Falls in the elderly : a primary care-based study

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FALLS IN THE ELDERLY

A primary care-based study

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A primary care-based study

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Promotores

Prof. dr. H.F.J.M. Crebolder

Prof. dr. J.A. Knottnerus

Co-promotor

Dr. J.P.M. Diederiks

Beoordelingscommissie

Prof. dr. J. Troost (voorzitter)

Prof. dr. L.M. Bouter (vrije Universiteit Amsterdam)

Dr. J.F.B.M. Fiolet

Prof. dr. A. Huson

Prof. dr. B. Meyboom-de Jong (Rijksuniversiteit Groningen)

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"The worst of all is indifference"

Elie Wiesel

Dedicated to my parents and parents in law
Opgedragen aan mijn ouders en schoonouders

P. Stalenhoef and M.K.C. Stalenhoef-Oosterwijk
A.J. Halling and N.L. Halling-Hakkesteegt
A.G. Scholte and J.Th Scholte-Woerts

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CHAPTER 1

General introduction

Introduction

A fall by an elderly person is a sudden and unintentional event, which may cause personal suffering. The balance of the elderly is disturbed abruptly, which evokes feelings of shame, helplessness and dependence. Falls in the elderly are a major problem in health care, because of their high incidence, important morbidity, mortality and high healthcare costs (1-10). It has to be expected that this problem will grow in the coming decades, because life expectancy of the population is still growing and the old and especially the very old people are increasingly living with disabilities, of which many are risk factors for falls (11).

A fall can be considered as the result of a failure or defect in the maintenance of balance. It is often a marker for frailty or the first sign of a disease or disability and therefore needs an accurate evaluation of its cause (12,13). Because of multi-morbidity in old age and the presence of many risk factors at the same time, it is often difficult to determine which risk factor is the main contributing factor.

General practitioners (GP) frequently face this phenomenon, although they are confronted with only approximately 20 percent of all falls, mostly injurious falls (14-17). About one-third of their elderly patients have at least one fall a year and about half of them two or more falls (8,9,18-20). Only a minority of falls, about ten percent, have serious consequences (7,8). Injuries, particularly fractures, are the most prominent direct consequences of falls in the elderly, with an incidence of hip fractures of one percent and other fractures of five percent of all falls (21-23). However, mobility impairment, functional decline and psychosocial functioning, such as fear of falling and social isolation, both to be considered as causes and consequences of falls, deserve GPs' attention as well (7,24-27). Moreover, the GPs experience the complexity of this problem due to the great differences of individual circumstances, determinants, causes and consequences. Another relevant aspect for the GP is the lack of transparency of the management of falls regarding immediate care, assessment and intervention of fall risk and risk factors, and fall preventive activities in primary care. There is increasing evidence of the effectiveness of interventions to prevent falls and subsequent injury, particularly interventions directed at improving mobility (28-33). However, it is yet not clear which risk factors should be targets for prevention in primary care and which categories of elderly people should be addressed (34).

These considerations have led to a community-based study on falls

in the elderly. In this introduction the definitions and fall mechanisms are discussed. The four aims of the study are elucidated and the research questions are presented in relation to the aims, followed by the structure of the thesis.

Definitions and fall mechanisms

Generally, a fall is defined as an unintentional event which results in the person coming down on the ground or to a lower level (2,35). Some authors exclude overwhelming hazards like loss of consciousness, traffic accidents, violence, stroke and insults (8,9). Falls associated with syncope are relatively uncommon: syncope causes probably only about one percent of all falls (36), although a rate of 13 percent has been reported (37).

Observational balance and gait studies in elderly persons have revealed, that falls can be described in three phases (5). The first phase deals with the displacement of the centre of body mass beyond its base of support. This phase can be initiated by environmental factors as well by intrinsic factors and by activities in progress at the time of the fall. The second phase of a fall concerns the failure of the systems for maintaining upright posture, generally due to intrinsic factors, such as loss of sensory functions and weakness of muscles. The third phase is caused by insufficient counteracted gravitational forces and results in the impact of the body on a surface, usually the ground or floor, with a transmission of forces to body tissue and/or organs, which may cause the damage. Whether, and to what extent, damage occurs, depends on the magnitude and the direction of forces, the susceptibility of tissues and organs and the properties of the environmental surfaces. Disturbance of balance frequently occurs in old age. Causes are related to a lot of conditions, due to physiological and pathophysiological changes (38). If maintenance of balance is inadequate or disturbed a fall may result, with or without injury.

Aims and related study questions

Aim I. Occurrence and incidence

Question 1. What is the incidence of falls ?

Aim II. Determinants and risk factors

Question 2. What are the determinants of and risk factors for falls?

Question 3. What is the relationship between intrinsic (person-related), extrinsic (environment related) and activity-related risk factors for falls?

Question 4. What are the characteristics of the elderly with one-time, recurrent and no falls?

Aim III. Health consequences

Question 5. What are the health consequences and the impact on daily functioning?

Aim IV. Relation to general practice

Question 6. What is the involvement of the general practitioner with falls and fallers?

Question 7. What are the elements of a fall risk assessment in general practice?

Question 8. Which recommendations can be made to the general practitioner regarding fall risk assessment and prevention?

I. Occurrence and incidence of falls

The annual incidence of falls in the community-dwelling elderly varies from about 25 % to 40 %, dependent on characteristics of the selected population and study design (8,9,18-20,39-42). One third to a half of the fallers experience more than one fall each year (8,9,18-20,39,42). These figures mean that an average general practice, consisting of 2300 persons, with 15 percent of persons aged 65 years or over, has to expect each year at least 120 elderly subjects with one or more falls. About 60 percent of them will have one and 40 percent two or more falls. With a mean fall rate for recurrent fallers of 2.5, these 120 elderly people will have circa 200 falls each year. Approximately, 20 percent are reported to the GP, what means that a GP yearly will be informed of about 40 falls in the 65+ population.

Indoor falls occur more frequently than outdoor falls: approximately 75 percent of falls in the elderly occur indoors (8). Falls in the younger age group has a tendency to occur more frequently in the active time of day and falls at night more in the older group (43). Distribution by month and day shows a pattern of more falls in the period November till January and in the weekend (43,44).

II. Determinants and risk factors

Falls in the elderly are mostly multi-factorial events, in which many determinants and risk factors play a role (5-9). Evidence-based knowledge of determinants and risk factors is the basis of fall prevention (45,46). Risk factors can be divided into intrinsic (person-related) and extrinsic (environment-related) risk factors (8,9,47,48). Some authors add to these the activity-related risk factors, which seem to be increasing due to a growing mobility and

activity level in old age (8).

Generally, fall risk is determined by a number of factors of different origin. Risk for falling is determined more by the personal conditions as health status and mobility than by the environmental situation: extrinsic risk factors play an additional role to the intrinsic risk factors (8,9,19,20). The literature shows a great variety in regard to the relative contribution of risk factors (8,9,16,19,20,39-42). This can be explained by differences in population, methodology and statistical techniques (49). The strength of evidence of the contribution to fall risk of a number of risk factors is not consistent (5). Falls are age-related in most studies, but the sex difference, regarding a higher incidence of falls in women, is not apparent in all studies (8,9,18,19,20,39,40). Nevertheless, there is consensus about the relevance of an important number of risk factors (5,6,49). Determinants and risk factors which have strong evidence for an independent contribution to falls in many studies are advanced age, a high level of dependence, cognitive impairment, depression, balance and gait disorders, use of sedatives and hypnotics and a number of other medications, a history of stroke, arthritis of the knee, a history of falls, reduced grip and muscle strength (5,6,8,9,18-20,49). An inconsistent association with falls was shown in many studies for female gender, postural hypotension, foot problems, impaired lower extremity sensory function, cardiovascular problems and impaired vision (5,49). Many risk factors for falls have been identified as having shared contributions with other geriatric syndromes (50,51).

III. Health consequences

Fall-related mortality is the leading cause of death from injury in old age (52). The rate of fall-related death is mainly associated with survival after hip fracture or other major trauma with an age and sex-related pattern, although improved trauma management has reduced mortality due to falls (53-55). "Long lies" due to inability to get-up after a fall is a marker for a bad prognosis and high mortality (56,57).

Major physical injuries are reported to occur in six to ten percent of all falls, with a fracture incidence of five to six percent and hip fracture incidence of one to three percent of falls (8,9,49,58-60). Most fractures in elderly people are caused by a fall (8,9,58). Risk of fracture is determined by the combined effects of falls, impact of falling and bone qualities (59). In the Netherlands each year elderly people have about 1.5 million falls. It means about 15,000 hip fractures a year, a number which is rising each year (60). Other

fall-related fractures amount to about 60,000. For an average general practice with an annual incidence of 200 falls in the 65+ population, these figures imply about 20 major injuries due to falls, including about two hip fractures and about 9 other fractures. Minor injuries like sprains, contusions and skin lesions account for 20 to 30 percent of all falls (8,9,49).

Important potential consequences other than injury are fear of falling, loss of self-confidence, functional decline and a decrease of social activities (7). All of these consequences may hamper daily functioning, and may be in turn risk factors for recurrent falling, resulting in vicious circles (4).

IV. Relation to general practice

In several population-based studies the task and role of the GP regarding falls in the elderly is underexposed (49). Falls are underreported to the health care system and most reported falls concern injurious falls (15-18,61). The management of falls in the elderly regarding cure, care and prevention by the GP often presents an unclear and insufficient picture. The attention paid by the GP to an elderly person with a fall is usually confined to the management of the injury and is mostly not also directed to the assessment of risk factors in view of rational prevention (61). One of the main conditions of a fall prevention strategy entails the GP developing an attitude of alertness and concern regarding falls and fall risk. GPs have a key position in the development of anticipatory care and preventive activities in primary health care (62,63).

Other basic conditions for rational prevention are an understanding of the etiology of falling and the availability and feasibility of validated assessment procedures (34,64,65). A risk model composed of data from medical history and fall-related tests has proved to be predictive in identifying the elderly at risk at an early stage and to predict falls (66). Fall prevention can be considered in a social epidemiological model, divided into primary, secondary and tertiary prevention, in three subsequent stages of falls: pre-fall stage, fall stage and post-fall stage, respectively (46). At all levels the GP will have a task, especially in the second and third stage.

Structure of this thesis

By way of introduction to the subject *chapter 2* presents three case histories from general practice: the accidental first fall, the recurrent fall and the elderly at risk in view of fall prevention.

Chapter 3 gives a description of the results from a preliminary study on health status and functioning in a random sample of 50 persons aged 70 years or over, registered in a primary health care centre. This study aimed especially to identify the contribution of the home visit by community nurses to the GPs' information of the health status. *Chapter 4* details a literature review on the incidence of, risk factors for and consequences of falls among community-dwelling elderly. According to inclusion criteria concerning originality, subject, population at risk and relevance to general practice of the pre-selected studies, 14 studies were selected and submitted to analysis based on ten criteria for quality.

Chapter 5 presents a general description of the design and methods of the surveys as an introduction to the following chapters. *Chapter 6* deals with the results of a mail survey on the impact of gait problems and falls on daily functioning in a population of persons of 55 years or over on the list of a primary health care centre. The results of another more extensive mail survey on incidence of, risk factors for and consequences of falls in the community-living elderly of 70 years or over are presented in *chapter 7*. The result is a risk model composed of data directly and easily derivable from patient records.

Chapter 8 describes the results of a prospective cohort study among a random sample from the respondents of the mail survey described in chapter 7, dealing with predictors for "ever falls" and recurrent falls. Two logistic models, mainly based on balance and gait performance tests, for the prediction of ever falls and recurrent falls, were developed and may be considered as complementary to the risk model based on the patient records, described in chapter 7. *Chapter 9* gives a description of the development and evaluation of a home-safety checklist on indoor falls. *Chapter 10* deals with the analysis of gait problems and self-reported causes, important risk factors for falls.

Chapter 11 concerns the involvement of GPs with falls, particularly the reporting of falls to the GP, their management in case of a fall or falls and estimation of fall risk and risk factors for falls.

In *chapter 12* the main results, methodological considerations, the implications for and recommendations to general practice and primary care, are discussed. In addition, some suggestions for further research and training are given. Finally, summaries in English and Dutch, are given.

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CHAPTER 2

Introduction to the subject
by cases from general practice

Falls in the elderly: pitfalls?

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Introduction

Case histories

Falling in the elderly is a problem with a high occurrence (1-3): in The Netherlands every year one million older persons (40 percent) have at least one fall (4,5). Three-quarters of these cases concern indoor falls (6). The risk of falling is greater for women than for men and increases with age (2). Only 20 percent of all falls are reported to the general practitioner (GP) (6).

Approximately ten percent of all falls cause major injury; in the half of hip fractures in one to three percent and other fractures in six percent of falls (2,7,8). A notable example is hip fracture, the incidence in the elderly is high: 15,000 per year in the Netherlands. About 90 percent of hip fractures are caused by falls (9,10).

The physical consequences of a fall are determined by a number of factors, of which the most important are: the direction of the fall, the fall-breaking capacity, the extent to which energy can be absorbed by the contact surfaces and the qualities of bone and/or its surrounding tissues (11). Also important are the psychological consequences of falls: many elderly persons, who have experienced a fall, subsequently lack confidence or are fearful, which in turn may lead to a new fall (2). A fall in an elderly indicates a disturbance of the balance and therefore has to be considered as a symptom of alarm: in a great number of cases a fall is a signal of an underlying disorder (12,13).

On the basis of three examples from general practice we aim to elucidate the diagnostics, treatment and prevention of falls in the elderly.

Accidentally fallen

Patient A is a woman, aged 77 years, living at home, lively and independent, who did not rely often on medical aid. She has fallen and lies groaning on the stone kitchen floor. Her 52-year-old son, who is caring for her, calls for an emergency visit. In the history taking she can report exactly what has happened: when standing up after breakfast, she had felt light-headed; and she had fallen "accidentally", "just if my legs could not bear me any more". She had felt a sharp pain in her hip.

In the examination she is *compos mentis*. The history taking reveals nothing of any acute, serious disorder, such as a myocardial infarct, and the vital functions are intact. The pulse is regular and steady with a frequency of 84 beats a minute. The blood pressure is 145/85 mm Hg. She cannot get up. There is local tenderness to

pressure in the region of the left trochanter major, but there is no axis pain or exorotation of the left leg.

Because of the possibility of an inclavation fracture, for which the classical symptoms of a fracture are lacking (14), the patient is admitted by ambulance to the emergency department of the hospital. There she is diagnosed as not having a hip fracture. After consulting her GP by telephone the patient is discharged that afternoon and at the end of the day the GP visits her again. It appears that she has got fever, caused by pneumonia. In addition, further examination reveals a disturbed glucose tolerance and a macrocytal anaemia.

The patient is treated with antibiotics, prescribed hydrocobamine and folium acid, and advised to follow a diet. Moreover, home care is applied for. She picks up quickly.

Fallen once again

Patient B is 83 years of age and living in a flat for the elderly. The nurse calls for a home visit. During the last couple of months Mr.B has been fallen several times a week. Today it occurred again. The patient is known as an excitable and dominating man, "heavy in mood and weight". He has been a widower for two years now and "that leaves its mark on me". In the last few months walking has been more difficult and especially getting up gives a lot of trouble. After the death of his wife he has been taking sleep medication (benzodiazepines), and he keeps on asking for stronger medication. Recently, a nurse discovered that he knows how to get sleeping pills clandestinely. The patient is found in his customary posture: sagging in his chair. He is sullen and depressive, complaining of pain in his lower back. In the physical examination there are no symptoms of a fracture. The balance and gait in the "get-up and go" test (15) are evidently disturbed. Patient management is aimed at reducing the sleeping medication, offering a structured contact with the nurses and a guidance by a physiotherapist to improve the mobility and the self-confidence. The prescription of anti-depressants is considered, but for the moment the decision is not to do so. A couple of weeks later the patient dies suddenly, probably due to a myocardial infarct.

Fall risk

Patient C, a widow of 89 years old, lives alone in an old farmhouse with a yard and a large garden. She is very ADL-dependent, but

finds it hard to accept help. Three of her five children are living in the neighbourhood. After her husband had died ten years ago, she became increasingly socially isolated, partly due to her depressive mood. Also her physical state is defective: polyarthrosis, loss of vision due to degeneration of the macula, heart failure with a poor patient compliance, COPD with recurrent airway infections and ulcera cruris. She potters around a bit in her house and garden and cooks her own food. The dwelling is cluttered with obstacles, is uneven, with loose carpets and things everywhere. Two yapping little dogs keep her company. Every day she shuffles through the barns, full of discarded agricultural equipment, vegetable boxes and tools. The smells remind her of an idealized past. Every time her GP visits, he wonders whether her living independently is still justified. Now, her children are asking for measures, because she has fallen in the shed. It appears that she falls, but keeps this a secret in the fear not being allowed to stay at home any more. With her children's agreement, as many obstacles and loose objects as possible will be removed. Also efforts are made to encourage her not to walk alone any more in the sheds and yard, which is only partly successful.

Half a year later the patient is bedridden due to general tiredness accompanied by vomiting and haemorrhagic stools. After deliberations between her, her children and the physician clinical diagnostics and treatment are foregone. After one week intensive home care she dies in her own bed.

Diagnostics

In diagnostics it is important to find in all cases a justified balance between the burden, caused by the examination on the one hand, and the therapeutical possibilities on the other hand - a rule, above all relevant in the elderly.

The first case concerns an acute fall and primarily whether there is injury. To answer this question an X-ray is indicated because of the suspicion of an inclavation fracture (14). The question why she has been fallen is finally answered in second instance. The number of possibilities is great in that case: a cardial cause (acute myocardial infarct or another cardial ischaemia, aorta stenosis, arrhythmia, sinus carotis syndrome), a non-cardial cause (stroke, absence), a post-miction or post-defaecation syncope, orthostatic low blood pressure, a decrease of blood pressure due to a disturbance of electrolytes, a vasovagal stimulus by medication, or another respiratory insufficiency, e.g. caused by an acute lung infiltration.

The last one finally appeared to be the probable cause (16). However, in a single fall the relation with risk factors is weak (17). The diagnostics in the second case are quite different. Here the accent lies on patient's disturbed mobility. Balance and gait are evidently abnormal, which is an important fall risk (2). Many causes may be responsible. Clearly the abuse of benzodiazepines comes to the fore, a relevant risk factor for falls in the elderly (2,18,19). Even the depressive mood is a possibly etiologic factor, although the relation with falls has not proven beyond doubt (2). Before therapeutic and preventive management can be determined, it seems significant also in this case to look into an underlying disorder, possibly neurological in origin (20). To assess the fall risk the "get-up and go" test can be used (15). This test is easy and quick to perform. The patient is asked to get-up from a chair, stay still for a second, next to walk three metres, turn around, walk back and sit again. In all stages of the test balance and gait are observed. Scoring is done on a 5-point rating scale. An increased fall risk exists if there is danger of falling at any moment in the test. In the third case the diagnostics relate almost exclusively to the determination of the fall risk. This risk can be determined by tracing the risk factors (21). These may be distinguished into intrinsic risk factors, related to health status of the person concerned, the extrinsic risk factors, related to the environment, and risk factors related to (hazardous) behaviour (2). In this case all three are present in abundance.

Intrinsic risk factors concern, besides the general health conditions, muscle strength and neuro-muscular diseases, disorders of the locomotion system, disturbances of balance and gait, cognitive disorders, disturbances of senses and the use of medication. Attention has to be paid to these factors systematically. Concerning extrinsic risk factors, it is important to find out if the removal of obstacles and elimination of dangerous situations are significant and possible. Probably this will meet resistance, particularly if the patient has lived in these surroundings for many years. In addition, from the literature it does not appear that elimination of extrinsic risk factors alone will decrease the fall risk significantly (22). The same is likely to apply to changing behaviour.

Therapy

The therapy in fall problems always depends on the underlying causes and the specific circumstances. An underlying disorder may need to be treated, but that disorder will not always be so plain as

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in the first case. In the second case the treatment is directed to a change of behaviour regarding the use of benzodiazepines, treatment of the depression and an active, intentional stimulating by a physiotherapist to improve the muscle strength, the mobility and the stability. Recently, regularly positive news has appeared on this subject (23–26). In the third case a substantial part of the treatment consists of contact with the family members, who have reason to be worried. But is it wise in this case? How great is the patient's suffering? Is it not more a problem for the family and the care providers? Too strong an approach concerning adjustment of the dwelling may have an inverted effect.

Treatment in this case also means renewed attention to the medical status, e.g. a small check-up, simplification of the medication, and an effort to elevate patient's cooperation. Also removing the main and most dangerous obstacles and ensuring that the patient will walk outside only when accompanied, can yield results. In this regard the aid of the nurse and/or home care provider is indispensable.

Prevention

Preventive measures are expensive and time consuming. A definitive judgement about the results cannot be given at the moment, but in some trials clear positive effects have been found (23–25). In all cases prevention is of interest, taking account of the high incidence of falls in the elderly, and the morbidity and mortality originating from falls. A distinction can be made between primary, secondary and tertiary prevention (27).

Primary fall prevention concerns the identification of elderly persons at high fall risk, the promotion of physical and social activities, directed education and instruction, signalling of physical and psychological problems, attention to extrinsic fall risk and, if necessary, change of habits. With a few questions and the “get-up and go” test an assessment of the fall risk can be made. Assessment questions are: “How often have you fallen in the previous year? If you have fallen, did you suffer injury? If you have not fallen, have you had a near-fall?” If there is an increased fall risk, a further history taking and examination are needed.

Concerning treatment of osteoporosis to prevent fall-related fractures, the jury is still out. It is a fact that every treatment, that results in a decrease of the reduction of the total bone mass, will reduce the brittleness of the skeleton. On the other hand, it is valuable to remember that the energy, generated in an accidental

fall from upright position, normally has such a magnitude that even a non-osteoporotic skeleton will fracture.

Secondary fall prevention consists of a directed assessment of background causes in fallers and the reduction of injury due to falls: absorbing floor-covering, hip protectors, teaching techniques how to break a fall, teaching how to get-up from the ground, adjusting footwear and using a walking aid. Reduction of the fall risk by adjustment of the dwelling comes under both primary and the secondary prevention. However, the results are generally disappointing (28).

Tertiary prevention includes measures on the long term, such as aid in fear of falling, offering contact, surveillance of lonesome elderly persons, a central alarm system and summoning volunteers to prevent social isolation. Moreover, rehabilitation after fall-related injury comes under this category.

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CHAPTER 3

Preliminary study

Home visits by community nurses may contribute to general practitioners' information about elderly patients.

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Abstract

Preliminary study

Objective To determine to what extent the general practitioner (GP) is aware of the health status and functioning of his elderly patients and in which areas this knowledge can be complemented with the aid of community nurses.

Design Cross-sectional, descriptive.

Setting A primary health care centre, connected to the Department of General Practice, Maastricht University, Maastricht, the Netherlands.

Methods A random sample of 50 patients aged 70 years and over, belonging to the population of a primary health care centre, were visited by community nurses. One patient was lost. The nurses made an inventory of the patient's health complaints and their daily functioning by means of a structured questionnaire. Data from these home visits were compared with data from the same questionnaire, regarding the same patients, which the three GPs of the health centre had filled in on the basis of their medical records.

Results Of the complaints recorded by the community nurses, 34% were not known to the GPs. This concerned mainly symptoms of depression, urinary incontinence, disabilities and impairments of the locomotion system, sleep disturbances, daily functioning and coping ability. The main determinants of coping ability were gait problems and to a lesser degree symptoms of depression.

Conclusion A structured interview of elderly patients by a community nurse yields substantial information about health problems.

Introduction

The general practitioner (GP) is often incompletely informed about the health status and functioning of his elderly patients (1-4). To provide effective health care it is desirable to be informed not only about diseases and problems, but also to have insight into the functional status of these patients (5,6). Functional status, particularly coping ability, determines whether patients may stay at home or not (7). Multidisciplinary cooperation, especially with community nurses, is a favourable condition to obtain extra information (2,8). These considerations have led us to conduct a study, in cooperation with community nurses, on the incidence of problems, complaints and impairments in the elderly and to what extent the GP is informed about these. We have chosen a population of elderly persons, aged 70 years and over, because from that age relatively many problems and limitations of functioning exist (9). The study questions were the following:

- To what extent are the health problems and the functioning of the elderly patients known to the GP?
- To what extent and in which areas does the GPs' knowledge adjust when they are confronted with recent data collected by a community nurse during a home visit in a systematic way?

Patients and method

From the register of 6500 patients of a primary health care centre, a random sample of 50 independently living persons of 70 years and over was taken. The patients came under the care of three GPs and two community nurses of the health centre, which participates in the Registration Network Family Practices (RNH) of Maastricht University (10). One person was lost due to an administrative mistake.

Original problem list The GPs had already at their disposal a problem list of every patient from the sample, named by us "the original problem list". These problem lists were constructed according to the "International Classification of Primary Care" (ICPC) (11).

For each patient the GPs filled in, using their medical register, a questionnaire designed to assess the activities of daily life and the particular daily activities (ADL/PDL functions) (12), the extent of coping ability and the physical and psychosocial complaints. (PDL functions concern activities such as household activities, cooking, administering, and the use of public transport.) The physical

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complaints covered dizziness, balance disturbances, gait problems, shortness of breath, sleeping problems, falling, overweight, hearing, vision, speech problems, and perceived health and other relevant problems. The psychosocial complaints concerned short and long term memory deficits, orientation problems of time, place and person, problems with word finding, complaints of depressive origin and loneliness. Scoring was done using 2- and 3-point rating scales. Complaints of depressive origin were recorded during the home visit by use of the "Symptom Check List" (SCL-90) (13).

Independently from the GP, around the same time the community nurse made a home visit, after written consent of the patient. Using the same questionnaire, as was filled in by the GP, the community nurse interviewed the elderly. The validity and the reproducibility of the investigation by the community nurses was ensured by the instructions before and the standardized questionnaires.

Final problem list Subsequently, the data were compared with each other by the GPs and the community nurses, discussed and, if consensus was reached, then recorded. If consensus was lacking, preference was given to the patient's answer in the inquiry.

In this way for each patient one complete series of answers was developed. The new problems, elicited from this procedure, were inserted into the original problem list, resulting in a new list, the "final problem list".

Discrepancies between the problem lists Comparing of the answers of the GP questionnaires to the series of answers resulting from the discussion between the GPs and the community nurses, enabled the extent to which the GP was informed about complaints and impairments of functioning in his patients to be determined. "Underestimation of problems" was defined as when the GP unjustly the patient classified as "free of complaints" or "without impairment of functioning". Conversely, the number of times that the GP made an "overestimation of problems" was determined.

Statistics In the statistical analysis the correlation test according to Spearman, the Chi-square test and the Fisher Exact test were used. Differences were defined as significant at $p < 0.05$. A stepwise forward logistic regression analysis was used to analyse determinants of coping ability.

Results

Problem lists Table 1 shows that following the discussion between the GPs and the community nurses 109 problems were added to the original problem list. This is 34% of the total number of codes of

Table 1 Problems of 49 persons aged 70 years or over, of which the GPs were aware (original problem list) compared to the problems found in the interview by the community nurses (final problem list)*

problem (ICPC code)	percentage of patients	
	original problem list #	final problem list•
depressive feelings (P03)	12	39
urinary incontinence (U04)	0	37
inability/impairment of the locomotion system (L28)	10	33
hypertension (K86)	29	29
sleep disturbance (P06)	2	25
arthrosis deformans of the spine (L84)	14	16
side effect of medication (A85)	12	14
syndromes of the cervical spine (L83)	14	14
hernia diaphragmatica (D90)	14	14
cataract (F92)	10	12
problems with partner's disease (Z14)	6	12
disability/impairment not otherwise described (A28)	6	12
presbycusis (H84)	12	12
deafness/bad hearing not elsewhere described (H86)	8	12
angina pectoris (K74)	12	12
arthrosis deformans of the knee (L90)	12	12
feeling old/concerned to get older (P05)	0	12
diabetes mellitus (T90)	12	12

ICPC = International Classification of Primary Care.

* The final problem list contained all problems of the original problem list, complemented by the problems that were traced in the interview by the community nurse.

In the original problem list of the 49 patients there were a total of 209 codes registered.

• In the final problem list of the 49 patients there were a total of 318 codes registered.

Table 2 The underestimations and overestimations by GPs of limitations of functioning in 49 persons aged 70 years or over, as a result of the community nurse interview.

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activity	number of elderly with limitations		
	total(n=49)	impairment by GP	
		underestimated	overestimated
<i>ADL activities</i>			
washing	8	4	1
walking	7	5	1
clothing	5	3	1
rising from chair	2	0	2
lie down	1	0	2
toilet	1	0	2
in and out bed	0	—*	4
eating	0	—*	0
mean number of limitations per elderly	0.5	0.25*	0.1
<i>PDL activities</i>			
heavy household activities	31	8	6
administration	18	4	5
shopping	17	3	3
light household activities	16	6	1
cooking	15	3	1
public transport	14	2	1
mean number of limitations per elderly	2.3	0.5	0.3

ADL = activities of daily life; PDL = particular activities of daily life.

* None of the elderly had limitations of getting in and out of bed or eating; therefore the GP could not make an underestimation. The means are calculated from the 6 other items.

the final problem list. The additions were not so much determined by diagnoses, but particularly by complaints: depressive feelings, urinary incontinence, disability/impairment of the locomotion system, sleep disturbances, problems with the partner's disease and feeling older or being concerned about getting older. The mean number of ICPC codes per patient consequently rose by a factor of 1.5: from 4.3 to 6.5.

General and particular activities of daily life (ADL/PDL) None of the elderly was completely ADL/PDL dependent. A high percentage of them (76%) were even fully ADL-independent. The mean number of ADL limitations per elderly person amounted to 0.5 and in case of PDL to 2.3 (table 2). Half of the ADL limitations and 23% of the PDL limitations were underestimated by the GPs. Overestimation of the ADL and PDL limitations amounted to 20% and 13%, respectively.

