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Gabriele Doblhammer (Ed.)

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Health Among the Elderly in Germany

New Evidence on Disease, Disability and Care Need

Barbara Budrich Publishers

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-
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Preface

The Series on Population Studies, which is edited by the Federal Institute for Population Research in Wiesbaden (Germany), has been established in 1975. Since then, one or two monographs or edited volumes have been published every year, mainly in German. Our aim is to provide a scientific platform for distinguished monographs and edited volumes in the broad field of population studies. To improve the scientific quality and recognition we have developed the Series on Population Studies further – the German title is "Beiträge zur Bevölkerungswissenschaft" – in the last two years: First, the change to the publishing company Barbara Budrich since Volume 45 enabled us to publish the volumes open access after a moving wall of five years which facilitates an international visibility. Second, we have established a peer review process with two reviews for each article, one by the editor and one by an anonymous reviewer (double blind peer review).

We are happy to have won over Gabriele Doblhammer for this edited volume on health in Germany. She is a full professor of empirical methods in social science and demography in Rostock and since 2006 executive director of the Rostock Center for the Study of Demographic Change. Since 2009, she is head of the Demography Department at the German Center for Neurodegenerative Disease. Gabriele Doblhammer is one of the leading experts in population studies on health and longevity. As such, she has published in several international journals. Being a native Austrian, she lives and works in Germany since 17 years and she also takes part in public discourses on health in Germany.

In this book, she and the other authors give a comprehensive overview on key developments as well as new insights on health in Germany. Which reasons make some people live longer and healthier and which do not? The relevance of this question is obvious, especially in an ageing population. Based on new data and innovative research designs the book examines the social and behavioural determinants of health. The research focuses on vanguard groups and vulnerable groups. What can be learnt from vanguard groups with regard to health risks? And what are the reasons for considerable health differences between migrant groups? Current results for those two groups are presented which are highly relevant for both research and policy.

Without the dedication of several people this volume could not have been realized. First of all, we thank Gabriele Doblhammer, her colleagues and all authors for their contributions. We are indebted to the reviewers for their competent and detailed comments and critical remarks. Our commitment to academic excellence is based on both innovative authors as well as honorary reviewers. Further, we thank Sybille Steinmetz for typesetting and Christian Fiedler for designing the cover.

We wish you stimulating reading and new insights into the topic of health in Germany.

Wiesbaden, Germany, September 2014
Federal Institute for Population Research

Introduction

Gabriele Doblhammer

1 Introduction

Since the latter decades of the 20th century, Germany and many other industrialized countries have been experiencing an unprecedented decline in the mortality of the old and oldest-old (Christensen et al. 2009). Today an 80-year-old German woman has the same remaining life expectancy as her 75-year-old counterpart would have had 50 years ago, and her probability of dying at age 80 has more than halved. The issue of whether trends in health, morbidity, functional limitations, and disability are following a similar path, particularly among the oldest-old, remains controversial. Health is a multidimensional concept, and several indicators are needed to capture trends. To assess patterns and trends in health, it is necessary to analyse different levels of health, while paying attention to the fact that different indicators reflect different phases of the disease and disability processes (Verbrugge and Jette 1994). The interpretation of studies that explore these trends is complicated by the problem that the indicators of morbidity, functional limitations, and disability have been applied inconsistently by different researchers. In addition, study designs, participation rates, and the wording of questions tend to change over time. Moreover, the institutional population is excluded in many health surveys. Despite these methodological problems, there is a general consensus that functional impairment and limitations related to the activities of daily living have been decreasing among the young old. Little evidence exists, however, for those aged 85 and above (Christensen et al. 2009).

The aim of this issue is to contribute to the discussion on trends and patterns in health among the elderly by focusing on three topics: (1) the identification of vanguard groups; (2) the social and behavioral determinants of health; and (3) the trends and patterns among vulnerable groups, particularly migrants. These three topics are embedded in the context of current international research interests, and feature prominently alongside the individual research questions each of the articles addresses. In the following, I will discuss the articles' contributions to these three topics. Since each article may contribute to more than one topic, the chronological order of the articles in the discussion differs from that of the special issue. In the special issue, the order of the articles is related to the health outcomes, and there is a separate group of articles about migrants.

