, A. and Sansilbano-Collilieux, M. (1991) Milieu urbain, milieu rural: le monde des vivants et des morts au haut moyen âge en Poitou et en Basse Normandie. Apports de l'anthropologie In *Ville et campagne en Europe occidentale (Ve - XIIIe siècle)*, Vol. 14 (Ed. Buchet, L.) CNRS Éditions, Paris, p. 83-101.
- Althoff, G. (1996) *Otto III.*, Wissenschaftliche Buchgesellschaft, Darmstadt.
- Arcini, C. (1999) *Health and disease in early Lund: Osteo-pathologic studies of 3,305 individuals buried in the cemetery area of Lund 990-1536*, Lund, p. 207.
- Ariès, P. (1977) *L'homme devant la mort*, Éditions du Seuil, Paris.
- Atsma, H. (1993) Les monastères urbains du nord de la Gaule In *La christianisation des pays entre Loire et Rhin (IVe-VIe siècle)*, Vol. 2 (Ed. Riché, P.) Les Éditions du cerf, Paris, p. 163-187.
- Auboire, G. (1988) La population de Villiers-le-Sec, VIIe-Xe siècle: Étude anthropologique In *Un village au temps de Charlemagne* (Eds. Cuisenier, J. and Guadagnin, R.) Éditions de la Réunion des musées nationaux, Paris, p. 180-183.
- Aufderheide, A. C. and Rodriguez-Martin, C. (1998) *The Cambridge encyclopedia of human paleopathology*, Cambridge University Press, Cambridge.
- Bach, A. (1986) *Germanen-Slawen-Deutsche: Anthropologische Bearbeitung des frühmittelalterlichen Gräberfeld von Rohnstedt, Kreis Sondershausen*, Weimar.
- Baetsen, S. (1998) *Het menselijk skeletmateriaal van het Salvatorplein te Susteren*, Amersfoort.
- Baetsen, S. (2001) *Graven in de Grote Kerk: het fysisch antropologisch onderzoek van de graven in de St. Laurenskerk van Alkmaar*, Gemeente Alkmaar, Alkmaar.
- Bakels, C. C. (1996) The pollen diagram Voerendaal-7 In *Borderland farming: Possibilities and limitations of farming in the Roman period and early middle ages between the Rhine and Meuse* (Ed. Kooistra, L. I.) Van Gorcum, Assen, p. 139-146.

- Bakels, C. C. and Dijkman, W. (2000) *Maastricht in the first millenium AD: the archaeobotanical evidence*, Archaeology Section of the Municipality of Maastricht.
- Barnes, E. (1994) *Developmental defects of the axial skeleton in paleopathology*, University Press of Colorado, Colorado.
- Bass, W. H. (1987) *Human osteology: A laboratory and field manual of the human skeleton*, Columbia.
- Bauchhenß, G. and von Prittwitz u. Gaffron, H.-H. (Eds.) (1992) *Spurensicherung: archäologische Denkmalpflege in der Euregio Maas-Rhein*, Verlag Philipp von Zabern, Mainz am Rhein.
- Bayliss, A., Shepherd Popescu, E., Beavan-Athfield, N., Bronk Ramsey, C., Cook, G. T. and Locker, A. (2004) The potential significance of dietary offsets for the interpretation of radiocarbon dates: an archaeologically significant example from medieval Norwich, *Journal of Archaeological Science*, 31, p. 563-575.
- Bay-Schuller, R. (1976) Die anthropologische Bearbeitung des menschlichen Skelettmaterials des fränkischen Friedhofes am Bernerring in Basel In *Das fränkische Gräberfeld von Basel-Bernerring*, Vol. 1 (Ed. Martin, M.) Archäologischer Verlag in Basel, Basel, p. 317-368.
- Bennike, P. (1985) *Palaeopathology of Danish skeletons*, Copenhagen.
- Bierbrauer, V. (1996) Romanen im fränkischen Siedelgebiet In *Die Franken - Wegbereiter Europas*, Vol. 1 (Eds. Wiczorek, A., Périn, P., von Welck, K. and Menghin, W.) Philipp von Zabern, Mainz, p. 110-120.
- Billard, M. (1994) Les lignes de Harris en ostéoarologie: évolution d'un stigmaté événementiel au cours de la croissance et du vieillissement squelettique: implications en paléo-épidémiologie In *La femme pendant le moyen âge et l'époque moderne*, Vol. 17 (Ed. Buchet, L.) CNRS Éditions, Paris, p. 135-155.
- Bloemers, J. H. F. (1973a) Archeologische kroniek van Limburg over de jaren 1969-1970, *Publications de la Société Historique et Archéologique dans le Limbourg*, 107-108, p. 7-79.
- Bloemers, J. H. F. (1973b) Twenty-five years of ROB research in Roman Limburg, *Berichten van de Rijksdienst voor het Oudheidkundig Bodemonderzoek*, 23, p. 237-258.
- Blok, D. P. (1979) *De Franken in Nederland*, Fibula - van Dishoeck, Haarlem.
- Blondiaux, J., Jacques, A. and Bayard, D. (1991) Dix-neuf squelettes dans l'habitat In *Ville et campagne en Europe occidentale (Ve - XIIIe siècle)*, Vol. 14 (Ed. Buchet, L.) CNRS Éditions, Paris, p. 11-24.
- Bocquet-Appel, J.-P. and Masset, C. (1982) Farewell to paleodemography, *Journal of Human Evolution*, 11, p. 321-333.
- Bocquet-Appel, J.-P. and Masset, C. (1985) Matters of moment, *Journal of Human Evolution*, 14, p. 107-111.
- Boddington, A. (1987) Chaos, disturbance and decay in an Anglo-Saxon cemetery In *Death, decay and reconstruction: Approaches to archaeology and forensic science* (Eds. Boddington, A., Garland, A. N. and Janaway, R. C.) Manchester University Press, Manchester, p. 27-42.
- Boeren, P. C. (1972) *Jocundus. Biographie de Saint Servais*, Den Haag.
- Boeren, P. C. (1993) Les évêques de Tongres-Maastricht In *La christianisation des pays entre Loire et Rhin (IVe-VIe siècle)*, Vol. 2 (Ed. Riché, P.) Les éditions du cerf, Paris, p. 25-36.
- Böhme, H. W. (1996) Söldner und Siedler im spätantiken Nordgallien In *Die Franken - Wegbereiter Europas*, Vol. 1 (Eds. Wiczorek, A., Périn, P., von Welck, K. and Menghin, W.) Philipp von Zabern, Mainz, p. 91-101.
- Boissavit-Camus, B., Galinié, H., Lorans, E., Prigent, D. and Zadora-Rio, E. (1996) Chrono-typologie des tombes en Anjou-Poitou-Touraine In *Archéologie*

- du cimetière chrétien FÉRAF / La Simarre, Tours, p. 257-269.
- Boocock, P., Roberts, C. A. and Manchester, K. (1995) Maxillary sinusitis in medieval Chichester, England, *American Journal of Physical Anthropology*, 98, p. 483-495.
- Boppert, W. (1986) Die frühchristlichen Grabinschriften aus der Servatiuskirche in Maastricht In *Sint-Servatius bisschop van Tongeren-Maastricht. Het vroegste Christendom in het Maasland*, Vol. 28 (Ed. de Dijn, G.) Borgloon, p. 64-96.
- Borghuis, N., van Hees, R., van Hellenberg Hubar, B., Mekking, A., te Poel, P., Visser, I. and Zeegers, G. (1979) Bijdragen tot de bouwgeschiedenis van de Sint Servaaskerk te Maastricht: Deel I, De Oostpartij, *Publications de la Société Historique et Archéologique dans le Limbourg*, 115, p. 6-266.
- Boswell, J. (1988) *The kindness of strangers: The abandonment of children in Western Europe from late antiquity to the renaissance*, Pantheon Books, New York.
- Bouts, W. H. M. and Pot, T. (1989) Computerized recording and analysis of excavated human dental remains In *Burial archaeology: Current research, methods and developments*, Vol. 211 (Eds. Roberts, C., Lee, F. and Bintliff, J.), p. 113-128.
- Breitinger, E. (1937) Zur Berechnung der Körperhöhe aus den langen Gliedmaßenknochen, *Anthropologischen Anzeiger*, 14, p. 249-274.
- Brennecke, H. C. (1986) Servatius von Tongern. Ein gallischer Bischof im arianischen Streit In *Sint-Servatius, bisschop van Tongeren-Maastricht. Het vroegste Christendom in het Maasland*, Vol. 28 (Ed. de Dijn, G.) Borgloon, p. 17-32.
- Breuer, H. (1969) *Die Maas als Schiffahrtsweg*, Franz Steiner Verlag, Wiesbaden.
- Bridger, C. and Siegmund, F. (1987) Die Xantener Stiftsimmunität. Grabungsgeschichte und Überlegungen zur Siedlungstopographie In *Beiträge zur Archäologie des Rheinlandes*, Vol. Sonderdruck Dr. Rudolf Habelt GmbH, Bonn, p. 63-133.
- Brimblecombe, P. (1988) Climate conditions and population development in the middle ages In *Die Bevölkerungsentwicklung des europäischen Mittelalters: Das wirtschaftsgeographische und kulturelle Umfeld*, Vol. 39 heft 2 (Eds. Herrmann, B. and Sprandel, R.) Verlag Karl Alber, München, p. 141-148.
- Brothwell, D. R. (1981) *Digging up bones*, British Museum (Natural History), London.
- Brothwell, D. R. (1987) The problem of the interpretation of child mortality in earlier populations, *Anthropol. Port.*, 4-5, p. 135-143.
- Brower, A. C. (1977) Cortical "defect" of the humerus at the insertion of the pectoralis major, *American Journal of Roentgenology*, 128, p. 677-678.
- Bruinjes, T. D. and Panhuysen, R. G. A. M. (1994) Hyoid bones in two early medieval populations from Maastricht (The Netherlands), *Homo*, 45 (Supplement), p. 26.
- Bruinjes, T. D. and Panhuysen, R. G. A. M. (1995) The paleopathological diagnosis of seronegative spondylarthropathies In *Proceedings of the IXth European meeting of the Paleopathology Association: Barcelona 1st - 4th September, 1992* (Eds. Batista, R., Campillo, D. and Carreras, T.) Museu d'Arqueologia de Catalunya, Barcelona, p. 73-77.
- Bruet, R. (1990) *La Gaule septentrionale au Bas-Empire: Occupation du sol et défense du territoire dans l'arrière-pays du Limes aux IVe et Ve siècles*, Rheinischen Landesmuseum Trier, Trier.
- Bruet, R. (1995) Das spätrömische Verteidigungssystem zwischen Mosel und Nordseeküste In *Die römische Reichsgrenze zwischen Mosel und Nordseeküste* (Eds. Bechert, T. and Willems, W. J. H.) Konrad Theiss Verlag, Stuttgart, p. 102-119.
- Buchet, L. (Ed.) (1989) *Homme et milieu*, Paris.

- Buchet, L. (Ed.) (1992) *Ville et campagne en Europe occidentale (Ve-XIIIe siècle)*, Paris.
- Buchet, L. (Ed.) (1994) *La femme pendant le moyen âge et l'époque moderne*, CNRS Éditions, Paris.
- Buchet, L. (1996) Die Landnahme der Franken in Gallien aus der Sicht der Anthropologen In *Die Franken - Wegbereiter Europas* Verlag Philipp von Zabern, Mainz, p. 662-667.
- Buchet, L. and Lorren, C. (1975) Dans quelle mesure la nécropole du haut moyen âge offre-t-elle une image fidèle de la société des vivants?, In *La mort au moyen âge*, Vol. Collection recherches et documents XXV Strasbourg, p. 27-48.
- Buchet, L. and Olive, C. (1983) Anthropologie: B. Interprétations provisoires In *Sépulture et traditions funéraires du Ve au XIIIe siècle ap. J.-C. dans les campagnes des Alpes Françaises du nord* (Ed. Colardelle, M.) Société Alpine de documentation et de recherche en archéologie historique, Grenoble, p. 420-433.
- Buikstra, J. E. and Ubelaker, D. H. (Eds.) (1994) *Standards for data collection from human skeletal remains*, Arkansas Archeological Survey, Fayetteville.
- Bullough, V. and Campbell, C. (1980) Female longevity and diet in the middle ages, *Speculum*, 55, p. 317-325.
- Cannon, A. (1995) Material culture and burial representativeness In *Grave reflections: portraying the past through cemetery studies* (Eds. Saunders, S. R. and Herring, A.) Canadian Scholars Press, Toronto, p. 3-17.
- Carli-Thiele, P. (1996) *Spuren von Mangelerkrankungen an steinzeitlichen Kinderskelette*, Erich Goltze, Göttingen.
- Caseltz, P. (1998) Caries-Ancient plague of humankind In *Dental Anthropolgy, fundamentals, limits and prospects* (Eds. Alt, K. W., Rösing, F. W. and Teschler-Nicola, M.) Springer Verlag, Vienna, p. 203-226.
- Charlier, C. (1994) Les enfants mérovingiens d'Erps-Kwerps: problème de croissance, *Acta Archaeologica Lovaniensia*, 33, p. 91-99.
- Chélini, J. (1991) *L'aube du moyen âge: Naissance de la chrétienté occidentale*, Editions Picard, Paris.
- Child A. M. (1995) Towards and Understanding of the Microbial Decomposition of Archaeological Bone in the Burial Environment, *Journal of Archaeological Science*, 22, p. 165-174.
- Cliff, A., Haggett, P. and Smallman-Raynor, M. (1998) *Deciphering global epidemics: Analytical approaches to the disease records of world cities, 1888-1912*, Cambridge University Press, Cambridge.
- Cohen, M. N. (1989) *Health and the rise of civilization*, Yale University Press, New Haven.
- Colardelle, M. (1983) *Sépulture et traditions funéraires du Ve au XIIIe siècle ap. J.-C. dans les campagnes des Alpes Françaises du nord*, Société Alpine de documentation et de recherche en archéologie historique, Grenoble.
- Colardelle, M., d'Archimbaud, D. and Raynaud, C. (Eds.) (1996a) *Typo-chronologie des sépultures du Bas-Empire à la fin du Moyen-Âge dans le Sud-Est de la Gaule*, FÉRACF / La Simarre, Tours.
- Colardelle, M., Démians d'Archimbaud, G. and Raynaud, C. (1996b) Typo-chronologie des sépultures du Bas-Empire à la fin du Moyen-Âge dans le Sud-Est de la Gaule In *Archéologie du cimetière chrétien* (Eds. Galinié, H. and Zadora-Rio, E.) FÉRACF / LA SIMARRE, Tours, p. 271-303.
- Comas, J. (1960) *Manual of physical anthropology*, Charles C Thomas, Springfield.
- Cordfunke, E. H. P., Borg, K. v. d. and Maat, G. J. R. (1998) De skeletten uit het grafmonument te Rijnsburg: een hernieuwd onderzoek, *Bulletin van de Koninklijke Nederlandse Oudheidkundige Bond*, 97, p. 1-14.
- Costa, R. L. (1980) Incidence of caries and abscesses in archeological Eskimo skeletal samples from