Physical and psychosocial complaints The complaints reported to the community nurses were divided into physical and psychosocial complaints (table 3). Of the physical complaints disturbances of senses were found the most prevalent: 50% of the elderly had disturbances of hearing and/or vision. Gait disorders, shortness of breath during effort, dizziness, sleep disturbances, and urinary incontinence were reported by approximately 40% of the participants. In one of five elderly persons there was accidental or recurrent falling. On the basis of the SCL-90, complaints of depressive origin were often found: 41% scored above the standard. The complaint of loneliness rose by 35%. We found a positive relation between loneliness and the presence of complaints of depressive origin (rank correlation coefficient: 0.68).

In two men and eight women (20% of the elderly) no single complaint was raised. The percentage of underestimations by the GP ranged from 10% in case of complaints of depressive origin to 75% regarding faecal incontinence. The mean percentage of underestimated complaints was 43%; mean overestimation was 18%.

Coping ability Because coping ability (classified as "good", "moderate" or "bad") had a strong correlation with ADL/PDL functioning (rank correlation coefficient: 0.72), we might assume that the coping ability was a valid measure of functioning. The coping ability was perceived by 34 (70%) of the elderly as good, while 14% perceived it as moderate and 16% as bad. Of the 15 patients who reported a moderate or bad coping ability, the GP had unjustly estimated the coping ability in 13% as good. Of the 34 elderly who reported good coping ability, the GP had unjustly estimated 38% of them as having moderate or bad coping ability.

From the stepwise regression analysis with the independent variables gender, age and physical and psychosocial complaints, it appeared that the main determinants of decreased coping ability consisted of gait disorders, and to lesser extent of the presence of complaints of depressive origin. The other variables did not give an independent contribution.

Table 3 The underestimations and overestimations by GPs of physical and psychosocial complaints of 49 persons aged 70 years or over, as a result of the community nurse interview.

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complaints	number of elderly		
	total (n=49)	complaints by GP	
		underestimated	overestimated
<i>physical complaints</i>			
hearing	26	12	8
vision	23	15	6
gait problems	21	8	3
shortness of breath			
during effort	21	3	7
dizziness	19	13	2
sleep disturbances	19	6	4
urinary incontinence	18	10	3
disturbances balance	16	10	1
overweight	11	4	0
falling	10	5	1
shortness of breath at rest	8	5	0
faecal incontinence	4	3	0
<i>psychosocial complaints</i>			
depressive complaint			
(SCL-90)	20	2	6
loneliness	17	4	6
mean number of complaints per elderly	4.8	2.0	0.9

Discussion

The GPs of the health centre in this investigation appeared not to know about 34% of the problems of their older patients or, in case of depressive feelings, urinary incontinence, sleep disturbances and an inability or impairment of the locomotion system, not to incorporate these problems into the problem list as a matter of course.

The good functional status of the elderly was noticeable. Three-quarters of them was fully ADL-independent and one-third fully

PDL-independent. What was also remarkable was that as many as 20 elderly persons (41%) had complaints of a depressive origin, in which, as could be expected, a clear relation with loneliness was found.

Generally, the GPs had a clearer picture of the impairments of functioning of their older patients than of their physical and psychosocial complaints. In all complaints, there was an underestimation by the GP, which accords with the findings of other authors (1,14). The number of underestimations regarding complaints of depressive origin was low, but more than one-third of the gait disorders were not known to the GP.

We conclude, that there are important gaps in the information of the GP regarding the complaints of his patients. The question arises, however, whether it is necessary for the GP to be informed about this in all cases. The relevant criteria are whether the complaint (or a combination of complaints) has important consequences for daily functioning and whether there are therapeutical possibilities. In that regard, the outcomes of table 3 are of interest. Approximately five complaints were recorded per elderly person. Two of these complaints were unknown to the GP and the GP incorrectly supposed the presence of one other complaint per elderly person. Of all signalled complaints - even if they are present in combination - one may suppose that they have a negative influence on daily functioning, and for a number (disturbances of senses, gait disorders, sleep disturbances, urinary incontinence, depressive complaints) therapeutical possibilities may be attempted. Structural cooperation between GP and community nurse offers possibilities for building up an inventory. Subsequently, interventions per patient and per discipline can be chosen. By means of an intervention study on a large scale the final effect of such cooperation can be determined.

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CHAPTER 4

LITERATURE REVIEW

*Incidence, risks factors and consequences of falls among elderly subjects living in the community.
A criteria-based analysis.*

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Abstract

In order to obtain an overview of the incidences, risk factors and health consequences of falls among elderly persons living in the community from the available literature, a Medline computer search of publications over the period 1981-1994 was carried out. Fourteen studies met the following inclusion criteria: (I) the study is an original investigation of falls among the elderly, (II) the study deals with the incidence, risk factors and/or consequences of falls among the elderly and (III) the study refers to a population at risk consisting of persons aged 60 years or over belonging to a population relevant to general practice. The selected studies were subjected to a methodological assessment on the basis of ten methodological criteria. All the studies were independently assessed by one author and one assistant to obtain a methodological consensus. The relevant outcomes of these studies are reported. Pooling of data was not performed because of relevant differences between the studies. Two studies met all methodological criteria and two other studies were second best. These four studies were given preference. Approximately 30% of subjects older than 65 years fall at least once a year and approximately 15% fall recurrently. The main risk factors for falls among the elderly belong to the intrinsic (patient-related) risk factors: cognitive impairment, balance and gait disorders, use of sedatives and hypnotics, a history of stroke, advanced age, arthritis of the knee and a high level of dependence. Extrinsic (environment-related) risk factors did not play a significant role in any of the studies. Not all studies dealt with the health consequences of falls among the elderly. Major injuries were reported in 0.5-9% and fractures in 3-14%.

Keywords: accidental falls, aged, elderly, incidence, risk factors, morbidity

Introduction

Falls among the elderly are a common problem in general practice. Approximately 30% of people aged 65 years and over who are living in the community fall at least once a year (1-7). This percentage rises with age. The fall rates for people aged 80 years and over are approximately 50% a year. Most falls among the elderly are not reported to a general practitioner. In a primary care-based study of the population aged 65 years and over in four general practices, 79.2 falls per 1000 persons per year (8%) were reported to the general practitioner (8). Approximately 5% of the falls result in fractures and 5% in other injuries (1).

Considering the importance of the problem of falls among the elderly in the context of the increased number of community-dwelling elderly people, it is a matter of interest for general practice to obtain a more detailed picture of the outcomes of studies. The results of studies published on this subject vary widely. In order to develop a solid preventive strategy for the elderly, it is necessary to have a valid and concise survey of the literature, particularly concerning the incidence of, risk factors for and consequences of falls among the elderly. Over the last few years the reports of the first intervention trials on fall risk have been published. Generally, intervention programmes appear to be effective (9-12). Particularly, exercise reduces falls and fall-related injuries in the elderly (9) or decreases muscle weakness (10). The risk of falling is also reduced by a multiple risk factor intervention strategy (11). However, if the intervention is not sufficient the effect on serious falls appeared not to be preventive (12).

In this paper we describe the characteristics and results of studies of falls among elderly persons living in the community. In order to evaluate the validity of the different studies we investigated whether the selected studies met important methodological criteria.

We had three questions:

- What is the methodological quality of the selected studies on falls among the community-dwelling elderly?
- What are the results of these studies with regard to incidence of, risk factors for and health consequences of falls among elderly people living in the community?
- What is the relationship between the methodological quality of the studies and their results?

Methods

A literature search was performed using three inclusion criteria.

- The study had to be an original investigation of falls among the elderly, living in the community.
- The study had to deal with the incidence, risk factors and consequences of falls among the elderly.
- The study had to comprise a population at risk of persons aged 60 years or over and relevant to general practice.

A Medline computer search was carried out in January 1994. The keywords (Medical Subject Headings: MeSH) were accidental falls, aged, elderly, incidence, risk factors and morbidity. The search included the period January 1981 to February 1994. The keywords yielded 274 references. Application of the above criteria led to the identification of 14 publications which could be subjected to methodological evaluation by means of a criteria-based analysis.

In order to obtain a measure for the quality of the studies selected, all studies were checked independently by one of the authors (P.S.) and an assistant, who is mentioned in the acknowledgements (R.L.), against a criteria list. The criteria are listed in the footnote of table 1. We used ten criteria for quality, partly based on those used by Sackett et al. (13) and partly arising from our own objectives. The criteria were dichotomous: each study was given a '+' or a '-' according to whether a particular criterion was met or not. Disagreements were discussed to reach consensus.

The first criterion (A) checked was whether a clear definition of falling was given. An example of a clear definition used by Tinetti et al. is 'A fall is defined as a subject's unintentionally coming to rest on the ground or at some lower level, not as a result of a major intrinsic event (e.g. stroke or syncope) or overwhelming hazard' (1).

The second criterion (B) was whether an adequate sample size had been chosen and whether sampling procedures had been carried out and described in a proper manner. For an adequate sample size we chose a minimum number of 100 persons.

The third criterion (C) was whether the outcomes were applicable to the elderly population in general practice.

The fourth criterion (D) was whether the design was prospective or retrospective. Prospective approaches are generally preferred over retrospective designs, with their disadvantages of recall and selection bias, particularly in studies of the elderly.

The fifth criterion (E) was whether both intrinsic (patient-related) and extrinsic (environment-related) risk factors for falling had been

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taken into account.

The sixth criterion (F) was whether an adequate clinical assessment had been made with the usual techniques, such as questionnaires, interviews and/or clinical examinations during home visits with standardized procedures and measurements.

The seventh criterion (G) was whether, in prospective studies, the duration of the follow-up was at least 6 months.

The eighth criterion (H) was whether, in prospective studies, the loss during follow-up had been less than 20%.

The ninth criterion (I) was whether the data analysis, data interpretation and data presentation were appropriate. This meant, that all relevant outcomes were reported, the outcome parameters were presented in an appropriate way, and the data were analysed using methods for multivariate analysis.

The tenth and final criterion (J) was whether the study could be reproduced by other investigators on the basis of the description of methods and outcomes.

For each of the above criteria the definitive score was noted. Combining all '+' and '-' then resulted in a total impression which provides a certain quality label.

Results

Methodological evaluation

Table 1 presents the results of the methodological evaluation of the 14 studies selected.

Samples had not always been taken in the same way, differed considerably in size and in some cases evidently suffered from selection processes. The studies by Wild et al.(14) and Hale et al.(15) were office-based. The populations in the studies by Wild et al.(14) and Nevitt et al.(16) were confined to elderly people with at least one fall accident in the previous year. People living in residential homes were excluded from the study by Downton and Andrews (17). In the study by Nevitt et al.(15) participants, fallers only, were recruited from senior centres, senior residences, churches and out-patient clinics. Lord et al.'s(20) study was confined to women. In Clark et al.'s(18) study all the participants were living in a residential home. In the studies by Prudham and Grimley Evans(5), Campbell et al.(6), Blake et al.(7), Clark et al.(18) and Cwikel(19) the health consequences of falls were not the subject of investigation at all. Data analysis and data presentation were incompletely reported in 2 studies: Campbell et al.(6) and Cwikel et al.(19) In Wild et al.'s(14,26) study data

Table 1 Application of criteria for methodological evaluation of 14 studies of falls among the elderly in the period of 1981-1994

Studies and reference number	A	B	C	D	E	F	G	H	I	J
Wild et al. ^{14,26}	+	-a,c,h	-	+	-	-	+l	-	-k	-
Prudham and Grimley Evans ⁵	-	+c,d	+	-	-	-	o	o	-	?
Campbell et al. ⁶	+	+d,i	+	-	-	+	o	o	+	-
Tinetti et al. ¹	+	+	+	+	+	+	+l	+	+	+
Blake et al. ⁷	+	+d,e	+	-	-	+	o	o	+	+
Nevitt et al. ¹⁶	+	-a,g	-	+	+	+	+l	+	+	+
Campbell et al. ^{3,4}	+	+	+	+	+	+	+l	+	+k	+
Downton and Andrews ¹⁷	+	+b,i	+	-	-	+	o	o	+	+
Cwikel ¹⁹ and Cwikel et al. ²⁷	-	+d,i	+	-	-	-	o	o	+k	-
Hale et al. ¹⁵	+	-h	-	+	+	+	+l	+l	-	-
Clark et al. ¹⁸	+	-d,f	-	+	-	+	+l	+	+	-
O'Loughlin et al. ²	+	+	+	+	-	+	+l	+	+	+
Lord et al. ²⁰	+	+i	+	-	-	-	o	o	+	+
Yasumura et al. ²¹	+	+	+	-	-	-	o	o	+	+

Criterion met: + = yes, - = no, ? = inconclusive, o = not applicable.

Criteria	Remarks
A clear definition of a fall	a fallers only ^{14,16,26}
B adequate sample size and procedure	b excluded residential homes ¹⁷
C results applicable to the elderly population in general practice	c case-control study ^{5,14,26}
D prospective study (+) or retrospective study (-)	d consequences of falls not investigated ^{5-7,18,19,27}
E both intrinsic and extrinsic risk factors for falling taken into account	e included mentally ill persons ⁷
F adequate clinical assessment	f residents of hostel for the aged only ¹⁸
G follow-up at least 6 months, in the case of a prospective design	g recruited from senior centres, senior residences, churches and out-patient clinics ¹⁶
H <20% loss to follow-up, in the case of a prospective design	h office-based selection ^{14,15,26}
I adequate data analysis, data interpretation and data presentation	i stratified selection ^{6,17,19,27}
J reproducibility of the study	j women only ²⁰
	k two publications available ^{3,4,14,19,26,27}
	l follow-up of one year ^{1-4,14-16,18,26}

analysis was insufficient. From three studies two publications were available and were taken into account: Campbell et al.(3,4), Wild et al.(14,26) and Cwikel(19), Cwikel et al.(27).

This table makes it clear that only the studies by Tinetti et al.(1) and Campbell et al.(3,4) met all our methodological criteria.

Characteristics and outcomes

Table 2 presents the main characteristics, incidences and health consequences of falls in the 14 studies selected.

• Characteristics

We included the year of publication, country, number of participants, age, mean age and sex ratio at time of recruitment. Twelve studies were from English-speaking countries, one study was from Israel(19) and one from Japan(21). The period of publication was in most cases between 1988 and 1994, but three publications dated from 1981(5,6,14).

There was an important divergence in the number of participants, varying from 76(18) to 761(3,4) in the prospective studies and from 203(17) to 3494(19) in the retrospective studies.

Most studies included persons of 65 years and older (2,5-7,14,15,19,20) or from 65 to 84 years(21), although the study by Nevitt et al.(16) included persons aged 60 years and over. Others included persons of 70 years and over (3,4,18) or even 75 years and over(1,17). The differences in age of the persons included should be taken into account when considering the incidences of, risk factors for and consequences of falls reported. The mean age of the participants ranged from 72 years(19) to 83 years(17,18), but was reported in only seven studies Tinetti et al.(1), O'Loughlin et al.(2), Hale et al.(15), Downton and Andrews(17), Clark et al.(18), Cwikel(19) and Lord et al.(20), with standard deviations in three studies: Tinetti et al.(1), Downton and Andrews(17) and Clark et al.(18). The sex ratio was missing in four studies: Wild et al.(14), Campbell et al.(6), Blake et al.(7) and Cwikel(19). Lord et al's(20) study concerned only women.

• Incidences

All studies investigated how many persons had a fall at least once a year. This percentage varied from 13% for men in Yasumura et al's(21) study, which excluded very aged persons, to 57% in Nevitt et al.'s(16) study, with a population recruited from senior centres and such like. The percentage of persons who had more than one fall a year had an approximately equal diversity: 12%(2)-42%(18). Only eight studies gave percentages of two or more falls a year(1-5,15,16,18,20). In those studies which provided mean ages there is

Table 2 Characteristics, incidences and health consequences of falls from 14 studies of falls among the elderly in the period 1981-1994

Studies and reference number	Characteristics						Incidences		Health consequences					
	1	2	3	4	5	6	7(CI 95%)	8	9	10	11	12	13*	14
Wild et al. ¹⁴ Prudham and Grimley Evans ⁵	81	UK	125	≥65	np	np	np	np	np	np	12.0*	2.4*	25	93
Campbell et al. ⁶	81	UK	2,357	≥65	np	1.4	28	13	np	np	np	np	np	o
Tinetti et al. ¹	88	NZ	553	≥65	np	np	34	np	np	np	np	np	np	o
Blake et al. ⁷	88	USA	336	≥75	78.3±5.1	1.2	32 (27-37)	17	np	4.4	6.25	1.5	2	312
Nevitt et al. ¹⁶	89	UK	1,042	≥65	np	np	35	np	np	np	np	np	np	o
Campbell et al. ^{3,4}	90	USA	325	≥60	np	4.5	57	31	55.9	1.2	3.1	0.2	3	316
		NZ	761	≥70	np	1.6	35	16	37m	1m	2m	1.1m	8	684
									41w	7w	4w	1.5w		
Downton and Andrews ¹⁷	91	UK	203	≥75	83.0±5.0	2.4	42	np	46.5*	2.3*	8.1*	np	np	o
Cwikel ¹⁹	92	ISR	3,494	≥65	72.0	np	16m	np	np	np	np	np	np	o
							31w							
Hale et al. ¹⁵	92	USA	120	≥65	74.7	4.0	37	13	35.7	8.9	5.4	np	np	102
Clark et al. ¹⁸	93	AUS	81	≥70	83.3±5.8	6.4	55	42	np	np	np	np	np	76
O'Loughlin et al. ²	93	CAN	409	≥65	73.7m	1.5	29	12m	43.1	0.5	2.5	1.5	3	375
					75.5w		34w	14w						
Lord et al. ²⁰	93	AUS	704	≥65	74.6	w	34	14	39	6.5	9.8	2.6	np	o
Yasumura et al. ²¹	94	JAP	807	65-84	71.7m	1.2	13m	np	np	np	np	np	np	o
					72.4w		22w							

Legend see next page

Legend to table 2

Characteristics	12	percentage of falls with a hip fracture
1 year of publication	13	mortality rate during 1 year follow-up
2 country	14	number of participants at the end of the follow-up period
3 number of participants		
4 age		Country
5 mean age		Aus Australia
6 female/male ratio		Can Canada
		ISR Israel
		JAP Japan
Incidences		NZ New Zealand
7 percentage of falls by subjects with 1 or more falls a year		UK United Kingdom
8 percentage of falls by subjects with 2 or more falls a year		USA United States of America
Health consequences		
9 percentage of falls with minor injury		
(lacerations without suture	*	percentage of subjects who had a fall
bruises, abrasions, and other soft tissue injury)	o	not applicable
10 percentage of falls with major injury	np	not provided
(lacerations with suture, dislocations, and sprains)	m	men
11 percentage of falls with a fracture other	w	women
than hip fracture		

a relationship between the mean ages and incidences of falls.

• Risk factors and other determinants

We only included those risk factors and determinants which were labelled as significant by the authors themselves.

We clustered risk factors and determinants into the following groups: medication, mental functioning, mobility disorders, various complaints, symptoms and disorders, activity level, demographic determinants, dependence, various risk factors and determinants, fall history and environmental risk factors (table 3).

It is not possible to distil from the studies selected a complete picture of statistically significant risk factors and determinants, for several reasons: 1. not all studies included the same risk factors and determinants for investigation; 2. risk factors were expressed in different parameters, such as relative risks, odds ratios and incidence rate ratios and 3. the statistical method used was not always described and if it was there was a diversity of statistical techniques: a multivariate analysis, which is a valid instrument for the analysis of a multiple factor phenomenon such as the risks of falling among the elderly, was not carried out in all the studies. Risk factors and

Legend to tabel 3

M	multivariate analysis	a	only injurious falls
B	bivariate analysis	b	only men
*	no information about statistical method	c	woman indoor falls and men outdoor falls
x	statistically significant	d	only women
(x)	no information about significance	e	risk factors for multiple falls

determinants most frequently mentioned as significant were cognitive impairment(1,5,6,17,18) and balance and gait disorders(1,4,16,18) (five times), the use of sedatives and hypnotics. (1,3,4,7,19) a history of stroke(2,5,21) and advanced age(5,6,19,21) (four times) arthritic knee(3,4,7,16) and high level of dependence(5,6,17) (three times) and the number of drugs, (1,3,4), foot problems, (1,7), limited mobility, (5,19), dizziness, (2,7), low systolic blood pressure, (2-4), poor vision, (20,21), high level of activity, (2-4), number of risk factors, (1,16), strength of the dominant hand, (3,4,7) contacts with general practitioner, (5,21), and a history of previous falls(14,15) (two times). Not a single study found extrinsic risk factors to be significant risk factors for falls among the elderly.

Health consequences of falls

Not all studies investigated the health consequences of falls. Five studies, all with a retrospective design (5,7,19,21) and one prospective study (18) provided no information about the health consequences of falls. In the other studies selected, we compared the percentages of falls with minor and major injuries, fractures, particularly hip fractures and mortality during a one year follow-up (table 2).

Major injuries, if provided, like laceration needing suture, dislocations and sprains as results of falls were reported in 0.5%(2)-8.9%(15) of falls. The percentage of falls resulting in fractures also showed a considerable divergence: 2.5%(2)-12%(14,26) Hip fractures resulting from falls showed percentages of 0.2%(16)-2.6%(20).

The mortality rates during a one year follow-up were not confined to mortality directly caused by falls but comprised all mortality during the follow-up. Mortality rates varied from 2%(1)-25%(14,26).

Finally, the loss to follow-up is registered in table 2: only Wild et al.'s (14) study (22%) exceeded 20% .

Once again we find noticeable differences in outcomes, caused

partly by differences between the populations and partly by the methods of investigation used. The consequence of missing data, differences in the definition of injury and the use of different methods of investigation is that it is not possible to give a valid survey of these outcomes. The data reported by Tinetti et al.(1), O'Loughlin et al.(2), Campbell et al.(3,4) and Nevitt et al.(16) are comparable.

Discussion

Methodological quality

Empirical investigations of elderly subjects living in the community encounter various limitations and are complicated in their nature as well as in the management of practical problems. Studies in this area should be viewed with this in mind otherwise results would seem disappointing.

In the presented criteria-based review we used ten criteria for quality. The weighing of these criteria is difficult. To avoid arbitrariness we did not use a weighing with points, but preferred a dichotomization into 'yes' or 'no' which has its limitations in not taking into account the differences in weight of the several criteria. We found a great diversity of methodological quality among the 14 studies selected. It is noticeable, that two studies(5,19) failed to provide a definition of a fall. The other studies used various definitions mostly excluding major intrinsic events such as stroke and syncope and accidents as well. Not all studies gave a clear description of the sampling procedure used, or used a sufficient sample size and not all samples were representative of the elderly population living in the community. One study(16) was confined to fallers, recruited from senior centres, senior residents, churches or university out-patient clinics. Another study(14), a case-control study of fallers only, had an insufficient statistical analysis. One study was an office-based study of ambulatory patients of a family practice with an insufficient sample size(15) and one study was confined to women(20). Other studies recruited their participants from populations such as a community survey(1,7,19), a regional area(2,5,6), records and registers of general practices(3,17), a municipal electoral list(21) or a hostel for elderly people(18). Sample sizes differed considerably.

Retrospective studies have the disadvantages of recall bias due to memory loss and potential selection bias resulting in lower incidence rates. However, it is surprising that the incidence rates found in the retrospective studies hardly differed from those found

in prospective studies. Two studies reported high incidence rates(16,18). In one study participants with a history of falling of a least one fall during the previous 12 months were recruited from senior centres and clinics(16). This probably concerns a population with more intrinsic risk factors. In the other study(18) the high incidence of falls can be explained from the fact that it concerns a population from a hostel for the aged, with a high mean age (83.3 ± 5.8 years), undoubtedly a population with many intrinsic risk factors.

The lack of a clear description of the statistical methods in many studies makes it difficult to judge their quality. Most investigators (1,2,6,7,16,21) analysed factors using a multiple, logistic, stepwise model to obtain a weighing of the different, independent risk factors. Data from studies using only a bivariate analysis (3,5,15) are not always comparable, because parameters are different.

Another problem is that two studies(14,15), with a small study sample lacked the statistical power to detect potentially important differences in the data.

Pooling of data was not performed because of major differences between the studies selected.

With all these shortcomings and differences of methodology in mind it must be concluded, that a definitive methodological assessment can hardly be made. Four studies with a good methodological quality may be given some degree of preference with regard to the outcomes: Tinetti et al.(1), O'Loughlin et al.(2), Campbell et al.(3,4) and Nevitt et al.(16). All four had a prospective design with a one year follow-up, gave sufficient and clear descriptions of the methods and results and offered a more complete view of the subject of falls among the elderly. Nevitt et al.'s(16) study, however, suffered from selection deficiencies and the outcomes of Campbell et al.'s(3,4) study were described in two different publications, which gave a disadvantage in comparing data.

Characteristics and outcomes

If we confine this discussion to the four above-mentioned studies we can try to summarize data to obtain the essentials with regard to the incidences of, risk factors for and health consequences of falls among the elderly. The yearly incidence rates in the studies by Tinetti et al.(1), O'Loughlin et al.(2) and Campbell et al.(3,4) were similar: 32%, 29%(m)/34%(w) and 35% respectively. In Nevitt et al.'s(16) study, however, the incidence rates were considerably higher: 57%, presumably due to the selection of the study

population, which consisted of subjects with a previous fall record, recruited from selected settings such as senior centres and clinics.

As for risk factors, there is hardly any similarity between the data in the four studies. Balance and gait problems are the only risk factors mentioned as significant in all four studies and a history of stroke is mentioned as being a significant risk factor by O'Loughlin et al.(2) and Campbell et al.(3,4) although in Campbell et al.'s(3,4) study the significance was only with regard to men. Tinetti et al.(1) emphasized the importance of the use of sedatives and hypnotics as an important risk factor, which was confirmed by Campbell et al.(3,4) for women, an outcome on which preventive strategies can be based. It is striking that only Tinetti et al.(1) found evidence for cognitive impairment as a statistically significant risk factor for falling. It must be taken into account, however, that Nevitt et al.'s(16) study excluded people who were unable to respond to questions and cognitively impaired persons probably belong to this group. It seems plausible that persons with Parkinson's disease have a higher risk of falling. Only Nevitt et al.(16) found statistically significant evidence for this in subjects with multiple falls. Low blood pressure, resulting in orthostatic disturbances, was mentioned as a risk factor by O'Loughlin et al.(2) for both sexes and by Campbell et al.(3,4) for women only. Both Tinetti et al.(1) and Nevitt et al.(16) found that the number of risk factors is an additional, statistically significant risk factor.

Summarizing the health consequences of the 14 studies selected we found that only eight studies gave information about the health consequences of falls. We differentiated minor and major injuries, fractures and specifically hip fractures. Here again outcomes differed considerably.

Significance of our findings

Several questions remain after the present review. In view of the high incidences, the many risk factors for falls among the elderly and the high risk of injury caused by a fall, efforts should be made in general practice to prevent falls among the elderly as much as possible. Preventive strategies should be based on the outcomes of investigations. The present review found a considerable incidence of falls in old age in all studies selected: per year each subject aged 65 years or over has a probability of at least one fall of approximately 30%, with a probability of recurrent falling of approximately 15% and a major injury from a fall of approximately 5%. The great diversity of significant risk factors presents a problem in selecting risk factors for preventive strategies. We would prefer

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to choose the risk factors found to be significant in the studies by Tinetti et al.(1), O'Loughlin et al.(2), Campbell et al.(3,4) and Nevitt et al.(16), on the basis of their methodological quality. Confining ourselves to these four studies we conclude that preventive programmes should be directed at least at medication, in particular the use of sedatives and hypnotics and the use of drugs in general, cognitive impairment, mobility disorders such as disabilities of the lower extremities, gait disorders due to a stroke, arthritis of the knee, foot problems and Parkinson's disease, the level of activities, low blood pressure, dizziness and insufficient muscle strength. It is a noticeable outcome of the present review that none of the studies selected found a basis for significance of environmental risk factors. It may be questioned which place efforts to improve environmental risks should have in preventive programmes.

Returning to our aims, formulated in the three questions in the introduction to this paper, we cautiously conclude that we have gained more insight into the incidences of, risk factors for and health consequences of falls among the elderly, taking the methodological quality into account. However, as a basis for an intervention programme for community-dwelling elderly people, we need more specific knowledge about intrinsic and extrinsic risk factors. We have therefore decided to set up a combined retrospective and prospective study as a basis for prevention. Our aim is to develop a prevention programme, based on data obtained from a retrospective study, followed by a clinical assessment performed in a randomly selected population with a systematical follow-up. Data from this study will be linked with data from registrations by general practitioners(25).

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CHAPTER 5

Design and methods of the surveys

Population

The study is community-based and consists of two cross-sectional surveys and one prospective study (1-3). Participants were recruited from two different community-based study populations (A and B). The prospective study was performed among a stratified random sample from the respondents on a mail survey in population B (4,5). Figure 1 presents an overview of characteristics and populations.

Population A: A mail survey on gait problems and falls (Chapter 6) was carried out among a random sample of 655 persons from the population of persons aged 55 years or over on the list of a rural primary health care centre.

Population B: The second mail survey (Chapters 7 and 10) concerns a cross-sectional study on incidence of, risk factors for and consequences of falls in the elderly living in the community. A mail questionnaire was sent to all 2744 included persons 70 years or over, registered in three urban and semi-urban health care centres and one rural duo general practice (Population B1). The subsequent prospective study (Chapters 8 and 9) was conducted in a random sample of 311 persons from the 1238 respondents on this mail questionnaire who gave written consent (Population B2). In addition, among the 16 general practitioners (GPs) of these elderly participants a mail survey on their involvement with falls and fallers was conducted (Chapter 11).

The participating GPs are members of the Registration Network Family Practices, a registration network, developed with the objective to provide data for scientific programmes of Maastricht University (6).

Data collection

For the survey on gait problems and falls (Chapter 6) in a population of persons 55 years and over (Population A), a questionnaire was constructed, containing 61 questions on demographic situation, falls and injuries in the previous year, including near-falls and fear of falling, mobility, physical and mental health indicators, functioning and quality of life (7-10).

A similar questionnaire was used in a second survey on incidence of, risk factors for and consequences of falls in a larger elderly population of 70 years and over (Population B; Chapter 7). Data from this questionnaire regarding self-perceived gait problems and causes were analysed separately (Chapter 10).