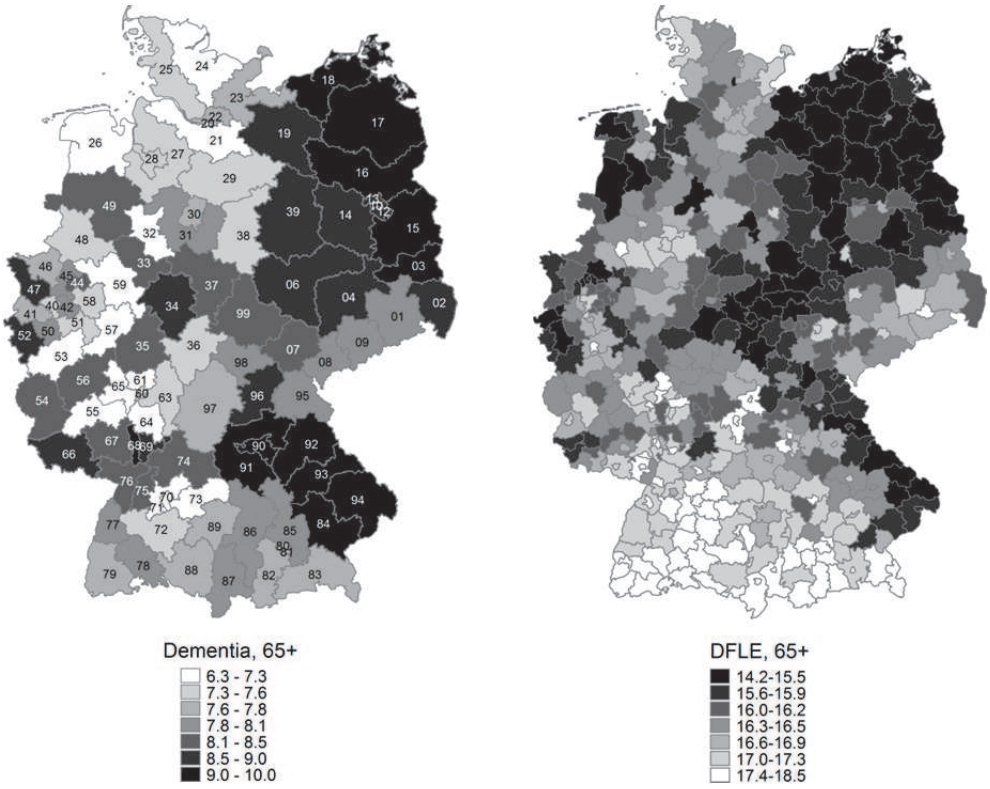
The first topic deals with health differences between the best practice group, or the vanguard, and the worst-off group. The vanguard is of particular interest because it can be seen as the highest level of health that can be reached under current conditions. From the vanguard, it is possible to infer how high health levels could be in the future if the general social and environmental conditions were to approach those of the vanguard group. The second topic deals with the identification of distal and proximal factors of health, as well as with the question of causality. Different study designs are applied in this issue, which lend themselves to causal interpretations to a greater or lesser extent. However, even when no causal inference is possible, these studies are important in generating new hypotheses. The third topic deals with the physical and mental health of elderly migrants, a group that is

becoming more important over time simply due to its increasing size. Many unobserved characteristics differ between populations, and migrants may be selected according to good health. In addition to data problems, the healthy migrant bias is frequently cited as an explanation for the high life expectancy levels found among migrants. Whether this high life expectancy also translates into a long life spent in good health is, however, questionable. A large number of studies have suggested that migrants are in worse physical health than non-migrants, and that this may also be true of mental health.