- Point Hope and Kodiak Island, Alaska, *American Journal of Physical Anthropology*, 52, p. 501-514.
- Coulon, G. (1994) *L'enfant en Gaule Romaine*, Éditions Errance, Paris.
- Cousin, M. (2002) *Archéologie des carrières souterraines de Doué-la-Fontaine*, Association Régionale pour la Diffusion de l'Archéologie en Pays de Loire, Angers.
- Crist, T. A. J., Washburn, A., Park, H., Hood, I. and Hickey, M. A. (1997) Cranial displacement as a taphonomic process in potential child abuse cases In *Forensic taphonomy: the postmortem fate of human remains* (Eds. Haglund, W. D. and Sorg, M. H.) CRC Press, Boca Raton, p. 319-336.
- Czarnetzki, A. (Ed.) (1996) *Stumme Zeugen ihrer Leiden: Krankheit und Behandlung vor der medizinischen Revolution*, Attempto, Tübingen.
- Czarnetzki, A., Uhlig, C. and Wolf, R. (1989) *Menschen des Frühen Mittelalters: im Spiegel der Anthropologie und Medizin*, Württembergisches Landesmuseum Stuttgart, Stuttgart.
- D' Hulst, A. (1990) Inventaire anthropologique In *Les fouilles du quartier Saint-Brice à Tournai: L'environnement funéraire de la sépulture de Childéric vol. 1*, Vol. LXXIII (Ed. Bruet, R.) Département d'archéologie et d'histoire de l'art, Louvain-la-Neuve, p. 106-121.
- Dastugue, J. and Gervais, V. (1992) *Paleopathologie du squelette humain*, Paris.
- Dawes, J. D. and Magilton, J. R. (1980) *The cemetery of St Helen-on-the-Walls Aldwark*, Council for British Archaeology, York.
- De Boe, G. (1970) *Een Merovingisch grafveld te Borsbeek (Antwerpen)*, Nationale dienst voor opgravingen, Brussel.
- De Boe, G., De Bie, M. and Van Impe, L. (1992) Neerharen-Rekem: Die komplexe Besiedlungsgeschichte einer vor den Kiesbaggern geretteten Fundstätte In *Spurensicherung: archäologische Denkmalpflege in der Euregio Maas-Rhein*, Vol. 136 (Eds. Bauchhenß, G. and von Prittwitz u. Gaffron, H.-H.) Verlag Philipp von Zabern, Mainz am Rhein, p. 477-496.
- De Boone, W. J. (1960) De Franken In *Limburgs verleden I* Maastricht, p. 173-176.
- De Grooth, M. E. T. (1987) Villa rustica: het boerenbedrijf in het Rijn/Maasgebied In *Langs de weg* (Eds. Stuart, P. and de Grooth, M. E. T.) Thermenmuseum Heerlen, Heerlen, p. 81-86.
- De la Haye, R. (1985a) *De bisschoppen van Maastricht*, Stichting Historische Reeks Maastricht, Maastricht.
- De la Haye, R. (1985b) Willem Heck en zijn schatgraverij in de Sint-Servaas, *De Sint Servaas*, 22, p. 173-175.
- De la Haye, R. (1988) Humbertus historie herschreven (II), *De Sint Servaas*, 41/42, p. 327-328.
- De la Haye, R. (1994) In welke eeuw leefde Sint Servaas?, *De Maasgouw: tijdschrift voor Limburgse geschiedenis en oudheidkunde*, 113, p. 5-28.
- De la Haye, R. (2002) 3. Liège In *Province ecclésiastique de Cologne (Germania Secunda)*, Vol. XII (Eds. Gauthier, N., Beaujard, B. and Prévot, F.) De Boccard, Paris, p. 117-124.
- De Moreau, É. (1940) *Histoire de l'Église en Belgique*, L'Édition Universelle, Brussels.
- Deeters, J. (1970) *Servatiusstift und Stadt Maastricht: Untersuchungen zu Entstehung und Verfassung*, Ludwig Röhrscheid Verlag, Bonn.
- Delahaye, G.-R. (1985) Les sarcophages de pierre In *Collections Mérovingiennes*, Vol. II (Ed. Périn, P.) Les musées de la ville de Paris, Paris, p. 689-699.
- Demougeot, E. (1979a) *La formation de l'Europe et les invasions barbares: II, 1 De l'avènement de Dioclétien (284) à l'occupation germanique de l'Empire romain d'Occident (début du VIe siècle)*, Aubier, Paris.
- Demougeot, E. (1979b) *La formation de l'Europe et les invasions barbares: II, 2 De l'avènement de Dioclétien (284) à l'occupation germanique de*

- l'Empire romain d'Occident (début du VI^e siècle)*, Aubier, Paris.
- Depeyrot, G. (1994) *Richesse et société chez les Mérovingiens et Carolingiens*, Éditions Errance, Paris.
- Dickinson, T. M. (2002) What's new in early medieval burial archaeology?, *Early Medieval Europe*, 11, p. 71-87.
- Dierkens, A. (2000) *Reflexions sur l'histoire religieuse de Maastricht à l'époque mérovingienne*, In *L'évangélisation des régions entre Meuse et Moselle et la fondation de l'abbaye d'Echternach (Ve-IXe siècle)*, Vol. CXVII (Ed. Polfer, M.) Centre Universitaire de Luxembourg, p. 542-567.
- Dierkens, A. (2004) La sculpture sur pierre du très haut moyen âge dans l'ancien diocèse de Tongres-Maastricht-Liège In *Bruc ealles well: Archaeological essays concerning the peoples of north-west Europe in the first millenium AD*, Vol. 15 (Ed. Lodewijckx, M.) Leuven University Press, Leuven, p. 73-86.
- Dierkens, A. and Margue, M. (2004) Memoria ou damnatio memoriae? L'image de Gislebert duc de Lotharingie (+ 939) In *Retour aux sources: textes, études et documents d'histoire médiévale offerts à Michel Parisse* Picard, Paris, p. 869-890.
- Dijkman, W. (1989) *Een vindplaats uit de IJzertijd te Maastricht-Randwyck*, Rijksdienst voor het Oudheidkundig Bodemonderzoek, Amersfoort.
- Dijkman, W. (1992a) *Funde aus Maastricht In Spurensicherung: archäologische Denkmalpflege in der Euregio Maas-Rhein*, Vol. 136 (Eds. Bauchhenß, G. and von Prittwitz u. Gaffron, H.-H.) Verlag Philipp von Zabern, Mainz am Rhein, p. 367-378.
- Dijkman, W. (1992b) La diffusion de la terre sigillée décorée à la molette dans la vallée Mosane (IVe-Ve siècles) In *Actes du congrès de Tournai, 28-31 mai 1992* (Ed. Rivet, L.) Société Française d'Étude de la Céramique Antique en Gaule, p. 291-296.
- Dijkman, W. (1993) La terre sigillée décorée à la molette à motifs chrétiens dans la stratigraphie maastrichtoise (Pays-Bas) et dans le nord-ouest de l'Europe, *Gallia: Fouilles et Monuments Archéologiques en France Métropolitaine*, 49 (1992), p. 129-172.
- Dijkman, W. (1994) Maas-Tricht, lieu de défense et centre religieux In *Archéologie des villes dans le Nord-Ouest de l'Europe (VIIe - XIIIe siècle) Actes du IVe Congrès International d'Archéologie Médiévale (Douai, 1991)*, Vol. 11 (Eds. Demolon, P., Galinié, H. and Verhaeghe, F.) Société Archéologique de Douai, Douai, p. 35-39.
- Dijkman, W. (1995) Een urnenveld in Maastricht-Withuisveld, *Archeologie in Limburg*, 66, p. 49-55.
- Dijkman, W. (1997) Crematieresten in Maastricht-Randwyck, *Archeologie in Limburg*, 74, p. 77.
- Dijkman, W. (2003) The Merovingian cemetery of Borgharen (Maastricht) and an early Frank named BOBO In *Essays on the Early Franks*, Vol. 1 (Eds. Taayke, E., Looijenga, J. H., Harsema, O. H. and Reinders, H. R.) Barkhuis, Groningen, p. 212-230.
- Dijkman, W. and Eryvynck, A. (1998) *Antler, bone, horn, ivory and teeth: The use of animal skeletal materials in Roman and early medieval Maastricht*, Archaeology Section, Municipality of Maastricht, Maastricht.
- Dijkman, W. and Hulst, R. A. (2000) Het urnenveld van Maastricht-Vroendaal, *Archeologie in Limburg*, 84, p. 19-26.
- Dijkstra, M. F. P. and Flamman, J. P. (2004) *Onderweg naar gisteren. Archeologisch onderzoek naar 2000 jaar wegopbouw langs de noordzijde van het Vrijthof te Maastricht*, Amsterdam, p. 113.
- Dougados, M., Van der Linden, S., Juhlin, R., Huitfeldt, B., Amor, B., Calin, A., Cats, A., Dijkmans, B., Olivier, I., Pasero, G., Veys, E. and Zeidier, H. (1991) The European Spondylarthropathy Study Group preliminary criteria for the classification of

- spondylarthropathy, *Arthritis and Rheumatism*, 34, p. 1218-1227.
- Drew, K. F. (1991) *The laws of the Salian Franks*, In *University of Pennsylvania Press: Middle Ages Series* Philadelphia, p. 256.
- Duby, G. (1979) *The early growth of the European economy: Warriors and peasants from the seventh to the twelfth century*, Cornell University Press, New York.
- Duday, H. (1990) Observations ostéologiques et décomposition du cadavre: sépulture colmatée ou en espace vide (1), *Revue Archéologique du Centre de la France*, 29, p. 193-196.
- Duday, H. and Masset, C. (Eds.) (1987) *Anthropologie physique et archéologie: Méthode d'étude des sépultures*, Paris.
- Dudo (1865) *De moribus et actis primorum Normanniae Ducum*, (Ed. Lair, J.) Caen.
- Dupertuis, C. W. and Hadden, J. A. (1951) On the reconstruction of stature from long bones, *American Journal of Physical Anthropology*, 9, p. 15-53.
- Dupras, T. L., Schwarcz, H. P. and Fairgrieve, S. I. (2001) Infant feeding and weaning practices in Roman Egypt, *American Journal of Physical Anthropology*, 115, p. 204-212.
- Durand, M. (1988) *Archéologie du cimetière médiéval au sud-est de l'Oise. Relations avec l'habitat et évolution des rites et pratiques funéraires du VIème au XVIème siècle*.
- Effros, B. (1994) *From grave goods to Christian epitaphs: Evolution in burial tradition and the expression of social status in Merovingian society*, In *History Los Angeles*, p. 492.
- Effros, B. (1997) Beyond cemetery walls: early medieval funerary topography and Christian salvation, *Early Medieval Europe*, 6, p. 1-23.
- Effros, B. (2000) Skeletal sex and gender in Merovingian mortuary archaeology, *Antiquity*, 74, p. 632-639.
- Einhard (1887) *Translatio et miracula ss. Marcellini et Petri*, In *Monumenta Germaniae Historica Scriptores*, Vol. 15 (Ed. Waitz, G.) Hannover, p. 238-264.
- Einhard (1911) *Vita Karoli*, In *Monumenta Germaniae historica, Scriptores rerum Germanicarum*, Vol. 25 (Ed. Holder-Egger, O.) Hannover, p. 1-41.
- Engen, L. (1985) *Les sarcophages mérovingiens dans la vallée de la Meuse*, In *La civilisation mérovingienne dans le bassin mosane*, Vol. 22 (Eds. Willems, J. and Otte, M.) Amay-Liège, p. 161-170.
- Es, W. A. v. (1968) *Grafitueel en kerstening*, Fibula van Dishoeck, Bussum.
- Ewig, E. (1980) *Frühes Mittelalter*, Pädagogischer Verlag Schwann, Düsseldorf.
- Ewig, E. (1993) *Die Merowinger und das Frankenreich*, W. Kohlhammer, Stuttgart.
- Farwell, D. E. and Molleson, T. I. (1993) *Excavations at Poundbury 1966-1980. Volume II: the cemeteries*, Dorchester.
- Fichtenau, H. (1984) *Lebensordnungen des 10. Jahrhunderts: Studien über Denkart und Existenz im einstigen Karolingerreich*, Anton Hiersemann, Stuttgart.
- Fichter, G. and Volk, P. (1980) The eastern orientation of Merovingian graves and the seasonal distribution of morbidity and mortality (using the Sasbach-Behans and Bischoffingen-Bigärten cemeteries as examples), *Journal of Human Evolution*, 9, p. 49-59.
- Finke, L., Dehmel, U., Klinkhardt, K. and Nöther, S. (1997) *Epigenetische Merkmale bei Bevölkerungsgruppen des frühen Mittelalters aus dem Mittelbe-Saale-Gebiet*, In *Medieval Europe*, Vol. 2 (Death and Burial in Medieval Europe) (Eds. De Boe, G. and Verhaeghe, F.) Brugge, p. 85-91.
- Fiorato, V., Boylston, A. and Knüsel, C. (Eds.) (2000) *Blood red roses: The archaeology of a mass grave*