Figure 1 Characteristics and populations of the study

Characteristics	Populations		
	Population A: Retrospective	Population B1: Retrospective	Population B2: Prospective
Objective	Impact of gait problems and falls on functioning	1. Incidence of risk factors for and consequences of falls 2. Risk models for falls based on medical records	Predictors of and risk models for falls based on performance tests
Design	Cross-sectional	Cross-sectional	Prospective cohort
Setting	1 Primary health care centre	3 Primary health care centres + 1 duo practice	3 Primary health care centres + 1 duo practice
Selection	Random sample	All elderly ≥ 70 yrs/registered; exclusion procedure	Random sample from respondents of B1
Age category	≥ 55 years	≥ 70 years	≥ 70 years
Sample size	730	2744	311
Study size	405	1660	287
Measurement	Mail questionnaire	Mail questionnaire	1. Base-line survey 2. Telephone follow-up
Analyses	Bivariate + Multivariate	Bivariate + Multivariate	Bivariate + Multivariate
Period	1992-1994	1993-1997	1994-1998
Chapters of this thesis	6	7 and 10	8 and 9 11 (retrospective)

Prior to the prospective cohort study two consensus procedures were carried out: a nominal group procedure to construct an assessment on fall risk (Chapter 8) and a Delphi procedure to construct a home-safety checklist on indoor fall risk (Chapter 9) (11-14). In home visits a baseline assessment with a standardized procedure was performed by three specifically trained physicians. A subsequent standardized method of telephone calls every six weeks in a 36-week follow-up was conducted by five interviewers, also specifically trained. The telephone interviews contained questions on the occurrence of falls and injuries due to falls, perceived causes and changes in life and living conditions, related to falls. A mail questionnaire was sent to the 16 GPs of the participating elderly persons about their involvement regarding reported falls and injurious falls, the diagnostic and therapeutic management and the estimation of fall risk and potential risk factors (Chapter 11).

Chronology

Community survey 1 in population A was carried out in 1992. The preparation of the community survey 2 in population B started in the autumn of 1992 and the operationalization in the autumn of 1993. The mail questionnaire of community survey 2 was sent in February 1994. The subsequent baseline assessment between June and September 1994 and the 36-week follow-up, linked to the baseline assessment, was conducted till June 1995. The questionnaire to the GPs about their involvement was carried out between June and September 1995.

The design of the project was approved by the Ethical Board of the University Hospital Maastricht

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CHAPTER 6

Community survey 1

The impact op gait problems and falls on functioning in independent living persons of 55 years and over: a community survey.

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Abstract

In a cross-sectional, population-based study among community-dwelling persons of 55 years and over the incidence of falls, risk indicators for falls, specifically age, and the impact of gait problems, falls and other risk factors on functioning were determined. A randomly age-stratified sample (N=730) was taken from all independent living persons of 55 years and over (N=2269) and registered in a primary health care centre. They received a mail questionnaire concerning demographic data, history of falls and injuries due to falls, physical and mental health status, gait problems, functional status, including social activities. The net sample was 655, with a response from 405 persons (response rate: 62%). Of the subjects aged 55 years and over and of those aged 65 years and over, 25 % and 31% respectively fell at least one time in the previous year. Half of the people reporting falls fell more than once. Serious injury occurred in 9% of the fallers, with 4% fractures. There is a significant association between falling and age and, even more clearly, between gait problems and age. The main risk factors of single and recurrent falls were female gender, physical health status and gait problems. Logistic regression analysis reveals that the main determinants of falling in general are gait problems and female gender and, of recurrent falling female gender, physical complaints and gait problems. Falls have some negative effect on functioning, i.e. mobility range and social activities, but this is overshadowed by mental status indicators and gait problems.

Key words: gait problems, falls, elderly, risk factors, functioning.

Introduction

Gait problems and falls, as well as fear of falling, result in important disabilities and morbidity in old age. About 6% of falls in the elderly result in fractures and about 5% in other injuries, like soft tissue damage, requiring immobilisation or hospitalisation (1). The year-incidence of falling in community-dwelling people of 65 years of age and over is 25 to 40% (1-4). Fifty percent of elderly people who fall are recurrent fallers (1-3,10). Only a small percentage of falls is reported to the general practitioner (5,6,7).

There is a growing consensus of the significance of risk factors for falls. Women fall more frequently than men and incidences increase by age (8,9,10). Persons with multiple falls in general have a worse health status and significantly more risk factors than persons with a single fall (2,8,11,12). Several authors divide risk factors of falls into intrinsic (individual), extrinsic (environmental) and activity-related factors (1,11). Particularly intrinsic risk factors play an important role: mobility disorders, medication, cognitive impairment and lower extremity disability seem to be the main risk factors (1-3,11). In a criteria-based analysis of studies of incidences of, risk factors for and consequences of falls among community-dwelling elderly, no single study appeared to report extrinsic risk factors playing a significant role (13). The risk of falling increases the more risk factors are present (1,11). Drugs are important risk factors, but in the available literature no consensus exists about the distinct relative risks of the different drugs (13). Anyhow, there is a cumulative risk of drugs: the more drugs are taken, the higher the risk of falling, independent of the type of drugs (1,6,13).

Most studies of falls in the elderly include persons of advanced age, mostly 65 years or 70 years and over, but it remains unclear if and to what extent age in categories of middle and advanced age is an independent risk factor for falls and recurrent falls (2,9,10,14). Disorders of mobility disability, particularly gait problems, increase by age, but it has to be explicated at which age the role as a risk factor for falls begins (15).

Balance and gait problems are important risk factors for falls among elderly persons in many studies (1-3,11,12). However, in the elderly living in the community the contribution of balance and gait problems and falls to decrease of functioning, particularly to impaired mobility and social activities, in relation to other risk factors is not yet very clear (16,17). Single falls do not appear to be associated with increased functional disability, but multiple falls are predictors for functional decline (18). With regard to designing

preventive programmes in primary health care it is important to gain more insight into these relationships in an extended age range. High-risk groups should be identified on the basis of understanding of risk factors and personal knowledge of the patients and their living conditions (19). In the community the general practitioner has the opportunity to detect possible high-risk groups and should regard any fall from a preventive point of view (20).

We therefore decided to study the following three interrelated questions in a cross-sectional study in a group of elderly with an extended age range.

1. What are the incidences of and risk factors for falls in elderly people aged 55 years and over living in the community?
2. Is age in all advanced age categories an independent risk indicator for falls in general and for recurrent falls in particular?
3. Are balance and gait problems and falls independent risk indicators for decreased functioning?

As we studied these questions in a cross-sectional design most associations found have not to be considered as causal relations, but as causal hypotheses. However, certain relations may be labelled as causal if there is a strong plausibility.

Methods

Subjects

A sample of 730 persons, living in the community, aged 55 years and over was taken from the population registered in a primary health care centre in a small town in the south of the Netherlands (N=2269). The sample was disproportionally stratified for age: from each 5-year age group a sample of 110 persons was taken. In the cohorts above 80 years, however, this was not possible due to an insufficient number of persons.

The questionnaire

The 730 persons selected were sent a prestructured mail questionnaire. This included questions on the following variables:

- socio-demographic: age, gender and marital status;
- three physical health indicators as potential risk factors for falls: the presence or absence of a number of physical complaints and chronic diseases and regularly taken medication (21);
- two mental health indicators as potential risk factors for falls: the subscales Psychological Autonomy and Emotional Stability from the Sickness Impact Profile (SIP68) (22,23,24);
- gait problems as potential risk factors for falls, measured with the

subscale Mobility Control (SIP68) (22,23,24);

- two variables concerning potential environmental risk factors for falls: the presence of stairs in the home and adjusted footwear (25,26);

- the occurrence of falls (≥ 1 fall) and recurrent falls (≥ 2 falls) in the previous year;

- the occurrence of injuries due to falls in the previous year, divided into major injuries (fractures and other injury needing hospitalisation) and minor injuries (skin lacerations, contusions and other soft tissue injury);

- two variables on functioning: the range of mobility and social activities, measured by the subscales Mobility Range and Social Behaviour (SIP68), respectively (22-24).

Table 1 presents an overview of these selected variables with their operationalisation, minimum and maximum of the scores and, if applicable, reliability of the measurement (Cronbach's alpha).

Data analysis

Incidence of falls was calculated by frequency counts. Weighing for age distribution resulted in an estimation of yearly incidence.

Bivariate analysis was performed to study the association of risk indicators and falls in general as well as recurrent falls (odds ratios and their 95% confidence interval). Next, in logistic regression analyses, entry mode, the independent contribution of each determinant was investigated. In these analyses age was controlled for, regardless of its statistical significance. Age was introduced in the analyses as indicator variable, with the youngest age group as the reference category. In the analysis the following cut-off points as median values were used : physical complaints and chronic diseases: 2 or more; Mobility Control: 1 or more; Psychological Autonomy and Emotional Stability: 2 or more. For the risk factors of decreased functioning (notably physical and mental health indicators, gait and balance problems and falls), the continuous variables which were applicable were analysed by Pearson correlation coefficients. Finally, the independent contribution of the risk factors for daily functioning, operationalized by Mobility Range and Social Behaviour (SIP68), was assessed by multiple regression analysis. For this analysis falls in general (one fall or more) and recurrent falls (two falls or more) were introduced separately.

Table 1 Variables and their measurement

Variables	Measurement	min - max	Cronbach's α
<i>Risk factors</i>			
age	years	55-93	n.a.
gender	male/female	0-1	n.a.
marital status	living alone (no/yes)	0-1	n.a.
physical complaints	number	0-17	n.a.
chronic diseases	number	0-20	n.a.
medication	no/yes	0-1	n.a.
mental status	Psychological Autonomy(SIP68)	0-11	0.77
	Emotional Stability(SIP68)	0-6	0.65
gait problems	Mobility Control(SIP68)	0-12	0.84
presence of stairs	no/yes	0-1	n.a.
adjusted footwear	no/yes	0-1	n.a.
<i>Falls</i>			
falls (≥ 1)	no/yes	0-1	n.a.
recurrent falls (≥ 2)	no/yes	0-1	n.a.
<i>Injuries</i>			
major injuries	no/yes	0-1	n.a.
minor injuries	no/yes	0-1	n.a.
<i>Consequences on functioning</i>			
range of mobility	Mobility Range(SIP68)	0-10	0.80
social activities	Social Behaviour(SIP68)	0-12	0.78

n.a. = not applicable

Results

Population

Table 2 presents the age distribution of the 55+ population in the health centre, the gross sample of 730 persons, the net sample of 655 persons, the response and the response rates.

Of the 730 persons of 55 years and over approached, 59 appeared to have moved to another address, had died or were too ill to participate and 16 persons lived in a home for the elderly. The net sample therefore was 655 persons. After two mail reminders the response was 405 persons (response rate 61.8%). Non-response increased strongly with age. People of 80 years and over are

Table 2 Age distribution of the 55+ centre population, the gross sample, the net sample, the response (study) population and the response rate.

Age	Health centre	Gross sample	Net sample	Response (N)	Response rate (%)
55-59	526	110	108	77	71.3
60-64	525	110	108	73	67.6
65-69	435	110	108	73	67.6
70-74	287	110	107	67	62.6
75-79	207	110	95	62	65.3
80-84	168	108	85	35	41.2
≥ 85	121	72	44	18	40.9
Total	2269	730	655	405	61.8

underrepresented in the study population. For this reason the higher age categories were united into one: 75 years and over. According to the general practitioners the reasons for non-response, checked in a random sample, were inability to read or write (20 percent), a poor health status (14 percent), the study is irrelevant (14 percent), and having no interest (11 percent).

Incidence of and risk factors for falls

Of the respondents of 55 years and over 25% reported to have had at least one fall in the previous year. In the group of 65 years and over the percentage rises to 31%. Weighing of age distribution in the total population in the health centre leads to an estimated yearly incidence of 23% among the people of 55 years and over. Half of the people reporting falls had fallen more than once in the previous year.

The direct consequence of a fall is the occurrence of injury. In the group of fallers, 32% did not have any injury and 59% had minor injury, such as skin lacerations, contusions and other soft tissue injury. Major injury occurred in 9% of the fallers: fractures in 4% and other serious injury like concussion of the brain or injuries of vertebrae in 5%.

There is a significant association of falling with age: in the age group 55-59 years 14% reported one or more falls, while in the group ≥75 this percentage rose to 34% (Figure 1). Recurrent falls increase from 4% in the youngest to 18% in the oldest age group. Figure 1 also shows that the percentage of the people with one or

Table 3. Incidence (I) of falls (≥ 1 fall) and recurrent falls (≥ 2 falls) in the presence (I1) and absence (I0) of each risk factor with their odds ratios for falls and recurrent falls (N=405).

Risk Factor	Falls (≥ 1)*				Recurrent Falls (≥ 2)**			
	I1(%)	I0(%)	OR	95% CI	I1(%)	I0(%)	OR	95% CI
Age (≥ 70 years)	33	19	2.1	1.3-3.5	18	10	2.0	1.5-2.8
Gender (F)	33	17	2.5	1.5-4.0	18	7	2.9	1.5-5.7
Living alone (yes)	35	21	2.0	1.2-3.3	18	11	1.8	0.9-1.2
Chronic diseases (≥ 2)	32	18	2.2	1.3-3.5	19	6	3.6	1.8-7.2
Physical complaints (≥ 2)	38	20	2.5	1.5-4.0	23	8	3.5	1.9-6.6
Medication (yes)	29	18	1.8	1.1-3.0	17	7	2.7	1.3-5.5
Psychol. Autonomy (≥ 2)	41	23	2.4	1.3-4.4	24	11	2.7	1.3-5.4
Emot. Stability (≥ 2)	34	23	1.7	0.9-3.0	21	11	2.2	1.1-4.3
Gait problems (≥ 1)	36	19	2.5	1.5-4.1	21	7	3.4	1.8-6.6
Presence of stairs (yes)	24	26	0.9	0.7-1.5	14	11	0.8	0.4-2.4
Adjusted footwear (yes)	41	24	2.3	1.0-1.6	28	11	3.0	1.2-7.2

- * "Fallers" (≥ 1) versus "non-fallers"
- ** "Recurrent fallers" (≥ 2) versus "non-fallers" + "one-time fallers"
- I1 Incidence of falls (≥ 1 fall) and recurrent falls (≥ 2 falls) in the presence of the risk factor
- I0 Incidence of falls (≥ 1 fall) and recurrent falls (≥ 2 falls) in the absence of the risk factor
- OR odds ratio
- 95% CI 95% confidence interval
- (F) female

Figure 1. Gait problems (≥ 1), falls (≥ 1) and recurrent falls (≥ 2) by age (%)

Table 4 Logistic regression analysed by "fallers" (≥ 1) versus "non-fallers"

Variable	B	(s.e)	OR	95% CI
Gender (F)	0.87	0.26	2.4	1.5 - 3.9
Gait problems (MC ≥ 1)	0.74	0.27	2.1	1.2 - 3.6
Age				
. 60-64	0.20	0.50	1.2	0.5 - 2.1
. 65-69	0.76	0.46	2.1	0.9 - 5.3
. 70-74	0.89	0.48	2.4	0.9 - 6.2
. ≥ 75	0.83	0.44	2.3	0.9 - 5.4

Table 5 Logistic regression analysed by "recurrent fallers" (≥ 2) versus "non-fallers"

Variable	B	(s.e)	OR	95% CI
Gender (F)	1.12	0.38	3.1	1.5 - 6.4
Complaints (≥ 2)	0.97	0.37	2.6	1.3 - 5.4
Gait problems (≥ 1)	0.85	0.38	2.3	1.1 - 5.0
Age				
. 60-64	0.11	0.81	1.1	0.2 - 5.4
. 65-69	0.92	0.71	2.5	0.6 - 10.2
. 70-74	1.36	0.71	3.9	0.9 - 15.8
. ≥ 75	0.81	0.68	2.3	0.6 - 8.5

B	regression coefficient	95%CI	95% confidence interval
(s.e.)	standard error	(F)	female
OR	odds ratio	(MC)	Mobility Control SIP68

more gait problems increases sharply with age: from 22% at the age of 55 years to 66% at 75 years and over.

The association of the risk factors with falls and recurrent falls, as shown in Table 3, reveals that age, gender, physical health status indicators, decreased Psychological Autonomy and gait problems increase the risk of both falls and recurrent falls. Living alone is associated only with falls in general and decreased Emotional Stability (SIP68) only with recurrent falls. The presence of stairs in the home is not associated with increased risk of neither falls nor recurrent falls. As to be expected, the odds ratios for recurrent falls are higher than for falls in general.

Table 6 Risk factors for negative consequences for functioning (Pearson correlations)

Risk factor	Mobility Range	Social Behaviour
Gender (F)	0.03	0.06
Age	0.35**	0.27**
Medication	0.26**	0.30**
Physical complaints	0.35**	0.38**
Chronic diseases	0.26**	0.32**
Psychological Autonomy	0.52**	0.48**
Emotional Stability	0.38**	0.43**
Gait problems	0.48**	0.49**
Adjusted footwear	0.18*	0.06
Falls (≥ 1)	0.24**	0.14*
Recurrent falls (≥ 1)	0.23**	0.22*
Injuries due to falls (yes)	0.23**	0.09

Table 7 Consequences in functioning: multiple regression analysis on Mobility Range and Social Behaviour (β 's)

Risk factor	Mobility Range	Social Behaviour
Age	0.18**	0.08*
Medication	-	0.12*
Gait problems	0.24**	0.26**
Psychological Autonomy	0.32**	0.27**
Emotional Stability	0.22**	0.26**
Falls (≥ 1)/	0.09/	-/
Recurrent falls (≥ 2)	0.09*	-
	$R^2_{adj}=0.43$	$R^2_{adj}=0.43$

(F) female

* $p < 0.05$

** $p < 0.01$

/ 2 subsequent analyses: first falls (≥ 1), second recurrent falls (≥ 2)

In the logistic regression analysis of falls, only women and persons with gait problems have an increased risk of falls in general (Table 4).

The risk of recurrent falls is, in addition, influenced by the presence of physical complaints of two or more (Table 5). In both analyses, the age category of 75 years and over excepted, there seems to be a tendency of an increasing risk with age, although none of the odds ratios is significant.

Consequences on functioning

The next question to be addressed is whether gait problems and falls have to be regarded as independent risk indicators for decreased functioning. Table 6 presents the correlations of several risk factors with functioning, operationalized in the subscales Mobility Range and Social Behaviour of SIP68.

Here, gender does not play a role as a risk factor. The most important factors associated with decreased functioning are the indicators of mental status and gait problems. Also, to a lesser degree, both falls in general and recurrent falls, are associated with a decrease of functioning. The occurrence of an injury due to falling is related to a decrease of the Mobility Range only. In the multiple regression analyses on Mobility Range and Social Behaviour, a small independent effect of falls on the Mobility Range is still present, while the effect of injuries on the Mobility Range, present in the Pearson correlations, disappears (Table 7). However, the prediction of functioning is dominated by mental status indicators and gait problems. Medication has a negative influence on social activities only.

Discussion

There is an overall congruence between the results of the present study and the literature on incidence of falls and potential risk factors. The incidence of injuries due to falls is also in accordance with the literature: some 9% of the falls are related to serious injury. Particularly, poor physical and mental health status and gait problems are consistent risk factors for falling. Recurrent falling is, in addition, more likely to occur when there are more physical complaints present. The most important and consistent independent risk factor for both falls and recurrent falls, however, is female gender. As age and gait problems are accounted for in the analysis one is tempted to believe that there should be a sex specific explanation. Perhaps the striking difference in muscle strength

between males and females is a candidate factor in this matter (27). In our study there was no independent contribution of extrinsic risk factors like the presence of stairs in the home and adjusted footwear. This finding is in accordance with earlier research (1). In a criteria-based analysis, no single study displayed evidence for an independent contribution of extrinsic factors to the total risk of falling (13).

Our results suggest that preventive measures should be directed to the elderly with gait problems, particularly the female elderly. The persistent negative findings on extrinsic risk factors, raises serious doubt about the priority of preventive measures in this area.

Although advanced age of 70 years and over and the distinct age categories show bivariately an association with falls and recurrent falls, in the logistic regression analysis the age categories from 60 to 75 years only show a tendency of significance in increasing risk by age.

In the present study mental status indicators and gait problems appeared to be the most important predictors of decreased functioning. Falls in general and recurrent falls, on the contrary, seem not to have serious independent impact on functioning, what provides some new insights. Some authors had supposed a functional decline as consequence of falls, and particularly recurrent and injurious falls, but our data did not reveal this (18,28). It still remains to be determined whether falls directly cause a decline of functions in old age or only serve as a marker for them (16).

From methodological point of view this study has some important limitations. In consequence of the cross-sectional design it is not possible to make sharp distinctions between risk factors for and consequences of falls, due to a lack of information about the time-sequence of risk factors, falls and consequences of falls. We marked some variables as potential risk factors for falls and some as consequences if there were reasons for plausibility. Therefore, certain results have to be considered as associations more than clear causal relations between risk factors and falls. In this respect we considered physical and mental health indicators, and gait problems as potential risk factors for falls, but the range of mobility and social activities, operationalized in the Mobility Range and Social Behaviour, respectively, as variables of functioning.

The non-response rate may seem high and may have caused confounding in the higher age categories, which were under-represented. However, we regard the response of 62 percent as satisfactory, taken into account the mean response rate of 60 percent among mail surveys published in medical journals (29).

Our results suggest that poor physical health, unfavourable mental status and gait problems are the more important determinants of decline of functioning. This again emphasises that poor physical and mental health and gait problems belong to the most important risk factors for functional decline in the elderly. With regard to preventive measures, directed at functional decline, prevention of gait problems and its determinants, are strongly recommended. A fair amount of published evidence about the benefits of physical activity and exercise in preventing falls is available (30-34). In general practice the early identification and treatment of elderly patients with and at risk for gait problems is important.

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CHAPTER 7

Community survey 2

*A patient record-based risk model for falls in
community-dwelling elderly*

Submitted as:

Stalenhoef PA, Diederiks JPM, Knottnerus JA, Witte
LPM de, Crebolder HFJM. A patient record-based risk
model for falls in community-dwelling elderly.

Abstract

Objectives To investigate incidence, determinants and consequences of falls in a community-dwelling elderly population and the contribution of data from patient records to a risk model of recurrent falls.

Design Population survey using a mail questionnaire.

Setting Four general practices (N=27,000)

Methods A mail questionnaire on occurrence of, risk factors for and consequences of falls was sent to 2744 community-dwelling elderly of 70 years and over, registered in four general practices. Data were analysed by bivariate techniques and logistic regression, resulting in a logistic model.

Results 1660 (60%) responded. Falls (≥ 1 fall) in the previous year were reported by 25% and recurrent falls (≥ 2 falls) by 19%. Women had significantly more falls than men. Major injury was reported by 8% of the fallers (1% hip fractures; 7% other fractures); minor injury by 49%. Treatment of injuries was done by the general practitioner in 67%. Logistic regression revealed that the main risk factors for falls and recurrent falls were similar, although risk factors for recurrent falls had higher odds ratios. A risk model for recurrent falls consisting of 6 risk factors: female gender, age 80 years or over, presence of a chronic neurological disorder, use of anti-depressants, problems of balance and sense organs and complaints of muscles and joints was developed. The addition of a 7th risk factor (Mobility Control SIP68 ≥ 3) did not result in an essential improvement of the model. The Receiver Operator Characteristic (ROC) analysis of the model yielded an Area under the Curve (AUC) of 0.73 (0.75 if MC SIP68 ≥ 3 is added).

Conclusion A risk model consisting of 6 variables (7 if MC SIP68 ≥ 3 is added) from the patients' records predict recurrent falls with a sensitivity of 64% (65% with MC), a specificity of 71% (74% with MC), a positive predictive value of 42% (45% with MC) and a negative predictive value of 86% (86% with MC).

Keywords: falls, elderly, general practice, population survey, risk factors, risk model, patient records.

Introduction

Falls in the elderly belong to the major problems in health care, because of their high incidence and severe consequences (1-4). From earlier studies it is known that 25-40% of community-dwelling elderly people of 65 years and over have at least one fall each year and half of them fall two or more times (4-6). The incidence of falls increases with age and reaches 40% at the age of 80 years or over and in institutionalized elderly persons even 100% (4,7). Women fall more often than men, but the sex difference in fall incidence disappears in the higher age categories (4,5,7). Falls may have important consequences for health and functioning (8-10). Fractures are the most common serious injuries resulting from falls in elderly persons. Hip fractures have an incidence of a half to one percent a year and a mortality of around 30 percent in the first 3 months (4,11-13). Other consequences are head traumas and wrist or hand fractures, which occur in about another five percent (14). The inability to get up after a fall may result in serious morbidity and "long lies" after falls have a bad prognosis and a high mortality (15,16). Also psychological and social consequences, such as fear of falls and social isolation, may occur, sometimes resulting in a "post-fall syndrome" (17-19).

Many determinants and risk factors are associated with falls in the elderly (4,5,20-24). Falls are usually classified on the basis of the type of risk factors such as intrinsic (individual), extrinsic (environmental) and risk factors related to hazardous behaviour (4,25). The predominant role of intrinsic risk factors in the etiology of falls is generally accepted (26). The most important intrinsic risk factors are mobility impairment, cognitive deterioration, use of medication, especially sedatives, quantity of regularly taken medication, a history of stroke and orthostatic hypotension (4,5,20-24). However, there is a great diversity in number and kind of risk factors (4,5). In an earlier study physical health indicators, such as the number of complaints and disorders, appeared to have strong associations with falls and recurrent falls (27). In some studies the difference in the risk profile between one-time and recurrent fallers is emphasized (2,11). For the general practitioner (GP), the question of the occurrence of a single fall should be: is it an occasional event or the beginning of a series of falls leading to general deterioration and impairment?

Based on the results of a criteria-based analysis of studies on falls in community-dwelling elderly, risk factors can be classified, apart from the classification into intrinsic and extrinsic risk factors, into

four main areas (5): 1. socio-demographic determinants; 2. physical and 3. mental health indicators, and 4. risk factors concerning and influencing mobility, including environmental hazards. Many of these risk factors can be deduced from the medical history, patient records and assessments at the disposal of the GP. It is of great interest to operationalize these data for the identification of the community-dwelling elderly at risk for falling in view of preventive strategies. In this respect a feasible risk model based on data easily and directly available from patient records could be very helpful to the GP (22). We therefore decided to set up a community survey with the following two study questions:

- What are the incidence, determinants and health consequences of falls and recurrent falls in a community-dwelling elderly population?
- Do data from patient records contribute to a risk model for recurrent falls?

Methods

Subjects

All elderly persons of 70 years or over (N=2946), registered in three primary health care centres and one duo practice (N=27,000), were selected for this study. Of these, 202 individuals were excluded by the general practitioners. Exclusion criteria were wheelchair dependence, advanced cognitive impairment, illiteracy and severe somatic or psychiatric disease, which would hamper participation. Furthermore, persons living in or planned for admission into a hospital or nursing clinic were excluded, but those independently living in residential homes and apartments for the elderly were included. Practices are members of the Registration Network Family Practices (RNH) (28).

The study design was approved by the Ethical Review Board of the University Hospital Maastricht.

Measurements

A questionnaire was sent to the study population (N=2744), including the following fall-related items:

- Socio-demographic data: age, gender, educational level, marital status and the presence of stairs in the dwelling.
- Fall history and injuries due to falls: falls and near-falls in the previous year, perceived causes of falls, injuries due to falls, treatment, and fear of falling.
- Physical health status: complaints and disorders, the number of

medicines taken, the regular use of prescribed medication being considered to increase the risk of falling, perceived health status and alcohol consumption (29,30).

- Mental health status: the Psychological Autonomy and Communication and the Emotional Behaviour scales from the Sickness Impact Profile (SIP68) (31-33).

- Mobility impairment: a 5-point rating scale regarding perceived gait problems and the Mobility Control (MC) scale from the (SIP68) (31-33).

- Dependence and activities of daily life (ADL) and household activities (HDL): a 5-point rating scale on need for professional aid and sumscores of six 3-point scales on ADL/HDL for the determination of the level of independent functioning (34).

A "fall" is defined as any unintentional coming down on the ground or to a lower level. "Ever fallers" were defined as participants with at least one fall in the previous year; "one-time fallers" with only one fall and "recurrent fallers" with two falls or more in the previous year.

Data analysis

Differences of socio-demographic characteristics between study population and up-dated RNH population of the participating practices were tested by Chi-square test. Potential determinants were analysed by odds ratios with 95% confidence intervals. Three outcome variables concerning falls in the previous year were defined: "ever fallers" (≥ 1 fall), "one-time fallers" and "recurrent fallers" (≥ 2 falls), all contrasted to "non-fallers".

Age was dichotomized into 2 categories: < 80 years and ≥ 80 years. Cut-off values for dichotomization of other variables were used as recommended in the relevant literature or, in case of the SIP68 scores, median values were used.

Factor analysis (Principle Components analysis, followed by Varimax Rotation) of complaints was performed to obtain a reduction of the number of complaints and to determine coherence between variables. Three relevant factors were extracted: factor 1 related to complaints of mobility such as pain and stiffness of joints and muscles, backache and foot problems; factor 2 related to problems of balance, dizziness and impairment of vision and hearing, and factor 3 related to chest complaints such as chest pain, palpitations and dyspnoea.

Forward stepwise logistic regression analysis of age, gender, variables reaching significance in the bivariate analysis and factors 1 and 2 from the factor analysis of complaints, was performed.

Variables were selected that had independent significant associations with outcome, taking their contribution into account simultaneously. From logistic regression analysis, a risk model containing the strongest independent risk factors was derived. The threshold for significance was $\alpha=0.05$. The fit of the logistic model was assessed using the goodness-of-fit test according to Hosmer Lemeshow (35).

A Receiver Operator Characteristic (ROC) analysis was performed to describe the relationship between sensitivity and specificity at different cut-off values and to determine the maximal sum of sensitivity and specificity as the statistically optimal cut-off value. The predictive power of the logistic model was determined using the Area Under the ROC Curve (AUC) (36,37). Finally, positive and negative predictive values (PV+ and PV-) of the model were calculated.