2 Vanguard groups

Differences in health within a country are often greater than the differences between countries or over time. Two articles in this special issue examined regional differences at the NUTS3 level and the two-digit postal code level in order to identify vanguard regions, as well as the worst-performing regions. Two measures of health were used. The first indicator was severe disability, which was defined as receiving benefits from the Statutory Long-Term Care (SLTC) insurance in Germany. Using the 2009 census of SLTC beneficiaries and regional life tables, the number of years lived from age 65 onwards without the need for care was calculated, and the resulting indicator was called disability-free life expectancy (DFLE). The second indicator was the period prevalence of dementia based on ICDN diagnoses from medical doctors. These data, which were for the year 2007, came from the largest German health insurer, the Allgemeine Ortskrankenkasse AOK. These two datasets, which are completely unrelated in terms of their administrative structure, identified similar vanguard and worst-performing regions in Germany. The vanguard regions were situated in the southern and southwestern counties of Baden-Württemberg and Bavaria. In these regions, the absolute vanguard was Stuttgart, with 18.7 years of DFLE and the third-lowest German-wide prevalence of dementia (age standardized: 7%). In eastern Germany, the vanguard was Dresden, with a DFLE of 17.8 years and a dementia prevalence of 8%. The worst-off regions in eastern Germany were Mecklenburg-Western Pomerania, and especially Rügen and Northern Pomerania. In these regions, the DFLE was 14.2/14.3 years and the dementia prevalence was 10%. The worst-off regions in western Germany were northeastern Bavaria, the Ruhr area, and Saarland. There the DFLE was between 14.1 and 15.5 years, and the dementia prevalence was between 9% and 10%. The overall difference between the vanguard and the worst-off region was about 4.5 years in terms of DFLE, and about four percentage points in terms of dementia prevalence.

Figure 1: Age-standardized dementia prevalence and disability-free life expectancy (DFLE) by 2-digit postal codes (dementia) and NUTS3 level (DFLE): Germany ages 65+



Data sources: AOK 2007 and SLTC census 2009. For further information, see the articles of Doblhammer et al. and Kreft in this issue.

A third article in this special issue applied the concept of the vanguard and the worst-off groups to a cross-country comparison of European health systems in examining the relationship between disability, as measured by the ability to perform activities of daily living (ADL), and chronic disease. This study examined the question of whether the health care system modulates the relationship between chronic disease and disability, particularly between stroke and ADL disability. Across Europe, mortality caused by stroke and other cerebrovascular diseases is decreasing, not primarily because of lower incidence, but because the chances of surviving the onset of these conditions, and the length of time lived thereafter, have increased. This means that cerebrovascular conditions, and specifically stroke, will increasingly become major drivers of long-term disability at older ages. Stroke is also a major risk factor for dementia in old age. Using the fourth wave of the "Survey of Health Aging and Retirement in Europe" (SHARE) for the population aged 60+ in 10 European countries, the study found that the impact of stroke on ADL disability differed markedly along a north/south gradient. The southern European countries were disadvantaged relative to the western and northern European countries, with Sweden being the vanguard and Spain being the worst-off.

The highly educated are a frequently studied vanguard group (Mäki et al. 2013), as they have higher life expectancy levels and better health. Kibele et al. (2013) found large mortality differentials based on lifetime earnings using data from the German Federal Pension Fund. Large educational differentials in German mortality have, for example, been found by Muth et al. (2008), Doblhammer et al. (2009), Kroll and Lampert (2009), and Klein (1996). A fourth article in this special issue showed that the highly educated not only have lower mortality, but they also have a lower incidence and a lower prevalence of care need, defined as receiving benefits from the SLTC system in Germany. Given the projected increase in the need for care, which will result in a doubling of the number of SLTC beneficiaries by 2050 (Statistische Ämter des Bundes und der Länder 2010), the compositional effects among the elderly due to changes in their educational structure are of great societal importance.