- from the battle of Towton AD 1461, Oxbow Books, Oxford.
- Floud, R., Wachter, K. W. and Gregory, A. (1990) *Height, health and history: nutritional status in the United Kingdom, 1750-1980*, Cambridge University Press, Cambridge.
- Folcuin [1841] *Gesta abbatum Lobliensium*, In *Monumenta Germaniae historica, Scriptores*, Vol. 4 (Ed. Pertz, G. H.) Hannover, p. 54-74.
- Fossier, R. (1991) *La société médiévale*, Armand Colin, Paris.
- Frère, H. (1977) *Le denier carolingien, spécialement en Belgique*, Institut supérieur d'archéologie et d'histoire de l'art, Louvain-la-neuve.
- Fried, J. (1995) The Frankish kingdoms: 817-911: the East and Middle kingdoms In *The New Cambridge Medieval History*, Vol. II c. 700-c. 900 (Ed. McKitterick, R.) Cambridge University Press, Cambridge, p. 142-168.
- Galinié, H. and Zadora-Rio, E. (Eds.) (1996) *Archéologie du cimetière chrétien*, FÉACF / La Simarre, Tours.
- Gallien, V. (1994) La femme: témoin de l'évolution du cimetière de la basilique à Saint-Denis, durant le haut moyen âge In *La femme pendant le moyen âge et l'époque moderne*, Vol. 17 (Ed. Buchet, L.) CNRS Éditions, Paris, p. 69-86.
- Gauthier, N. (1975) *Recueil des inscriptions Chrétiennes de la Gaule*, Paris.
- Geldhauser, B., Guckenhart, S. and Heudorfer, R. (1996) Hiebverletzungen und Trepanationen In *Stumme Zeugen ihrer Leiden: Krankheit und Behandlung vor der medizinischen Revolution* (Ed. Czarnetzki, A.) Attempto, Tübingen, p. 183-205.
- Gerstenberger, J. (2002) *Analyse alter DNA zur Ermittlung von Heiratsmustern in einer frühmittelalterlichen Bevölkerung*, In *Mathematics and Science* Göttingen, p. 201.
- Gijn, M. v. (1994) *Ancient DNA*, Maastricht.
- Gill-King, H. (1997) Chemical and ultrastructural aspects of decomposition In *Forensic taphonomy: the postmortem fate of human remains* (Eds. Haglund, W. D. and Sorg, M. H.) CRC Press, Boca Raton, p. 93-108.
- Glazema, P. and Ypey, J. (1956) *Merovingische ambachtskunst*, Wereldvenster, Maastricht.
- Goetz, H.-W. (1995) Social and military institutions In *The New Cambridge Medieval History*, Vol. II c. 700-c. 900 (Ed. McKitterick, R.) Cambridge University Press, Cambridge, p. 451-480.
- Goossens, W. (1920) Een Frankische grafvondst in de St. Servaaskerk te Maastricht, *Oudheidkundige Mededelingen van het Rijksmuseum voor Oudheden te Leiden*, 1, p. 64-65.
- Goossens, W. (1927) Vondst van een Romeins brandgraf te Maastricht, *Oudheidkundige Mededelingen van het Rijksmuseum voor Oudheden te Leiden*, 8, p. 55-59.
- Grauer, A. L. (1989) *Health, disease and status in medieval York*, In *Anthropology*, p. 313.
- Grauer, A. L. (Ed.) (1995) *Bodies of evidence: Reconstructing history through skeletal analysis*, New York.
- Gregory of Tours (1885) *Liber in gloria confessorum*, In *Monumenta Germaniae historica, Scriptores rerum Merovingicarum*, Vol. 1, 2 (Ed. Krusch, B.) Hannover, p. 744-820.
- Gregory of Tours (1951) *Historiarum libri decem*, In *Monumenta Germaniae historica, Scriptores rerum Merovingicarum*, Vol. 1, 1 (Eds. Krusch, B. and Levison, W.) Hannover, p. 537.
- Gregory of Tours (1986) *Historiarum libri decem*, In *Ausgewählte Quellen zur deutschen Geschichte des Mittelalters*, Vol. 2 (Ed. Buchner, R.) Darmstadt, p. 1-381.
- Grierson, P. and Blackburn, M. (1991) *Medieval European Coinage: I The early middle ages (5th-10th centuries)*, Cambridge University Press, Cambridge.

- Grmek, M. D. (1989) *Diseases in the ancient Greek world*, The Johns Hopkins University Press, Baltimore.
- Grolleau-Raoux, J.-L., Crubézy, E., Rougé, D., Brugne, J.-F. and Saunders, S. R. (1997) Harris lines: a study of age-associated bias in counting and interpretation, *American Journal of Physical Anthropology*, 103, p. 208-217.
- Guigon, P. (1994) *Les sépultures du haut moyen-âge en Bretagne*, Rennes.
- Guy, H., Masset, C. and Baud, C. (1997) Infant taphonomy, *International Journal of Osteoarchaeology*, 7, p. 221-229.
- Hagen, A. (1995) *A second handbook of Anglo-Saxon food & drink: production and distribution*, Anglo-Saxon Books.
- Haglund, W. D. (1997) Rodents and human remains In *Forensic taphonomy: the postmortem fate of human remains* (Eds. Haglund, W. D. and Sorg, M. H.) CRC Press, Boca Raton, p. 405-414.
- Halsall, G. (1995) *Settlement and social organization: The Merovingian region of Metz*, Cambridge University Press, Cambridge.
- Halsall, G. (1998) Social identities and social relationships in early Merovingian Gaul In *Franks and Alamanni in the Merovingian period: an ethnographic perspective*, Vol. 3 (Ed. Wood, I.) The Boydell Press, San Marino, p. 141-165.
- Hanihara, T. and Ishida, H. (2001) Frequency variations of discrete cranial traits in major human populations. I. Supernumerary ossicle variations, *Journal of Anatomy*, 198, p. 689-706.
- Hardenberg, H. (1962) De Maastrichtse Vroenhof In *Miscellanea Trajectensia: Bijdragen tot de geschiedenis van Maastricht*, Vol. 4 Limburgs Geschied- en Oudheidkundig Genootschap, Maastricht, p. 29-53.
- Härke, H. (1997) The nature of burial data In *Burial & Society: The chronological and social analysis of archaeological burial data* (Eds. Jensen, C. K. and Høilund Nielsen, K.) Aarhus University Press, Aarhus, p. 19-28.
- Harris, H. A. (1933) *Bone growth in health and disease*, Oxford University Press, London.
- Harris, M. and Ross, E. B. (1987) *Death, sex and fertility*, Columbia University Press, New York.
- Hartmann, J. L. H. (1986) *De reconstructie van een middeleeuws landschap: Nederzettingsgeschiedenis en instellingen van de heerlijkheden Eijsden en Breust bij Maastricht (10e-19e eeuw)*, Van Gorcum, Assen.
- Hassenpflug, E. (1999) *Das Laienbegräbnis in der Kirche. Historisch-archäologische Studien zu Alemannien im frühen Mittelalter*, Verlag Marie Leidorf, Rahden.
- Hauser, G. and De Stefano, G. F. (1989) *Epigenetic variants of the human skull*, E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart.
- Henderson, J. (1987) Factors determining the state of preservation of human remains In *Death, decay and reconstruction: Approaches to archaeology and forensic science* (Eds. Boddington, A., Garland, A. N. and Janaway, R. C.) Manchester University Press, Manchester, p. 43-54.
- Henrion, F. and Hunot, J.-Y. (1996) Archéologie et technologie du cercueil et du coffrage de bois In *Archéologie du cimetière chrétien*, Vol. 11 (Eds. Galinié, H. and Zadora-Rio, E.) FÉRAF / La Simarre, Tours, p. 197-204.
- Herlihy, D. (1987) Outline of population developments in the middle ages In *Determinanten der Bevölkerungsentwicklung im Mittelalter* (Eds. Herrmann, B. and Sprandel, R.) VCH Verlagsgesellschaft, Weinheim, p. 1-23.
- Herrmann, B. (1987) Anthropologische Zugänge zu Bevölkerung und Bevölkerungsentwicklung im Mittelalter In *Determinanten der Bevölkerungsentwicklung im Mittelalter* (Eds. Herrmann, B. and Sprandel, R.) Weinheim, p. 55-73.

- Herrmann, B., Grupe, G., Hummel, S., Piepenbrink, H. and Schutkowski, H. (1990) *Prähistorische Anthropologie: Leitfaden der Feld- und Labormethoden*, Berlin.
- Herrmann, B. and Sprandel, R. (Eds.) (1987) *Determinanten der Bevölkerungsentwicklung im Mittelalter*, Weinheim.
- Herrmann, B. and Sprandel, R. (Eds.) (1988) *Die Bevölkerungsentwicklung des europäischen Mittelalters: Das wirtschaftsgeographische und kulturelle Umfeld*, Verlag Karl Alber, Freiburg.
- Hershkovitz, I., Greenwald, C., Rothschild, B. M., Latimer, B., Dutour, O., Jellema, L. M. and Wish-Baratz, S. (1999) Hyperostosis frontalis interna: an anthropological perspective, *American Journal of Physical Anthropology*, 109, p. 303-325.
- Hessing, W. A. M. (1994) Tien eeuwen grafritueel (Eds. Es, W. A. v. and Hessing, W. A. M.) Rijksdienst voor het Oudheidkundig Bodemonderzoek, Romeinen, Friezen en Franken in het hart van Nederland, p. 130-137.
- Heymans, H. (1978) De topografie van de Merovingische grafvelden in Belgisch-Limburg en Maastricht, *Acta Archaeologica Lovaniensia*, 17, p. 66-134.
- Higgins, V. (1989) A model for assessing health patterns from skeletal remains In *Burial archaeology: Current research, methods and developments*, Vol. 211 (Eds. Roberts, C. A., Lee, F. and Bintliff, J.) Oxford, p. 175-204.
- Higgins, V. (2002) The people of San Vincenzo in late Antiquity and the early middle ages In *San Vincenzo al Volturno 3: The finds from the 1980-86 excavations* (Eds. Mitchell, J. and Hanssen, I. L.) Centro Italiano di studi sull'alto medioevo, Spoleto, p. 425-437.
- Hillson, S. (1996) *Dental anthropology*, Cambridge University Press, Cambridge.
- Hillson, S. (2001) Recording dental caries, *International Journal of Osteoarchaeology*, 11, p. 249-289.
- Hlawitschka, E. (1986) *Vom Frankenreich zur Formierung der europäischen Staaten- und Völkergemeinschaft 840-1046: Ein Studienbuch zur Zeit der späten Karolinger, der Ottonen und der frühen Salier in der Geschichte Mitteleuropas*, Wissenschaftliche Buchgesellschaft, Darmstadt.
- Hofman, P. A. M., Panhuysen, R. G. A. M. and Maat, G. J. R. (1995) Use of computed tomography in age determination In *Proceedings of the IXth European meeting of the Paleopathology Association: Barcelona 1st - 4th September, 1992* (Eds. Batista, R., Campillo, D. and Carreras, T.) Museu d'Arqueologia de Catalunya, Barcelona, p. 157-161.
- Hofman, P. A. M., Panhuysen, R. G. A. M. and Maat, G. J. R. (in press) Assessment of the trabecular structure of the proximal femur: A comparison of two techniques In *Proceedings of the Xth European meeting of the Paleopathology Association: Göttingen 1994* Göttingen.
- Holck, P. (1986) *Cremated bones*, Anatomical Institute, University of Oslo, Oslo.
- Hoppa, R. D. (1996) *Representativeness and bias in cemetery samples: implications for palaeodemographic reconstructions of past populations*, In *Department of Anthropology*.
- Hühne-Osterloh, G. and Grupe, G. (1989) Causes of infant mortality in the Middle Ages revealed by chemical and palaeopathological analyses of skeletal remains, *Zeitschrift für Morphologische Anthropologie*, 77, p. 247-258.
- Hulst, R. A. (1995) *Verslag opgraving Lage Kanaaldijk*, Maastricht.
- Hulst, R. A. and Dijkman, W. (1997) *Maastricht/Amby-Heukelstraat: een archeologische A-locatie*, *Archeologie in Limburg*, 74, p. 61-70.
- Hulst, R. A. and Dijkman, W. (2001) *Rapport AAO Pasestraat, Borgharen, gemeente Maastricht*, Maastricht.