Results

Subjects

After one mail reminder, completed questionnaires were received from 1660 persons, 642 men (39%) and 1018 women (61%) (response rate: 60%). Table 1 presents the main socio-demographic characteristics of the study population compared to the 70+ population registered in the RNH practices. Respondents were similar to the RNH 70+ population regarding sex, but not regarding age: in the study population the percentage of subjects of 80 years or over was lower than in the RNH population. Percentages of widowed and single persons were similar in both populations. In the study population the percentage of persons living independently was 89 percent. The level of education was subdivided into low (63 percent), medium (20 percent), high (13 percent) and not classifiable (4 percent). The presence of stairs was reported by 57 percent.

Falls

Seven hundred and twenty-three subjects (44 percent) had at least one fall in the previous year. One fall was reported by 413 (25 percent) and recurrent falls (≥ 2 falls) by 310 persons (19 percent). Women had significantly more one-time falls (29 percent versus 19 percent) and recurrent falls (22 percent versus 12 percent) than men. Indoor falls were reported by 41 percent, outdoor falls by 42 percent and both indoor and outdoor falls by 17 percent. Near-falls were reported by 37 percent and fear of falling by 48 percent of the

Table 1 Socio-demographic characteristics of the study population compared to the RNH population (column percentages)

Socio-demographic characteristics	Study population N=1660		RNH population N=2170		Sign. #
	N	%	N	%	
<i>Sex</i>					
Male	642	39	829	38	N.S.
Female	1018	61	1341	62	
<i>Age</i>					
<80 years	1279	77	1556	72	**
≥80 years	381	23	614	28	
<i>Sex by age</i>					
Male					
<80 years	521	81	636	77	*
≥80 years	121	19	193	23	
Female					
<80 years	758	74	920	69	**
≥80 years	260	26	421	31	
<i>Marital status</i>					
Married/living together	876	53	1062	49	N.S.
Widowed/single	778	47	1039	48	

level of significance; Chi square

N.S. not significant

* $p < 0.05$

** $p < 0.01$

respondents. Generally, fallers have a higher mean age than non-fallers: mean age of non-fallers was 75.4 years (SD 4.8), of one-time fallers: 76.4 years (SD 5.4) and of recurrent fallers: 77.4 years (SD 5.3).

Table 2 presents major and minor injuries due to falls in the previous year with type of injury, the proportion of subjects needing treatment and the location of treatment.

Determinants

Table 3 lists prevalences of and odds ratios for potential determinants of ever falls (≥1 fall), one-time falls and recurrent falls (≥2 falls). Comparison of the odds ratios in the three outcome

Table 2 Injuries due to falls in the previous year*

Injury	Percentage of fallers (N=723)
<i>Major injury</i>	11.5
Hip fractures	1.4
Other fractures	6.6
Other major injury	3.5
<i>Minor injury</i>	49.1
Skin and soft tissue damage	46.7
Lacerations needing sutures	2.4
Treatment	Percentage of injured fallers (N=438)
Treatment by GP	40.9
Treatment in hospital	16.6
Treatment by others	2.1

* multiple response possible

groups reveals a spectrum of increasing odds ratios for one-time fallers, ever fallers and recurrent fallers. Variables which showed associations with falls in all fall groups are age 80 years or older, female gender, living alone (widowed or single), gait problems, mobility impairment, more than two complaints and disorders, rheumatoid disease, use of anti-depressants and decreased Psychological Autonomy and Communication according to SIP68. Variables which did not show any associations with falls are the presence of stairs in the dwelling, use of anti-hypertensives and cardiac agents and alcohol consumption of five or more units a week. The strongest associations are shown in the recurrent fall group, particularly for impaired mobility, the presence of more than two complaints, chronic neurological disease, use of anti-depressants and a poor perceived health, all reaching odds ratios above 3. It has to be noted that the prevalence of chronic neurological disorder and the use of anti-depressants is low: 3 and 2 percent, respectively. About 73 percent of all respondents regularly used prescribed medication. Some 32 percent were regularly using other prescribed medication. Comparison in all fall groups of 6

Determinants	Ever falls			One-time falls			Recurrent falls		
	Prev (%) ⁰	OR	95% CI	Prev (%) ⁰	OR	95% CI	Prev (%) ⁰	OR	95% CI
<i>Socio-demographic</i>									
Age ≥ 80	23	2.0	1.4-2.2	20	1.4	1.1-1.9	22	2.3	1.7-3.0
Female gender	61	2.1	1.6-2.8	58	2.2	1.7-2.8	58	2.6	1.9-3.4
Low educational level	63	1.6	1.2-2.0	61	1.3	1.0-1.6	65	0.7	0.5-0.9
Widow/single	47	1.9	2.5-2.5	56	1.7	1.3-2.1	55	2.3	1.7-3.0
Presence of stairs	57	0.8	0.6-1.0	55	0.9	0.7-1.1	54	0.7	0.6-0.9
<i>Physical health</i>									
Complaints ≥ 3	64	4.3	3.1-6.1	59	1.9	1.5-2.4	62	5.2	3.7-7.4
Disorders ≥ 3	30	2.0	1.5-2.6	27	1.2	1.0-1.6	30	2.2	1.6-2.8
Chronic back disorder	39	1.9	1.5-2.5	25	1.4	1.1-1.8	27	2.1	1.6-2.8
Rheumatoid disease	48	1.9	1.5-2.5	30	1.3	1.0-1.6	32	2.1	1.6-2.7
Chronic neurological disease	3	4.2	2.3-7.7	2	1.8	0.8-4.1	3	5.1	2.5-10.4
Medicines ≥ 3	11	1.5	1.1-2.2	10	1.3	0.9-1.9	11	1.7	1.2-2.5
Sedatives	9	1.6	1.1-2.4	8	0.5	0.3-0.7	8	0.5	0.3-0.7
Anti-depressants	2	3.5	1.9-6.7	2	2.3	1.0-5.3	2	4.9	2.3-10.5
Hypnotics	17	1.3	1.0-1.8	17	1.2	0.9-1.6	17	1.4	1.0-1.9
Anti-hypertensives	23	0.8	0.6-1.0	24	1.0	0.8-1.3	23	0.8	0.6-1.0
Diuretics	21	1.3	1.0-1.7	21	1.2	0.9-1.6	21	1.4	1.0-1.9
Cardiac agents	27	1.2	0.9-1.6	26	1.1	0.8-1.4	27	1.2	0.9-1.6
<i>Perceived health:</i>									
moderate-very bad	41	2.6	2.0-3.4	36	1.6	1.2-2.0	40	3.0	2.3-4.0
Alcohol consumption ≥ 5/wk	21	0.6	0.5-0.9	21	0.8	0.6-1.1	20	0.5	0.4-0.8
<i>Mental health</i>									
PAC SIP68 ≥ 2 #	24	2.5	1.9-3.3	21	1.4	1.1-1.9	24	2.8	2.1-3.7
EB SIP68 ≥ 2 #	23	2.5	1.9-3.3	20	1.3	0.9-1.7	24	2.7	2.1-3.6
<i>Mobility impairment</i>									
Gait problems	21	2.9	2.2-3.8	17	1.6	1.2-2.2	21	3.4	2.5-4.5
MC SIP68 ≥ 3 #	36	2.7	2.1-3.5	32	1.7	1.3-2.1	35	3.2	2.5-4.2

Legend to table 3

0	Actual number of cases varied between 1475 and 1660 due to missing values
⊕	Actual number of cases varied between 1294 and 1349 due to missing values
⊗	Actual number of cases varied between 1203 and 1248 due to missing values
Prev(%)	prevalence in percentages
OR	odds ratio
95% CI	95% confidence interval
#	PAC SIP68 = Psychological Autonomy and Communication SIP 68 EB SIP68 = Emotional Behaviour SIP 68 MC SIP68 = Mobility Control SIP 68

categories of medicines, adjusted for age and sex, revealed that only anti-depressants in all fall groups, and hypnotics and diuretics in the ever falls and the recurrent falls groups were significantly associated.

Logistic regression

Variables showing strong associations with recurrent falls in the bivariate analysis, included two factors from the factor analysis reaching significance (factor 1: pain and stiffness of muscles and joints, backache and footproblems and factor 2: balance problems, dizziness and impairment of vision and hearing) were retained into a logistic regression analysis. Six variables appeared to give an independent statistically significant contribution to the prediction of recurrent falls. To this logistic model, a seventh variable from the section Mobility impairment, MC SIP68 ≥ 3 , was added, resulting in two variants of the logistic model, Models 1 and 2, respectively. Table 4 reveals that female gender, the presence of a chronic neurological disease and the use of anti-depressants are the strongest independent risk factors for recurrent falls in both models. In a calculation of probabilities for recurrent falls three examples of the application of the model are given.

Table 5 presents the predicted probability of model 1 and model 2 for predictions of recurrent falls according to the goodness-of-fit test of Hosmer Lemeshow. Both Models 1 and 2 had satisfactorily scores for the fit test, i.e. there is no difference between expected and observed number of recurrent fallers. Calculation of the Area Under the Curve (AUC) revealed about equal values for the model variants : 0.73 and 0.75, respectively.

Table 6 reveals that the statistically optimal cut-off value in both models is reached at 0.26, being the maximum sum of the sensitivity and the specificity. The positive predictive values (PV+)

Table 4 Logistic regression analysis of Model 1 and Model 2 for recurrent fallers (≥ 2 falls); N=1226*

Variables	Model 1		Model 2	
	OR	95% CI	OR	95% CI
Age: ≥ 80 years	1.7	1.3-2.4	1.5	1.1-2.1
Gender: female	2.4	1.7-3.2	2.3	1.7-3.2
Pain/stiffness in muscles and joints	2.2	1.7-3.0	1.9	1.4-2.6
Balance/senses	2.0	1.5-2.7	1.8	1.3-2.4
Chronic neurological disorder	4.0	1.8-8.9	3.5	1.6-7.9
Anti-depressants	2.0	1.5-6.6	2.6	1.1-6.0
Mobility impairment (MC SIP68 ≥ 3)	n.a.	n.a.	1.8	1.3-2.5
Constant		-2.6		-2.7

OR odds ratio

95%CI confidence interval

n.a. not applicable

*The probability of recurrent falls can be estimated according to the formula:

$$p = 1 / \left\{ 1 + e^{-g} \right\}$$

where $g = (c + b_1x_1 + b_2x_2 + b_3x_3 + \dots b_nx_n)$, c is the coefficient of the constant in the model, and $b_1, b_2, \dots b_n$ are the coefficients of the variables in the model.

Example 1: A woman, 84 years old, with the risk factors complaints of dizziness and poor vision and mobility impairment, has a probability of:

$$1 / \left\{ 1 + e^{-(-2.7+0.43+0.84+0.58+0.60)} \right\} = 0.44$$

for recurrent falls in the future.

Example 2: A man, 76 years old, with M. Parkinson and mobility impairment, has a probability of:

$$1 / \left\{ 1 + e^{-(-2.7+1.26+0.60)} \right\} = 0.54$$

for recurrent falls in the future.

Example 3: A woman, 86 years old, with pain in joints, but not restricted in mobility according to MC SIP68, using an anti-depressant, has a probability of:

$$1 / \left\{ 1 + e^{-(-2.6+0.86+0.55+0.81+1.05)} \right\} = 0.34$$

for recurrent falls in the future.

Table 5 Predicted probability of Model 1 and Model 2 for prediction of recurrent falls (≥ 2 falls); N=1226

Predicted probability	Model 1		Model 2	
	N	Observed %	N	Observed %
0 - 10 %	178	5.1	178	6.2
10 - 20 %	386	13.7	430	12.6
20 - 30 %	362	26.5	225	27.1
30 - 40 %	67	44.8	190	38.4
40 - 50 %	133	45.1	117	47.9
50 - 60 %	77	48.1	5	80.0
60 - 70 %	9	66.6	64	46.9
70 - 80 %	7	71.4	10	80.0
≥ 80 %	7	85.7	5	80.0
Chi square		5.53		3.04
Hosmer Lemeshow p		0.6		0.6
AUC*		0.73		0.75

* AUC = Area Under the Receiver Operator Characteristic (ROC) curve

at this cut-off point are rather low (42 and 45 percent), but the negative predictive values are high (86 percent both).

Tabel 6 Predictive value of the logistic models for recurrent falls (≥ 2 falls) at different cut-off points for predicted probability.

Cut-off point for predicted probability	Model 1				
	Sensitivity %	Specificity %	Σ %	PV+ %	PV- %
0.10	97	18	115	28	95
0.20	79	54	133	36	89
0.26	64	71	135*	42	86
0.30	48	83	131	48	83
0.40	38	87	125	49	81
0.50	18	95	113	54	78
0.60	6	99	105	74	76
0.70	4	99.6	104	79	76
0.80	2	99.8	102	86	76

Model 2					
0.10	96	18	114	29	95
0.20	78	59	137	38	89
0.26	65	74	139*	45	86
0.30	58	76	134	45	85
0.40	34	89	123	51	81
0.50	16	96	112	55	78
0.60	15	96	111	54	77
0.70	5	99.7	105	82	76
0.80	2	99.9	102	86	76
0.90	0.7	100	101	100	75

Σ sum of sensitivity + specificity
 * maximum Σ
 PV+ positive predictive value
 PV- negative predictive value

Discussion

Main results

The reported incidences of falls and mean ages of the fallers, one-time and recurrent fallers do not essentially differ from other, comparable retrospective and prospective studies (2,4,5,6,8,20-24). The proportion of fallers with major and minor injury (8% and 49%) is also in accordance with other investigations (5). In our study two-thirds of all fall-related injuries were treated by the GP and about one third in an emergency ward of a hospital, which emphasizes the important contribution of the GP to the management of fall-related injuries in community-dwelling elderly (38). The relevant contribution of complaints and disorders to fall risk, already revealed in an earlier study (27), is confirmed in this study. In some studies on falls in the elderly the regular use of medication appeared to be a significant risk factor and in other studies the risk of falling is positively associated with the quantity of medication taken (4,22-24). In our data only the use of sedatives, hypnotics and anti-depressants appeared to be associated with ever falls and recurrent falls (4,8,23,24). However, in the regression analysis only the use of anti-depressants had a significant, independent contribution to the risk of ever falls and recurrent falls (8). Alcohol consumption of five or more units a week does not play a significant role, a finding already known from other studies (4,11,21).

The logistic regression analysis yields a risk model for recurrent falls consisting of six variables, which are usually known to the GP from the patients' medical records. The addition of a seventh variable, a performance test on mobility, the Mobility Control (MC) from the SIP68, cut-off value 3, offers no fundamentally better performance in the diagnostic and predictive application (Tables 5 and 6). The consequence of this finding is that the short variant of the risk model is preferable to the variant with an extra test.

With regard to the PV+ and PV- the models are apparently more appropriate to predict no falls in the absence of risk factors than the occurrences of falls in the presence of them.

Methodological considerations

A limitation of this study is that because of the cross-sectional design no definitive conclusions can be drawn about the time-sequence of risk factors, falls and consequences of falls. As a consequence of this, determinants and outcomes are not always conceptually distinguishable. Therefore, observed associations have

to be considered as indicators for risk, supported by plausibility, and can be the basis for further prospective investigations. Examples of interpretation problems in this cross-sectional study regarding the direction of the associations concern near-falls, fear of falling, certain complaints and impairments of functioning, such as mobility impairment, which can be considered as causes and consequences of falls as well.

The study population had a similar sex distribution as the community population of persons of 70 years or over, registered in the practices belonging to the Registration Network Family Practices (RNH). However, the 80+ population in this study is somewhat under-represented: 23 versus 28 percent. This means that overall results from this study have to be considered as relatively flattered, the age-dependence of incidence of and risk factors for falls taken into account. In the regression analysis, however, we have controlled for age.

In clinical studies a response rate of 60% may not seem to be high, but in mail surveys published in medical journals the mean response rate appeared to be 60% (39). We consider the response from our mail survey in a community-dwelling elderly population of 70 years and over acceptable. There is no evidence of selection bias due to non-response. Retrospective studies may suffer from recall bias, due to short-term memory loss, but we tried to avoid this by pre-structuring the questions on falls into two separate, sequential periods of a half year each (40,41). Data on incidence from this retrospective study are comparable to other prospective studies (4,20-24). This is in accordance with our finding in an earlier criteria-based analysis in which we did not find significant differences of incidence rates of falls between selected retrospective and prospective studies (5).

Implications for general practice

For the GP the main outcome of this study is that all six independent and significant risk factors for recurrent falls of the risk model are usually known to the GP or easy to extract from the patient's medical record. In order to obtain more detailed information about the impairment of the mobility, the addition of a seventh risk factor to the model, the MC SIP68, a self-rating scale on mobility impairment and consisting of 12 items, offers no particular advantage. Depending on the variant of the model used, recurrent falls can be predicted with positive predictive values of 42% and 45% with a risk model variant of six or seven variables, respectively; these values are rather low. The sensitivity values are

satisfactorily, but in the application of the model a higher sensitivity is of interest from a prevention point of view. The choice of a cut-off value at 0.20 may be preferable to the statistically optimal cut-off value at 0.26, reaching a sensitivity of nearly 80 percent. However, the positive predictive value is lower at that cut-off point (38 percent).

Our conclusion is that a useful risk model to predict recurrent falls can be based on variables which are usually known to the GP or directly derivable from patient records.

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CHAPTER 8

Prospective cohort study

*Predictors of falls in community-dwelling elderly:
a prospective cohort study.*

Submitted as:

Stalenhoef PA, Diederiks JPM, Knottnerus JA, Kester A,
Crebolder HFJM. Predictors of falls in community-dwelling
elderly: a prospective cohort study.

Abstract

Background Predictive models of fall risk in the elderly living in the community may contribute to fall risk assessment and fall preventive strategies in primary care.

Aim To determine the predictive value of data from a fall risk assessment in order to identify elderly living in the community at risk for falling.

Design Prospective cohort study.

Setting Four general practices (N=27,000)

Method A mail questionnaire on incidence of, risk factors for and consequences of falls was sent to elderly persons 70 years or over living in the community. In a sample stratified on fall history in the previous year, age and gender, a selected group of 311 elderly persons aged 70 years or over were visited at home for a fall risk assessment as a baseline survey, consisting of a physical, and a balance and gait examination. Subsequently, a 36-week follow-up study with telephone calls every six weeks was conducted to obtain outcome data for falls and changes in life and living conditions.

Results During the follow-up 197 falls were reported by 95 of 287 participants (33%): one fall by 49 (17%) and two or more falls by 46 persons (16%). Injury due to fall was reported by 43 persons (45% of fallers): two hip fractures, four other fractures, and 44 other minor injuries. Logistic regression analysis yielded two risk models. The main determinants for ever falling were two or more falls in the previous year, decreased somatic autonomy on the SIP68 and decreased foot strength (Model 1). For recurrent falls two or more falls in the previous year, a depressive state of mind, poor scores for hand grip strength and abnormal postural sway were the strongest independent risk factors (Model 2).

Conclusions Two predictive fall risk models, consisting of variables with significant association with risk for ever falling and recurrent falling are useful in the identification of elderly at risk for falling living in the community.

Keywords: elderly, falls, community-dwelling, general practice, predictors, assessment.

Introduction

Falls in the elderly represent a major problem in general practice, because of their high incidence, the involvement of many risk factors and the considerable post-fall morbidity and mortality (1-8). In community-dwelling elderly of 65 years of age and over lifetime cumulative incidence of falls ranges between 25 and 40 percent (9,10). Major injury caused by falls account for about 10 percent, of which one percent concern hip fractures and five percent other fractures (5,7,10,11). By far most hip fractures are caused by falls (5,7,12). Hip fracture represents an important health problem, because of the high mortality in the first three months, decline in the level of functioning, threat to independence and the need for cost-consuming clinical care and rehabilitation facilities (13-16). Other consequences of falls are psychosocial: fear of falling, "post-fall syndrome" and social isolation partly due to fear of falling and partly to mobility impairment (16-20).

Falls in the elderly are multifactorial: intrinsic (patient-related), extrinsic (environment-related) and activity-related (hazardous behaviour) risk factors contribute to risk (5-7,21). Earlier studies have reported that, particularly in recurrent falls, intrinsic risk factors play a dominant role and extrinsic risk factors mainly an additional role (5-8). However, the distinction between intrinsic and extrinsic risk factors is often not very clear (22). In a criteria-based analysis on falls in the elderly, no study provided information about the independent contribution of extrinsic risk factors to falling (8). Therefore, at this moment it is not clear to which particular risk factors preventive strategies of falls in community-dwelling elderly should be addressed and where accents have to be laid (23).

In general practice, falls and fall-related injury in the elderly, particularly the increase of age-adjusted incidence of hip fracture, have become a prominent problem with the growth of the number of disabled elderly people as a consequence of the increase of life expectancy and better survival for the frail elderly (24). An average general practice (N=2300) can expect each year about 120 elderly persons with at least one fall. Of these about 45 persons will experience more than one fall and approximately 12 will have major injury due to a fall (5-8). However, only about 20 percent of all, mainly injurious, falls are reported to the general practitioner (25-27).

Because of the high incidence, important consequences and the fact that many falls are potentially preventable, efforts to develop a

strategy to prevent falls should be made (28-31). To set up and to promote fall preventive activities in primary care, particularly secondary and tertiary prevention, the availability of a validated and feasible fall assessment protocol is of great interest (31). In a cross-sectional study we already found indications that in the first identification of the elderly at risk, the patient register provides sufficient data to estimate fall risk (32). However, to complete this information a more detailed assessment by use of performance tests on health and mobility indicators, particularly balance, gait and muscle strength, may be needed and useful. Several tests and assessments of mobility problems have already been recommended by many authors, but generally without an evidence-base and/or without sufficient feasibility in general practice (33-37). A fall risk assessment from physical examination should preferably be developed using a prospective design, because of the possibility to draw conclusions regarding causal associations.

Therefore we set up a prospective study to answer the following questions:

- What are the diagnostic values (sensitivity and specificity) and predictive values (positive and negative predictive values) of data from physical examination tests on risk factors for falls in a community-based elderly population?
- Which predictive models can be recommended to general practitioners for the assessment of the elderly at risk for falling with regard to daily care preventive programmes?

Methods

Subjects

The potential participants were the respondents to a mail questionnaire on the occurrence of, risk factors for and consequences of falls in the elderly, sent to all persons aged 70 years or over registered in four primary health care centres (N=2744). Criteria for exclusion applied by the general practitioners were wheelchair dependency, serious cognitive impairment, illiteracy and serious somatic or psychiatric disease. After one mail reminder a complete questionnaire was received from 1660 respondents (response: 60%). Written permission for further investigation was obtained from 1238 respondents, who were classified into three groups, according to self-reported number of falls in the previous year: "non-fallers", "one-time fallers" and "recurrent fallers" (≥ 2 falls).

Stratification on fall history, age and gender in these groups was

performed to obtain a more balanced distribution of persons regarding fall history in relation to the variables age and gender, in order to avoid under-representation of important subgroups. A random sample was taken from 1 in 5 of the persons in the group of 70-80 years and from 1 in 2.5 from the group of 80 years and over, resulting in an overall sample of 1 in 4. Generally, compared to the study population, stratification resulted in more fallers, more men and more persons of advanced age in the stratified samples. By calculated guess a minimum required number of 300 participants was determined. The 392 persons selected were randomly contacted by telephone as a reminder for written consent earlier given, until a cohort of 311 persons was reached for a follow-up study.

The study design was approved by the Medical Ethical Board of the University Hospital Maastricht.

Baseline data

In a panel of five experts, a rehabilitation specialist, a neurologist, a geriatrician and two general practitioners, with special interest and experience in this subject, a nominal group process consensus procedure was performed and resulted in a protocol for a baseline assessment (38-40). Criteria for inclusion of proposed tests were their clinical relevance, reliability, validity and feasibility in general practice. Consensus was reached if four members of the panel agreed (80 percent consensus). The protocol for a baseline assessment consisted of an interview, scales on functioning and tests on general health, cognitive functioning and mobility impairment. All 311 persons selected were visited by one of three physicians, specifically trained in performance, interpretation and reliability of the tests. In a one-hour home visit each participant was assessed on potential risk factors for falls as a baseline survey for the subsequent follow-up study.

The interview. The pre-structured interview yielded information supplementary to the prior mail questionnaire. It was focused on the interval between mail questionnaire and baseline examination and concerned the occurrence, the circumstances and self-perceived causes of falls, injuries, treatment and fear of falling. Data about changes in morbidity, functioning, medication, living conditions and life events were registered as well.

Scales on functioning. Physical, mental and social functioning were tested by the short version of the Sickness Impact Profile (SIP68) (41-43), the activities of daily life and household activities by the Barthel index (BI) (scores 0-20) (44,45), the cognitive functioning

by the Mini Mental State Examination (MMSE) (scores 0-30) (46,47) and the depressive state of mind by the depression subscale of the Symptom Checklist (SCL90) (containing 16 items on a 5-point scale, total score 0-80) (48).

Physical examination. Tests on body weight and height to obtain Quetelet indices, blood pressure in sitting and lying position, pulse regularity and frequency, distant vision using Snellen's chart, hearing of speech at a distance of 2 metres with or without hearing aid, inspection of the feet to detect skin lesions, deformities and callus, senso-motorical examination of the feet (strength, proprioception, measured by reduced toe position sense, and sensibility) and a handgrip dynamometry using the My Gripper dynamometer¹*, testing the strength in the dominant hand with a mean of three attempts as a measure for the total body muscle strength, in particular of the lower extremities (4,49-56).

Mobility was tested using six validated independent performance tests.

- The "Get-Up and Go Test" (GUGT): a test on balance and gait comprising the ability to rise from a chair, standing in upright position for 5 seconds, walking three metres, turning, walking three metres back, and sitting again. Scoring on a 3-point rating scale for all the seven performances: normal, doubtful and abnormal. The scores were transformed subsequently into a 5-point scale for the whole test, following the original description, with a cut-off point set on 3 (57-59).

- The Romberg Test (RT): a test on the sense of position by standing in upright position for 10 seconds, feet with shoes on together, arms at 90 degree ventral flexion and eyes first open and then closed. The test is positive if a person is not able to remain standing stable with eyes closed (60).

- The Postural Sway Test (PST): a test of propulsion and retropulsion. It gives an indication of the presence of a disorder of the central nervous system and differentiates between accidental falls and recurrent falls. Scores: normal or abnormal (61-63).

- The Trendelenburg Test (TT): a test of balance standing on one leg. It tests the ability to stand on one leg for 5 seconds without support. Scores: normal or abnormal (64).

- The "Bending Down Test" (BDT): the person is asked to pick up a small object from the floor. The test is positive if a person is unable to resume upright position after bending down or takes multiple attempts to get upright. Scores on a 3-point scale: normal, doubtful and abnormal (64).

- The Functional Reach Test (FRT): a test to assess the balance by

* My Gripper, Yamasa, Tokyo, Japan: out of trade.

measuring the maximal reach of the elevated, dominant arm in 90 degree position, in three attempts. Scoring on a 4-point scale: 0 = not able at all to reach; 1 = reach of 1 to 15 cm; 2 = reach of 15 to 25 cm; 3 = reach of 25 cm or more (65,66).

Cognitive behaviour was tested with the "Double Task Test" (DTT). Participants were asked to walk three metres and at the same time to solve two simple calculations. Scoring on a 3-point scale: normal if the test is performed without any problem; doubtful if there is any hesitation or delay in the performance; and abnormal if the participant is not able to perform both tasks in the same time (67).

A home-safety checklist of indoor fall risk was developed in a separate Delphi procedure among occupational therapy experts. The evaluation is described elsewhere (68,69).

Definitions, outcome and follow-up

A "fall" was defined as an unintentional coming down on the floor or to a lower level. "Ever fallers" were defined as participants with at least one fall, "one-time fallers" with only one fall, "recurrent fallers" with two or more falls and "non-fallers" with no falls during the follow-up period.

Three dependent variables were defined as outcome parameters: "ever fallers" (≥ 1 fall), "one-time fallers" and "recurrent fallers" (≥ 2 falls), all contrasted to "non-fallers".

Subsequent to the baseline assessment, a 36-week telephone follow-up with standardized telephone calls after each 6-week interval was performed by trained interviewers. The occurrence, circumstances and self-perceived causes of falls, and changes in living conditions and life events were registered. To avoid recall bias, all answers were compared to answers from the previous call and checked for possible mistakes due to memory deficits (70).

Data analysis

Independent variables were initially analysed using bivariate techniques, resulting in odds ratios with their 95% confidence intervals. All variables were dichotomous. Cut-off points are listed in Table 1. For hand dynamometry sex-specific cut-off points were chosen because of striking differences in performances between men and women: cut-off point for women: 12 kg and for men: 22 kg. For the Barthel Index (BI) (≤ 19), the Mini Mental State Examination (MMSE) (≤ 24), the Get-Up and Go Test (GUGT) (≥ 3) and the Functional Reach Test (FRT) (≤ 15 cm) cut-off points were chosen as recommended in the available literature (44,46,57,65). In the SIP68 scores median values were used

(42,43).

Prospective cohort study

Variables showing statistically significant associations in the bivariate analysis were entered into a forward stepwise logistic regression analysis with $p < 0.05$ both as an entry and remove criterion. Two logistic models for the prediction of ever falls and recurrent falls were obtained. The odds ratios with their 95% confidence intervals of the variables in the models were determined. In addition, the observed and predicted probability of the models were calculated. Next, the fit of the logistic models was determined by the goodness-of-fit test according to Hosmer Lemeshow (71). The predictive power of the models were tested by the Area under the Receiver Operator Characteristic (ROC) Curve (AUC) (72,73). Finally, in a Receiver Operator Characteristic (ROC) analysis, the data from logistic regression were evaluated at different cut-off values to determine the maximum sum of sensitivity and specificity as the optimal cut-off value and the positive and negative predictive values.

Results

Subjects

After the stratification and random selection procedure, 311 subjects were contacted and visited at home for a baseline assessment. The baseline procedure was completed by 302 and the follow-up by 287 participants: 115 men (40 percent) and 172 women (60 percent) with a mean age of 77.2 (SD 4.9) and 78.5 (SD 5.2) years, respectively. The proportion of individuals of 80 years and over was 37 percent. About 50 percent were widowed or single.

In all 24 persons did not complete participation: nine persons during the baseline period and 15 in the subsequent follow-up period. The following reasons were registered: ten participants died, three refused further participation for personal reasons, three were not physically and one not cognitively able, two were admitted into a hospital or nursing clinic, one moved to another town and four did not respond for unknown reasons.