3 Determinants of health and causal pathways

Studying health differentials between groups leads to questions being raised about the determinants and the causal pathways of these differences. Several studies in this special issue tried to identify these determinants based on a number of factors, including the macroeconomic, educational, social, demographic, and health care systems. These researchers also sought to identify determinants that are directly related to health, such as individual lifestyle or behavioral characteristics, social status, medical treatment, or co-morbidities. These determinants are usually classified into proximal (near) and distal (far) determinants, but some scholars have recently argued (Krieger 2008) that the emphasis should instead be on (1) levels such as those of nations, regions, cities, neighborhoods, and households, as well as on the interplay of these levels; (2) causal pathways; and (3) the power to act. Two of the studies in this special issue incorporated level into their analysis by exploring health factors at both the individual and the macro levels. The first of these two studies explored the cross-level effects of the social and the demographic structures of the community on individual-level associations between formal volunteering and informal helping on the one hand, and subjective health and depressive symptoms in middle age and older adulthood on the other. The second study, as noted above, dealt with the impact of the health care system on the relationship between stroke and ADL disability. The findings of the first study suggested that the health effects of volunteering and informal helping in middle age and older adulthood were not moderated by community characteristics. Instead, the variables of both levels showed an independent effect on health outcomes. The second study found that the health care system had a large impact on the disabling outcome of stroke, even when individual-level characteristics were taken into account.

Two other studies in this special issue employed cross-sectional ecological study designs by inferring correlations at the individual level from correlations at the macro level. While these study designs are subject to the problem of the ecological fallacy, they were chosen because of the lack of information about individual-level characteristics. The data used in these two studies did, however, cover the total population or a large representative share of the population. The SLTC census and the health care claims data of the AOK have limited information about individual characteristics. Information at the macro level was therefore used to infer the effects of both the distal and the proximal determinants. While

this type of study design only provides information about correlations, and not about causal pathways, it can be valuable for generating new hypotheses about possible pathways.

One study in this special issue explored the medical treatment histories of dementia patients using longitudinal AOK health claims data. The aim was to explore whether a first diagnosis by a neurologist/psychologist or by a general practitioner influenced the subsequent transition to care. In addition, anti-dementia medication was accounted for. While the longitudinal study design should have allowed for a causal inference to be made, a close examination of the results suggested that the findings may have been strongly influenced by the structure of the German health care system. In this study, the results may partly reflect the distribution of the diagnoses of dementia patients between specialists and generalists according to the severity of the disease. Thus, the results may have been driven by selection forces. This leads us to the third topic of vulnerable groups and migrant selection by health.

4 Migrant health

While migrants may be positively selected on the basis of their health prior to migration (Fennelly 2005; Singh and Siahpush 2001; Muennig and Fahs 2002), their socially disadvantaged position, together with effects of the demanding process of migration and integration into a new environment, may be detrimental to the health of migrants over the long term (Rumbaut 1997; Ng 2011). For elderly migrants, this may mean that they will live more years while in poor physical and mental health. In this issue, the first article about migrants explored the differences in healthy life expectancy between Turkish migrants and native Germans by combining death data from Destatis 2004/05 with population data from the Central Register of Foreigners 2005/06 and survey data on health from the Gender and Generations Survey (GGS) 2005. Even after a careful examination of the official population and death data was conducted, the findings still indicated that Turkish migrants had a remarkably high life expectancy. This advantage relative to native Germans was, however, counterbalanced by more years spent in poor health. The second article focused on the mental health of different migrant groups in comparison to native Germans. Using the German Socioeconomic Panel Study, the mental health of elderly migrants was followed over a nine-year time period from 2002 to 2009. The differences found in mental health between the different migrant groups could not be explained by their social position or individual characteristics, including those of health and lifestyle. Ethnic Germans were found to have mental health levels comparable to those of native Germans, which gives this group a vanguard position among immigrants in Germany, and makes ethnic Germans a best-practice example of positive integration.