- Hummel, S. and Herrmann, B. (1994) General aspects of sample preparation In *Ancient DNA: recovery and analysis of genetic material from paleontological, archaeological, museum, medical and forensic specimens* (Eds. Herrmann, B. and Hummel, S.) Springer-Verlag New York, New York, p. 59-68.
- Iscan, M. Y. and Kennedy, K. A. R. (Eds.) (1989) *Reconstruction of life from the skeleton*, Wiley and Liss, New York.
- Iscan, M. Y. and Loth, S. R. (1989) Osteological manifestations of age in the adult In *Reconstruction of life from the skeleton* (Eds. Iscan, M. Y. and Kennedy, K. A. R.) Wiley and Liss, New York.
- Iscan, M. Y., Loth, S. R. and Wright, R. K. (1984) Age estimation from the ribs by phase analysis: White males., *Journal of Forensic Sciences*, 29, p. 1094-1104.
- Iscan, M. Y., Loth, S. R. and Wright, R. K. (1985) Age estimation from the rib by phase analysis: White females, *Journal of Forensic Sciences*, 30, p. 853-863.
- James, E. (1991) *The Franks*, Basil Blackwell, Oxford.
- Janaway, R. C. (1997) The decay of buried human remains and their associated materials In *Studies in Crime: An introduction to forensic archaeology* (Eds. Hunter, J., Roberts, C. A. and Martin, A.) Routledge, London, p. 58-85.
- Janssen, H. A. M. and Maat, G. J. R. (1999) Canons buried in the "Stiftskapel" of the saint Servaas basilica at Maastricht A.D. 1070-1521. A paleopathological study, *Barge's Anthropologica*, Leiden.
- Janssens, P. (1963) Examen anthropologique des squelettes mérovingiens d'Arlon In *Sépultures mérovingiennes au "Vieux cimetière" d'Arlon*, Vol. 94 (Eds. Roosens, H. and Alenus-Lecerf, J.) Arlon, p. 175-186.
- Janssens, P. (1967) Examen anthropologique des ossements du cimetière Mérovingien de Hollogne-aux-Pierres In *Tombes Mérovingiennes à Hollogne-aux-Pierres*, Vol. 101 (Eds. Alenus-Lecerf, J. and Dradon, M.) Brussels, p. 91-129.
- Janssens, P. (1970) Het anthropologisch onderzoek In *Grafvondsten uit de Romeinse en Merovingische tijd te Tongeren*, Vol. 116 (Eds. Roosens, H. and Mertens, J.) Brussels, p. 29-42.
- Jocundus (1856) *Translatio et miracula s. Servatii Traiectensis*, In *Monumenta Germaniae historica, Scriptores*, Vol. 12 (Ed. Köpke, R.) Hannover, p. 85-126.
- Judd, M. A. and Roberts, C. A. (1998) Fracture patterns at the Medieval Leper Hospital in Chichester, *American Journal of Physical Anthropology*, 105, p. 43-55.
- Kalf, J. (1916) Opgravingen in de St. Servaaskerk te Maastricht, *Bulletin van den Nederlandschen Oudheidkundige Bond*, p. 17-44.
- Kemkes-Grottenthaler, A. (2002) Aging through the ages: historical perspectives on age indicator methods In *Paleodemography: age distributions from skeletal samples*, Vol. 31 (Eds. Hoppa, R. D. and Vaupel, J. W.) Cambridge University Press, Cambridge, p. 48-72.
- Knussmann, R. (Ed.) (1988) *Anthropologie: Handbuch der Vergleichende Biologie des Menschen*, Stuttgart.
- Koch, U. (1996) Stätten der Totenruhe - Grabformen und Bestattungssitten der Franken In *Die Franken - Wegbereiter Europas* Verlag Philipp von Zabern, Mainz, p. 723-737.
- Köbl, S. (2004) *Das Kinderdefizit im frühen Mittelalter - Realität oder Hypothese?*, In *Geowissenschaftlichen Fakultät Tübingen*, p. 204.
- Kooistra, L. I. (1996) *Borderland farming: Possibilities and limitations of farming in the Roman period and early middle ages between the Rhine and Meuse*, Van Gorcum, Assen.
- Krogman, W. M. and Iscan, M. Y. (1986) *The human skeleton in forensic medicine*, Charles C Thomas, Springfield.

- Kroos, R. (1985) *Der Schrein des Heiligen Servatius in Maastricht*, Zentralinstitut für Kunstgeschichte in München.
- Künter, M. and Wittwer-Backofen, U. (1996) Die Franken - Anthropologische Bevölkerungsrekonstruktionen im östlichen Siedlungsgebiet In *Die Franken - Wegbereiter Europas* (Eds. Wiczorek, A., Périn, P., von Welck, K. and Menghin, W.) Verlag Philipp von Zabern, Mainz, p. 653-661.
- Lammers, S. (1992) Medieval Christian interments in stone: monolithic limestone sarcophagi, *Berichten van de Rijksdienst voor het Oudheidkundig Bodemonderzoek*, 39 (1989), p. 377-434.
- Lanting, J. N. and van der Plicht, J. (1996) Wat hebben Floris V, skelet Swifterbant S2 en visotters gemeen?, *Palaeohistoria*, 37/38, p. 491-519.
- Larsen, C. S. (1997) *Bioarchaeology: interpreting behavior from the human skeleton*, Cambridge University Press, Cambridge.
- Le Jan, R. (1995) *Famille et pouvoir dans le monde Franc (Vile-Xe siècle)*, Publications de la Sorbonne, Paris.
- Le Jan, R. (1996) Austrasiens - Versuch einer Begriffsdefinition In *Die Franken - Wegbereiter Europas*, Vol. 1 (Eds. Wiczorek, A., Périn, P., von Welck, K. and Menghin, W.) Verlag Philipp von Zabern, Mainz, p. 222-226.
- Le Jan, R. (2000) Frankish giving of arms and rituals of power: Continuity and change in the Carolingian period In *Rituals of power*, Vol. 8 (Eds. Theuvs, F. C. W. J. and Nelson, J. L.) Brill, Leiden, p. 281-309.
- Lebecqz, S. (1990) *Les origines franques Ve-IXe siècle*, Éditions du Seuil, Paris.
- Leupen, P. H. D. (1997) Het gelijk van Sint-Servaas en Onze-Lieve-Vrouwe. De Maastrichtse kapittels in de Vroege Middeleeuwen In *De kerk en de Nederlanden: Archieven, instellingen, samenleving* (Eds. Erkelens-Buttinger, E. S. C., Henderikx, P. A., Leeuwenberg, H. L. P., Leupen, P. H. D., Maarschalkwereld, P. and Verkerk, C. L.) Verloren, Hilversum, p. 29-42.
- Levison, W. (1948) Das Testament des Diakons Adalgisel-Grimo vom Jahre 634 In *Aus rheinischer und fränkischer Frühzeit* (Ed. Levison, W.) Düsseldorf, p. 118-138.
- Lilley, J. M., Stroud, G., Brothwell, D. R. and Williamson, M. H. (1994) *The Jewish burial ground at Jewbury*, Council for British Archaeology, York.
- Livi-Bacci, M. (1990) *Population and nutrition: an essay on European demographic history*, Cambridge University Press, Cambridge.
- Livi-Bacci, M. (1993) *A concise history of world population*, Blackwell, Cambridge.
- Lohier, F. and Laporte, J. (Eds.) (1936) *Gesta sanctorum patrum Fontanellensis coenobii*, Rouen-Paris.
- Lohrke, B. (2004) *Kinder in der Merowingerzeit: Gräber von Mädchen und Jungen in der Alemannia*, Leidorf, Rahden/ Westfalen.
- Lonnée, H., A. (1990) Pathologie van menselijke botresten uit de Romeinse tijd afkomstig uit de inhumatiegraven van het grafveld op het Marktveld te Valkenburg (Z.H.) In *Graven bij Valkenburg III: het archeologisch onderzoek in 1987 en 1988* (Eds. Bult, E. J. and Hallewas, D. P.) Eburon, Delft, p. 117-129.
- Lonnée, H., A. and Maat, G. J. R. (1998) *Inhumations in a Roman cemetery at Valkenburg-Marktveld (Zuid Holland) in the Netherlands*, In *Barge's Anthropologica*, Vol. 3 Leiden, p. 54.
- Lorans, E. (2000) Le monde des morts de l'antiquité tardive à l'époque moderne (IVe-XIXe S.) In *Archéologie funéraire* (Eds. Crubézy, E., Lorans, E., Masset, C., Perrin, F. and Tranoy, L.) Editions Errance, Paris, p. 155-197.
- Löwe, H. (1973) *Vorzeit und Karolinger*, Hermann Böhlau Nachfolger, Weimar.
- Lukacs, J. R. (1989) Dental paleopathology: methods for reconstructing dietary patterns In

- Reconstruction of life from the skeleton* (Eds. Iscan, M. Y. and Kennedy, K. A. R.) Alan R. Liss, Inc., New York, p. 261-286.
- Maat, G. J. R. (1984) The dating and rating of Harris's lines, *The American Journal of Physical Anthropology*, 63, p. 291-299.
- Maat, G. J. R. (1987) Practising methods of age determination: comments on methods combining multiple age indicators, *Journal of Anthropology*, 2, p. 93-99.
- Maat, G. J. R. (2003) Male stature: a parameter of health and wealth in the low countries, 50-1997 AD In *Wealth, health and human remains in archaeology*, Vol. 25 (Ed. Metz, W. H.) Stichting Nederlands Museum voor Anthropologie en Praehistorie, Amsterdam, p. 57-88.
- Maat, G. J. R., Mastwijk, R. W. and van der Velde, E. A. (1994) Skeletal distribution of degenerative changes in vertebral osteophytosis, vertebral osteoarthritis and DISH, *International Journal of Osteoarchaeology*, 5, p. 289-298.
- Maat, G. J. R., Panhuysen, R. G. A. M. and Mastwijk, R. W. (2000) *Manual for the physical anthropological report*, Leiden.
- Maat, G. J. R., van den Eynde, G. and Mastwijk, R. W. (1997) De eerste Nassaus in Nederland: identificatie van en paleopathologische bevindingen bij de voorouders van Willem van Oranje, begraven in de Grote of Onze Lieve Vrouwe Kerk te Breda., *Nederlands Tijdschrift voor Geneeskunde*, 141, p. 2501-2513.
- Maat, G. J. R. and van der Velde, E. A. (1987) The caries-attribution competition, *International Journal of Anthropology*, 2, p. 281-292.
- MacLaughlin, S. and Bruce, M. F. (1985) A simple univariate technique for determining sex from fragmentary femora: Its application to a Scottish short cist population, *The American Journal of Physical Anthropology*, 67, p. 413-417.
- Mafart, B.-Y. (1980) *L'abbaye Saint-Victor de Marseille: Étude anthropologique de la nécropole des IV^{ème} - VI^{ème} siècles*, Paris.
- Mafart, B.-Y. (1983) *Pathologie osseuse au Moyen Âge en Provence*, Paris.
- Mann, R. W. and Murphy, S. P. (1990) *Regional atlas of bone disease: A guide to pathologic and normal variation in the human skeleton*, Springfield.
- Manouvrier, L. (1893) La détermination de la taille d'après les grands os longs des membres, *Bulletins et Mémoires de la Société d'Anthropologie de Paris*, 4, p. 347-402.
- Mant, A. K. (1987) Knowledge acquired from post-War exhumations In *Death, decay and reconstruction: Approaches to archaeology and forensic science* (Eds. Boddington, A., Garland, A. N. and Janaway, R. C.) Manchester University Press, Manchester, p. 65-78.
- Manzi, G., Salvadei, L., Vienna, A. and Passarello, P. (1999) Discontinuity of life conditions at the transition from the Roman imperial age to the early middle ages: Example from central Italy evaluated by pathological dento-alveolar lesions, *American Journal of Human Biology*, 11, p. 327-341.
- Maresh, M. M. (1955) Linear growth of long bones of extremities from infancy through adolescence, *American Journal of Diseases in Children*, 89, p. 125-142.
- Martin, R. and Saller, K. (1957) *Lehrbuch der Anthropologie in systematischer Darstellung*, Stuttgart.
- Mays, S. (1998) *The archaeology of human bones*, Routledge, London.
- Mays, S. and Cox, M. a. (2000) Sex determination in skeletal remains In *Human osteology in archaeology and forensic science* (Eds. Cox, M. a. and Mays, S.) Greenwich Medical Media Ltd., London, p. 117-130.

- McKinley, J. I. and Roberts, C. A. (1993) *Excavation and post-excavation treatment of cremated and inhumed human remains*, Birmingham.
- McKitterick, R. (Ed.) (1995) *The new Cambridge medieval history*, Cambridge University Press, Cambridge.
- McWhirr, A., Viner, L. and Wells, C. (1982) *Romano-British cemeteries at Cirencester*, Cirencester Excavation Committee, Cirencester.
- Mekking, A. (2000) Die Darstellung der Flucht nach Ägypten und des Bethlehemitischen Kindermordes in der Servatiuskirche zu Maastricht. Eine Syrische Ikonographie auf einem frühmittelalterlichen Chorschrankenrelief aus Metz? In *L'évangélisation des régions entre Meuse et Moselle et la fondation de l'abbaye d'Echternach (Ve-IXe siècle)*, Vol. 117 (Ed. Polfer, M.) Luxembourg.
- Mekking, A. J. J. (1986) *De Sint-Servaaskerk te Maastricht: Bijdragen tot de kennis van de symboliek en de geschiedenis van de bouwdelen en de bouwsculptuur tot circa 1200*, Clavis, Utrecht.
- Melzer, W. (1993) *Das fränkische Gräberfeld von Saffig, Kreis Mayen-Koblenz*, Verlag Marie L. Leidolf, Buch am Erlbach.
- Merckx, M. and Panhuysen, R. G. A. M. (2004) Enamel hypoplasia and health during childhood in early medieval Maastricht and nineteenth century Zwolle (The Netherlands), *Programme and abstracts of the 15th European meeting of the Paleopathology Association, Durham, U.K.*, p. 68.
- Merret, D. C. and Pfeiffer, S. (2000) Maxillary Sinusitis as an Indicator of Respiratory Health in Past Populations, *American Journal of Physical Anthropology*, 111, p. 301-318.
- Mertens, J. (1987) De weg Boulogne-Keulen op Belgisch grondgebied In *Langs de weg* (Eds. Stuart, P. and de Grooth, M. E. T.) Thermenmuseum, Heerlen, p. 16-21.
- Mertens, J. (1990) La destinée des centres urbains gallo-romains à la lumière de l'archéologie et des textes In *La genèse et les premiers siècles des villes médiévales dans les Pays-Bas méridionaux: Un problème archéologique et historique*, Vol. 83 Crédit Communal, Brussels, p. 61-74.
- Meschan, I. (1975) *An Atlas of Anatomy Basic to Radiology*, W.B. Saunders Company, Philadelphia.
- Micozzi, M. S. (1991) *Postmortem change in human and animal remains: a systematic approach*, Charles C Thomas, Springfield.
- Molleson, T. I. (1991) Demographic implications of the age structure of early English cemetery samples In *Ville et campagne en Europe occidentale (Ve-XIIIe siècle)*, Vol. 14 (Ed. Buchet, L.) CNRS Éditions, Paris, p. 113-122.
- Molleson, T. I. (1994) Can the degree of sexual dimorphism provide an insight into the position of women in past populations? In *La femme pendant le moyen âge et l'époque moderne*, Vol. 17 (Ed. Buchet, L.) CNRS Éditions, Paris, p. 51-67.
- Molleson, T. I. and Cox, M. (1993) *The Spitalfields project. Volume 2: the anthropology. The middling sort*, London.
- Moore Jr., T. C., Rea, D. K. and Godsey, H. (1998) Regional variation in modern radiocarbon ages and the hard-water effects in Lakes Michigan and Huron, *Journal of Paleolimnology*, 20, p. 347-351.
- Morris, I. (1992) *Death-ritual and social structure in classical antiquity*, Cambridge University Press, Cambridge.
- Morrison, K. F. and Grunthal, H. (1967) *Carolingian coinage*, New York.
- Najjar, M. Y. E.-. and McWilliams, K. R. (1978) *Forensic anthropology*, Charles C Thomas, Springfield.
- Nawrocki, S. P. (1995) Taphonomic processes in historic cemeteries In *Bodies of evidence: Reconstructing history through skeletal analysis* (Ed. Grauer, A. L.) New York, p. 49-66.