Falls and injuries

During the 36-week follow-up period, 197 falls were reported by 95 of the 287 participants who completed follow-up (33 percent; 56 women and 39 men) and no falls by 192 participants (67 percent). One fall was reported by 49 (17 percent) and two falls or more by 46 persons (16 percent). Twenty-three subjects of them (8

percent) had three falls or more, with a maximum of eight falls by one participant. Of the 95 individuals who reported falls, 63 (66 percent) had indoor falls. The influence of the season on the fall pattern appeared to be negligible.

Altogether 54 injuries due to falls (27 percent of all falls during follow-up) were reported by 43 individuals (45 percent of the fallers): two persons had a hip fracture and four other fractures (2 and 4 percent of the fallers, respectively). Contusions were reported by 12, other soft tissue damage by 32 persons and wounds needing sutures by five persons (13, 33 and 5 percent of the fallers, respectively).

Risk

Bivariate analysis

Table 1 presents results from bivariate analysis. Comparing odds ratios for potential risk factors for ever falls, one-time falls and recurrent falls, it appeared that age 80 years or over, female sex, living alone and all physical health parameters, excluding feet qualities, did not have any significant association with falls. Falls in the previous year show association with ever falls and recurrent falls, but not with one-time falls. Variables like poor handgrip strength scores, mental health status, and particularly mobility and functioning are associated with ever falls, but even more so with recurrent falls.

Logistic regression analysis

In a forward stepwise logistic regression analysis, 18 variables, with bivariately significant associations with ever falls and recurrent falls, including age and sex were retained. Two logistic models resulted: Model 1 for the prediction of ever falls and Model 2 for the prediction of recurrent falls. In a next step, method enter, the selected variables in the two models were analysed to calculate the odds ratios and their 95% confidence intervals (Table 2). The variables in Model 1 which showed independent significant associations with ever falls are a score on the Somatic Autonomy SIP68 ≥ 1 , two or more falls in the previous year and decreased foot strength. The variables of Model 2 which showed independent associations with recurrent falls are: a hand dynamometry score of ≤ 12 kg for women and ≤ 22 kg for men, two or more falls in the previous year, a SCL90 depression score of ≥ 22 and an abnormal postural sway.

Table 3 presents an evaluation of the observed and predicted

Table 1 Prevalence of and odds ratios for potential risk factors for ever falls (≥ 1 fall) (N = 287), one-time falls (N=241) and recurrent falls (≥ 2 falls) (N=238) versus no falls.

Risk factor	Cut-off value	Ever falls (≥ 1 fall)			One-time falls (=1 fall)			Recurrent falls (≥ 1 fall)		
		Prev	OR	95% CI	Prev	OR	95% CI	Prev	OR	95% CI
Socio-demographic determinants										
Age	≥ 80 yrs	37	1.1	0.7-1.0	36	1.0	0.5-2.0	37	1.3	0.7-2.4
Sex	Female	60	0.9	0.6-1.6	58	0.6	0.3-1.2	62	1.5	0.8-3.0
Living alone	yes	50	1.0	0.6-1.7	49	0.8	0.4-1.4	54	1.1	0.7-1.8
Fall history										
≥ 1 Fall MQ	yes	66	2.0	1.1-3.4	63	1.4	0.7-2.8	66	3.0	1.3-6.8
≥ 2 Falls MQ	yes	25	2.6	1.5-4.6	21	1.8	0.9-3.7	24	4.0	2.0-7.9
Physical health										
weight:light	≤ 64 kg	32	0.9	0.6-1.6	33	1.0	0.5-1.9	32	0.9	0.4-1.8
height:short	≤ 156 cm	30	0.8	0.5-1.4	30	0.7	0.3-1.5	31	0.9	0.4-1.8
height:long	≥ 168 cm	29	1.0	0.6-1.8	29	1.2	0.6-2.4	28	0.9	0.4-1.8
Quiet:index	≥ 30	17	0.7	0.3-1.4	17	0.5	0.2-1.3	18	0.9	0.4-2.1
Quiet:index	< 20	3	1.6	0.4-6.3	3	1.6	0.3-8.5	3	1.7	0.3-9.1
Pulse freq.	≥ 80	33	0.9	0.5-1.5	33	0.9	0.4-1.7	33	0.9	0.4-1.7
Dist. vision	< 0.5	33	1.3	0.8-2.2	31	1.1	0.6-2.1	33	1.6	0.8-3.1
Hearing	abn	8	0.2	0.0-0.8	8	0.8	0.7-8.3	9	0.4	0.1-1.7
Insp. feet	abn	31	1.2	0.7-2.1	29	1.1	0.5-2.1	31	1.4	0.7-2.8
Strength feet	abn	11	4.0	1.9-8.6	9	3.4	1.3-8.5	10	4.7	1.9-11.5
Proprioc. feet	decr	4	3.7	1.1-13.2	2	2.0	0.4-11.2	4	5.7	1.5-22.0
Sensibil. feet	decr	11	2.1	1.0-4.3	9	1.8	0.7-4.7	10	2.3	0.9-5.8
Sumscore feet	decr	18	3.1	1.7-5.7	15	2.3	1.0-5.0	17	4.1	2.0-8.5
Dynamometry	≤ 12 kg	33	2.5	1.5-4.2	28	1.5	0.8-2.9	33	4.	2.2-8.4
Dynamometry	≤ 22 kg	66	1.7	1.0-3.0	63	1.2	0.6-2.2	66	2.9	1.3-6.6

Mental health										
MMSE	≤24	9	1.2	0.5-2.7	8	0.7	0.2-2.6	9	1.7	0.6-4.5
	≥24	39	1.7	1.0-2.8	35	1.0	0.5-1.9	40	2.9	1.5-5.6
	≥1	44	1.8	1.1-2.9	43	1.7	0.9-3.1	44	1.9	1.0-3.6
	≥1	28	1.7	1.0-2.9	24	1.0	0.5-2.1	28	2.7	1.4-5.2
	abn	16	1.1	0.6-2.1	15	0.8	0.3-1.9	17	1.5	0.7-3.3
Mobility impairment										
SIP68 MC	>2	52	2.1	1.3-3.4						
	≥1	48	2.5	1.5-4.1	49	1.7	0.9-3.2	51	2.6	1.3-5.3
	≥3	19	2.6	1.4-4.7	16	1.8	0.8-3.9	18	3.6	1.7-7.4
	pos	18	2.3	1.2-4.2	14	1.2	0.5-2.9	18	3.7	1.8-7.8
	abn	5	1.5	0.4-5.9	5	1.5	0.4-5.9	8	7.2	2.7-19.2
Bending down	abn/doubt	10	1.3	0.5-3.4	10	1.3	0.5-3.4	12	2.5	1.1-5.9
	abn	41	1.3	0.7-2.5	41	1.3	0.7-2.5	42	1.5	0.8-2.9
	≤15cm	32	2.3	1.2-4.4	32	2.3	1.2-4.4	31	2.0	1.0-3.9
Functioning										
Barthel	≤19	31	1.8	0.9-3.4	31	1.8	0.9-3.4	34	3.3	1.7-6.5
	≥1	26	2.4	1.2-4.6	26	2.4	1.2-4.6	28	3.5	1.8-6.8
	≥8	47	1.5	0.8-2.8	47	1.5	0.8-2.8	50	2.5	1.3-4.9

distant vision with Snellens' chart: best performance vision of both eyes

OR	odds ratio	Dist. vision			
95% CI	95% confidence interval	MMSE	Mini Mental State Examination		
Prev	prevalence (%)	SCL 90 Depr	Symptom checklist 90 depression subscale		
abn	abnormal	SIP68	Sickness Impact Profile 68		
abn/doubt	abnormal or doubtful	SIP68 Psych	SIP 68 Psychological Autonomy and Communications		
decr	decreased	SIP68 Emot	SIP 68 Emotional Behaviour		
MQ	mail questionnaire	SIP68 Som	SIP 68 Somatic Autonomy		
Quetelet index	Quetelet index	SIP68 Tot	SIP 68 Total score		

Table 2 Logistic regression analysis of “ever fallers” (≥ 1 fall) (Model 1) and “recurrent fallers” (≥ 2 falls) (Model 2) versus “nonfallers” *.

Model 1			
Variable	Cut-off value	OR	95% CI
Gender	Female	1.3	0.8-2.3
Age	≥ 80 years	0.9	0.5-1.9
Recurrent falls in previous year	≥ 2 falls	2.4	1.3-4.3
Somatic Autonomy SIP68	≥ 1	2.2	1.2-3.9
Strength feet	abnormal	3.7	1.6-8.5
Constant	-1.74		
Model 2			
Gender	Female	0.7	0.3-1.5
Age	≥ 80 years	1.0	0.5-2.2
Recurrent falls in previous year	≥ 2 falls	3.1	1.5-6.7
Depression SCL90	≥ 22	2.2	1.1-4.5
Hand dynamometry	Men: ≤ 22 kg Women: ≤ 12 kg	3.1	1.5-6.6
Postural sway	abnormal	3.9	1.3-12.1
Constant	-2.28		

OR odds ratio
 95%CI 95% confidence interval
 * see next page

probability of the models. It reveals a general congruence between the increase of predicted probability and percentage of observed cases in both models. The predicted values of both models, calculated according to the Hosmer Lemeshow goodness-of-fit, showed good fits. The values of the Areas under the Receiver Operator Characteristic (ROC) Curves, the AUC for Model 1 was 0.69 and for Model 2: 0.79. The diagnostic values of the logistic models at different cut-off values in a ROC analysis are listed in Table 4. The statistically optimal cut-off value, the maximum sum of the sensitivity and specificity, was found at 0.3 in both models.

* The probability of ever falls and recurrent falls are to estimate according to the formula:

$$p = 1 / \left\{ 1 + e^{-g} \right\}$$

where $g = (c + b_1x_1 + b_2x_2 + b_3x_3 + \dots + b_nx_n)$, c is the coefficient of the constant in the models, and $b_1, b_2, b_3, \dots, b_n$ are the coefficients of the variables in the models.

Three examples for application of the model are given:

Example 1 for the prediction of ever falls: A woman, 87 years, more than two falls in the previous year, has a probability of ever falls of:

$$1 / \left\{ 1 + e^{-(-1.74 + 0.29 - 0.07 + 0.86)} \right\} = 0.34$$

For the probability of recurrent falls, the result is:

$$1 / \left\{ 1 + e^{-(-2.28 - 0.39 + 0.04 + 1.14)} \right\} = 0.18$$

Example 2 for the prediction of recurrent falls: A woman, 82 years, hand dynamometry score 10 kg and a depressive state of mind, has a probability of recurrent falls:

$$1 / \left\{ 1 + e^{-(-2.28 - 0.39 + 1.14 + 0.78)} \right\} = 0.33$$

Example 3 for the prediction of ever falls: A man, age 76 years, more than two falls in the previous year, poor strength of the feet and a score on SA SIP68 ≥ 1 , has a probability of ever falls:

$$1 / \left\{ 1 + e^{-(-1.74 + 0.86 + 0.78 + 1.32)} \right\} = 0.77$$

Table 3 Predicted and observed probability of Model 1 for the prediction of ever falls (≥ 1 fall) and Model 2 for the prediction of recurrent falls (≥ 2 falls)

Predicted probability	Model 1		Model 2	
	N	Observed %	N	Observed %
0 - 10%	0	0	99	8.1
10 - 20%	84	7.1	68	13.2
20 - 30%	67	23.9	19	10.5
30 - 40%	53	32.1	25	36.0
40 - 50%	30	43.3	11	63.6
50 - 60%	27	63.0	5	60.0
60 - 70%	18	61.1	4	75.0
70 - 80%	0	0	1	100
$\geq 80\%$	7	71.4	6	66.6
Chi-square	0.51df(5)		3.41df(7)	
p-value	>0.5		>0.5	
AUC*	0.69		0.79	

* AUC = Area Under the Receiver Operator Characteristic (ROC) curve

Table 4 Diagnostic and predictive values of the logistic models for ever falls (≥ 1 fall) (Model 1) and recurrent falls (≥ 2 falls) (Model 2) at different cut-off values for predicted probability.

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Model 1					
Cut-off value of the model	Sensitivity %	Specificity %	Σ %	PV+ %	PV- %
0.10	100	0	100	33	0
0.20	84	36	120	39	82
0.30	67	63	130*	47	79
0.40	49	81	130*	56	76
0.50	35	90	125	63	74
0.60	17	9	112	64	70
0.70	5	99	104	71	68

Model 2					
0.10	83	47	130	27	92
0.20	63	78	141	41	90
0.30	59	87	146*	52	90
0.40	39	95	134	67	87
0.50	24	97	121	69	84
0.60	17	98	115	73	83
0.70	11	99	110	71	82

Σ	Sum of sensitivity and specificity
*	maximal Σ
PV+	positive predictive value
PV-	negative predictive value

At cut-off point 0.30 Model 1 has a positive predictive value (PV+) of 47% and a negative predictive value (PV-) of 79 %. For Model 2 these values are 52% and 90%, respectively.

Discussion

This prospective study revealed that data on incidence of falls and injuries are comparable with other prospective community studies (5-13). To obtain annual incidence data a factor 1.4 has to be applied.

In a bivariate analysis many risk factors showed a significant association with falls and recurrent falls, but only a few were included in the final risk models, because of dependence on other risk factors. Age and gender appeared not to have any significant association, not with ever falls, nor one-time falls nor recurrent falls. This finding seems contrary to other studies, but our data may be explained by the influence of other variables with a strong age and gender dependence. Two or more falls in the previous year appeared to have strong associations with both ever falls and recurrent falls, but not with one-time falls. In this respect memory deficits have to be taken into account (26,70).

In the baseline assessment only blood pressure measurements in lying and sitting position were performed, and not, contrary to many studies, in upright position. Low and high blood pressure rates in sitting and lying position did not show any association with fall risk. In the available literature there is no consensus about a standardized method of measuring orthostatic blood pressure (74). In addition, some authors admit the contribution of this factor only if orthostatic hypotension causes dizziness upon standing, which raises the question whether it is dizziness upon standing itself that is actually the true risk factor (75-77). Also the actual contribution of orthostatic hypotension to falls in the elderly is controversial (78). The panel discussion about the inclusion of measurement of blood pressure in upright position did not yield the required consensus of 80 percent. Therefore from our study no data on orthostatic hypotension as risk factor for falls are available.

Changes in medication were assessed in this study, but, because of a prevalence below five percent, were not further analysed. It is noticeable that in our data foot qualities like poor strength, reduced toe position sense (decreased proprioception) and to a lesser degree decreased sensibility showed significant associations with falls. Peripheral neuromuscular dysfunction plays an important role in falls in the elderly (49,50). Although the systematic examination of feet in the elderly is not common practice, these findings merit a closer evaluation. Cognitive impairment, measured by the MMSE appeared not to be significantly associated with falling. Some authors regard the MMSE as insufficient to detect mild or moderate

cognitive impairment and more appropriate to evaluate intervention (45,46). Severely cognitively impaired persons were excluded from this study. Therefore, cognitive impairment may be an underestimated risk factor. A depressive state of mind, measured by the SCL90 depression subscale, appeared to be associated with ever falling and particularly with recurrent falling. The SIP68 scales for psychological and emotional functioning had moderate associations with falls.

Poor muscle strength is a strong predictor for ever and recurrent falls in the elderly, but showed strong sex differences (4,53,54). Similarly, other tests on mobility showed stronger associations with falls in women than in men. An explanation for these sex differences could be the differences in muscle strength, which points to a strong relationship between maintaining balance and muscle strength (51). In women, particularly balance-related tests like the PST, the GUGT, the RT and the FRT had a strong association with ever falls and the PST and the RT with recurrent falls. The RT, however, is disputed because of problems with its performance, interpretation and the notable number of false-positive results (79). In men only the FRT appeared to have a clear association with ever falls and the GUGT with recurrent falls. The FRT is difficult to perform and to standardize and not very safe, and for these reasons cannot be recommended to the GP. Probably also sex differences in incidences of falls, although not apparent in our data, could be, at least for a part, explained by this phenomenon. The sex-related differences in mobility tests and the sex-specific approach in interpretation of the results deserves further examination.

To summarize, taking the sex differences into account, the hand dynamometry, the GUGT and the PST can be considered as valid and feasible tests on mobility, easily to perform and interpret, and for these reasons can be recommended in general practice.

The decline in functioning in our data can be regarded as a risk factor for falls. Impaired level of activities of daily life, measured by BI ≤ 19 , and SIP68 Somatic Autonomy ≥ 1 have associations with ever falls and recurrent falls. A SIP68 total score ≥ 8 is, in addition, positively associated with falls in all fall groups. However, even to consider daily functioning as a risk factor for falls more than as a consequence will meet criticism and can be defended only on the basis of clinical plausibility.

Logistic analysis resulted in risk models for ever falls and recurrent falls. The main independent significant risk factors for ever falls are two or more falls in the previous year, poor strength of the feet and

a score on SIP68 Somatic Autonomy ≥ 1 . For recurrent falls these risk factors are two or more falls in the previous year, a depressive state of mind, poor muscle strength and abnormal postural sway. The fit of both models is satisfactory. Risk models derived from logistic regression, containing these risk factors, are easily to apply in general practice. In fall preventive activities a higher sensitivity would be preferred. A cut-off threshold of 0.3 or 0.4 in Model 1 offers values for sensitivity of 67% and 49% and for specificity 63% and 81%, respectively, both offering a maximal sumscore of 130. From clinical point of view a cut-off value of 0.3 is preferable. Model 2 reaches its optimal cut-off point at 0.3 with values for sensitivity of 59% and for specificity 87%. The predictive power of model 1 is moderate (AUC=0.69) and of model 2 acceptable (AUC=0.79).

The main advantage of this study is the prospective design and the use of standardized procedures for data collection in baseline assessment and follow-up. This allows conclusions to be drawn about the significance of causal associations between risk factors for falls and falling.

There are some methodological limitations, however. Stratification resulted in a study population consisting of more fallers, more men and more older persons compared to the response population to the mail questionnaire. Consequently, as a result of the dependence of falls on age and sex, there is some confounding in incidence rates of falls and injuries. Due to the lack of consensus about the value of orthostatic hypotension as a risk factor for falls in the elderly no conclusive statements can be made. The duration of the follow-up was determined at 36 weeks for practical and budget reasons. A follow-up period of one year should have offered possibilities to differentiate in the analysis between the degree of recurrent falling. This study has demonstrated that assessment of risk factors for falls in the elderly by the GP can be simplified into two risk models, which are complementary to a risk model derived from the patient's record. This study also revealed that the GP should mainly focus his attention on four groups of risk factors to identify the community-dwelling elderly at risk for falling. Firstly, the question of a history of two or more falls in the previous year. Secondly, the assessment of mobility impairment, particularly balance and gait disturbances, by use of the GUGT, the PST, the hand dynamometry and the examination of feet qualities like muscle strength and sensibility. Thirdly, the application of the SIP68 Somatic Autonomy, an indicator of frailty and a predictor of ever falls. And fourth, the identification of the depressive elderly, having

a particularly greater risk of recurrent falls, by use of the depression subscale of the SCL90. The implementation of these recommendations in general practice is easy and costs little time and money.

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Prospective cohort study

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CHAPTER 9

Home-safety checklist

How predictive is a home-safety checklist for indoor fall risk in the elderly living in the community?

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Abstract

Objective Development and evaluation of a home-safety checklist of indoor fall risk for the elderly living in the community.

Methods A checklist of indoor fall risk was developed in a Delphi procedure as part of a base-line assessment of fall risk. Based on the number of falls in the previous year the 1238 respondents to a mail questionnaire on occurrence of, risk factors for and consequences of falls in community-living elderly of 70 years or over, were divided into three groups: non-fallers, one-time fallers and recurrent fallers (≥ 2 falls). Out of each group 130 subjects were randomly selected and stratified on age and gender ($N=392$), of which 311 subjects (79%) were available for participation in a prospective study: a baseline assessment including a home-safety assessment of indoor fall risk, and a subsequent 36 week follow-up procedure with telephone calls every six weeks. Outcome variables were indoor falls and the number of subjects with indoor falls during follow-up. Prevalences of potential risk factors were determined. In addition, by bivariate analysis associations between potential risk factors for indoor falls risk and indoor falls during follow-up were calculated.

Results Follow-up was completed by 293 subjects and data from 287 subjects were available for analysis. During follow-up 198 falls were reported by 96 participants (32%). Two persons had a hip fracture (1%) and four had other fractures (2%). 135 Indoor falls were reported by 63 (21%) and 63 outdoor falls by 45 persons (15%). Potential risk factors for indoor falls equally belong to structural (immobile) and non-structural (mobile) risk factors. Stairs, bedrooms and bathrooms are the locations of the dwelling in which most potential risk factors are situated, but do not correspond with locations in which indoor falls actually occur. In bivariate analyses high scores on the checklist do not have a predictive value for indoor falls with an exception for indoor falls in the entrance.

Conclusions A checklist on indoor fall risk is useful in the identification of potential risk factors for indoor falls, but does not have a predictive value for indoor falls in the community-dwelling elderly with an exception for indoor falls in the entrance.

Keywords: falls, elderly, home-safety checklist, general practice

Introduction

Falls are an important health problem and a threat to independence of elderly people. They are characterized by a high incidence, many risk factors and severe consequences (1-4). Moreover, they serve as markers for morbidity, frailty and functional decline (5). Fractures, particularly hip fractures belong to the major fall-related injuries (6). About 90 percent of all hip fractures are caused by falls (4). Therefore a reduction of incidence of fractures and other fall-related injuries should be an outcome measure of fall prevention programmes (7). Falls in the elderly are associated with both intrinsic (patient-related) and extrinsic (environment-related) risk factors (3,8,9). About three-quarters of all falls occur indoors (10,11). Generally, it is assumed that extrinsic risk factors play an additional role to intrinsic risk factors (3,9). The main intrinsic risk factors identified as significant are balance and gait problems, cognitive impairment and medications (3,4,12-14). Extrinsic risk factors for indoor falls can be classified into structural (immobile) risk factors like dangerous stairs or floors, insufficient lighting and high thresholds, and non-structural (mobile) risk factors such as absence of nightlamps, absence of anti-slip material in the bathroom, too high or low storage, dangerous furniture, loose carpets and objects or insufficient walking space (15). The presence of stairs is mentioned as an important hazard (16). It has been estimated that extrinsic risk factors contribute to between one third and a half of all falls by elderly people living in the community (8,17). Until now extrinsic risk factors have appeared to be associated mainly with accidental falls and not with frailty and seem not to contribute independently to recurrent falls (3,12,14,18-21). Hazards in the dwelling as risk factors for falls are rarely assessed in prospective studies (3,4,22). In addition, it is difficult to define environmental hazards and to standardize methods for assessing them (18).

In view of prevention of falls and fractures it is important to gain more insight into the prevalence and significance of extrinsic risk factors for indoor falls. The assessment of indoor fall risk with a checklist is recommended by many authors, but an evidence-base is generally lacking (19,22-26). To investigate the prevalence and significance of potential extrinsic risk factors for indoor falls, we developed and evaluated a home-safety checklist to assess potential risk factors for indoor falls as part of a prospective study on falls in the community-dwelling elderly.

The following questions were formulated:

1. Which potential risk factors for indoor falls in the community-dwelling elderly can be identified by use of a home-safety checklist?
2. In which locations of the dwelling are these potential risk factors situated?
3. What is the predictive value of this checklist?

Material and Methods

Construction of the measurements instrument

A home-safety checklist of indoor fall risk was developed in a Delphi procedure (27-29). Members of the Delphi panel were five occupational therapists, one district nurse and one social insurance expert. In three rounds consensus was reached. Figure 1 presents this checklist consisting of 23 potential risk factors subdivided into six categories (I. through VI.; rows) and eight locations of the dwelling (a. through h.; columns), totally 116 cells for homes with stairs and 96 cells for homes without. Categories of potential risk factors are: I. Floors; II. Lighting; III. Walking Space; IV. Stairs; V. Obstacles and VI. Various. Locations of the dwelling in which risk factors are situated are: a. Entrance; b. Stairs; c. Kitchen; d. Bathroom; e. Toilet; f. Bedroom; g. Living room and h. Loft and Cellar. The assessment of the homes was performed by three physicians, specifically trained for this study. Each location of the dwelling was inspected and scored on the checklist for each allocated potential risk factor. An inter-observer test between two observers for the total checklist scores of ten randomly selected homes was performed to ensure inter-observer reliability, resulting in a Cohens' kappa of 0.66.

The analysis was conducted in two steps: frequency counts and bivariate analyses. The frequency counts yielded for each participant a total checklist score and subscores of risk factors, risk categories and locations. The checklist was controlled for stairs and not applicable items. Means of checklist scores with their 95% confidence intervals were calculated overall, and for fallers versus non-fallers and indoor fallers versus non-indoor fallers, both controlled for stairs, and analysed with analysis of variance (One-way ANOVA).

An individual checklist score, compared to the overall mean score, offered a rough measure of potential indoor fall risk. To obtain more insight into the prevalence of potential risk factors by their locations, from each checklist totals of rows and columns were taken, controlled for stairs and not applicable items and related to

	a. Entrance	b. Stairs	c. Kitchen	d. Bathroom	e. Toilet	f. Bedroom	g. Living room	h. Loft & Cellar
I. Floors								
1. Smooth floors								
2. Different floor levels								
3. Inclining floors								
4. Rough floors								
5. Thresholds too high								
II. Lighting								
6. Insufficient lighting								
7. Lightswitches not within reach								
8. Absence of nightlights								
III. Walking Space								
9. Walking space insufficient								
IV. Stairs								
10. Smooth surfaces								
11. Steep stairs								
12. Sharp turn in stairs								
13. Absence of banisters								
14. Inadequate banisters*								
V. Obstacles								
15. Loose carpets								
16. Loose objects on the floor								
VI. Various								
17. Storage too high/low**								
18. Unstable furniture								
19. Chairs unadjusted								
20. Dangerous shower								
21. Absence of anti-slip mats								
22. Absence of handbars								
23. Bed too high/low								

Legenda

* optimal: 2 banisters, diameter: 4-5 cm; height: 75-90 cm

** too high (>140cm); too low (<50cm)

= not applicable

Figure 1

the possible maximum scores.

Subsequently, to perform bivariate analysis the means of checklist scores were trichotomized into three risk groups: low (<10), medium (10-19) and high scores (19 and higher). Cut-off points were chosen on the basis of the distribution of all total checklist scores: 20 and 80 percent, respectively. Odds ratios (OR) and the 95% confidence intervals (CI) for the risk groups with medium plus high (≥ 10) and high risk scores (>19) for indoor falls during follow-up were calculated in the presence of stairs, representing potentially the highest risk. Finally, odds ratios and their 95% CI for the six risk categories and the eight locations were determined. A "fall" was defined as any unintentionally coming down on the floor or at a lower level. Outcome measures were falls (≥ 1 fall), indoor falls and number of subjects with or without falls or indoor falls during follow-up.

Subjects

From the population of three primary health care centres and one duo general practice, all persons of 70 years and over were enrolled for participation in a survey on incidences, risk factors and health consequences of falls in the community-dwelling elderly ($N=2946$). Persons living in residences for the elderly were included. A total of 202 subjects were excluded in accordance with the exclusion criteria applied by the general practitioners (GPs). Exclusion criteria were: severe illness, severe dementia, illiteracy, blindness and wheelchair dependence. A mail questionnaire was sent to 2744 included persons, of whom 1660 responded (response rate: 60%; one mail reminder). Written consent for further participation in a prospective study, consisting of a baseline assessment on potential risk factors for indoor falls and a 36-week telephone follow-up, was obtained from 1238 persons. To reach a more homogeneous distribution of the follow-up population regarding fall history in the previous year, age and gender, the respondents to the mail questionnaire were divided into three groups: non-fallers, one-time fallers and recurrent fallers (≥ 2 falls) and stratified on age and gender. Out of each group 130 persons were randomly selected and stratified to obtain at least 100 participants in each group, resulting in 311 participants for the follow-up study. The number of participants and the duration of the follow-up period was determined by calculated guess. The baseline assessment was performed in June till September 1994 and the subsequent follow-up from June 1994 till June 1995.

The study design was approved by the Ethical Review Board of the

Results

Population and falls

Out of the 311 subjects, 303 started and 293 completed the 36-week follow-up: eight persons died, six refused further participation for several reasons, two were institutionalised in a clinic, one moved to another address and one was not cognitively capable. At the end of the follow-up period data from 287 participants were available for further analysis. The proportion of

Table 1 Prevalence (%) of potential risk factors for indoor falls (N=311)

Rank	Potential risk factor	Checklist notation	Prevalence (%)
1	Absence of nightlamps	II.8	70
2	Absence of handbars	VI.22	57
3	Storage too high/low	VI.17	51
4	Inadequate banisters*	IV.14	41
5	Dangerous shower	VI.20	39
6	Absence of anti-slip mats	VI.21	36
7	Loose carpets	V.15	29
8	Steep stairs*	IV.11	18
9	Absence of banisters*	IV.13	12
10	Sharp turn in stairs*	IV.12	11
11	Thresholds too high	I.5	10
12	Loose carpets on the floor	V.16	6
13	Walking space insufficient	III.9	4
14	Smooth surfaces stairs*	IV.10	3
15	Smooth floors	I.1	3
16	Bed too high/low	VI.23	3
17	Chairs unadjusted	VI.19	2
18	Insufficient lighting	II.6	1
19	Light-switches not within reach	II.7	1
20	Unstable furniture	VI.18	1
21	Different floor levels	I.2	1
22	Rough floors	I.4	1
23	Inclining floors	I.3	<1

* adjusted for stairs

homes with stairs was 45%. During the 36-week follow-up period, 198 falls were reported by 96 of the 303 participants, who initially participated in the follow-up (32%): fifty people (17%) reported one fall and 46 (15%) recurrent falls. Sixty-three persons (21%) reported 135 indoor falls and 45 participants (15%) 63 outdoor falls. Totally, 54 fall-related injuries were reported by 43 individuals (45 percent of the fallers). Two persons had a hip fracture and four other fractures (2% and 4% of the fallers, respectively). Contusions were reported by 12 (13%), other soft tissue damage by 32 (33%) and wounds needing sutures by five persons (5%).