The articles in this special issue drew upon a wide variety of data sources. The three articles that studied SLTC beneficiaries were based on the complete census of all beneficiaries (Pflegestatistik) for the year 2009, a representative longitudinal sample of the health claims data of the AOK for the years 2004 to 2008, and the German micro-census panel for the years 2002 to 2004. These are the first studies on SLTC beneficiaries which have used these secondary data in a multi-level and longitudinal study design. The Central Register of Foreigners 2005/06, together with death and population data from Destatis 2004/05, formed the basis of the life expectancy estimates for Turkish migrants living in

Germany. Survey data from the GSOEP 2002 to 2009 and the GGS 2005 were important sources for the study of the health of migrants, while the third wave of the European-wide Survey of Health and Retirement in Europe (SHARE) in 2011/2012 was used in the comparative cross-sectional analysis of the relationship between stroke and disability in 10 European countries. The German Ageing Survey for the years 2002 and 2008 formed the basis of the study about the effect of volunteering on health.

5 The articles in detail

In this issue, the chronological order of the articles has been divided into three groups. The first group consists of three articles dealing with the topics of disability, dementia, and subjective health. The second group focuses on the German Statutory Long-Term Care system and its beneficiaries, while the third group deals with migrant health.

5.1 Subjective health, disability, dementia, and depression

The first article by Alexander Barth and co-authors focused on stroke as a driver of disability at older ages, and looked at whether there were country-level differences in the impact of stroke on disability in Europe. Stroke is an important proximal factor in functional disability, which is expected to become more prevalent in the coming years. Since rates of survival after stroke have increased, more cases of disability related to stroke are expected to occur. Barth et al. developed the hypothesis that in the aftermath of a stroke, health care utilization is especially frequent. Therefore, the impact of stroke on levels of ADL disability should depend on the type of health care regime. The authors tested this hypothesis using the third wave of the European-wide survey SHARE of people aged 60+, which was conducted in 2011/12. The results suggested that stroke leads to disability more frequently in southern Europe than in western or northern Europe. According to the study, a possible causal pathway for this correlation was the accessibility of the health care system, particularly the availability of specialist or generalist medical treatment. However, a selection bias in the study population could not be completely ruled out. As in most studies based on survey data, people living in institutions, such as nursing or retirement homes, were excluded or underrepresented. Whereas in the northern and western European countries up to 10% of the older population live in institutions, institutionalization rates are very low in southern Europe. Individual health and care requirements, including those that arise from a stroke, are among the main reasons why people move to a care facility. Thus, elderly people who suffer from ADL disabilities after having stroke may be more likely to be included in the SHARE sample in southern than in western and northern Europe. The authors tried to correct for this possibility by introducing a macro-variable into the analysis that accounted for country-specific over- and underestimations of the age group 85+ in SHARE. But because this macro-variable had little effect on the overall results, the authors concluded that the national health care system likely played an important role. Future studies should explore the effect of the health care system on a sub-national level, and take into consideration whether people live in an urban or a rural area. The accessibility of health care may differ to a greater extent between communities than between nation states.

The second article by Gabriele Doblhammer and co-authors presented spatial patterns in dementia prevalence in Germany using health claims data from the AOK for the year 2007. This was the first year for which regional data on dementia were available for Germany. Large differences in dementia prevalence were found, with higher levels observed in eastern Germany, as well as in northeastern Bavaria, Saarland, and the Ruhr area. In western Germany, prevalence was shown to be low in the southern regions around Stuttgart, Frankfurt, and Mainz; in the area of Cologne-Bonn; in Schleswig-Holstein; and in Lower Saxony. Most importantly, the regional distribution of the dementia prevalence was shown to be highly correlated with the spatial distribution of the three major cardiovascular risk factors; i.e., high blood pressure, diabetes mellitus, und hypercholesterolemia. These results lend support to findings from earlier epidemiological studies which showed that the risk factors for cardiovascular disease are also risk factors for dementia. While health claims data are subject to administrative influences that may create various types of biases, they are a valid tool for generating hypothesis and testing correlations at the population level. Future regional studies should try to account for a possible bias by taking into consideration the regional structure of the AOK population, and by examining whether regions with high levels of dementia prevalence correlate with regions of high AOK coverage, and vice versa. Another fruitful area for future research may lie in the analysis of the correlation of the spatial pattern with regional meta-data on the socioeconomic composition of the population. Based on the concept of cognitive reserve, regions in which a larger proportion of the population are endowed with more social capital should fare better.