- Nelson, J. L. (1995a) The Frankish kingdoms, 814-898: the West In *The New Cambridge Medieval History*, Vol. II c. 700-c. 900 (Ed. McKitterick, R.) Cambridge University Press, Cambridge, p. 110-141.
- Nelson, J. L. (1995b) Kingship and royal government In *The New Cambridge Medieval History*, Vol. II c. 700-c. 900 (Ed. McKitterick, R.) Cambridge University Press, Cambridge, p. 383-430.
- Niermeyer, J. F. (1984) *Mediae latinitatis lexicon minus*, E.J.Brill, Leiden.
- Nithard (1907) *Historiarum Libri III*, in *Monumenta Germaniae historica, Scriptores in usum scholarum*, Vol. 44 (Ed. Müller, E.) Hannover.
- Nonn, U. (1983) *Pagus und Comitatus in Niederlothringen: Untersuchungen zur politischen Raumgliederung im Frühen Mittelalter*, Bonn.
- Novak, S. (2000) Battle-related trauma In *Blood red roses: The archaeology of a mass grave from the battle of Towton AD 1461* (Eds. Fiorato, V., Boylston, A. and Knüsel, C.) Oxbow books, Oxford, p. 90-102.
- Ohler, N. (1990) *Sterben und Tod im Mittelalter*, Artemis Verlag, München.
- Olivier, G. (1963) L'estimation de la stature par les os long des membres, *Bulletins et Mémoires de la Société d'Anthropologie de Paris*, 4, p. 433-449.
- O'Loughlin, V. D. (2004) Effects of different kinds of cranial deformation on the incidence of Wormian bones, *American Journal of Physical Anthropology*, 123, p. 146-155.
- Ortner, D. J. (2003) *Identification of pathological conditions in human skeletal remains*, Academic Press, Amsterdam.
- Ortner, D. J. and Aufderheide, A. C. (Eds.) (1991) *Human paleopathology: Current syntheses and future options*, Washington.
- Ortner, D. J. and Putschar, W. G. J. (1985) *Identification of pathological conditions in human skeletal remains*, Washington.
- Otten, T. (2003) *Die Ausgrabungen unter St. Viktor zu Xanten: Dom und Immunität*, Mainz.
- Paine, R. R. and Boldsen, J. L. (2002) Linking age-at-death distributions and ancient population dynamics: a case study In *Paleodemography: age distributions from skeletal samples*, Vol. 31 (Eds. Hoppa, R. D. and Vaupel, J. W.) Cambridge University Press, Cambridge, p. 169-180.
- Panhuysen, R. G. A. M. (1989) *Giselbert II van Lotharingen, een tweede Catilina?*, Leiden/Münster.
- Panhuysen, R. G. A. M. (1994) Begravingen in het Witte Vrouwenklooster In *De Theateropgraving in Maastricht (1988-1989)*, Vol. 1 (Ed. Hulst, R. A.) Maastricht, p. 61-63.
- Panhuysen, R. G. A. M. (1995) Paleopathology and history: one story many sources In *Proceedings of the IXth European meeting of the Paleopathology Association: Barcelona 1st - 4th September, 1992* (Eds. Batista, R., Campillo, D. and Carreras, T.) Museu d'Arqueologia de Catalunya, Barcelona, p. 263-266.
- Panhuysen, R. G. A. M. (1999) *La population maastrichtoise du Vie au VIIIe siècle*, In *Mosa Nostra*, Vol. 23 (Eds. Plumier, J., Plumier-Torfs, S. and Regnard, M.) Namur, p. 39-40.
- Panhuysen, R. G. A. M. (2000) Rapportage menselijke skeletresten, Deel 2: resultaten van het fysisch antropologisch onderzoek In *Aanvullend Archeologisch Onderzoek Borgharen-Pasestraat (gem. Maastricht)* (Eds. Hulst, R. A. and Dijkman, W.) Maastricht.
- Panhuysen, R. G. A. M. (2002) Het scherp van de snede, Sporen van geweld in vroegmiddeleeuws Maastricht, *Archeologie in Limburg*, 92, p. 2-7.
- Panhuysen, R. G. A. M. (2005a) *Human skeletal remains at the Boschstraat site (MAGM-B): A catalogue of inhumations with archaeological, physical anthropological and palaeopathological data*, Maastricht.

- Panhuysen, R. G. A. M. (2005b) *Human skeletal remains at the Servaas church site (MAKK-3): A catalogue of inhumations with archaeological, physical anthropological and palaeopathological data*, Maastricht.
- Panhuysen, R. G. A. M. (2005c) *Human skeletal remains from the Chapelle Saint Hilaire site (Namur, Belgium): A catalogue of inhumations with archaeological, physical anthropological and palaeopathological data*, Maastricht.
- Panhuysen, R. G. A. M., Coenen, V. and Bruintjes, T. D. (1997) Chronic maxillary sinusitis in medieval Maastricht, The Netherlands, *International Journal of Osteoarchaeology*, 7, p. 610-614.
- Panhuysen, R. G. A. M., Walenkamp, G. H. I. M. and Maat, G. J. R. (1994) Osteolytic lesions on humerus and clavicle, *Homo*, 45, p. 597.
- Panhuysen, R. G. A. M., Walenkamp, G. H. I. M. and Maat, G. J. R. (in press) Cortical "defects" in humerus and clavicle In *Paleopathology today. Proceedings of the Xth European Meeting of the Paleopathology Association, Göttingen, 29th August - 3rd September 1994*. (Eds. Schultz, M., Teege, W.-R. and Kreutz, K.) Verlag Marie L. Leidorf, Rahden.
- Panhuysen, T. A. S. M. (1982) 1981. MAKK. 3: Een mijlpaal in het onderzoek van de Sint Servaas In *Campus Liber*, Vol. 8 Limburgs Geschied- en Oudheidkundig Genootschap, Maastricht, p. 21-55.
- Panhuysen, T. A. S. M. (1984) *Maastricht staat op zijn verleden*, Stichting Historische Reeks Maastricht, Maastricht.
- Panhuysen, T. A. S. M. (1986) Wat weten we over de continuïteit van Maastricht? In *Sint-Servatius, bisschop van Tongeren-Maastricht. Het vroegste Christendom in het Maasland*, Vol. 28 (Ed. de Dijn, G.) Borgloon, p. 125-146.
- Panhuysen, T. A. S. M. (1988) Humbertus, bouwheer van de Sint-Servaaskerk te Maastricht, overleden 2 mei 1086, *De Maasgouw*, 107, p. 159-163.
- Panhuysen, T. A. S. M. (1990) Die Maastrichter Servatiuskirche im Frühmittelalter: Ein Vorbericht über die jüngsten Grabungen des städtischen Amtes für Bodendenkmalpflege Maastricht, *Kunstchronik: Monatschrift für Kunstwissenschaft, Museumswesen und Denkmalpflege*, 43, p. 541-553.
- Panhuysen, T. A. S. M. (1991) De Sint-Servaaskerk te Maastricht in de vroege middeleeuwen. Voorlopig eindverslag van de opgravingen door de dienst Stadsontwikkeling Maastricht in de periode 1981-1989, *Bulletin van de Koninklijke Nederlandse Oudheidkundige Bond*, 90, p. 15-24.
- Panhuysen, T. A. S. M. (1992a) Die Euregio Maas-Rhein, 300 bis 1250. Von der Peripherie ins Zentrum der europäischen Geschichte In *Spurensicherung: archäologische Denkmalpflege in der Euregio Maas-Rhein*, Vol. 136 (Eds. Bauchhenß, G. and von Prittwitz u. Gaffron, H.-H.) Verlag Philipp von Zabern, Mainz am Rhein, p. 115-144.
- Panhuysen, T. A. S. M. (1992b) *Technisch verslag van het archeologisch bodemonderzoek in de Sint-Servaaskerk te Maastricht*, Maastricht, p. 14.
- Panhuysen, T. A. S. M. (1996a) Barbarische oder römische Barbarei? In *Akten des 3. internationalen Kolloquiums über Probleme des provinzialrömischen Kunstschaffens* (Ed. Bauchhenß, G.) Dr. Rudolf Habelt GmbH, Bonn, p. 121-126.
- Panhuysen, T. A. S. M. (1996b) *Romeins Maastricht en zijn beelden*, Van Gorcum, Maastricht.
- Panhuysen, T. A. S. M. and de la Haye, R. (2002) 2. Maastricht In *Province ecclésiastique de Cologne (Germania Secunda)*, Vol. XII (Eds. Gauthier, N., Beaujard, B. and Fr., P.) De Boccard, Paris, p. 91-115.
- Panhuysen, T. A. S. M., Dijkman, W., Hulst, R. A. and Panhuysen, R. G. A. M. (1991) Opgravingen door het Gemeentelijk Oudheidkundig Bodemonderzoek Maastricht (GOBM) in het jaar

- 1990 From: Stoeper, H. (Ed.) *Archeologische kroniek van Limburg over 1990, Publications de la Société Historique et Archéologique dans le Limbourg*, 127, p. 237-251.
- Panhuysen, T. A. S. M., Dijkman, W., Hulst, R. A. and Panhuysen, R. G. A. M. (1992) Opgravingen door het Gemeentelijk Oudheidkundig Bodemonderzoek Maastricht (GOBM) in het jaar 1991 From: Stoeper, H. (Ed.) *Archeologische kroniek van Limburg over 1991, Publications de la Société Historique et Archéologique dans le Limbourg*, 128, p. 259-288.
- Panhuysen, T. A. S. M. and Leupen, P. H. D. (1990) *Maastricht in het eerste millennium: De vroegste stadsontwikkeling in Nederland*, In *La genèse et les premiers siècles des villes médiévales dans les Pays-Bas méridionaux: Un problème archéologique et historique*, Vol. 83 Brussels, p. 411-455.
- Parkin, T. G. (1992) *Demography and Roman society*, The Johns Hopkins University Press, Baltimore.
- Paxton, F. S. (1996) *Christianizing death: the creation of a ritual process in early medieval Europe*, Cornell University Press, New York.
- Pearson, K. (1898) On the Reconstruction of the Stature of Prehistoric Races, *Philosophical Transactions of the Royal Society*, 192A, p. 169-244.
- Pearson, K. L. (1997) Nutrition and the early-medieval diet, *Speculum*, 72, p. 1-32.
- Perizonius, W. R. K. (1982) Excavation data of skeletal remains for the human osteologist; a questionnaire for the archaeologist, *Journal of Human Evolution*, 11, p. 461-479.
- Pfäffgen, B. (1992) *Die Ausgrabungen in St. Severin zu Köln Teil 1*, Verlag Philipp von Zabern, Mainz am Rhein.
- Pfäffgen, B. and Ristow, S. (1996a) Die Religion der Franken im Spiegel der archäologischer Zeugnisse In *Die Franken - Wegbereiter Europas*, Vol. 2 (Eds. Wiczorek, A., Périn, P., von Welck, K. and Menghin, W.) Philipp von Zabern, Mainz, p. 738-744.
- Pfäffgen, B. and Ristow, S. (1996b) Die Römerstadt Köln zur Merowingerzeit In *Die Franken - Wegbereiter Europas*, Vol. 1 (Eds. Wiczorek, A., Périn, P., von Welck, K. and Menghin, W.) Philipp von Zabern, Mainz, p. 145-159.
- Pilet, C. (Ed.) (1994) *La nécropole de Saint-Martin-de-Fontenay*, Calvados, Éditions du CNRS, Paris.
- Pilet, C. (1996) Chrono-typologie des tombes de Normandie In *Archéologie du cimetière chrétien* FÉRAF / La Simarre, Tours, p. 251-255.
- Pilet, C., Alduc-le Bagousse, A., Blondiaux, J., Buchet, L., Grévin, G. and Pilet-Lemière, J. (1990) Les nécropoles de Giberville (Calvados) fin du Ve siècle - fin du VIIe siècle ap. J.C., *Archéologie Médiévale*, XX (1990), p. 3-140.
- Pol, A. (1995) Les monétaires à Huy et Maastricht. Production et distribution des monnaies mérovingiennes mosanes, *Bulletin de l'Institut Archéologique Liégeois*, 107, p. 185-200.
- Polet, C. and Katzenberg, M. A. (2003) Reconstruction of the diet in a mediaeval monastic community from the coast of Belgium, *Journal of Archaeological Science*, 30, p. 525-533.
- Polet, C., Orban, R. and Herbosch, A. (1994) Différences sexuelles des teneurs en zinc et en strontium dans les ossements humains de quelques échantillons médiévaux de Belgique (résultats préliminaires) In *La femme pendant le moyen âge et l'époque moderne*, Vol. 17 CNRS Éditions, Paris, p. 173-187.
- Pontal, O. (1989) *Histoire des conciles mérovingiens*, Éditions du Cerf, Paris.
- Powell, M. L. (1988) *Status and health in prehistory*, Washington.
- Pycke, J. (1990) "Urbs fuerat quondam, quod adhuc vestigia monstrant" *Réflexions sur l'histoire de Tournai pendant le Haut Moyen Âge (Ve-Xe siècle)*, In *La genèse et les premiers siècles des villes médiévales dans les Pays-Bas méridionaux*:

- Un problème archéologique et historique, Vol. 83
Brussels, p. 211-233.
- Randsborg, K. (1991) *The first millennium AD in Europe and the Mediterranean: an archaeological essay*, Cambridge.
- Reichs, K. J. (Ed.) (1986) *Forensic osteology: Advances in the identification of human remains*, Springfield.
- Reus, J. (1988) *De geschiedenis van het zuidlimburgse cultuurlandschap*, Van Gorcum, Assen.
- Resnick, D. (1996) *Bone and joint imaging*, W.B. Saunders Company, Philadelphia.
- Reynolds, S. (1994) *Fiefs and vassals: The medieval evidence reinterpreted*, Oxford.
- Riché, P. (1983) *Les Carolingiens: Une famille qui fait l'Europe*, Hachette, Paris.
- Richer (1930) *Histoire de France*, Vol. 1 (888-954) (Ed. Latouche, R.) Paris.
- Riddle, J. M. (1994) *Contraception and abortion from the ancient world to the Renaissance*, Harvard University Press, Cambridge.
- Rivet, L. (Ed.) (1992) *Actes du congrès de Tournai, 28-31 mai 1992*, Société Française d'Étude de la Céramique Antique en Gaule.
- Robb, J., Bigazzi, R., Lazzarini, L., Scarsini, C. and Sonega, F. (2001) Social "status" and biological "status": a comparison of grave goods and skeletal indicators from Pontecagnano, *American Journal of Physical Anthropology*, 115, p. 213-222.
- Roberts, C. and Cox, M. (2003) *Health and disease in Britain, from prehistory to the present day*, Sutton Publishing.
- Roberts, C., Lee, F. and Bintliff, J. (Eds.) (1989) *Burial archaeology: Current research, methods and developments*.
- Roberts, C. and Manchester, K. (1995) *The archaeology of disease*, Alan Sutton Publishing, New York.
- Rodriguez, W. C. (1997) Decomposition of buried and submerged bodies in *Forensic taphonomy: the postmortem fate of human remains* (Eds. Haglund, W. D. and Sorg, M. H.) CRC Press, Boca Raton, p. 459-467.
- Roebroeks, W. (1992) Von "Urmenschen", Landschaftszerstörung und archäologischer Forschung in der Grube Maastricht-Belvédère In *Spurensicherung: archäologische Denkmalpflege in der Euregio Maas-Rhein*, Vol. 136 (Eds. Bauchhenß, G. and von Prittwitz u. Gaffron, H.-H.) Verlag Philipp von Zabern, Mainz am Rhein, p. 413-420.
- Roemen, H. C. W. (1947) Maastricht: Een geografische - hoofdzakelijk economisch-geografische - beschrijving en verklaring der agglomeraties in de gemeente Maastricht, p. 345.
- Rogers, J. and Waldron, T. (1995) *A field guide to joint disease in archeology*, John Wiley & Sons, Chichester.
- Rogers, J. and Waldron, T. (2001) DISH and the monastic way of life, *International Journal of Osteoarchaeology*, 11, p. 357-365.
- Rogers, J., Waldron, T., Dieppe, P. and Watt, I. (1987) Artthropathies in palaeopathology: the basis of classification according to most probable cause, *Journal of Archaeological Science*, 14, p. 179-193.
- Roosens, H. (1973) Siedlung und Bevölkerungsstruktur im Spiegel merowingischer Gräberfelder In *Siedlung, Sprache und Bevölkerungsstruktur im Frankenreich*, Vol. 49 (Ed. Petri, F.) Wissenschaftliche Buchgesellschaft, Darmstadt, p. 383-399.
- Roosens, H. (1989) De Merovingische vondsten op het grondgebied van Groot-Bilzen In *Bodenschatten: Archeologisch onderzoek in Groot-Bilzen van de Bandceramiek tot de Merovingers* (Eds. Gorissen, M. and Roosens, B.) Stadsbestuur van Bilzen, Bilzen, p. 50-59.

- Roosens, H., De Boe, G. and De Meulemeester, J. (1976) *Het Merovingisch grafveld van Rosmeer*, Nationale Dienst voor Opgravingen, Brussel.
- Roth, H. (1986) *Kunst und Handwerk im frühen Mittelalter: Archäologische Zeugnisse von Childerich I. bis zu Karl dem Grossen*, Konrad Theiss Verlag, Stuttgart.
- Rouche, M. (1973) La faim à l'époque carolingienne, *Revue Historique*, 250, p. 295-320.
- Russell, W. M. S. (1983) The palaeodemographic view In *Disease in ancient man* (Ed. Hart, G. D.) Clarke Irwin, Ontario, p. 217-253.
- Sablerolles, Y., Henderson, J. and Dijkman, W. (1997) Early medieval glass bead making in Maastricht (Jodenstraat 30), The Netherlands. An archaeological and scientific investigation In *Perlen: Archäologie, Techniken, Analysen*, Vol. 1 (Eds. von Freeden, U. and Wiczorek, A.) Dr. Rudolf Habelt GmbH, Bonn, p. 293-313.
- Salin, E. (1952) *La civilisation Mérovingienne: d'après les sépultures, les textes et le laboratoire*, Editions Picard, Paris.
- Sapin, C. (1996) Dans l'église ou hors l'église, quel choix pour l'inhumé? In *Archéologie du cimetière chrétien* (Eds. Galinié, H. and Zadora-Rio, E.) FÉRAFAC / LA SIMARRE, Tours, p. 65-78.
- Saunders, S. R. (1992) Subadult skeletons and growth related studies In *Skeletal biology of past peoples: research methods* (Eds. Saunders, S. R. and Katzenberg, M. A.) New York, p. 1-20.
- Saunders, S. R. and Barrans, L. (1999) What can be done about the infant category in skeletal samples? In *Human growth in the past* (Eds. Hoppa, R. D. and Fitzgerald, C. M.) Cambridge University Press, Cambridge, p. 183-209.
- Saunders, S. R. and Herring, A. (Eds.) (1995) *Grave Reflections: Portraying the Past through Cemetery Studies*, Canadian Scholars' Press Inc., Toronto.
- Saunders, S. R., Herring, D. A. and Boyce, G. (1995) Can skeletal samples accurately represent the living population they come from? The St. Thomas cemetery site, Belleville, Ontario In *Bodies of evidence: Reconstructing history through skeletal analysis* (Ed. Grauer, A. L.) New York, p. 69-89.
- Saunders, S. R. and Katzenberg, M. A. (Eds.) (1992) *Skeletal biology of past peoples: research methods*, New York.
- Schaeffer, U. (1963) *Anthropologische Untersuchung der Skelette von Haithabu*, Karl Wachholtz Verlag, Neumünster.
- Scheuer, L. and Black, S. (2000) *Developmental Juvenile Osteology*, Academic Press, San Diego.
- Schultz, R. J. (1990) *The language of fractures*, Williams & Wilkins, Baltimore.
- Schutkowski, H., Herrmann, B., Wiedemann, F., Bocherens, H. and Grupe, G. (1999) Diet, status and decomposition at Weingarten: trace element and isotope analyses on early mediaeval skeletal material, *Journal of Archaeological Science*, 26, p. 675-685.
- Schwartz, J. H. (1995) *Skeleton keys*, Oxford University Press, Oxford.
- Shaffer, I. A. and Collins, W. V. (1966) The deep clavicular rhomboid fossa, *Journal of the American Medical Association*, 195, p. 778-779.
- Simon, C. and Leemans, E. (1991) Problème posé par une population moyenâgeuse de la campagne genevoise (Satigny-Genève) In *Ville et campagne en Europe occidentale (Ve - XIIIe siècle)*, Vol. 14 (Ed. Buchet, L.) CNRS Éditions, Paris, p. 135-154.
- Siraisi, N. G. (1990) *Medieval and early Renaissance medicine: an introduction to knowledge and practice*, The University of Chicago Press, Chicago.
- Sirianni, J. E. and Higgins, R. L. (1995) A comparison of death records from the Monroe county almshouse with skeletal remains from the associated Highland Park cemetery In *Grave reflections: Portraying the past through cemetery studies* (Eds. Saunders, S. R. and

- Herring, A.) Canadian Scholars' Press, Toronto, p. 71-89.
- Skinner, M. and Goodman, A. H. (1992) Anthropological uses of developmental defects of enamel In *Skeletal biology of past peoples: research methods* (Eds. Saunders, S. R. and Katzenberg, M. A.) Wiley-Liss, New York, p. 153-174.
- Slaus, M., Kollmann, D., Novak, S. A. and Novak, M. (2002) Temporal trends in demographic profiles and stress levels in medieval (6th-13th century) population samples from continental Croatia, *Croatian Medical Journal*, 43, p. 598-605.
- Soeters, G. (1989) *Het grafveld in de pandhof van de St. Servaaskerk te Maastricht*, Maastricht, p. 115.
- Sprenger, J. (1956) Fundamentresten, een tweetal sarcophagen en een 17e eeuwse grafsteen gevonden te Sint Pieter, te Maastricht, *De Maasgouw*, 70, p. 141-150.
- Sprenger, J. (1958) Herkomst der sarcophagen in de crypten der St. Servaas-kerk en in het Bonnefantenmuseum te Maastricht, *De Maasgouw*, 72, p. 1-12.
- St. Hoyme, L. E. and Iscan, M. Y. (1989) Determination of sex and race: accuracy and assumptions In *Reconstruction of life from the skeleton* (Eds. Iscan, M. Y. and Kennedy, K. A. R.) New York, p. 53-94.
- Staab, F. (1996a) Die Franken - Wegbereiter Europas In *Die Franken - Wegbereiter Europas*, Vol. 1 (Eds. Wiczorek, A., Périn, P., von Welck, K. and Menghin, W.) Philipp von Zabern, Mainz, p. 10-22.
- Staab, F. (1996b) Die Gesellschaft des Merowingerreichs In *Die Franken - Wegbereiter Europas*, Vol. 1 (Eds. Wiczorek, A., Périn, P., von Welck, K. and Menghin, W.) Verlag Philipp von Zabern, Mainz, p. 479-484.
- Steckel, R. H. and Rose, J. C. (2002) *The Backbone of History: Health and Nutrition in the Western Hemisphere*, Cambridge University Press, Cambridge.
- Stedman, T. L. (1990) *Stedman's medical dictionary*, Williams & Wilkins, Baltimore.
- Steinbach, F. (1926) *Studien zur Westdeutschen Stammes- und Volksgeschichte*, Stuttgart.
- Steuer, H. (1982) *Frühgeschichtliche Sozialstrukturen in Mitteleuropa*, Vandenhoeck & Ruprecht, Göttingen.
- Stirland, A. J. (2000) *Raising the dead: the skeleton crew of Henry VIII's great ship, the Mary Rose*, John Wiley & Sons, Chichester.
- Stoodley, N. (1999) *The spindle and the spear. A critical enquiry into the construction and meaning of gender in the early Anglo-Saxon burial rite*, Archaeopress, Oxford.
- Stork, I. (1997) Friedhof und Dorf, Herrenhof und Adelsgrab: der einmalige Befund Lauchheim In *Die Alamannen* (Eds. Fuchs, K., Kempa, M., Redies, R., Theune-Grosskopf, B. and Wais, A.) Konrad Theiss Verlag, Stuttgart, p. 290-310.
- Stroud, G. and Kemp, R. L. (1993) *Cemeteries of the church and priory of St Andrew, Fishergate*, Council for British Archaeology, York.
- Sullivan, A. (2004) Reconstructing relationships among mortality, status, and gender at the Medieval Gilbertine Priory of St. Andrew, Fishergate, York, *American Journal of Physical Anthropology*, 124, p. 330-345.
- Tanner, J. M. (1978) *Foetus into man*, Harvard University Press, Cambridge.
- Theis, L. (1990) *L'héritage des Charles: De la mort de Charlemagne aux environs de l'an mil*, Éditions du Seuil, Paris.
- Theuvs, F. C. W. J. (1988) *De archeologie van de periferie: Studies naar de ontwikkeling van bewoning en samenleving in het Maas-Demer-Schelde gebied in de vroege middeleeuwen*, In *Faculteit der Ruimtelijke wetenschappen* Amsterdam, p. 351.
- Theuvs, F. C. W. J. (1998) *Changing settlement patterns, burial grounds and the symbolic construction of ancestors and communities in*