Checklist

The mean of the checklist scores of potential risk factors for indoor falls of the 287 analysed cases is 14.3 (SD:5.06) with a range of 2 to 32.

Table 1 presents the prevalence of 23 potential risk factors for indoor falls in the base-line population, adjusted for stairs (N=311). Out of the ten potential risk factors with the highest scores, four are non-structural, mobile and more amenable to prevention: absence of nightlamps (70%), storage too high/low (51%), absence of anti-slip mats in bathroom (36%) and loose carpets (29%). The other six are structural, immobile risk factors: absence of handbars (57%), inadequate and absence of banisters in stairways (41% and

Table 2 Prevalence (%) of potential risk factors for indoor falls by location (N=311), compared to percentage of indoor fallers during follow-up (N=63)

Rank	Location	Checklist notation	Prevalence (%)	Indoor fallers in follow-up**
1	Stairway *	b.	24	7
2	Bedroom	f.	19	19
3	Bathroom	d.	18	7
4	Living room	g.	16	37
5	Toilet	e.	12	2
6	Kitchen	c.	11	5
7	Loft & Cellar *	h.	9	5
8	Entrance	a.	7	19

* adjusted for stairs
** column percentages

Table 3 Analysis of variance (One-way ANOVA) of mean checklist scores of groups of subjects with and without falls or indoor falls during follow-up, adjusted for stairs (N=287)

Groups of subjects	Mean	95% CI	F	p-value
Fallers	14.9	13.8-16.1	2.0	0.16**
Non-fallers	14.0	13.4-14.7		
Indoor fallers	14.1	12.7-15.8	0.1	0.75**
Non-indoor fallers	14.4	13.7-15.0		
Fallers*	12.6	11.8-13.5	1.4	0.24**
Non-fallers*	12.0	11.5-12.6		
Indoor fallers*	12.0	10.9-13.1	0.2	0.62**
Non-indoor fallers*	12.3	11.8-12.8		

* adjusted for stairs ** p-values not significant: >0.05

Table 4 Prevalence of and odds ratios for risk categories and locations for indoor falls (N=287)

Risk-categories		Cut-off value	Prevalence (%)	OR*	95% CI*
I	Floors	>0	52	1.0	0.6-1.8
II	Lighting	>1	78	0.7	0.4-1.4
III	Walking space	>0	16	1.5	0.7-3.0
IV	Stairs	>0	57	1.1	0.6-1.9
V	Obstacles	>2	51	1.5	0.9-2.7
VI	Miscellaneous	>3	82	0.6	0.3-1.1
Locations		Cut-off value	Prevalence (%)	OR*	95% CI*
a	Entrance	>1	23	2.5	1.4-4.6**
b	Stairway	>1	36	0.8	0.4-1.5
c	Kitchen	>1	41	0.9	0.5-1.5
d	Bathroom	>3	33	0.6	0.3-1.2
e	Toilet	>2	22	0.9	0.5-1.8
f	Bedroom	>3	32	1.1	0.6-1.9
g	Living room	>2	31	1.2	0.6-2.1
h	Loft & Cellar	>0	33	0.7	0.4-1.3

* OR = odds ratio; 95% CI = 95% confidence interval ** Bonferroni adjustment: 95% CI: 1.1-5.9

12%), dangerous shower (39%), steep stairs and sharp turns in stairs (18% and 11%).

Table 2 presents the prevalence of potential risk factors for indoor falls by location, adjusted for stairs. In addition, table 2 presents the reported percentage of fallers with indoor falls by location. It shows that the stairway (24%), followed by the bedroom (19%) and the bathroom (18%) represent the locations in which most potential risk factors are recorded. Most indoor fallers, however, reported falls in the living room (37%), followed by entrance and bedroom (19% both). Only seven percent of indoor fallers reported falls on stairs and in bathrooms. Falls in kitchen, loft and cellar were reported in five and falls in toilet in only two percent of the indoor fallers.

Table 3 presents the results of the analysis of variance (One-way ANOVA). It does not reveal significant differences between the means of checklist scores of groups of subjects with or without falls and with or without indoor falls during the follow-up period. The same results were obtained if there is adjusted for stairs.

A bivariate analysis of the risk groups medium plus high (cut-off point: 10; prevalence: 80 percent) and high (cut-off point: 19; prevalence: 20 percent) against the group with indoor falls and stairs, potentially the group with the highest risk, yielded no significant associations between checklist scores and indoor falls: OR: 1.6 (CI 95%: 0.5-4.9) and OR: 0.7 (CI 95%: 0.3-1.9), respectively.

Table 4 presents cut-off values, corresponding prevalences of and odds ratios for risk categories and locations for indoor falls during follow-up. Except for falls in the entrance, no significance was found. The analysis of locations was completed by Bonferroni adjustment, resulting in CI 95%: 1.1-5.9 for the entrance, which still remains significant (30).

Discussion

This home-safety checklist for assessment of indoor fall risk for elderly persons, living in the community was developed as a part of a baseline examination of potential risk factors for falls. The evaluation of this checklist revealed that the application as an instrument for screening has no predictive value for indoor fall risk in the elderly. In several ways we tried to find a correlation between indoor risk factors and indoor falls. Except for falls in the entrance we found no evidence of a significant contribution of indoor risk factors to falling. An explanation for the lack of an association between potential indoor risk factors and indoor falls

might be the assumption, that elderly people are used to environmental hazards in their own homes (23,31).

Application of this checklist resulted in an overview of the prevalence of potential risk factors for indoor falls by their locations. Frequency counts of potential risk factors revealed that mobile and immobile risk factors are about equally distributed with a wide range in frequency. In addition, there is an important difference between the prevalence of potential risk factors by location and the locations in which falls were reported to have occurred during the follow-up period.

Regarding the total checklist scores, analysis of variance did not reveal any difference in checklist scores for subjects with or without falls and indoor falls, not even if controlled for stairs. Application of the checklist in a potentially high risk group, i.e. fallers with stairs in their homes, compared to the rest of the population revealed no significant associations between the scores of potential risk factors and indoor falls. Finally, bivariate analysis did not give any significant association of potential risk categories and their locations with indoor falls, except of the entrance. An explanation for this finding may be that the entrance is a transit between indoor and outdoor space, where adaptation problems may arise such as adaptation to lightness or darkness (32).

The development of a checklist for home hazards meets two main limitations. Firstly, the lack of useful definitions and standardized assessment methods of extrinsic risk factors for falls and secondly, the inter- and intra-observer variability. The first point concerns the question how to define indoor risk factors for falling and how to assess them. No definitions in literature were available. To cope with this problem a Delphi procedure was conducted. Regarding the assessment of indoor fall risk factors only non-validated checklists are circulating without published evaluation. The second item, the inter- and intra-observer variability is a reliability problem. The inter-observer variability is related to a lack of clear definitions of risk factors for falls and to differences in interpretation of the items between observers. The intra-observer variability is caused by insufficient routine and experience of the examiners. We have tried to overcome this shortcoming by training the examiners in both performance and interpretation of tests and scores. An inter-observer test gave a reasonable Cohen's kappa of 0.66.

The duration of the follow-up period seems rather short compared to other prospective studies with a one year follow-up (3,4,12,13,21). However, because of expected high incidence of

falls of about 40% in the population of 70 years and over, the sample size guess appeared to be sufficient for an adequate analysis: no essentially different outcomes in significance of indoor fall risk factors were to expect if the follow-up period had been longer.

From a methodological point of view two other remarks have to be made. Firstly, the telephone calls did not reveal that participants took any measures of home adjustments after the home-safety assessment, which might have influenced the results of the evaluation of the checklist. And secondly, a potential risk factor becomes an actual risk factor if analysis reveals a significant increase of falls during follow-up due to that particular risk factor. However, we did not check the condition for this, i.e. the actual use of all locations of the dwelling by the participants.

There are indications that the statement cited in the introduction is confirmed by our results: extrinsic risk factors play an additional role to intrinsic risk factors (3,9). The actual contribution of indoor risk factors to falls in the elderly remains unclear (33). Our hypothesis is that indoor risk factors are not to be considered primarily as causal factors but more as factors giving occasion to falls. Elderly people with important intrinsic risk factors do fall anyhow, but when, where and how they fall is a matter of randomness or occasion. It means that regarding fall risk prevention a general improvement of the environmental conditions in which elderly people stay will have limited results. More prospective studies are needed to obtain evidence for this hypothesis.

Based on our results the application of this checklist cannot be recommended with regard to preventive measures, neither in a screening programme, nor in activities of everyday care. The benefit of home visits to assess fall risk by use of checklists can be doubted and may have contrary effects: every change in home conditions as a result of not evidence-based assessments might provoke new hazards. The consequence for fall preventive programmes and activities in everyday care is that the attention, paid to conditions caused by intrinsic risk factors, has to prevail over the methodological assessment of extrinsic hazards.

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CHAPTER 10

Gait disorders

Characteristics of elderly with gait disorders and self-reported causes.

Submitted as:

Buys MFA, Stalenhoef PA, Diederiks JPM, Knottnerus JA, Crebolder HFJM. Kenmerken van ouderen met loopstoornissen en door hen gerapporteerde oorzaken.

Abstract

Objective To determine the characteristics of elderly people living in the community with gait disorders and self-reported causes.

Design Cross-sectional, descriptive.

Setting General practice.

Methods A mail questionnaire on incidence of, risk factors for and health consequences of falls in the elderly was sent to 2744 independently living elderly persons of 70 years or over. The answers to the question: "Do you generally have problems with walking?", obtained from 1648 respondents (response: 60%), were used to determine the characteristics of elderly people with a gait disorder. In addition, an inventory was made of the self-reported causes of those who indicated they had a gait disorder.

Results Response to the questionnaire was 60%. A gait disorder was reported by 800 of the 1648 respondents (48.5%). Their main characteristics were age 80 years or over, more near-falls and falls in the previous year and a moderate to bad perceived health status. In addition, in comparison with those without a gait disorder they appeared to have lower scores for health variables, functioning and quality of life. The most relevant reported causes of gait disorders related, apart from the locomotion system, to the cardiovascular, respiratory and central nervous systems, and general deterioration.

Conclusion Nearly one half of the elderly of 70 years or over reported having a gait disorder. They were older and had significantly more unfavourable scores for fall history, health status, functioning and quality of life compared to those without a gait disorder. Self-reported causes lay, apart in the locomotion system, in the cardiovascular, respiratory and central nervous systems, and general deterioration.

Keywords: Community-living elderly, gait disorders, causes, falls.

Introduction

Mobility impairment in the sense of the possibility to move, is a serious problem in the elderly. Together with other disturbances of functioning it hampers quality of life, well-being and the possibility to continue living independently. The main causes of mobility impairment are gait disorders, which are risk factors for falls and determinants of coping ability. Consequently, it is important to identify, diagnose, treat and prevent these disorders in an early stage (1-10).

In the literature, gait disorders comprise a multitude of disorders, affecting different organ systems (11-13). In addition, useful data on possible causes among the population of independent living elderly persons are scarce. It is presumed that an accumulation of disorders provides the most of the explanation for the decline of functioning.

In their contacts with the general practitioner (GP), many elderly persons report complaints about walking. Nevertheless, one of three elderly persons with serious mobility complaints never requests help (10,14).

To obtain more insight into the characteristics of independently living elderly people with gait disorders and the causes of them, we conducted a study on the basis of the following study questions:

- What are the characteristics of elderly persons who report a gait problem?
- What are the causes of gait problems as perceived by elderly persons?

Methods

The investigation is part of a cross-sectional study on incidence of, risk factors for and health consequences of falls in elderly people aged 70 years or over. A questionnaire was sent to all persons aged 70 year or over (N=2744), on the list of three primary health care centres and one group practice. The questions concerned falls and mobility-related variables as follows:

Socio-demographic situation: Age, gender and marital status.

Health status: Nature and number of complaints (20 in total) and disorders (17 in total), use of medication (yes/no), and categories of prescribed medication regularly used, which may have influence on mobility (sedatives, anti-depressants, hypnotics, anti-hypertensives, diuretics, heart agents and other medication), the perceived health status on a 3-point scale (good, moderate or bad), and the use of

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alcohol in a 7-point scale ("never" to "more than 40 glasses a week") (15).

Functioning: The level of functioning was determined using three measurements:

- The short version of Sickness Impact Profile (SIP68), a measurement consisting of six components concerning functioning (somatic and psychological autonomy, physical and social mobility, and social and emotional behaviour) (16);
- The Activities of Daily Life and Particular activities of Daily Live (ADL/PDL): six modalities concerning transport, cooking, household, washing, taking medication, and toileting, expressed in the sumscore of separate 3-point scales ("no help needed", "some help needed", and "help necessary") (17);
- The Quality of Life (QL), determined by sumscores of two separate 7-point scales concerning feeling of happiness ("very happy" to "very unhappy") and satisfaction ("very satisfied" to "very dissatisfied") (18).

Mobility: The criterion for having a gait disorder was derived from the answers to the question: "Do you generally have problems with walking?" with possibilities to answer in a 5-point scale: "yes, a great deal", "yes, many", "yes and no", "no, not really" and "no, certainly not". Those who answered with one of the first three categories were subsequently asked in an open question about what they perceived to be the cause of the problem with walking: "What is, according to you, the cause of your problems with walking?". The answers were coded independently by three experienced general practitioners (GPs) according to the International Classification of Primary Care (ICPC) (19). In case of differences, a fourth GP being a particular expert on ICPC, was consulted, who determined the definitive code (20).

Falls: The number of falls (6-point scale: "never" to "5 times or more") and near-falls (4-point scale: "never" to "4 times or more") in the previous year and fear of falling (4-point scale: "never" to "always") (21).

Self-reported gait problems were used as dependent variables; the other variables as independent.

Bivariate associations were calculated and expressed in relative risks with their 95% confidence intervals. T-tests and the Mann-Whitney test were used to test the differences with $\alpha = 0.05$ as threshold value for significance.

The study design was approved by the Medical Ethical Board of the University Hospital Maastricht.

Results

Characteristics of elderly people with a gait disorder

The response to the questionnaire was 60% (N=1659). Because it appeared that 11 of the respondents could not walk at all, they were subsequently excluded from this part of the study. As a consequence, 1648 elderly persons were included, 61 percent women, with a mean age of 76 years (SD 5.1).

Of the 1648 elderly persons 800 reported having a gait disorder, 64 percent of them women. Table 1 presents the categorical variables that show a strong association with gait disorders. Elderly persons with a gait disorder differentiate themselves particularly by a poorer perceived health status, a higher age, a near-fall and, to a lesser extent, a fall in the previous year. The numerical variables, associated with self-reported gait disorders, are given in table 2. People with a gait disorder have significantly unfavourable scores for both the health variables investigated and functioning according to the SIP68, PDL and QL.

Causes of gait disorders

Figure 1 presents an overview of the causes, reported by 800 respondents, expressed in the code letters of the chapters of the ICPC. It appears that as expected, the most frequently reported

Table 1 Prevalences and relative risks of characteristics of elderly persons with self-reported gait disorders in categorical variables.

Characteristics	Prevalence (%)		RR	95% CI
	L+	L-		
	N=800	N=848		
<i>Socio-demographic variables</i>				
Age ≥80 years	31	15	2.1	1.7-2.5
Gender: female	64	59	1.1	1.0-1.2
Widow/alone	50	44	1.1	1.0-1.3
<i>Falls</i>				
Fall in previous year ≥1	53	35	1.5	1.3-1.6
Near-fall in previous year ≥1	71	31	2.1	1.9-2.3
<i>Health</i>				
Perceived health status:				
moderate or bad	63	20	3.1	2.7-3.5

RR	relative risk	L+	gait disorder present
95% CI	95% confidence interval	L-	gait disorder absent

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causes concern the locomotion system (L codes). The L codes are differentiated according to organ sites (knee, hip, leg, back, foot, and other) and compared to the other ICPC categories. It is noticeable that a relatively high number of respondents report cardiovascular (K codes), neurological (N codes), general (A codes) and respiratory (R codes) causes for their gait disorder. Table 3 presents in ICPC codes the “top ten” of the causes of gait disorders most frequently reported by the 800 respondents. It appears then, that causes of gait disorders are identified far more in terms of complaints than in terms of diagnoses.

Table 2 Mean scores and significance levels of characteristics of elderly persons with and without self-reported gait disorders in numerical variables.

Characteristics		Mean score		Level of significance
		L+ (N=800)	L- (N=848)	
<i>Health</i>				
Number of complaints		6.1	2.6	**
Number of disorders		2.5	1.4	**
Number of medicines		1.3	0.7	**
<i>Functioning</i>				
Somatic Autonomy SIP68		1.1	0.1	**
Mobility Control SIP68		3.7	0.8	**
Psychological Autonomy and Communication SIP68		1.7	0.8	**
Social Behaviour SIP68		4.1	1.9	**
Emotional Behaviour SIP68		0.6	0.2	**
Mobility Range SIP68		2.3	0.4	**
Total SIP68 score SIP68		13.6	4.0	**
ADL/PDL score #		2.7	1.6	**
Quality of life \$		10.5	11.4	*
L+	gait disorder present	*	p<0.05	
L-	gait disorder absent	**	p<0.01	
#	activities and particular activities of daily life: sumscore of 6 items on a 3-point scale: 0 = no help needed; 1 = some help needed; 2 = help necessary.			
\$	quality of life: sumscore of 2 items on a 7- point scale: from 1 = very unhappy/dissatisfied to 7 = very happy/satisfied			

Figure 1. Causes of gait disorders (ICPC codes)

L=Locomotion tract, K=Cardiovascular tract, N=Central nervous system, A=General and not specified, R= Respiratory tract, F=eyes, P=Psychological, H=Ears, S= Skin, T= Endocrine, metabolic and alimentation

Table 3. “Top-ten” of the most frequently reported causes of gait disorders (N=800).

Reported causes	ICPC code #	Number	Percentage
1. Complaints/symptoms of leg	L14	69	8.6
2. Vertigo/dizziness	N17	65	8.1
3. Complaints/symptoms of hip	L13	62	7.8
4. Disorders of peripheral arteries	K92	57	7.1
5. Shortness of breath	R02	53	6.6
6. Complaints/symptoms of knee	L15	52	6.5
7. General deterioration	A04	49	6.1
8. Complaints/symptoms of back	L02	43	5.4
9. Arthrosis deformans of knee	L90	38	4.8
10. Complaints/symptoms of foot	L17	37	4.6

see legend to figure 1 (ICPC codes)

Discussion

This study shows that nearly half of the independently living elderly persons of 70 years or over reported having a gait disorder. Particularly elderly persons who perceived their health status as moderate or bad, who were 80 years of age or over, and who experienced a near-fall (and to a lesser extent a fall) in the previous year, have a greater relative risk of having a gait disorder. In addition, elderly persons with a gait disorder have significantly poorer scores for health indicators, functioning, activities and particular activities of daily life and quality of life.

Gait disorders are not only the result of problems of the locomotion system, but a substantial part of the causes are consequences of complaints and disorders of the cardiovascular, respiratory and central nervous systems, and general deterioration. These are important and underestimated categories of causes of gait disorders: a fact that deserves further consideration in the prevention of gait disorders.

Post-registration of the causes of gait disorders using the ICPC, may raise some objections. Little is known about the use of the ICPC where clarification during a doctor-patient encounter is not possible: interpretation and codification of the responses may reduce the level of information and may be open to bias.

Gait disorders concern many more aspects of daily life than only somatics and coping ability. The use of the other SIP68 scores can identify the strong association that not only somatic aspects but also emotional and social aspects have with gait disorders. Possibly influence flows in both directions. It is of great importance that both in daily care and in the design of preventive programmes attention is paid to elderly persons who already have a gait disorder or who are at risk of developing one (21–24). Moreover, besides the aim to improve the gait pattern and the general condition, it is necessary to take the cardiovascular, respiratory and neurological status into account.

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CHAPTER 11

The general practitioner

Falls in the elderly: the involvement of the general practitioner.

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Abstract

Aim To determine the involvement of the general practitioner (GP) with falls in the elderly living in the community regarding diagnosis, treatment and prevention.

Design Cross-sectional study

Setting General practice

Methods Data from a telephone follow-up study on falls in the elderly, aged 70 years and over, randomly selected from the response-population to a mail questionnaire on falls (N=1660) and stratified on fall history, age and gender (N=303), were compared to data from a questionnaire sent to the GPs of the participating elderly. In this way the extent of reporting of falls to the GP was determined. The management of the GP in elderly who had fallen, regarding diagnosis, treatment and prevention and their estimation of fall risk and risk factors for falls, were determined as well.

Results Eighty percent of falls reported in the follow-up by the participants were not known to the GP. The GPs were informed about only half of the falls with serious consequences. The examination by the GPs was mainly directed at the detection of injury and yielded little information about the cause of the fall. Their management after a fall concerned particularly referring to a physiotherapist, giving extra advice, contacting the family and paying extra attention. Little attention was paid to the use of medication. In 170 out of the 303 elderly persons (56 percent), the GPs assessed an increased fall risk, of which mobility disorders played a main role.

Conclusion GPs are aware of only 20 percent of all falls in the elderly population. Their examination is not cause-directed. In about half of the elderly they found an increased fall risk, particularly due to mobility disorders.

Keywords: falls, elderly, general practice, reporting, patient management, fall risk.

Introduction

Among elderly people aged 65 years or over, 25-40 percent have at least one fall a year. Women have more falls than men and falls increase with age (1-4). The incidence of fractures is about six percent of all falls, with hip fractures one percent (4).

For the general practitioner (GP) it is important that recurrent falls by an elderly person have to be considered as a sign of alarm, because a great number of cases originate in one or more underlying disorders (5). Prevention of falls in the elderly has to be based on the understanding of the incidence of and risk factors for falls (5). In studies on falls in the elderly conducted between 1981 and 1994, and selected in a Medline search, the GP was hardly mentioned, while he is often confronted with this problem (6). Hale et al. reported that the estimation of the mobility of the elderly by the GP is a good predictor of falls; in contrast, the estimation of risk of falls and injury by the GP would not have any predictive value (7,8).

The majority of falls are not reported to the health care: percentages of 80 to 95 percent are mentioned (1,2,9,10). Hale et al. found that less than a fifth of all falls are registered by the GP (10). Part of the explanation for the underreporting to the GP may be that elderly people quickly forget that they have fallen, which results in the so-called "recall bias". Even injuries are poorly recalled (10,11).

The involvement of the GP with falls in the elderly was investigated on the basis of the following study questions:

- To what extent are GPs informed about falls in elderly people aged 70 years or over?
- Which management do GPs undertake in case of a fall by an elderly person, regarding diagnostic, therapeutic and preventive activities?
- What is the risk estimation on falls in the elderly by the GPs?

Methods

A mail questionnaire on the incidence of, risk factors for and consequences of falls in the elderly, was sent to all persons aged 70 years or over, registered in three primary health care centres and one duo group practice (N=2744), connected to the Registration Network Family Practices (RNH) (12). After one written reminder a valid questionnaire was received from 1660 persons (response: 60 percent). Of these 1238 persons gave written consent for

participation in the follow-up study (response: 75 percent), distributed in 56% non-fallers, 26% one-time fallers and 18% recurrent fallers (≥ 2 falls).

Based on fall incidences in the previous year, three groups were randomly formed from this population – each of about 100, in total 311 persons – and stratified on age and gender. The distribution in fall groups and stratification on age and gender was done to obtain a more balanced distribution of numbers of persons in the fall groups, men and women, and persons aged 70–80 years and 80 years and over. Of these 303 persons indicated their willingness to participate in a 36-week telephone follow-up with telephone calls every six weeks concerning incidences, causes and consequences of falls.

During follow-up, the loss due to death, admission into hospital, incapacity and refusal totalled 21, leaving data from 282 elderly persons available for a comparative analysis of the results from follow-up and GP questionnaires.

To the 16 GPs a questionnaire was sent with the request to report for each participant, using the patient record, their awareness of a fall in the follow-up period and if so, which causes they perceived, which injury had possibly occurred, which consequences there were and which management they had made.

In addition, they were asked afterwards to give a risk estimation of the fall risk on a 5-point rating scale, and in case of an increased risk, to mention the risk factors that were of interest according to them.

In this way two sets of data were generated: one from the 282 elderly persons that completed the telephone follow-up and one from the inquiry among the GPs concerning the 303 elderly that started the follow-up study.

For each patient data on the incidences of falls reported by the GP were compared to the falls reported by the participating elderly during the follow-up. In this way the extent of under- and overreporting to the GPs could be determined.

From the results concerning the management by the GPs in case of a fall regular counts were produced. The outcomes were statistically tested by the Chi-square test where necessary. The mean ages of the persons in the groups non-fallers, one-time fallers and recurrent (≥ 2) fallers were compared to each other using one-way ANOVA. The threshold value for significance was determined as p -value < 0.05 .

A “fall” is defined as unintentionally coming down on the floor or to a lower level by whatever cause. “Underreporting” is defined as

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the percentage of elderly persons that reported having experienced a fall in the follow-up, which was not known to the GP. "Overreporting" is defined as the percentage of elderly persons that reported not having fallen during the follow-up, but who had fallen according to the GP.

Results

Ninety-two elderly subjects (33 percent) reported having fallen at least once during follow-up and half of them more than once. There were no significant differences between the mean ages of the fallers and the non-fallers ($p=0.7$ in one-way ANOVA), but the people aged 80 years or over had significantly more falls than those under 80 years ($P<0.001$ in Chi-square test). There were no significant differences in falls between men and women ($p>0.05$, Chi-square test).

Of the 92 elderly subjects that had fallen during follow-up, the GPs were informed about one or more falls concerning 18 persons and not informed about 74 persons (reporting: 20 percent and underreporting: 80 percent). The GPs reported a fall in 8 persons who according to their own statement not had fallen (overreporting: 4 percent).

During the inquiry the GPs reported a fall by 31 persons during follow-up, of whom 13 more than once. Injury occurred in 18 of them (58 percent); in nine of them seriously: six fractures, of which one hip fracture, one luxation of the hip, one traumatic plexus injury of the leg and one distorsion of the cuff of both shoulder joints. Light injuries, such as contusions, abrasions and a wound needing suturing, were recorded in 14 patients. Especially women and persons of 80 years or over suffered injury: 13 out of 18 injured elderly subjects were 80 years or over and 17 of them were female.

Further examination as to the cause of a fall was done more often in the absence of injury than in its presence. According to the GPs, there were noticeable consequences of a fall in five patients, all female: fear of falls in five, a mobility disorder in four, general deterioration and other symptoms in two persons.

Of the 92 elderly persons who had fallen, 43 reported in the telephone follow-up being injured due to a fall, of which 21 reported having been treated for it. In only the half of the 21 who were treated for an injury, did the GPs know about a fall. In four persons with a fracture the GPs did not know that these fractures were caused by falls. And of those, who suffered injury that did not

need to be treated, the GPs were not aware of any single fall. The GPs reported injury in nine patients who did not mention it in the telephone inquiry; five of them were lost to follow-up.

In the 31 persons whose GPs were aware of falls, the GPs reported totally 47 causes, on average 1.5 cause a person. Gait problems and dizziness were reported ten times. Other causes that were mentioned were five times a stroke, four times stumbling, three times getting sick, twice a fall from stairs, and once poor vision, slippery floor, infection with fever, paroxysmal atrium fibrillation and a bike accident. In seven of the 31 cases the cause was not known to the GPs.

Table 1 presents an overview of the physical and additional examination by the GP into the cause of a fall in 31 patients. In 12 patients they did not do any examination. Judgement of the haemodynamic situation, the state of consciousness, the cognitive status and the pattern of gait were most frequently carried out. Much less frequently other tests of mobility, such as the standing and trunk balance, the Romberg test, the senso-motoric

Table 1 Physical and additional examination into causes of the fall in 31 elderly persons. Numbers.

Blood pressure in sitting/lying position	16
Pulse qualities	13
Consciousness	11
Cognitive status	10
Gait pattern	10
Mood	7
Check of medication	6
Standing balance	6
ADL functions	6
Romberg	5
Laboratory tests	5
Home-safety check	4
Senso-motoric qualities of the feet	3
X-ray	3
Trunk balance	2
Inspection of the feet	2
Blood pressure after one minute standing	1
Trendelenburg (one leg stance)	1
Tandem gait	1
Vision	0
No examination into causes	12

Table 2 Patient management in 31 elderly who had fallen, known to the GP. Numbers.

Physiotherapy	12
Concrete advice	11
Contact with family	8
Call in community nurse	7
Extra attention	7
Call in non-professional aid	5
Consult specialist	4
Call in family care	3
Stop medication	2
Information about medication	2
Further examination	2
Home-safety advice	2
Change of management	2
Change of medication	0
No explicit management	10

Table 3 Estimation of risk factors by the GPs in 170 elderly persons with an increased fall risk.

Risk factor	Number	Percentage
Mobility disorder	115*	68
Dizziness	65	38
Bad condition	45*	26
Multi-medication	42	25
Getting unwell	38	22
Depression	30	18
Loneliness	29*	17
Psychopharmaceuticals	27	16
Cognitive disorder	23	14
Poor vision	22*	13
Hazardous dwelling	16	9
Risky behaviour	15	9
Orthostatic hypotension	8	5
Other risk factors	3	2

* Significantly more often than in persons with a low fall risk: $p < 0.05$

examination of the feet, the Trendelenburg sign (one leg stance) and the tandem gait were performed.

In only six of 19 patients did the examination yield important information about the cause of the fall. According to the GPs, in no single case did a check of the medication give additional information about the cause. Generally, the examination was not related to the supposed cause of the fall.

Measures taken by the GPs with reference to a fall are presented in table 2. Here again there was no relationship between the management and the supposed cause of the fall. In 10 percent of the 31 patients who had fallen, the GPs did not give an explicit management.

From the answers on a 5-point rating scale it appeared that in 170 of the 303 participants (56 percent), about whom the GPs had filled in the questionnaire, the GPs subsequently determined the presence of an increased risk of falling. Table 3 presents an overview of the risk factors indicated by the GPs in these 170 elderly subjects. Risk factors which are present significantly more frequently in persons with an apparent increased fall risk according to their GPs, compared to persons with low risk, were loneliness, bad condition, mobility disorder and poor vision ($p < 0.05$ in the Chi-square test). Extrinsic risk factors, such as a hazardous dwelling and risky behaviour, played a minor role according to the GPs.