The aim of the third article by Andreas Mergenthaler was to identify to what extent the positive effect of volunteering on health depends on the characteristics of the place where the individual volunteer lives. Volunteering is not only beneficial for the recipient and for civil society; it can also have a positive impact on the health and longevity of the volunteer. Whether the social and physical conditions of the community or the neighborhood act as modifying factors on this relationship remains an open question. The author used two waves from the German Ageing Survey (DEAS) for the years 2002 and 2008 for individuals aged 40 and above in estimating multiple random coefficient models (growth curve models). Macro-data that referred to street sections were selected from the database of the Microm Micromarketing Systems and Consult GmbH. The author looked at both subjective health and depressive symptoms. The results indicated that there were direct positive health effects of volunteering at both the individual and the community levels, but that there was no modifying effect of the community on the individual level. Future studies should try to incorporate the household level as an additional intermediate level between the individual and the community levels. As the household context has been repeatedly shown to have important consequences for health, it may also influence the likelihood of volunteering.

5.2 Long-term care in Germany

Three of the articles in this special issue focused on the Statutory Long-Term Care system (SLTC) in Germany. Long-term care was defined in this context as the services provided to individuals who are receiving benefits from statutory long-term care insurance in Germany. These beneficiaries represent a sub-group of all of the people in Germany who are in need of care due to limitations in their ability to perform the activities of daily living. While the

study of disability beyond a specific legal context is valuable, the study of disability as defined by the German SLTC is becoming increasingly important. As the proportion of the population who are elderly grows, the problems associated with long-term care provision and utilization are increasingly attracting the attention of researchers and policy makers. In the German context, the question of the financial sustainability of the SLTC system in an aging population is of particular importance, as is the issue of how care need is defined. In the Statutory Long-Term Care system, only individuals with severe restrictions in their ability to perform the activities of daily living are considered as in need of care. The criteria only partly allows that individuals with limitations due to cognitive impairment may require care, unless those limitations are combined with physical impairments. The articles cover different dimensions of the German Statutory Long-Term Care system in an attempt to identify the groups of people who are at particularly high risk of becoming disabled.

The article by Olga Grigorieva analyzed the impact of education on the transition to statutory long-term care among the elderly in Germany. The author developed the hypothesis that less educated people have a higher incidence and a higher prevalence of long-term care than highly educated people. While several studies on the utilization of the Statutory Long-Term Care have been carried out for Germany, information about educational differentials among long-term care beneficiaries has been lacking. This is due to insufficient data, as the German SLTC census only provides information about sex, year of birth, grade of disability, and county of residence. No further information about the characteristics of the beneficiaries is given. A series of studies on educational differentials in ADL disabilities or functional limitations have been conducted for Germany, but the number of people in these groups was much larger than the number of SLTC beneficiaries, because not all individuals with physical impairments fulfill the rather strict SLTC criteria. By using the micro-census panel for the years 2002 to 2004, the author was able to examine for the first time for Germany the educational differentials in the transition to long-term care, and the prevalence of long-term care. As hypothesized, she found that the less educated of both sexes and in eastern and western Germany were at considerably higher risk of becoming disabled than the highly educated. The SLTC incidence rate was 19.2 persons per 1,000 person-years for all ages 65+ for the less educated, while the corresponding figure for the highly educated was 11.7. As with mortality and health in general, the educational differentials were found to be smaller among women than men, and they appeared to be higher in the east than in the west. Even after this analysis, however, information about survival in long-term care by educational group is still missing. While the micro-census panel has a sufficient number of cases for studying the incidence and the prevalence of SLTC, the number of deaths among SLTC beneficiaries by educational group is too small for any meaningful analysis. One hypothesis is that the highly educated are able to postpone disability into higher ages, and thus receive SLTC allowances later in life. Once disabled, however, their health might deteriorate faster, and they may die soon thereafter. Thus, it remains unclear whether the less educated move into SLTC at an earlier age, and whether they receive more years of SLTC allowances than the highly educated.