- the late Merovingian southern Netherlands, In *Settlement and Landscape* (Eds. Fabech, C. and Ringtved, J.) Aarhus, p. 337-349.
- Theuws, F. C. W. J. (2001) Maastricht as a centre of power in the early Middle Ages In *Topographies of power in the early Middle Ages*, Vol. 6 (Eds. de Jong, M. and Theuws, F. C. W. J.) Brill, Leiden, p. 155-216.
- Theuws, F. C. W. J. (2003) *De sleutel van Sint Servaas: Uitwisseling, religie, identiteit en centrale plaatsen in de Vroege Middeleeuwen*, Vossiuspers UVA, Amsterdam.
- Theuws, F. C. W. J. and Hiddink, H. A. (1996) Der Kontakt zu Rom In *Die Franken - Wegbereiter Europas*, Vol. 1 (Eds. Wiczorek, A., Périn, P., von Welck, K. and Menghin, W.) Philipp von Zabern, Mainz, p. 66-80.
- Thirion, E. (1985) *L'origine des sarcophages et leur diffusion dans la vallée de la Meuse*, In *La civilisation mérovingienne dans le bassin mosane*, Vol. 22 (Eds. Willems, J. and Otte, M.) Amay-Liège, p. 171-180.
- Timmers, J. J. M. (1955) Twee vroege grafinschriften uit de pandtuin der Maastrichtse St. Servaas, *Bulletin van de Koninklijke Nederlandse Oudheidkundige Bond*, 8, p. 77-84.
- Toussaint-Samat, M. (1994) *A history of food*, Blackwell, Cambridge.
- Trancho, G. J., Campillo, D. and Sanjosé, N. (1995) Tibial periostitis in several individuals of the Vallisoleitana necropolis at Wamba (Spain) (15th-17th century a.d.) In *Proceedings of the IXth European meeting of the Paleopathology Association: Barcelona 1st - 4th September, 1992* (Eds. Batista, R., Campillo, D. and Carreras, T.) Museu d' Arqueologia de Catalunya, Barcelona, p. 407-415.
- Treffort, C. (1996) *L' église carolingienne et la mort: Christianisme, rites funéraires et pratiques commémoratives*, Presses universitaires de Lyon, Lyon.
- Trotter, M. (1970) Estimation of stature from intact limb bones In *Personal identification in mass disasters* (Ed. Stewart, T. D.) Smithsonian Institution, Washington, p. 71-83.
- Trotter, M. and Gleser, G. C. (1958) A re-evaluation of estimation of stature based on measurements of stature taken during life and of long-bones after death, *American Journal of Physical Anthropology*, (n.s.) 16, p. 79-123.
- Tyrell, A. (2000) Skeletal non-metric traits and the assessment of inter- and intrapopulation diversity: past problems and future potential in *Human osteology in archaeology and forensic science* (Eds. Cox, M. a. and Mays, S.) Greenwich Medical Media, London, p. 289-306.
- Ubelaker, D. H. (1989) *Human skeletal remains. Excavation, analysis, interpretation*, Taraxcum, Washington.
- Ulijaszek, S. J. (1994) Growth monitoring and growth cyclicities in developed countries In *Anthropometry: the individual and the population* (Eds. Ulijaszek, S. J. and Mascie-Taylor, C. G. N.) Cambridge University Press, Cambridge, p. 99-107.
- Ulrich-Bochsler, S. (1997) *Anthropologische Befunde zur Stellung von Frau und Kind in Mittelalter und Neuzeit. Soziobiologische und soziokulturelle Aspekte im Lichte von Archäologie, Geschichte, Volkskunde und Medizingeschichte*, Haupt Verlag, Bern.
- Valenzuela, C. Y. (1983) Pubertal origin of the larger sex dimorphism for adult stature of a Chilean population, *American Journal of Physical Anthropology*, 60, p. 53-60.
- Van Dam, R. (1988) *Gregory of Tours: Glory of the confessors*, In *Translated Texts for Historians: Latin Series*, Vol. IV Liverpool, p. 127.
- Van Impe, L., Huyge, D., Van Laere, R. and Vynckier, G. (1992) *Archäologische Untersuchungen im Demertal und seiner Umgebung In Spurensicherung: archäologische Denkmalpflege*

- in der Euregio Maas-Rhein, Vol. 136 (Eds. Bauchhenß, G. and von Prittwitz u. Gaffron, H.-H.) Verlag Philipp von Zabern, Mainz am Rhein, p. 550-572.
- Van Lith, S. M. E. (1987) Late Roman and early Merovingian glass from a settlement site at Maastricht (Dutch south Limburg) Part I, *Journal of Glass studies*, 29, p. 47-59.
- Van Lith, S. M. E. (1988) Late Roman and early Merovingian glass from a settlement site at Maastricht (Dutch south Limburg) Part II, *Journal of Glass studies*, 30, p. 62-76.
- Van Ommeren, H. R. (1991) Bronnen voor de geschiedenis van Maastricht (359-1204): Deel 1: Bronnen betreffende het tijdvak vanaf het jaar 359 tot en met 923, *Publications de la Société Historique et Archéologique dans le Limbourg*, 127, p. 5-48.
- Van Ossel, P. (1992) *Etablissements ruraux de l'Antiquité tardive dans le nord de la Gaule*, Éditions du CNRS, Paris.
- Vanderhoeven, A. (2002) 1. Tongres In *Province ecclésiastique de Cologne (Germania Secunda)*, Vol. XII (Eds. Gauthier, N., Beaujard, B. and Fr., P.) De Boccard, Paris, p. 75-89.
- Vanderhoeven, A., Nouwen, R. and Vynckier, G. (1992) Tongern In *Spurensicherung: archäologische Denkmalpflege in der Euregio Maas-Rhein*, Vol. 136 (Eds. Bauchhenß, G. and von Prittwitz u. Gaffron, H.-H.) Verlag Philipp von Zabern, Mainz am Rhein, p. 387-402.
- Verhulst, A. (1995) Economic organisation In *The New Cambridge Medieval History*, Vol. II c. 700-c. 900 (Ed. McKitterick, R.) Cambridge University Press, Cambridge, p. 481-509.
- Verhulst, A. (1999) *The rise of cities in north-west Europe*, Cambridge University Press, Cambridge.
- Verwers, W. J. H. (1986) Het grafveld in de Pandhof van de Sint-Servaas te Maastricht: een voorlopig verslag In *Munsters in de Maasgouw*, Vol. 9 Limburgs Geschied- en Oudheidkundig Genootschap, Maastricht, p. 56-71.
- Vos, A. D. (2002) *Resten van Romeinse bruggen te Maastricht in de Maas*, Lelystad.
- Wahl, J. (1985) Gräber der Vorzeit: Knochen erzählen von Leben, Krankheit und Tod In *Der Keltenfürst von Hochdorf, Methoden und Ergebnisse der Landesarchäologie* (Eds. Planck, D., Biel, J., Süßkind, G. and Wais, A.) Konrad Theiss Verlag GmbH, Stuttgart, p. 288-313.
- Waldron, T. (1985) DISH at Merton Priory: evidence for a 'new' occupational disease?, *British Medical Journal*, 291, p. 1762-1763.
- Waldron, T. (1987) The relative survival of the human skeleton: implications for palaeopathology In *Death, decay and reconstruction: Approaches to archaeology and forensic science* (Eds. Boddington, A., Garland, A. N. and Janaway, R. C.) Manchester University Press, Manchester, p. 55-64.
- Waldron, T. (1994) *Counting the dead*, John Wiley & Sons, Chichester.
- Walker, P. L. (1995) Problems of preservation and sexism in sexing: some lessons from historical collections for palaeodemographers In *Grave reflections: portraying the past through cemetery studies* (Eds. Saunders, S. R. and Herring, A.) Canadian Scholars Press, Toronto, p. 31-47.
- Walker, P. L., Johnson, J. R. and Lambert, P. M. (1988) Age and sex bias in the preservation of human skeletal remains, *American Journal of Physical Anthropology*, 76, p. 183-188.
- Wampach, C. (1935) *Urkunden- und Quellenbuch zur Geschichte der altluxemburgischen Territorien bis zur burgundischen Zeit*, Vol. 1 Luxemburg, p. 160.
- Weaver, D. S. (1986) Forensic aspects of fetal and neonatal skeletons In *Forensic osteology: advances in the identification of human remains*

- (Ed. Reichs, K. J.) Charles C Thomas, Springfield, p. 90-100.
- Weber, J. and Czarnetzki, A. (2001) Brief Communication: Neurotraumatological Aspects of Head Injuries Resulting From Sharp and Blunt Force in the Early Medieval Period of Southwestern Germany, *American Journal of Physical Anthropology*, 114, p. 352-356.
- Weidemann, M. (1990) Die kirchliche Organisation der Provinzen Belgica und Germania vom 4. bis zum 7. Jahrhundert In *Willibrord, zijn wereld en zijn werk. Voordrachten gehouden tijdens het Willibrordcongres Nijmegen, 28-30 september 1989*, Vol. 6 (Eds. Bange, P. and Weiler, A. G.) Nijmegen, p. 286.
- Weinfeld, R. M., Olson, P. N., Maki, D. D. and Griffiths, H. J. (1997) The prevalence of diffuse idiopathic skeletal hyperostosis (DISH) in two large American Midwest metropolitan hospital populations, *Skeletal Radiology*, 26, p. 222-225.
- Weiss, E. (2003) Understanding Muscle Markers: Aggregation and Construct Validity, *American Journal of Physical Anthropology*, 121, p. 230-240.
- Weiss, K. M. (1972) On the systematic bias in skeletal sexing, *American Journal of Physical Anthropology*, 37, p. 239-250.
- Wells, C. and Green, C. (1973) Sunrise dating of death and burial, *Norfolk Archaeology*, 35, p. 435-442.
- Werner, J. (1973) Zur Entstehung der Reihengraberzivilisation In *Siedlung, Sprache und Bevölkerungsstruktur im Frankenreich*, Vol. II (Ed. Petri, F.) Wissenschaftliche Buchgesellschaft, Darmstadt, p. 285-325.
- Werner, M. (1980) *Der Lütticher Raum in Frühkarolingischer Zeit: Untersuchungen zur Geschichte einer karolingischen Stammlandschaft*, Vandenhoeck & Ruprecht, Göttingen.
- Wieczorek, A., Périn, P., von Welck, K. and Menghin, W. (Eds.) (1996) *Die Franken - Wegbereiter Europas*, Philipp von Zabern, Mainz.
- Wieger, A. (1992) Die Naturgeographischen Voraussetzungen der Euregio Maas-Rhein In *Spurensicherung: archäologische Denkmalpflege in der Euregio Maas-Rhein*, Vol. 136 (Eds. Bauchhenß, G. and von Prittwitz u. Gaffron, H.-H.) Verlag Philipp von Zabern, Mainz am Rhein, p. 1-15.
- Wieringen, J. C. v. (1972) *Seculaire groeiverschuiving: Lengte en gewicht surveys 1964-1966 in Nederland in historisch perspectief*, Nederlands Instituut voor Praeventieve Geneeskunde TNO, Leiden.
- Willems, W. J. H. (1983) Archeologische kroniek van Limburg over de jaren 1980-1982, *Publications de la Société Historique et Archéologique dans le Limbourg*, 119, p. 197-291.
- Willems, W. J. H. (1992) Die kaiserzeitliche villa von Voerendal In *Spurensicherung: archäologische Denkmalpflege in der Euregio Maas-Rhein*, Vol. 136 (Eds. Bauchhenß, G. and von Prittwitz u. Gaffron, H.-H.) Verlag Philipp von Zabern, Mainz am Rhein, p. 526-534.
- Wiltshcke-Schrotta, K. and Teschler-Nicola, M. (1991) *Das spätantike Gräberfeld von Lentia/Linz, Tiefer Graben/Flüßelhofgasse*, Stadtmuseum Linz-Nordico, Linz.
- Wood, I. (1994) *The Merovingian kingdoms, 450-751*, Longman, London.
- Wood, J. W., Milner, G. R., Harpending, H. C. and Weiss, K. M. (1992) The osteological paradox: problems of inferring prehistoric health from skeletal samples, *Current Anthropology*, 33, p. 343-370.
- Workshop of European Anthropologists (1980) Recommendations for age and sex diagnoses of skeletons, *Journal of Human Evolution*, 9, p. 517-549.
- Wright, L. E. and Yoder, C. J. (2003) Recent progress in bioarchaeology: approaches to the osteological paradox, *Journal of Archaeological Research*, 11, p. 43-70.

- Wurm, H. (1985) Über die durchschnittlichen Körperhöhen der sozialen Mittel- und Unterschichten im mitteleuropäischen germanischen Siedlungsraum vom Frühmittelalter bis zur Neuzeit, *Anthropologischen Anzeiger*, 43, p. 11-30.
- Wurm, H. and Leimeister, H. (1986) Ein Beitrag zur spezifischen Auswahl von Vorschlägen zur Körperhöhenschätzung nach Skelettfunden, zur Vergleichbarkeit von Schätzergebnissen und zur allgemeinen Problematik realistischer Lebendhöhenschätzungen, *Gegenbauers morphologisches Jahrbuch*, 132, p. 69-110.
- Young, B. K. (1999) The myth of the pagan cemetery In *Spaces of the living and the dead: an archaeological dialogue*, Vol. 3 (Eds. Karkov, C. E., Wickham-Crowley, K. M. and Young, B. K.) Oxbow Books, Oxford, p. 61-85.
- Ypey, J. (1985) Enkele 5de-eeuwse vondsten uit Zuid- en Noord-Nederland, *Westerheem*, XXXIV, p. 2-10.
- Zeeman, J. (1861) Rapport van de commissie voor statistiek over de lotelingen van de provincie Groningen 1836-1861, *Nederlands Tijdschrift voor Geneeskunde*, 5, p. 691.
- Zink, A. (1999) *Kindersterblichkeit im frühen Mittelalter: Morphologische und paläopathologische Ergebnisse an der Skeletserie von Altenerding, Ldkr. Erding, Bayern*, Cuvillier Verlag, Göttingen.
- Zoepf, L. (1908) *Das Heiligen-Leben im 10. Jahrhundert*, B.G. Teubner, Leipzig.