In the judgement of the GPs, 66 of the 92 subjects who had fallen during follow-up had an increased fall risk. Of the 190 persons, who had not fallen during follow-up, the GPs did not find an increased fall risk in 99, but did indeed find so in 91 individuals.

Discussion

The GPs were informed about approximately 20 percent of the elderly who had reported a fall during the 36-week follow-up. This percentage is in accordance to earlier studies (1,9,10). Conversely, four percent of the elderly did report a fall to the GP, but not in the telephone follow-up. Presumably, this is a consequence of recall bias and loss to follow-up (10,11). Only falls in which complaints that may or may not be consequences of injury occurred were reported to the GPs. Apparently, that is the only reason for the elderly to consult their GP in the event of a fall.

According to the GPs, fall-related injuries occur mainly in women over 80 years, which may also be determined by stratification. In case of injuries due to a fall, the GPs performed less examination into the possible cause of the fall than when no injury had

occurred. This suggests, that GPs primarily direct their attention to the injury. It was remarkable, that the GPs were not aware of a fall in four elderly subjects with fractures due to falls.

According to the GPs, the causes of falls are mostly gait problems, dizziness, stumbling, or becoming unwell. Their examination into the cause of a fall was generally not goal-directed and also yielded little additional information. It was salient, that examination into the mobility disorders was mainly focused on the gait pattern and much less on balance, while balance too, is considered as an important risk factor for falls (13).

In elderly subjects with an increased fall risk, mobility disorders were reported by the GPs, indeed as the most important risk factor for falls, which is in accordance with the opinion of many authors (3,4,6,7,13-16). Measures subsequent to a fall were not always taken and the nature of the measures taken was not determined by the cause of the fall. Medication was little checked, although use of medication is among the main risk factors for falls (3,4,6). In persons with an evidently increased fall risk, the GPs considered especially the risk factors loneliness, bad condition, mobility disorder and poor vision as responsible.

The results of this study were obtained from two data collections: data from the GP inquiries concerning 303 elderly persons, who started the follow-up study, and data from 282 elderly that completed follow-up. Among the 21 persons that were lost during follow-up, there were five elderly subjects, which had according to the GPs one or more falls. These have been included into the regular counts of the outcomes, but have been excluded in the comparison of the outcomes of the two data collections to determine the extent of reporting.

The study population is formed by random samples from the population responding to a mail questionnaire stratified on age and gender. As a consequence only significant differences in incidence of falls were found in the elderly of 80 years and over were found, but no significant differences in sex and age, as mentioned in several other studies, were observed (1-4).

The four participating practices are characterized by their organization in primary health care teams and connection to the Registration Network Family Practices: this makes them distinctive from the "average" general practice. However, they do not differ from other Dutch practices regarding the percentage of registered elderly individuals of 70 years or over. In addition, there are no reasons to suppose that the GPs differentiate themselves in their management from that which is customary in general practice in

regard to falls in the elderly. It may be assumed that the quality of the registration by the participating GPs is at a sufficient level, because of their participation in the Registration Network Family Practices are subject to procedures of quality assurance (12).

The GPs filled in the questionnaires after the follow-up study, which of course may have influenced their estimation of the fall risk. However, its direction is not clear. Therefore, the answer to the third study question is explorative in nature.

Regarding falls in the elderly, the GP is dealing with an "iceberg" phenomenon: he is confronted with only approximately 20 percent of all falls in the elderly and almost exclusively when there are complaints or injury as consequences of, or in reference to, a fall. He focuses primarily on the diagnosis and treatment of complaints and injury and scarcely on the background of the causes of the fall. The GP's task is mainly in the area of secondary prevention: the conscientious and timely tracing of the underlying causes of and risk factors for falls in the elderly and subsequently trying to eliminate these causes.

From recent intervention studies it is known that improvement of the mobility and muscle strength may lead to a decrease of the number of falls (17-19). Other measures belonging to the area of the secondary prevention are reduction of injury due to a fall, such as teaching patients how to get up and the application of absorbing floor surfaces and hip protectors. However, little is known about the effects of these measures in community-dwelling elderly.

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CHAPTER 12

General discussion

Introduction

This chapter presents and comments on the main results of this study on falls in community-dwelling elderly with respect to the four aims: 1. the occurrence and incidence; 2. the determinants and risk factors; 3. the health consequences and 4. the relation to general practice. The methodological strengths and limitations are discussed. Subsequently, the implications for general practice and proposals for preventive activities, are presented. And finally, suggestions for further research and training conclude this chapter.

Main results

1. Occurrence and incidence of falls and fall-related injuries

In the literature review (Chapter 4) preference based on criteria for methodological quality, was given to four prospective studies, which enabled us to make an overall picture of incidence of falls and injuries (1-4). Yearly incidences of "ever falls" from these four range from 32 to 57 percent, depending on population characteristics and selection procedures (5,6). Yearly incidences of recurrent falls, however, are provided only in half of the 14 studies included and range from 13 to 42 percent (1-4,9,11,12). Similarly, not all studies provided incidences of injuries. In the 14 studies selected major injury ranged from 0.5 to 8.9 percent and minor injuries from 37 to 56 percent of all falls (1-4,12-14)

Chapters 6, 7 and 8 contain outcomes on incidence of falls and injuries from the community surveys and the prospective cohort study. Table 1 presents a comparison of incidences of falls from the review with those from our own studies. Comparison of data from the two community surveys with the same design and methodology results in lower incidences in survey 1, due to inclusion of participants from 55 years of age or older.

Data from the prospective study (Chapter 8) were obtained from a 36-week follow-up period. Conversion to a yearly incidence by a factor of 1.4 results in higher rates for falls and recurrent falls but lower for injuries, compared to incidences from the two community surveys. However, in the review of 14 selected studies surprisingly there were no evident differences in yearly incidences between retrospective and prospective studies, which illustrates the relativity of the weight of recall bias in retrospective studies (7,8). Comparison of injury rates from the four preferred studies yields relevant differences of minor and major injuries. The incidence of major injuries from Tinetti's study are higher due to a higher age

Table 1 Incidence of ever falls (≥ 1 fall), recurrent falls (≥ 2 falls) and injuries due to falls from 4 preferred studies selected from a criteria-based analysis (1997) and from own studies (percentages)

Selected studies	I ≥ 1 *	I ≥ 2 *	Minor* injury	Major* injury	Fractures*	Hip fractures*
Tinetti et al.(1) (≥ 75 years; N=336)	32	17	np	12.5	6.3	1.5
Nevitt et al.(2) (≥ 60 years; N=325)	57	31	56	4.5	3.1	0.2
Campbell et al.(3) (≥ 70 years; N=761)	35	16	37m* 41w*	4.1m* 12.5w*	2 4	1.1 1.5
O'Loughlin et al. (4) (≥ 65 years; N=409)	29m 34w	12m 14w	43	4.5	2.5	1.5
Stalenhoef et al.						
Survey 1 (≥ 55 years; N=405)	25	13	38	5.8	2.6	np
Survey 2 (≥ 70 years; N=1660)	44	19	20	4.7	2.7	0.6
Prospective study** (≥ 70 years; N=287)	46	22	35	5.7	2.8	1.4
<hr/>						
* I ≥ 1	yearly incidence of 1 or more falls					
I ≥ 2	yearly incidence of 2 falls or more					
Minor injury	percentage of falls with minor injury					
Major injury	percentage of falls with major injury					
Fractures	percentage of falls with a fracture other than hip fracture					
Hip fractures	percentage of falls with hip fracture					
m	men					
w	women					
**	converted to yearly incidences by factor 1.4					
np	not provided					

category of the population (75 years or over) (1).

2. Determinants and risk factors

In table 2 the significance of the twelve main determinants and risk factors identified in the four preferred studies from the literature review is compared with the studies presented here. Not all data from our own studies are comparable, because study methods are different: in the community surveys there are no performance tests

Table 2 Significant risk factors for ever falls (≥ 1 fall) and recurrent falls (≥ 2 falls) from 4 preferred studies selected in a criteria-based analysis (1997) and from own studies

Selected studies	1	2	3	4	5	6	7	8	9	10	11	12
Tinetti et al. (1)	-	-	-	+	-	-	-	-	-	+	+	+
Nevitt et al. (2)	-	+	-	-	-	-	+	-	-	+	+	-
Campbell/w (3)	-	-	-	+	-	+	-	+	+	-	+	-
O'Loughlin et al. (4)	-	-	+	-	-	+	-	-	-	-	+	-
Stalenhoef et al.												
Survey 1	+	*	+	-	-	*	-	*	*	np	+	-
Survey 2	-	*	+	-	+	*	+	*	*	np	+	-
Prospective study	-	+	+	-	-	np	-	+	+	np	+	-
+	significant		1 socio-demographic variables									
-	not significant		2 history of previous falls									
/w	women only for 3 and 6		3 fall-related physical complaints									
*	not applicable		4 use of sedatives/hypnotics									
np	not provided		5 use of anti-depressants									
			6 orthostatic low blood pressure									
			7 chronic neurological disease									
			8 increased body sway									
			9 decreased strength dominant hand									
			10 number of risk factors									
			11 mobility disorders									
			12 cognitive impairment									

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used and previous falls belong to the outcome, and not to the independent variables, unlike the prospective study. Mobility disorders belong to the most constant risk factors for falls, both in the review and in our own studies (1-4,9-17). The use of sedatives and hypnotics are considered important risk factors by two authors only; moreover they do not play a relevant role in our study (1,3). It is noticeable in our prospective study, that age and gender do not play a significant role as independent determinants of falls, in contrast to what is found in other studies (7,15-17). This may be due to suppression by other stronger variables with an age and gender dependence.

Survey 2 and the prospective cohort study both yielded risk models, consisting of variables showing significance in logistic analyses. However, the risk models are not comparable, but can be considered as complementary. To determine which risk model is

preferable and whether they are interchangeable, equivalent or complementary, further research is demanded. The risk model derived from the community survey, a logistic model with two variants, consists of data from the regular medical history and the patient's record, which can be supplemented by data from the MC SIP68. The logistic risk models from the prospective study comprise, in addition to age, gender and fall history, variables derived from the performance tests. The complementarity of both types of models lies in the variables, related to mobility impairment, which show strong associations with ever falls and recurrent falls. The sex differences of many risk factors may be accounted for by the important differences in muscle strength between men and women. This hypothesis, however, needs further investigation: the determination if and to what extent sex-related decrease of muscle strength, measured by hand dynamometry, is a causing factor among risk factors related to mobility, particularly balance and gait (18).

In a supplementary study of survey 2 the prevalence and significance of gait disorders in relation to falls were investigated (Chapter 10). About 49 percent of the respondents (N=1648) reported to have a gait problem. The main determinants of gait disorders appeared to be age of 80 years or over, multiple falls or near-falls in the previous year, a moderate to bad perceived health status and low scores on physical health parameters, daily functioning and quality of life. Apart from the locomotion system a noticeable proportion of the reported causes of gait disorders relate to the respiratory and the cardiovascular systems, the central nervous system and general impairment.

3. Health consequences other than direct injuries

Health consequences of falls other than direct injuries concern fall-related mortality, included indirect mortality, the impact of falls on functioning and mobility, and psychosocial consequences. Not all selected studies in the literature review provided data on these health consequences. The studies which did, had a prospective design and labelled functioning as a risk factor and not as a consequence of falls (1,3,4,19). Only Nevitt et al. mentioned "activity limitation due to fall" as a consequence (2). Generally, due to the absence of a time sequence it is difficult to trace from retrospective studies whether falls directly cause a decline of functioning or only serve as a marker for them (21). Associations found are rather explained by plausibility than by evidence.

In the literature review mortality rates are given in only four

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prospective out of 14 studies selected and vary from 2 to 25 percent during one-year follow-up, depending on methodology and population (1,2,4,19). However, fall-related mortality was not investigated in our studies.

In community survey 1 (Chapter 6) the impact of gait problems and falls on functioning was one of the study objectives. The outcome was that falls, contrary to gait problems and mental indicators, only have a minor impact on functioning, measured by mobility range and social activities. Falls are apparently to be regarded as "a final stage", having no specific influence on functioning. Due to the retrospective design this conclusion is indicative and based on clinical plausibility.

In the mail questionnaire in community survey 2 (Chapter 7) fear of falling is reported by 48 percent of the respondents. Again due to the retrospective design, no conclusion can be drawn whether it concerns cause or effect of falls. Probably it is a matter of circularity of causes and consequences.

4. Relation to general practice

In the reviewed studies (Chapter 4) the task and role of the GP, with regard to falls in the elderly, is not even mentioned (22). As part of the prospective cohort study we investigated the involvement of the 16 GPs of the participants of the follow-up study (Chapter 11). Overall, 20 percent of all, mainly injurious, falls are reported to the GP, which is congruent with data from literature (23-25).

In their management, GPs primarily direct their attention to the detection and treatment of injury, and much less to fall-related risk factors and background variables. It seems that many GPs are used to a diagnostic approach, in which an evidence base is missing. Mostly, risk factors are not systematically assessed and even if they are, the assessment is quite incomplete. The physical examination in relation to falls often did not appear to be targeted on the cause of the fall and generally yielded little information. If further physical examination was done, it was directed mainly to gait problems and far less to balance disturbances. Blood pressure is usually measured, but seldom in upright position in order to detect orthostatic low blood pressure. Measures, taken as a consequence of a fall, mainly concern referral to other professional or non-professional care providers, and only in a minority of them concern the assessment and change of risk factors.

In summary, the management of the patient with a fall by the GP is fragmentary and not very rational, and does not seem to be based

on knowledge of incidence and risk factors, a primary condition for a preventive approach.

Methodological aspects

Methodologically, the study for this thesis consists of three categories:

1. A criteria-based analysis of the literature (Chapter 4);
2. Retrospective studies: two community surveys (Chapters 6 and 7), a cross-sectional study on gait problems (Chapter 10) and a cross-sectional study among GPs (Chapter 11);
3. Prospective studies: a cohort study (Chapter 8) and an evaluation of a checklist on indoor fall risk (Chapters 9).

In this section methodological strengths and limitations of design and methods will be discussed.

Strengths

- The research questions were investigated by various study methods: a criteria-based literature review, retrospective and a prospective studies, which provide possibilities to compare data (Chapter 5).
- The literature review (Chapter 4) was based on two sets of criteria: three criteria for inclusion and ten criteria for quality (26). This offered the advantage of comparing data from the studies included among themselves and with our own studies in an accurate and systematic way (27). In addition, it yielded a rather complete picture of the many aspects of falls in community-living elderly, which was then used as a guide for the design of the baseline assessment of our follow-up study.
- The study has been conducted in two different populations at risk: a sample from a population of 655 persons of 55 years or over from one general practice (population A; survey 1: Chapter 6) and a population of all 2744 persons of 70 years or over registered in four general practices (population B; survey 2: Chapter 7 and the prospective study: Chapter 8). The similar design and methods in community survey 1 and 2, provided opportunities to compare data and draw conclusions. (See figure 1, Chapter 5)
- The participating general practices are connected to the Registration Network Family Practices. The advantages are adequate age and gender registers, uniform way of registration and submission to a quality assurance system (28).
- Mail surveys offer the advantages to reach many persons and to get answers on many questions in a short time against relatively low

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costs (Chapters 6,7,10 and 11).

- The participants were recruited from population-based registers, which means well-defined population denominators in analyses. In addition, data from the investigation of the GPs' involvement with falls in the elderly, regarding diagnosis, treatment and prevention, could be linked to data from the retrospective and prospective studies (Chapter 11).

- The follow-up study among a stratified sample out of the respondents of the mail survey offers some advantages. Outcomes of the mail survey, such as data on falls in the previous year, could be used as independent variables in the follow-up study and data from both studies could be compared or linked, which provides insight into the consistency of data. Analysis of data from the mail survey and the follow-up study yielded two complementary logistic risk models for the prediction of falls, one model consisting of variables from medical history and one mainly from performance tests. (Chapters 7 and 8).

- Loss to follow-up in the prospective study was limited: data from 287 out of the 311 persons participating initially (92 percent) were available for analysis (Chapter 8).

Limitations

- The non-response in the surveys 1 and 2 is 38 and 40 percent, respectively, with higher responses in the younger age categories. Because of an age dependence of falls and a number of risk factors, observed outcomes are lower than expected. Reasons for non-response were not investigated, in consideration of privacy (Chapters 6 and 7).

- Because of the absence of validated and evidence-based protocols, feasible for general practice, we had to use a non-validated baseline assessment protocol on fall risk, developed in a consensus procedure (Chapter 8).

- The consensus procedure was carried out strictly according to the principles and rules for nominal group process consensus procedures (29). Based on the majority of votes, the decision was taken to measure blood pressures only in sitting and lying positions, and not, as usual and as recommended in literature to detect orthostatic hypotension, in upright position. As a consequence of this decision, no data of orthostatic blood pressure as risk factors for falls were available (Chapter 8).

- The duration of the follow-up period was 36 weeks, shorter than one year, which is usual in comparable studies. A longer exposure period was not possible for reasons of budget. In addition, calculated guess of the 36 weeks follow-up time did not reveal any

disadvantages, except for a limited number of reported falls in the follow-up period. Therefore in the analysis a differentiation of frequency of falls in the recurrent fall group was not possible (Chapter 8).

- The inter-observer test of the checklist on indoor fall risk was conducted on a small scale, i.e. in only ten random cases among two observers, resulting in a Cohen's kappa with a moderate outcome: 0.66 (Chapter 9).

- Although the evaluation of the home-safety checklist as an instrument for screening has appeared to be negative, it might be useful if intrinsic risk factors are also taken into account simultaneously. However, we were not able to evaluate the value of this checklist in relation to intrinsic risk factors on an individual level. This would need a more extensive and detailed study (Chapter 9).

- The checklist on indoor falls was only applied in the own dwelling. No conclusions can be drawn about its value in other indoor environments (Chapter 9).

- The GPs filled in the questionnaires after the follow-up study. This might have been influenced their estimation of the fall risk of the participating persons, although the direction of this influence is not clear (Chapter 11).

Implications for general practice

Falls in the elderly are multifactorial events and this makes it difficult to assess risk factors separately and to choose elements for prevention. From an increasing number of randomized trials that have shown evidence for the effectiveness of interventions to prevent falls and subsequent injury in older people, there is a strong conviction that prevention is beneficial (30). But, still, full agreement is lacking about the identification of optimal prevention strategies (31). In general practice, prevention has to be done by the GP in a primary care team, mainly on a secondary and tertiary level (32). This means a constant awareness of and alertness for potential fall risk and risk factors for falls by the GP, an attitude to assess determinants and risk factors with a view to prevention and preparedness to cooperate with other primary health care providers to develop and evaluate preventive activities. The Dutch health care system offers the GP the conditions for health promotion and anticipatory care through regular consultation and continuous care. The GPs' knowledge of patients' medical history, lifestyle, risk profile, health perceptions and personal circumstances gives them

opportunities to integrate aspects of health promotion and prevention into their daily care (33).

Our studies offer detailed insight into the incidence of falls and injuries and provide tools for the assessment of risk factors. Without great efforts, each GP is able and has the capacity to assess these risk factors. The medical registers provide data, which are sufficient for a first identification of most elderly persons at risk. In a subsequent step, it seems feasible to add other variables, such as results of performance tests on balance and gait, to obtain more detailed information. Clinical evaluation of this approach is recommendable.

Preventive home visits seem to be useful in improving the health status of community-dwelling elderly people only if restricted to the elderly with a poor health status (34). Home visits to assess risk factors for indoor falls using a checklist should be done only in relation to the assessment of intrinsic risk factors for falls and not be used as a separate general method for screening (chapter 9). However, in combination with an assessment of intrinsic risk factors it might be beneficial for the individual, because information about the presence and the location of potential risk factors in the dwelling can be integrated into a personal prevention programme.

An approach for assessment and classification of fall risk, based on outcomes of our studies, could be done on five successive levels:

Level 1: Identification

The first identification of community-dwelling elderly at risk for falling by use of a risk model based on medical history and/or patient's record.

Level 2: Confirmation

After a first identification of the elderly at risk, the identification can be confirmed using a risk model based on performance tests.

Level 3: Classification

The elderly person at risk and assessed by the two risk models, and thus having one or more risk factors for falls, can be classified into a four-axis classification model:

Axis I Physical condition

Axis II Mental condition

Axis III Functioning and mobility

Axis IV Environmental hazards in the dwelling

Ideally, each axis can be scored on a quantitative rating scale, resulting in a fall risk profile.

Level 4: Codification

In a fourth step the elderly person at risk for falling and classified in the four-axis system should be codified according to the ICPC system (35). This means that the problem criteria correspond to the criteria used in the problem-oriented approach of the ICPC (36). However, at present a specific code for falling is missing. For the time being, the L 28 code, indicating "disability and mobility impairment" can be used, until international consensus is reached on more detailed proposals.

Level 5: Determination of preventive activities

The last step is to determine which preventive activities are needed in a particular person or particular group of persons based on the classified risk factors.

One of the essentials of our study is the finding that falls are markers for frailty and impairment and therefore deserve special attention from the GP. One-time fallers have a different risk profile from recurrent fallers. Every first fall should be considered as potentially the first fall in a series, until accurate assessment by medical history and physical examination reveals that no important risk factors for falls are present. The recurrent fallers, however, represent a separate category and require for a different approach. They have to be considered as belonging to a potentially high risk group, and need to be special subjects for anticipatory and preventive care.

Evidence-based preventive strategies should be developed and evaluated, based on a number of criteria. The first criterion is the identification and scoring of a person into a classification model, which provides a characteristic of a person at risk. The second criterion is the estimation of the presence of preventable risk factors. If no preventable risk factors are present, no preventive activities should be conducted. The third criterion are the results and validity of preventive activities in general practice. And finally, the fourth criterion is the feasibility of preventive activities in general practice.

Further research and training

Four general recommendations for further research can be made. Firstly, evaluation studies on the application of prediction models in general practice are recommended. In this regard, sex-differences of several variables, particularly mobility tests, need further exploration.

Secondly, the coherence of the risk models from medical history

and from assessment procedures needs a closer prospective evaluation: are the models to be used separately or only complementarily? And if separately: which model is preferable?

Thirdly, the identification of the elderly at risk for falling by use of risk models may be beneficial for the individual patient with regard to secondary and tertiary prevention, if integrated in every day care. However, regarding the development of preventive programmes in primary care, it seems rational to reach consensus first on the benefits of fall preventive activities. In addition, an analysis of costs against returns of fall prevention programmes in primary care is needed. If, subsequently, agreement about the benefits of fall prevention in primary care is reached, a further question has to be answered concerning "the prevention paradox" (37): are preventive activities to be addressed only to elderly people at risk for falling (secondary and tertiary prevention), or, taking the high incidence of falls into account, to all elderly people (primary prevention)?

Finally, intervention studies in general practice have to provide answers on questions of feasibility and validity of preventive activities in general practice. Criteria for fall risk have to be developed. Cut-off points and validity of a fall risk assessment protocol have to be determined in follow-up studies. Outcome criteria for fall prevention in general practice have to be developed. Because of the importance of the problem and the impact of falls on daily living, falls in the elderly deserve attention in the undergraduate and postgraduate curriculum, as well in the continuous medical education of the GP. A first step is awareness and alertness concerning this phenomenon: falls may be a signal of disease, impairment or deterioration. A second step is the actual training of assessment procedures to be integrated into the physical and mental examination of all elderly persons at risk. And finally, the implementation of a preventive approach in primary care entails the teaching of knowledge and understanding of the incidence, determinants and health consequences of falls in community-dwelling elderly.

Our findings, based on data from community-dwelling elderly people, contribute to the development of criteria for an evidence-based identification of the community-dwelling elderly at risk for falling, both for daily care and for prevention.

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SUMMARY

Summary

This thesis deals with falls in the community-dwelling elderly from the point of view of the general practitioner (GP). Falls in the elderly are one of the major health problems in health care. They are characterized by a high incidence, multiple contributing risk factors and important post-fall morbidity and, mainly indirectly, mortality.

The GP faces this problem very often, in different circumstances and conditions. A fall, particularly a first fall, has to be considered as a potential signal of a disease, inability or the beginning of deterioration. Therefore, every fall requires an accurate evaluation of its cause and contributing risk factors. Considering the high incidence of fall-related injuries, particularly hip fractures, both secondary and tertiary prevention in primary health care need to be developed. Another important aspect for the GP concerns the management of the patient with a fall, regarding diagnostic, therapeutic and preventive measures.

Chapter 1 is a general introduction to this primary care-based study. It gives our definition of a fall, a description of fall mechanisms, the aims and related study questions, and the structure of the thesis. The main objectives of this study consist of four areas. Each area is covered by one or more study questions.

Aim I. Occurrence and incidence

- Question 1: What is the incidence of falls?

Aim II. Determinants and risk factors

- Question 2: What are the determinants of and risk factors for falls?
- Question 3: What is the relationship between intrinsic (person-related), extrinsic (environment-related) and activity-related risk factors for falls?
- Question 4: What are the characteristics of elderly people with one-time, recurrent and no falls?

Aim III. Health consequences

- Question 5: What are the health consequences and the impact on daily functioning?

Aim IV. Relation to general practice

Question 6: What is the involvement of the general practitioner with falls and fallers?

- Question 7: What are the elements of a fall risk assessment in general practice?
- Question 8: Which recommendations can be made to the general practitioner regarding fall risk assessment and prevention?

Chapter 2 introduces the subject with three cases from general practice. The cases are examples of various and real situations in general practice: a first fall due to mainly somatic causes, the recurrent faller with multiple patient-related risk factors and the elderly patient at risk for falls and near-falls living in a dwelling with many environmental risk factors. The theme running through this chapter is the awareness that falls, particularly recurrent falls, have to be considered as potential markers of disease, disability or beginning deterioration, or, in case of a first fall, as the potential start of a series of falls to come. An accurate assessment of causes and risk factors may be needed. Understanding the incidence and risk factors may contribute to a systematic approach. In the considerations of possibilities of prevention, the pros and cons of preventive measures have to be evaluated.

Chapter 3 gives the results of a preliminary study on health status and functioning of the elderly, living in the community and particularly the contribution of home visits by the community nurse to the GP's information about his elderly patients.

In a cross-sectional design a random sample of 50 elderly persons of 70 years and over was taken from the 70+ population of a primary health care centre. The GP's information with and without the contribution of the home visit by a community nurse was studied. About 34 percent of complaints and disabilities were not known to the GP. Particularly, it concerned depressive feelings, urinary incontinence, mobility impairments and sleep disturbances. Gait disorders were reported by approximately 40 percent and falls by 20 percent of the participants. The main determinants of functional decline were gait disorders and depressive feelings.

Chapter 4 presents a systematic review of the fall-related literature on incidence of, risk factors for and health consequences of falls in community-dwelling elderly people. A Medline search was carried out using relevant key words. This yielded 274 references, which were submitted to three inclusion criteria regarding originality of the studies, aims and target populations. Fourteen studies were selected and submitted to a methodological evaluation on the basis of ten criteria for quality. Four studies met all, or nearly all methodological criteria and were given preference in the interpretation and description of the results. Approximately 30 percent of all community-dwelling elderly persons of 65 years and over have at least one, and 15 percent two or more falls a year. The main risk factors, which were labelled as significant by the authors

Summary

themselves, belong exclusively to the intrinsic (person-related) risk factors: cognitive impairment, balance and gait disorders, use of sedatives and hypnotics, a history of stroke, advanced age, arthritis of the knee and a high level of dependence. Extrinsic (environment-related) risk factors did not play a significant role as independent risk factors in any of the 14 selected studies. Not all of the selected studies provided data on health consequences. Major injury was reported in half of one percent to nine percent and fractures in three to 14 percent of all falls.

Chapter 5 discusses the design and methods of the surveys. The community surveys are carried out in two different primary care populations A and B. Community survey 1 on gait problems and falls was performed among a random sample of 730 persons aged 55 years or over, registered in a primary health care centre. Community survey 2 on incidence of, risk factors for and consequences of falls, covers a cross-sectional study among all 2744 elderly persons, aged 70 years or over, on the list of three primary health care centres and one duo practice, and submitted to an exclusion procedure by their own GPs. Of the 1660 respondents to this survey, 1238 gave written consent for participation in a follow-up study. Out of them a random sample of 311 elderly persons stratified on age, gender and fall history was taken for a baseline assessment on fall risk and a subsequent follow-up study, with telephone calls every six weeks. (See figure 1, Chapter 5)

The mail questionnaires in both surveys were similar. They consist of questions on fall-related items of incidence, determinants and health consequences of falls. The baseline assessment protocol of the follow-up study was constructed on the basis of the results of a nominal group consensus procedure on fall risk and risk factors for falls and carried out in standard conditions by three trained physicians. The subsequent 36-week telephone follow-up with six-weekly telephone calls was also standardized and performed by trained interviewers.

A home-safety checklist on indoor fall risk was constructed by a Delphi consensus group, consisting of five occupational therapists, a social insurance expert and a district community nurse, resulting in a five-minute home-safety check on indoor fall risk factors, as a part of the baseline assessment.

The 16 GPs received about each participant a mail questionnaire about their involvement with falls and dealing with falls reported to them, their diagnostic and therapeutic management and their estimation of fall risk and risk factors.

Chapter 6 presents the description of the results of community survey 1, conducted among a random sample of 730 persons of 55 years and over. It deals with the impact of gait problems and falls on functioning. As outcome variables for functioning the mobility range and social activities were used. It turned out that there was a significant association between falling and age, and even more between gait problems and age. The main risk factors for falls were female gender, a poor physical health status and gait problems. Falls have some negative influence on functioning, but mental health indicators and gait problems appeared to have much more impact on functioning.

