

Geographic Information Systems (GIS) in Public Health

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Valorisation of this thesis

Relevance of research results

The innovative aspect of this research is the provision of new insights on the importance of geographic aspects for demand-based planning and allocation of healthcare and targeted prevention strategies. The insight that geographic aspects are important determinants of health and disease has broad implications that are useful beyond science.

There are three areas where these research results could improve public health policies beyond academia:

1. Demand-based planning and allocation of healthcare
2. Improvement of current prevention strategies
3. Improvement of public health surveillance through implementation of geographic information systems and spatial epidemiological methods

Demand-based planning and allocation of healthcare

The case study on type 2 Diabetes Mellitus in Germany is important for demand-based planning and allocation of healthcare in northeastern Germany. This case study is part of a larger and on-going project between the AOK Nordost health insurance and the Beuth University of Applied Sciences to enhance the current planning and allocation of primary healthcare in northeastern Germany. The current planning of general practitioners (GPs) is still based on a target ratio of 1671 inhabitants per GP and does not acknowledge a higher prevalence of chronic diseases in socially disadvantaged areas nor the accessibility of GPs in rural areas. Since the planning and provision of GPs is planned between health insurance providers and the association of statutory health insurance physicians, health insurance providers have a high interest to detect an increased medical demand of their insurants to provide healthcare where it is needed most. This in turn decreases the chance of expensive and possibly avoidable complications. Logically, spatial analyses of chronic diseases are important for evidence-based negotiations where new GPs should be allocated. Providing background knowledge about geographic determinants of chronic diseases thus helps to model the expected demand for healthcare in the future. Detecting areas with increased medical demand and identifying associated determinants of chronic diseases is not only important for type 2 Diabetes Mellitus, but also for several other chronic diseases with high prevalence rates such as hypertension or cardiovascular diseases. The knowledge that a lower socio-economic status is a strong determinant for chronic diseases

facilitates the current debate about including additional population-based variables such as area deprivation into planning of healthcare. The discussion about the consideration of area deprivation as driving factor for healthcare needs is still relatively young in Germany when compared to other countries.

Improvement of current prevention strategies

The results of the four case studies are relevant for prevention strategies for different actors in the healthcare sector:

1. General practitioners

Disseminating the results of the case studies on hepatitis C and type 2 Diabetes Mellitus to general practitioners in the respective region could facilitate the implementation of preventive screenings. Although hepatitis C and type 2 Diabetes Mellitus are fundamentally different, these two diseases have one particular characteristic in common: Both diseases are often asymptomatic in the beginning and have a high probability of adverse health outcomes if they remain undetected. For both diseases, preventive screening could help to provide early diagnosis and necessary medical care and could thus minimize the risk of potentially preventable complications – such as liver cirrhosis in the case of hepatitis C and lower extremity amputations in the case of type 2 Diabetes Mellitus. The onset of type 2 Diabetes Mellitus could even be prevented or delayed if possible pre-diabetic conditions such as glucose intolerance are detected early enough. Providing GPs with background knowledge about local clusters and location-specific risk groups for these diseases could therefore enable GPs to offer free testing to patients belonging to local risk groups.

2. Health insurance providers

The AOK Nordost health insurance is the second key actor for whom the results of the case study on type 2 Diabetes Mellitus are relevant. Early diagnosis of Diabetes is likely to reduce the amount of potentially preventable complications. However, demographic and socio-economic risk factors remain largely unknown within the database. The AOK Nordost can benefit in several ways from the results of this case study: They provide important information about the location-specific risk groups. This information can be used to invite insurants with similar socio-demographic risk factors for preventive screenings. Additionally, health insurance providers in Germany have

intensive care programs for chronic diseases – the so-called disease management programs - where participating GPs provide intensive care for insurants with one or several chronic diseases. The areas highlighted as local clusters for type 2 Diabetes Mellitus can help the AOK Nordost to invite GPs to participate in disease management programmes for type 2 Diabetes Mellitus. This approach might ultimately benefit insurants by reducing the risk of potentially preventable complications through planning and allocation of more specialized and intensive medical care.

3. Local public health agencies

The results of the case study on hepatitis C have been used by the public health service South Limburg (GGD ZL) to facilitate preventive screening programmes in the areas highlighted as clusters in Maastricht. This shows the importance of a spatial ecological analysis for practical prevention strategies. By disseminating the results of the case studies for acute undifferentiated fever, hepatitis C and pertussis to other local public health agencies, public health departments in the Netherlands and India can be motivated to conduct similar studies. It is likely that the risk factors may be different in other regions. Enabling local public health agencies to assess location-specific risk groups for prevalent diseases within their jurisdiction could be an effective way to enhance preventive strategies, tailored towards local needs.

Improvement of public health surveillance through implementation of geographic information systems and spatial epidemiological methods

The three case studies based on surveillance data in India and the Netherlands have clearly demonstrated the added value of analysing surveillance data geographically, ranging from an analysis of location-specific risk groups in the case of hepatitis C, the analysis of possible determinants of testing to the identification of possible disease outbreaks in space and space-time for pertussis. With geographic identifiers becoming increasingly available in datasets generated by surveillance systems, important opportunities for prevention and effective public health response emerge from the spatial analysis of surveillance data. All analytical methods used in this dissertation were available in sophisticated open-source software such as SaTScan, GeoDa, CrimeStat and GWR4. With the increasing additional availability of spatial statistical methods within the R programming language and enhancements in open source GIS software such as Quantum GIS, spatial epidemiological methods can be easily

implemented even in public health departments with limited financial resources. This is important for GGD ZL as it empowers GGD ZL to conduct analyses of different diseases and develop further prevention strategies. Communicating these possibilities to other public health departments also could be an effective way to make further use of the potential of spatially referenced surveillance data for effective public health strategies.