10

Samenvatting
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Samenvatting

Over de levensomstandigheden in de vroege middeleeuwen weten we in het algemeen weinig. De spaarzame schriftelijke bronnen leveren doorgaans nauwelijks informatie over dat onderwerp. Een mogelijkheid om meer te weten te komen over ziekte en gezondheid in het verleden is door bestudering van menselijke skeletresten gevonden bij opgravingen. Voor deze studie zijn de menselijke resten van twee begraafplaatsen uit Maastricht onderzocht. Bij opgravingen in het Boschstraatkwartier zijn menselijke skeletresten van 54 individuen verzameld, deze dateren uit het einde van de zevende en het begin van de achtste eeuw. De graven uit het Boschstraatkwartier lagen voor een deel bijeen in een klein grafveld en een tiental graven lag verspreid over een nederzettingsterrein. Deze nederzetting lijkt vooral gebruikt te zijn voor bewoning en productie-activiteiten van een kleine groep handwerkslieden. Tijdens de opgravingen in de Servaaskerk werden 184 skeletten uit de periode tussen 350 en 950 na Christus gevonden. Voor een belangrijk deel waren de graven uit de Sint Servaaskerk "ad sanctos" begravingen, dit zijn graven die dicht bij de vermoedde locatie van het gebeente van Sint Servaas lagen. In ieder geval vertegenwoordigen de graven uit de kerk slechts een klein deel van een veel grotere begraafplaats die zich met naar het noorden naar de Pandhof uitstrekte.

De skeletten uit de Sint Servaaskerk zijn in drie groepen ingedeeld op grond van hun datering: een groep skeletten uit de periode van circa 350-480 na Christus (de *cella* fase), een groep uit de periode tussen circa 480 en 700 na Christus (de *templum* fase) en een groep van circa 700-950 na Christus (de *basilica* fase). Hierdoor is het mogelijk om te onderzoeken of er veranderingen optreden in de gezondheidssituatie vanaf de laat-Romeinse tijd tot het einde van de Karolingische tijd. Verder werden drie groepen onderscheiden aan de hand van de status van het graf. Parameters voor het bepalen van de status van het graf waren de begraafplaats, het graftype, de positie van het graf binnen de begraafplaats en eventuele grafgriffen. De graven van het Boschstraatkwartier werden op grond van de vondsten uit de bijbehorende nederzetting en uit de graven gecategoriseerd als graven met een lage status. De graven uit de Sint Servaaskerk werden zo mogelijk in twee groepen ingedeeld. Een groep van gemiddelde status, bestaande uit graven die doorgaans wat verder weg lagen van de vermoede locatie van het graf van Sint Servaas. In deze groep werden geen grafgriffen gevonden en de graftypen waren ook eenvoudig, meestal kist- of kuilgraven. De groep van graven van hoge status bestond uit graven dicht tegen de toenmalige kerk aan of zelfs daarin. Bovendien betrof het vaak sarcophagen of gemetselde grafkelders. Tot deze categorie behoorden ook graven met kostbare bijgriffen.

De skeletten werden onderzocht met behulp van gestandaardiseerde methoden. Eventuele pathologische aandoeningen werden besproken tijdens bijeenkomsten van een team van medisch specialisten. In totaal werden 238 skeletten onderzocht. Niet alle skeletten bleken even compleet te zijn. Hiervoor konden twee factoren als oorzaak worden aangewezen. Ten eerste was het duidelijk dat de intensieve verstoringen van de bodem, bijvoorbeeld tijdens de bouw en de sloop van een kerkgebouw, de graven uit de voorafgaande fase ernstig hadden verstoord. De

tweede factor was het graftype. Begravingen in kuilgraven, dus direct in de grond zonder kist, bleken in het algemeen de meest complete skeletten op te leveren.

De skeletten uit de laat-Romeinse *cella* fase lagen oorspronkelijk aan de rand van de begraafplaats. Ongeveer evenveel mannen als vrouwen werden aangetroffen in deze populatie. Ook waren er relatief veel onvolwassenen in deze groep. De gemiddelde leeftijd bij overlijden en de lengte waren relatief hoog. Er was geen sprake van opvallende pathologische aandoeningen. Wel had verhoudingsgewijs een groot aantal skeletten verschijnselen van DISH (diffuse idiopathische skelet hyperostose). DISH is een aandoening die doorgaans geassocieerd wordt met een overmatig rijke voeding.

In de graven uit de *templum* fase werden meer vrouwen dan mannen aangetroffen. Met name de vrouwen werden gemiddeld ouder dan hun tijdgenoten en met name hun lengte was bovengemiddeld. Qua algemene gezondheid lijkt deze groep daarom niet onder te doen voor die in de voorafgaande periode. Wel zijn er in deze groep twee mannen met zwaardverwondingen aan de schedel.

De graven uit de *basilica* fase werden aangelegd in en om een grote nieuwe kerk. In deze groep werden er meer mannen gevonden. Voor zover kon worden vastgesteld, waren alle individuen die in de kerk begraven zijn van het mannelijk geslacht. Mogelijk waren dit geestelijken, die als kanunnik of monnik aan het Sint Servaas klooster waren verbonden. De gemiddelde lichaamslengte van de mannen in deze groep is hoog, net als de gemiddelde leeftijd bij overlijden. Voor de vrouwen werden iets lagere waarden voor leeftijd en lengte gevonden dan in de voorafgaande fase. De meeste indicatoren voor de algemene gezondheid wezen in deze groep op een goede gezondheid. DISH kwam relatief veelvuldig voor in deze groep. Ook in deze fase werden er mannen met zwaardverwondingen aan de schedel gevonden. Drie van deze mannen lagen dicht bij elkaar pal ten zuiden van het koor, hetgeen doet vermoeden dat ze mogelijk aan elkaar gerelateerd waren.

De begravingen uit het Boschstraatkwartier gaven een volstrekt afwijkend beeld van de graven uit de Servaaskerk. In het Boschstraat grafveld kwamen veel meer jonge kinderen voor en er werden ongeveer vijf maal zoveel vrouwen als mannen begraven. Hoewel de lengte van deze individuen gemiddeld iets achterbleef, is de algemene indruk toch dat ook in deze populatie geen grote gezondheidsproblemen optraden.

Met name het ontbreken van een deel van de mannen op het Boschstraat grafveld, maar ook een aantal afwijkende leeftijdsverdelingen in de begraafplaatsen wijzen er op dat er in Maastricht in de Merovingische tijd een constellatie van complementaire begraafplaatsen bestond. Op dit moment zijn ongeveer negen begraafplaatsen in en om Maastricht bekend. Kennelijk werd een aantal mensen niet begraven op de aanpalende begraafplaats. In het Boschstraat grafveld lijkt dit vooral bij mannen op grote schaal te zijn gebeurd. De vergelijking van de fasen in de Servaaskerk laat qua gezondheidsindicatoren weinig verschil zien tussen de laat-Romeinse *cella* fase en de Merovingische *templum* fase. Dit pleit dus tegen de algemeen veronderstelde verslechtering in levensomstandigheden tijdens de overgang van de laat-Romeinse tijd naar de Merovingische tijd. De analyse van de verschillen tussen de skeletten uit verschillende status groepen toont verwaarloosbare verschillen tussen de graven van lage en

gemiddelde status. De graven van hoge status vertonen wel een afwijkend patroon. Met name mannen uit graven van hoge status graven bereikten gemiddeld een significant hogere leeftijd. Als gevolg daarvan vertoonden ze ook meer aan een hoge leeftijd gerelateerde pathologie is. Op grond van dit onderzoek kunnen we vastgesteld dat er in de onderzochte begraafplaatsen groepen aanwijsbaar zijn die van elkaar verschillen in levensomstandigheden. In de *templum* fase zien we een groep vrouwen uit rijke graven, wier grote gemiddelde lichaamslengte wijst op gunstige levensomstandigheden tijdens de groei. Hetzelfde geldt voor een groep mannen uit de *basilica* fase. Het is verleidelijk om in die groepen respectievelijk adellijke vrouwen en kanunniken te herkennen. Maar verder onderzoek moet uitwijzen of er overeenkomsten zijn qua verwantschap (ancient DNA) of herkomst (isotopen). De bevolking van vroegmiddeleeuws Maastricht kende in het algemeen gunstige levensomstandigheden en lijkt niet structureel te hebben geleden onder ernstige ziekten.

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This book is the result of a project that materialised in the second half of the eighties. In a way it even started long before that with my grand parents. Both the parents of my mother and father had strong ties with Maastricht. The father of my mother, Ferdinand Rondagh, came from a family with a long history in the region and Maastricht in particular. My father's father, Gerard Panhuysen, was the first in the family to write a Ph.D. thesis on the history of Maastricht in 1933. His youngest son, Titus Panhuysen was in 1996 the second to write a Ph.D. thesis discussing the meaning of fragments of Roman sculpture from Maastricht. With this background it is not surprising that this thesis also addresses aspects of the history of Maastricht. My first involvement with the history of Maastricht was when I participated in several excavations in Maastricht; among these were the Boschstraat and the Servaas church excavations. I have good memories of the fieldwork at the various sites with Breur Emmenes, Jules Lebon, Maurice Roufflard, Henk Siebels (†), Jean Zwakhalen, and Piet Boyens.

Actual work on skeletal remains from Maastricht started with a project with Tjasse Bruintjes. Together, we studied the "tall man" of Maastricht, a skeleton found during excavations in the Servaas church. Tjasse had examined the bones, and I had searched the written sources looking for possibilities to identify this individual. We spent days and nights discussing and writing a paper on now obscure computer systems of friends. After Lucas van Beeck capably edited the English text of the paper it was accepted for publication, but we decided to withdraw it when the dating of the grave became unclear. Still, this project convinced me of the possibilities of combining osteo-archaeological data with historical and archaeological information. After following a short course in physical anthropology with George Maat, I seized the opportunity to study twelve skeletons from the Servaas church excavation. During this project I was familiarised with physical anthropological methods by Herman Lonnee and Wim Mulder.

The next step was writing a programme for what was called the Saint Servaasproject. For the development of a plan to study human skeletal remains from several early medieval cemeteries in Maastricht I received much support from Tjasse Bruintjes. The project started even before funding was found. Together with Ronny Dassen the bones were cleaned and packed. And thanks to the support of Hans Beijer the first skeletons were examined at an unused attic of one of the buildings of Maastricht University. At the same time attempts were made to acquire financial support for the project by professor van Engelshoven, Titus Panhuysen and Geert Walenkamp with the support of the members of the board of the Willem Goossens foundation: Messrs. Jamar, Gehlen, Poesen, and Versteeg. Thanks to their effort the City of Maastricht and the Stichting Wetenschappelijk Onderwijs Limburg (the Foundation for Scientific Education Limburg) both subsidised the Saint Servaasproject for four years. The department of radiology of the Maastricht University Hospital provided the institutional setting and facilities for the project.

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While working in the radiology department Paul Hofman soon was a strong supporter of the project and a friend. I enjoyed the time we spend making x-rays and CT-scans and discussing various diseases of the skeleton. The department of radiology provided a pleasant working environment, not at the least due to the support of the secretariat and Mrs. Mordant. After George Maat had returned to the Netherlands he became strongly involved in the project and we spent a lot of time looking at the bones from the two cemeteries and discussing methodological issues and pathology. What made the project special were the pathology sessions, which were attended by Tjasse Brintjes, professor van Engelshoven, Paul Hofman, Hein Janssen, Ed van der Linden, Riël Snoep, Ton Vermeulen, and Geert Walenkamp. During these meetings all individuals with pathology were presented, if necessary together with x-rays. These meetings generally evolved into an animated debate.

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Curriculum Vitae

The author was born in 1963 in Leeuwarden and attended secondary school at the Jeanne D'Arc College, in Maastricht from 1975 to 1981. From 1981 to 1989 he studied history at Leiden University. In the year 1988-1989 he studied in Münster with professor Althoff at the Institut für Frühmittelalterforschung of the Westfälische Wilhelms Universität. During his studies he participated in various excavations in Maastricht. In 1989 he finished his studies (Doctoraal examen oude stijl) in medieval history with prehistory and physical anthropology as subsidiary subjects. Between 1990 and 1992 he worked with the archaeological service of the City of Maastricht. From 1992 to 1996 he worked as a research fellow at the department of radiology of the Academisch Ziekenhuis Maastricht. November 1996 the author worked as a physical anthropologist in a team of Physicians for Human Rights (Boston, USA) in a project aimed at the determination of the identity and the cause of death of victims found in the mass grave of Vukovar (Croatia). During 1997 author worked as a contract physical anthropologist. From 1998 to 2002 the author worked as an assistant professor in physical anthropology with Barge's Anthropologica the centre for physical anthropology of the medical faculty of Leiden University. In 1999 he spend a month in Kosovo as a member of the British Forensic Team, working as a forensic anthropologist examining mass graves in the area around Prizren. During the summer of 2000 the author participated in an excavation of the faculty of archaeology of Leiden University at Anse à la Gourde, Guadeloupe. In 2002 the author started working as a research fellow for the Saint Servatiusproject (NWO-funded) at the Amsterdam Archaeological Centre of the University of Amsterdam. Recently he also started working in Leiden as a Postdoc in physical anthropology for the Mobility and Exchange project (NWO-funded) in the Faculty of Archaeology of Leiden University. The author is married with Jet Panhuysen-van den Akker and they have two sons: Tijmen and Caius.

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