In *chapter 7* the results of a cross-sectional study are presented. Using a mail questionnaire sent to all 2744 elderly persons aged 70 years or over, registered in three primary health care centres and one duo general practice, the incidence of, risk factors for, and health consequences of falls among community-dwelling elderly were investigated. Incidence and injury rates are in accordance to data from literature: 25 percent of the respondents had at least one fall and 19 percent two falls or more in the previous year. Fractures were reported by eight percent of the fallers: hip fractures by about one percent and other fractures by nearly seven percent. Bivariate analysis yielded many risk factors that showed a significant association with ever falling and recurrent falls. However, logistic regression revealed a limited number of independent and significant risk factors for falls and recurrent falls due to the dependence of risk factors on each other. The strongest risk factors for recurrent falls were: female gender, age 80 years or over, the presence of a chronic neurological disorder, the use of anti-depressants, problems of balance (dizziness), and sense organs (impaired vision or hearing) and complaints of muscles and joints. These risk factors are components of a logistic risk model. The addition of an indicator of mobility impairment to the risk model, a score of ≥ 3 on the Mobility Control (MC) from the Sickness Impact Profile, short version (SIP68), did not yield an essential improvement of the performance of the risk model: the values for the Area Under the Receiver Operator Characteristic (ROC) Curve, the AUC, indicating the predictive power of the model, were 0.73 and 0.75, respectively. The statistically optimal cut-off value was found at 0.26. At this cut-off value the sensitivity was 64 percent and the specificity 71 percent and the positive and negative predictive value (PV+ and PV-) 42 and 86 percent, respectively. Also these values yielded only slightly better performances with the addition of the

MC SIP68.

For the GP the main conclusion from this study is that the contributing significant risk factors to a risk model for the prediction of recurrent falls are easily and directly derivable from the patient records. In this way it is possible to identify the elderly at risk for falling at an initial stage, with satisfactorily diagnostic and predictive values.

Chapter 8 deals with the results of a prospective study on predictors of falls, with emphasis on performance tests. From the respondents to the mail questionnaire in community survey 2, who gave written consent for further participation, a random sample of 311 persons was taken after stratification on fall history, age and gender. They were visited at home for a one hour standardized baseline assessment on fall risk, performed by three trained physicians. The baseline consisted of an interview, tests on physical health and mobility, and a check on indoor fall risk using a checklist. Because of the absence of a validated and for general practice feasible fall risk assessment, the baseline assessment was developed in two consensus panels: a nominal group procedure for the assessment on health and mobility and a Delphi procedure for the home-safety checklist. Subsequently to the home visit, a 36-week follow-up study with telephone calls every six weeks was conducted to obtain outcome data for falls and fall-related conditions.

Altogether 197 falls were reported by 95 of the 287 participants (33 percent), who completed follow-up. One fall was reported by 49 (17 percent) and two or more falls by 46 (16 percent) persons. Out of the fallers 43 (45 percent) suffered injury: hip fractures by two and other fractures by four persons. Bivariate analysis yielded a number of fall-related risk factors that showed a significant association with ever falling, one-time falls and recurrent falls. Logistic regression resulted in two logistic models for the prediction of ever falls (Model 1) and for the prediction of recurrent falls (Model 2). The main determinants of ever falls were a history of two or more falls in the previous year, decreased somatic autonomy, measured by the SIP68 and reduced strength of feet. For recurrent falls the strongest independent determinants were a history of two or more falls in the previous year, a depressive state of mind, measured by the depression subscale of the Symptom Checklist (SCL90), poor scores for hand grip strength, measured by hand dynamometry and an abnormal postural sway.

The models had a good fit on the goodness-of-fit test according to Hosmer Lemeshow. The ROC analysis of the models gave a

statistically optimal cut-off value of both models at 0.30 with a sensitivity of 67 and 59 percent and a specificity of 63 and 87 percent, respectively. The positive predictive values (PV+) were 47 and 52 percent; the negative predictive values (PV-) 79 and 90 percent, respectively. The predictive power is expressed in the value for the AUC, resulting in a moderate value of 0.69 for Model 1 and a reasonable value of 0.79 for Model 2. These fall predictive models are feasible in general practice and can be applied separately or complementarily, as a confirmation of the risk model obtained from the patients' medical record, as described in Chapter 7.

Chapter 9 presents the results of the assessment of indoor fall risk by use of a home-safety checklist on indoor fall risk. The checklist was developed in a Delphi consensus procedure with a panel, consisting of five occupational therapists, a social insurance expert and a district community nurse. The checklist consists of 116 cells if stairs are present and of 96 cells if not. The checklist has six categories of potential risk on the Y axis: floors, lighting, walking space, stairs, obstacles and a category various risk factors. On the X-axis the locations of the dwelling are placed: entrance, stairway, kitchen, bathroom, toilet, bedroom, living room and cellar and loft. During the home visit for baseline assessment on potential risk factors for falls the dwellings of all 311 participants were inspected, assessed and recorded on the checklist. Potential risk factors for indoor falls belong equally to structural (immobile) and to non-structural (mobile) risk factors. The locations of the dwelling, in which most potential risk factors are situated are the stairway, the bedroom and the bathroom, but these scores do not correspond to locations in which falls actually occur. Bivariate analysis did not reveal a significant association of high checklist scores and fall risk, except for falls in the entrance.

The conclusion of this study is that a checklist may be useful to identify potential risk factors for indoor falls by type and by location, but does not have any predictive value for actual indoor falls, falls in the entrance excluded. Light-dark adaptation and other adaptive mechanisms might be the explanation for the exception of the entrance.

Chapter 10 deals with the results of an analysis of two questions of the mail questionnaire in survey 2, concerning self-perceived gait disorders and causes. Approximately half of the elderly aged 70 years or over report having a gait disorder. The main characteristics of them are age 80 years or over, more than one near-falls and falls

Summary

in the previous year and a moderate to bad perceived health status. In addition, compared to those without a gait disorder they had lower scores for health variables, functioning and quality of life. Perceived causes lie, in addition to the locomotive tract, in the cardiovascular and respiratory tract, the central nervous system and general deterioration, possibly underestimated causes of gait disorders.

In *chapter 11* the results of the investigation of the involvement of the GP in falls by the elderly are described. Data from the telephone follow-up were compared to data from a questionnaire about each participant of the follow-up study, sent to the 16 GPs. Eighty percent of all falls reported by the participating elderly during the follow-up were not known to the GP. Only about half of all falls with major injury were known to the GPs. The examination of the elderly after a fall was mainly directed to identify injury and yielded little information about the cause of a fall. The management by the GP after a fall concerned mainly referral to a physiotherapist, giving advice, contact with members of the family and offering extra surveillance. Little attention was paid to the use of medication. In 170 of the 303 participating elderly (56 percent), the GPs estimated an increased fall risk, in which mobility disorders played the main role.

In *chapter 12* the main results of the study are presented according to the the aims and study questions. The methodological strengths and limitations are discussed and implications for general practice are formulated. In addition, recommendations for research and training are given.

This study yielded an overview from literature and from empirical investigations of incidence of, risk factors for and health consequences of falls in the community-living elderly. The importance of falls as markers for disease, disability and frailty is emphasized. Another outcome is that the GP is able to predict falls using risk models consisting of variables directly derivable from patients' medical records or easy to assess from tests. These prediction models are of interest in the development of preventive strategies in primary care. A stepwise approach to assess and classify fall risk is introduced, but its validation and feasibility in general practice has to be evaluated by future research.

SAMENVATTING

Samenvatting

In dit proefschrift wordt het vallen van zelfstandig wonende ouderen bestudeerd vanuit het gezichtspunt van de huisarts. Het vallen van ouderen behoort tot één van de belangrijkste gezondheidsproblemen in de gezondheidszorg. Het wordt gekenmerkt door een frequent vóórkomen, een veelheid van oorzaken en risicofactoren, die eraan ten grondslag liggen en belangrijke gevolgen wat betreft morbiditeit en, meestal indirecte, mortaliteit.

De huisarts heeft vaak met dit probleem te maken, in allerlei omstandigheden. Vallen van ouderen, en in het bijzonder herhaald vallen, dient te worden beschouwd als een teken van ziekte, beperking of het begin van algemene achteruitgang. Daarom is bij iedere val een nauwgezet onderzoek naar de oorzaak en de risicofactoren op zijn plaats. Gelet op de hoge frequentie van letsels door vallen, vooral de heupfractuur, is het nodig dat secundaire en tertiaire preventie in de eerstelijns gezondheidszorg worden ontwikkeld. Een ander belangrijk aspect voor de huisarts is zijn beleid wat betreft diagnostiek, therapeutische en preventieve maatregelen, bij een patient, die is gevallen.

Hoofdstuk 1 is een algemene inleiding tot deze eerstelijns studie. Wij geven onze definitie van vallen, een beschrijving van valmechanismen, de doelstellingen en de onderzoeksvragen. Bovendien wordt een beknopt overzicht gegeven van de opzet van dit proefschrift.

De doelstellingen van deze studie bestrijken vier gebieden. Op elk gebied zijn één of meer vraagstellingen van toepassing.

Doelstelling I Vóórkomen en incidentie

- Onderzoeksvraag 1: Wat zijn de incidenties van vallen?

Doelstelling II Determinanten en risicofactoren

- Onderzoeksvraag 2: Wat zijn de determinanten en risicofactoren van vallen?
- Onderzoeksvraag 3: Wat is het verband tussen intrinsieke (persoonsgebonden), extrinsieke (omgevingsgebonden) en activiteiten gebonden risicofactoren van vallen?
- Onderzoeksvraag 4: Wat zijn de kenmerken van ouderen met éénmalig, herhaald en niet vallen?

Doelstelling III Gevolgen voor de gezondheid

- Onderzoeksvraag 5: Wat zijn de gevolgen voor de gezondheid en het dagelijks functioneren?

Doelstelling VI Relatie met de huisartspraktijk

- Onderzoeksvraag 6: Wat is de betrokkenheid van de huisarts met

vallen en vallers?

- Onderzoekvraag 7: Uit welke elementen bestaat een onderzoek naar valrisico in de huisartspraktijk?
- Onderzoekvraag 8: Welke aanbevelingen aan de huisarts kunnen worden gedaan aan de huisarts wat betreft onderzoek naar valrisico en preventie?

In *hoofdstuk 2* geven we een inleiding op het onderwerp aan de hand van drie casus uit de huisartspraktijk. De casus zijn voorbeelden van verschillende en reële situaties: een oudere met een eerste val ten gevolge van voornamelijk lichamelijke oorzaken, een oudere met herhaald vallen, die vele patiëntgebonden risicofactoren heeft en een oudere met een hoog risico op vallen en bijna-vallen, die woont in een huis met veel omgevingsgebonden risicofactoren.

In dit hoofdstuk wordt de nadruk gelegd op het besef, dat vallen, en in het bijzondere herhaald vallen, dient te worden beschouwd als mogelijke voorbode van ziekte, beperking of beginnende algemene achteruitgang, of, in geval van een eerste val, als het mogelijke begin van een reeks van komende valincidenten. Een nauwgezet onderzoek naar de oorzaken en risicofactoren kan nodig zijn. Kennis over het vóórkomen en de risicofactoren kunnen bijdragen aan een systematische aanpak. In de beschouwing over mogelijkheden van preventie dient een afweging te worden gemaakt van de voor- en nadelen van preventieve maatregelen.

In *hoofdstuk 3* beschrijven we de resultaten van een voorbereidende studie over de gezondheidstoestand en het functioneren van zelfstandig wonende ouderen. Vooral de bijdrage, die het huisbezoek van de wijkverpleegkundige kan bieden aan de kennis van de huisarts over zijn oudere patiënten wordt belicht.

Het betreft een dwarsdoorsnede onderzoek, waarin een aselechte steekproef werd genomen van 50 ouderen van 70 jaar of ouder uit de populatie van een gezondheidscentrum. De kennis, die huisartsen hebben over hun oudere patiënten werd onderzocht. Vervolgens werd nagegaan op welk gebied en in welke mate deze kennis met de bijdrage van het huisbezoek door de wijkverpleegkundige kon worden aangevuld. Ongeveer 34 procent van de klachten en beperkingen van ouderen waren bij de huisarts niet bekend. Het betroffen vooral depressieve gevoelens, incontinentie voor urine, beperkingen van het bewegingsapparaat en slaapstoornissen. Loopstoornissen werden gemeld door ongeveer 40 en vallen door 20 procent van de deelnemers. De belangrijkste

determinanten van functionele achteruitgang waren loopstoornissen en depressieve gevoelens.

Samenvatting

Hoofdstuk 4 biedt een systematisch overzicht van de literatuur over vallen met betrekking tot vóórkomen, risicofactoren en gevolgen voor de gezondheid van vallen van zelfstandig wonende ouderen. A Medline zoekactie werd uitgevoerd aan de hand van relevante sleutelwoorden. Dit leverde 274 artikelen op, die werden onderworpen aan drie inclusiecriteria betreffende de oorspronkelijkheid van de studies, de doelstellingen en de doelpopulaties. Veertien studies werden geselecteerd en vervolgens methodologisch geëvalueerd met behulp van tien methodologische kwaliteitscriteria. Vier studies beantwoordden aan alle - of bijna alle - criteria en werden bij de interpretatie en de beschrijving van de uitkomsten extra belicht. Bijna 30 procent van alle zelfstandig wonende ouderen van 65 jaar en ouder valt tenminste éénmaal en 15 procent twee maal of vaker per jaar. De belangrijkste, door de auteurs zelf significant genoemde risicofactoren behoren uitsluitend tot de intrinsieke (persoonsgebonden) risicofactoren: geestelijke achteruitgang, balans- en loopstoornissen, gebruik van kalmerings- en slaapmiddelen, een beroerte in de voorgeschiedenis, een hoge leeftijd, arthrose van het kniegewricht en een hoge mate van afhankelijkheid. Extrinsieke (omgevingsgebonden) risicofactoren speelden geen rol van betekenis als onafhankelijke risicofactoren in de 14 geselecteerde studies. Niet alle studies verstrekten gegevens over de gevolgen van vallen voor de gezondheid. Ernstig letsel werd genoemd in een half tot negen procent en botbreuken in drie tot 14 procent van alle valincidenten.

In *hoofdstuk 5* worden het onderzoekontwerp en de onderzoeksmethoden van de studies besproken. De twee post-enquêtes zijn uitgevoerd in twee verschillende eerstelijns populaties. Onderzoek 1 is een dwarsdoorsnede studie over de invloed van loopstoornissen en vallen op het functioneren, uitgevoerd in een aselekt getrokken steekproef van 730 personen van 55 jaar of ouder en ingeschreven in een gezondheidscentrum. Onderzoek 2 over vóórkomen, risicofactoren en gevolgen van vallen, betreft eveneens een dwarsdoorsnede onderzoek. De onderzoekspopulatie bestond uit 2744 ouderen van 70 jaar of ouder, ingeschreven in drie gezondheidscentra en een groepspraktijk, die door hun eigen huisartsen in staat werden geacht aan het onderzoek deel te nemen. Van de 1660 personen, die een bruikbare vragenlijst hadden ingevuld gaven 1238

schriftelijk toestemming voor deelname aan een vervolgonderzoek. Uit hen werd een op leeftijd, geslacht en valgeschiedenis gestratificeerde steekproef getrokken van 311 ouderen. Zij namen deel aan een prospectief onderzoek, bestaande uit een huisbezoek voor een nullijnonderzoek naar valrisico en een 36 weken durende vervolgstudie met iedere 6 weken een telefonisch contact. (zie Hoofdstuk 5, figuur 1)

De post-enquêtes in beide onderzoeken waren ongeveer gelijk. Zij bevatten vragen over onderwerpen met betrekking tot vallen zoals vóórkomen, determinanten en gevolgen voor de gezondheid van vallen. Het protocol van het nullijnonderzoek werd gemaakt aan de hand van de uitkomsten van een discussie over valrisico en risicofactoren van vallen in een panel van deskundigen op dit terrein. Het nullijnonderzoek werd uitgevoerd onder standaard condities door drie geïnstrueerde artsen. Het daaropvolgende telefonisch vervolgonderzoek werd eveneens gestandaardiseerd uitgevoerd door geoefende interviewers.

Een checklist op valrisico binnenshuis werd ontwikkeld door een Delphi consensus groep, bestaande uit vijf ergotherapeuten, een deskundige op het gebied van sociale verzekeringen en een districtswijkverpleegkundige. De inspectie van de woning op valrisico aan de hand van deze checklist duurde ongeveer vijf minuten en maakte deel uit van het nullijnonderzoek.

De zestien deelnemende huisartsen ontvingen een post-enquête over hun betrokkenheid met vallen. Hen werd gevraagd per patient een vragenlijst in te vullen over aan hen gemelde valincidenten, hun diagnostisch en therapeutisch beleid en hun inschatting van valrisico en risicofactoren.

Hoofdstuk 6 geeft de beschrijving van de uitkomsten van onderzoek 1, uitgevoerd in een aselechte steekproef van 730 personen van 55 jaar of ouder, ingeschreven in een gezondheidscentrum. Het betreft de invloed van loopstoornissen en vallen op het functioneren. Als uitkomstvariabelen voor functioneren werden het mobiliteitsbereik en de mate van sociale activiteit gebruikt. Het bleek, dat er een verband van betekenis bestond tussen vallen en leeftijd, maar meer nog tussen loopstoornissen en leeftijd. De belangrijkste determinanten van vallen waren het vrouwelijk geslacht, een slechte gezondheidstoestand en loopproblemen. Vallen heeft weliswaar enige negatieve invloed op het functioneren, maar dit wordt sterk overtroffen door geestelijke gezondheid indicatoren en loopstoornissen.

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In hoofdstuk 7 worden de resultaten van een dwarsdoorsnede onderzoek beschreven. Met behulp van een vragenlijst, toegestuurd aan alle 2744 ouderen van 70 jaar of ouder, ingeschreven in drie gezondheidscentra en een groepspraktijk, werden het vóórkomen, de risicofactoren en de gevolgen voor de gezondheid van vallen van zelfstandig wonende ouderen onderzocht. Uitkomsten over het vóórkomen van vallen en letsel ten gevolge van vallen zijn ongeveer in overeenstemming met gegevens uit de literatuur: 25 procent van de respondenten viel tenminste één keer en 19 procent twee keer of vaker in het voorafgaande jaar. Botbreuken werden gemeld door acht procent van devallers: heupfracturen door ongeveer één procent en overige fracturen door bijna zeven procent. Bivariate analyse leverde veel risicofactoren op met een significant verband met vallen en herhaald vallen. Maar de logistische regressie resulteerde in een beperkt aantal onafhankelijke en significante risicofactoren van vallen en herhaald vallen ten gevolge van onderlinge afhankelijkheid. De sterkste risicofactoren van herhaald vallen waren: het vrouwelijk geslacht, een leeftijd van 80 jaar of ouder, de aanwezigheid van een chronische neurologische ziekte, het gebruik van anti-depressiva, balansstoornissen (duizeligheid), zintuigproblemen, zoals verminderd gezichtsvermogen of gehoor en spier- en gewrichtsklachten. Deze risicofactoren zijn de componenten van een logistisch risicomodel. De toevoeging van een indicator voor een bewegingsstoornis, een score van 3 of meer op de Mobiliteits Controle van de verkorte versie van de Sickness Impact Profile (SIP68), leverde geen wezenlijke verbetering van de resultaten van het risicomodel op: de waarden van de Area Under the Receiver Operator Characteristic (ROC) Curve, the AUC, een maat voor de voorspellende kracht van het model, waren bijna gelijk, respectievelijk 0,73 en 0,75. Het statistisch optimale afkappunt werd gevonden bij 0,26. Bij dit afkappunt was de sensitiviteit 64 procent en de specificiteit 71 procent en de positieve en negatieve voorspellende waarden (PV+ en PV-) respectievelijk 42 en 86 procent. Ook deze waarden vertoonden slechts een geringe verbetering bij toevoeging van de MC SIP68.

De belangrijkste conclusie voor de huisarts uit deze studie is, dat de significante risicofactoren die bijdragen aan een risicomodel voor de voorspelling van herhaald vallen, gemakkelijk en direct zijn af te leiden uit het dossier van de patiënt. Op deze wijze is het mogelijk de oudere met verhoogd valrisico in een vroegtijdig stadium op te sporen met bevredigende diagnostische en voorspellende waarden.

Hoofdstuk 8 gaat over de uitkomsten van een longitudinale studie over predictoren van vallen met de nadruk op uitvoeringstesten. Uit de 1238 van 1660 respondenten van de post-enquête van onderzoek 2, die schriftelijk toestemming gaven voor verdere deelname, werd na stratificatie op valgeschiedenis, leeftijd en geslacht, een aselechte steekproef getrokken van 311 personen. Zij werden thuis bezocht voor een één uur durend gestandaardiseerd nullijnonderzoek op valrisico, uitgevoerd door drie geïnstrueerde artsen. Het nullijnonderzoek bestond uit een interview, testen op lichamelijke gezondheidstoestand en mobiliteit en een inspectie van de woning op valrisico aan de hand van een checklist. Omdat er geen gevalideerd en voor de huisartspraktijk geschikt onderzoekprotocol op valrisico voor handen was, werd het nullijnonderzoek ontwikkeld in twee consensus panels: een panel van vijf deskundigen op het terrein van vallen voor het lichamelijke onderzoekprotocol en een Delphi consensus procedure met zeven deskundigen voor de ontwikkeling van een checklist op valrisico binnenshuis. Na het huisbezoek werd een 36 weken durende vervolgstudie, bestaande uit zes wekelijkse telefonische contacten, uitgevoerd om gegevens over vallen en omstandigheden, die met vallen verband houden, te verkrijgen.

In totaal werden 197 valincidenten gemeld door 95 van de 287 deelnemers (33 procent), die het vervolgonderzoek voltooiden. Eén val werd gemeld door 49 (17 procent) en twee of meer valincidenten door 46 (16 procent) personen. Van de vallers liepen 43 personen (45 procent) ietsel op: een heupfractuur bij twee en een andere fractuur bij vier personen. Bivariate analyse leverde een aantal risicofactoren van vallen op, die een significant verband vertoonden met vallen in het algemeen, éénmalig en herhaald vallen. Logistische regressie leverde twee logistische modellen op voor de voorspelling van vallen in het algemeen (Model 1) en herhaald vallen (Model 2). De belangrijkste onafhankelijke determinanten van vallen in het algemeen waren twee of meer valincidenten in het voorafgaande jaar, een verminderde somatische autonomie, bepaald met de SIP68 en verminderde voetracht. De sterkste onafhankelijke determinanten van herhaald vallen waren twee of meer valincidenten in het voorafgaande jaar, een depressieve gemoedstoestand, gemeten met de depressie subschaal van de Symptom Checklist (SCL90), slechte scores voor de hand knijpkracht, gemeten met de handdynamometer en een abnormale postural sway.

De modellen hadden goede uitkomsten bij de test volgens Hosmer Lemeshow. The ROC analyse van de modellen leverde een

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statistisch optimaal afkappunt van beide modellen bij 0,30 op met een sensitiviteit van respectievelijk 67 en 59 procent en een specificiteit van respectievelijk 63 en 87 procent. De positieve voorspellende waarden (PV+) waren 47 en 52 procent; de negatieve voorspellende waarden (PV-) 79 en 90 procent. De voorspellende kracht is uitgedrukt in de waarde voor de AUC, met een matige waarde van 0,69 voor Model 1 en een redelijke waarde van 0,79 voor Model 2. Deze modellen voor de voorspelling van vallen zijn toepasbaar in de huisartspraktijk en kunnen apart of complementair worden gebruikt, als een bevestiging van het risico model verkregen uit het patiëntendossier, beschreven in hoofdstuk 7.

In hoofdstuk 9 worden de uitkomsten van het onderzoek van de woning op risicofactoren voor binnenshuis vallen aan de hand van een checklist beschreven. De lijst is ontwikkeld in een Delphi consensus procedure door een panel, bestaande uit vijf ergotherapeuten, een deskundige op het gebied van de sociale verzekeringen en een districts wijkverpleegkundige. De checklist bestaat uit 116 cellen bij aanwezigheid van trappen en 96 cellen indien er geen trappen zijn in de woning. Op de Y-as staan zes categorieën van potentiële risicofactoren: vloeren, verlichting, loopruimte, trappen, obstakels en een categorie diverse risicofactoren. Op de X-as staan de vertrekken van de woning: de entree, het trappenhuis, de keuken, de badkamer, het toilet, de slaapkamer, de woonkamer en de kelder/zolder. Tijdens het huisbezoek voor het nullijnonderzoek van potentiële risicofactoren voor binnenshuis vallen werden de woningen van alle 311 deelnemers geïnspecteerd en werden potentiële risicofactoren geregistreerd op de checklist. Potentiële risicofactoren voor vallen binnenshuis behoren gelijkmatig tot de structurele (immobiele) en tot de niet-structurele (mobiele) risicofactoren. De vertrekken van de woning, waarin de meeste risicofactoren voorkomen, zijn het trappenhuis, de slaapkamer en de badkamer, maar deze scores komen niet overeen met de vertrekken, waarin valincidenten zich ook werkelijk voordoen: de woonkamer, de slaapkamer en de entree. Bivariate analyse leverde geen significant verband op tussen hoge scores op de checklist en valrisico, uitgezonderd voor vallen in de entree.

De conclusie, die uit deze studie kan worden getrokken is, dat een checklist weliswaar nuttig kan zijn om potentiële risicofactoren van binnenshuis vallen naar soort en naar vertrek op te sporen, maar géén voorspellende waarde heeft voor valincidenten binnenshuis

uitgezonderd voor vallen in de entree. De verklaring hiervoor kan zijn dat ouderen problemen hebben met licht-donker adaptatie en andere adaptaties in de entree.

Hoofdstuk 10 beschrijft de resultaten van een analyse van twee vragen uit de vragenlijst van post-enquête 2, betreffende door ouderen zelf ervaren loopstoornissen en oorzaken ervan. Ongeveer de helft van de ouderen van 70 jaar of ouder, meldden een loopstoornis te hebben. De belangrijkste kenmerken van hen zijn: een leeftijd van 80 jaar of hoger, één of meer val- en bijna-valincidenten in het voorafgaande jaar en een matig of slecht ervaren gezondheidstoestand. Bovendien hadden zij, vergeleken met degenen zonder loopstoornis lagere scores voor gezondheidsvariabelen, functioneren en kwaliteit van leven. Genoemde oorzaken behoren, behalve tot het bewegingsapparaat, tot het hart-vaatstelsel, de luchtwegen, het centrale zenuwstelsel en algemene achteruitgang, welke waarschijnlijk onderschatte oorzaken van loopstoornissen vormen.

In *hoofdstuk 11* worden de uitkomsten van het onderzoek naar de betrokkenheid van de huisarts met vallen van ouderen beschreven. Gegevens uit het telefonisch vervolgonderzoek werden vergeleken met gegevens afkomstig van een vragenlijst, toegestuurd aan de 16 huisartsen van de deelnemers aan het vervolgonderzoek. Tachtig procent van alle, door de deelnemende ouderen in het vervolgonderzoek gerapporteerde, valincidenten waren niet bekend bij de huisarts. Slechts ongeveer de helft van alle valincidenten met ernstig letsel was bekend bij de huisartsen. Het onderzoek van ouderen na een val was vooral gericht op het diagnosticeren van letsel, maar leverde in het algemeen weinig informatie op over de oorzaak van de val. Het beleid van de huisartsen na een val betrof vooral verwijzing naar een fysiotherapeut, het geven van gerichte adviezen, overleg met familie, het inschakelen van de wijkverpleegkundige en het geven van extra aandacht. Weinig aandacht werd besteed aan het gebruik van medicatie. Bij 170 van de 303 deelnemende ouderen (56 procent) gaven de huisartsen een opgave van een verhoogd valrisico, waarbij stoornissen van het bewegingsapparaat de belangrijkste waren.

In *hoofdstuk 12* worden de belangrijkste resultaten van het onderzoek gepresenteerd in samenhang met de doelstellingen en de onderzoeksvragen. De methodologisch sterke en zwakke punten worden besproken en de consequenties voor de huisartspraktijk

worden genoemd. Ook worden enkele aanbevelingen gedaan voor verder onderzoek en opleiding.

Deze studie geeft een overzicht van uitkomsten van de literatuur en eigen onderzoek van het vóórkomen, de risicofactoren en de gevolgen voor de gezondheid van vallen van zelfstandig wonende ouderen. Het belang van vallen als teken van ziekte, beperking en zwakte is benadrukt. Een andere uitkomst is, dat de huisarts in staat is vallen te voorspellen met risicomodellen, bestaande uit variabelen, die direct zijn af te leiden uit het patientendossier of gemakkelijk zijn te onderzoeken met testen. Deze voorspellende modellen zijn van belang voor de ontwikkeling van preventieve strategieën in de eerstelijns gezondheidszorg. Een stapsgewijze benadering om valrisico te beoordelen en in te delen is geïntroduceerd, maar de betrouwbaarheid en de geschiktheid ervan moeten nog nader worden bepaald in toekomstig onderzoek.

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Dankwoord

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Curriculum vitae

Paul Stalenhoef werd geboren op 11 november 1947 te Nederhorst den Berg (NH). Na het behalen van het gymnasium β diploma aan het voormalig R.K. Lyceum voor het Gooi (tegenwoordig Alberdingk Thijm College) te Hilversum in 1966, startte hij de studie geneeskunde aan de Rijksuniversiteit Utrecht. Na het artsexamen in 1973, volgde hij de éénjarige huisartsopleiding te Utrecht.

In mei 1974 associeerde hij zich met de huisartsen They Lemmens (†) en Léon Lodewick in een groepspraktijk, die in 1976 overging in het gezondheidscentrum Dr. van Kleef te Maastricht.

Sinds 1976 heeft hij een deeltijdaanstelling bij de vakgroep huisartsgeneeskunde van de Universiteit Maastricht.

De huisartspraktijk in het gezondheidscentrum Dr. van Kleef wordt uitgeoefend in samenwerking met de huisartsen L. Huynen (vanaf 1980), G. Castermans (vanaf 1985) en M. Maaskant (vanaf 1990).

Paul was getrouwd met Betsy Halling († 28 november 1992), destijds huisarts en wetenschappelijk medewerker van de vakgroep Onderwijsontwikkeling en onderwijsresearch van de Universiteit Maastricht. Hun kinderen zijn: Anneneeltje (23), Pieter (21) en Klaartje (19).

Zijn levensgezellin is Josje Reuten-Scholte, weduwe van Bart W.J.M. Reuten. Hun kinderen zijn: Marieke (27), Job (24) en Joris Jan (21).