The article by Daniel Kreft explored spatial differences in SLTC prevalence, and linked these differences to regional indicators of socioeconomic performance, socioeconomic composition, level of urbanization, and health structure. The author asked two main questions. First, he examined whether life expectancy in a county was correlated with life expectancy free of the need for care. Second, he tried to identify the regional correlates of poor versus good health. The first question is linked to research on the compression or

expansion of morbidity, which attempts to determine whether increasing life expectancy leads to more years with poor health and disability (= an expansion of morbidity) or whether the additional years of life are healthy (= a compression of morbidity). In order to answer this question, it would appear that a study design that follows a time trend would be needed. Currently, however, little reliable and valid data on long-term trends are available. An alternative design that has frequently been used in the international comparison of health in Europe involves comparing at a single point in time the health expectancy levels of regions with different levels of life expectancy. The author used this approach to study for the first time for Germany the cross-sectional relationship between life expectancy and care need. He came to the conclusion that individuals who were living in regions with high life expectancy spent a smaller proportion of their life with disabilities, according to the SLTC criteria. Results from the author's meta-regression suggested that there was a significant relationship between a county's health and the county's socioeconomic performance, socioeconomic composition, level of urbanization, and health structure. A high household income per capita, a low long-term unemployment rate, a high population density, and a low level of premature mortality in a county was significantly linked to a larger proportion of years lived without disability. Thus, this study appears to strengthen the findings of Olga Grigorieva's article, which showed that care need is differentiated by social status. However, while the latter article found a social gradient at the individual level, this study found a gradient at the regional level. Since the SLTC census does not contain socioeconomic information at the individual level, it was not possible to infer whether the regional differentials reflected the effect of the environment or the effect of the aggregated individual characteristics. Future studies should combine the individual and the regional approaches.

The article by Anne Fink dealt with the transition to SLTC after an incident dementia diagnosis. Treatment of dementia is one of the leading challenges facing health care systems. Because a large share of dementia sufferers require long-term care, it is a very cost-intensive disease to treat. Studies have shown that at the end of life, 90% of all people with dementia are in need of care, and that they require longer periods of care than people without dementia. While anti-dementia drug therapies cannot cure dementia, research has shown that these drugs can reduce periods of long-term care and delay nursing home placement. The author examined the question of whether anti-dementia drug treatment reduces the risk of needing long-term care. In addition, she looked at whether an incident dementia diagnosis by a neurologist/psychiatrist (NP) was more likely to be correlated with a postponement of the transition to SLTC than a diagnosis by a general practitioner (GP). Research has shown that GPs prescribe anti-dementia drugs less frequently than neurologists, and that they tend to be less informed about the treatment options. The analysis was based on longitudinal health claims data from the largest public health insurer in Germany, the AOK, which followed insured individuals with an incident dementia diagnosis in 2006 until the end of 2008. Surprisingly, the empirical evidence suggested that the patients who were receiving anti-dementia drug treatment were at increased risk of SLTC. This may be because the patients who were receiving the drug treatment, which is generally administered at a later stage of the disease, had more severe forms of dementia. In line with the hypothesis, it appeared that patients who were first diagnosed by an NP had a significantly reduced risk of qualifying for SLTC compared to patients who received their first diagnosis from a GP. Despite the initial assumption, this difference was not attributable to differing anti-dementia drug prescription patterns, which were controlled for in the

analysis. One explanation for the advantage observed among the patients diagnosed by an NP may be that they received more appropriate treatments beyond dementia drugs. Another explanation is that GPs may have difficulties in diagnosing mild dementia cases, and thus diagnoses are delayed to a later, more severe stage. In other words, the patients of both the NPs and the GPs survived the same amount of time with long-term care, but the NP patients were diagnosed earlier and their LTC-free survival time appears to have been longer. Determining which of the two explanations is correct will require further analysis, and will probably involve differentiating between the types of anti-dementia drug prescribed, as well as between the SLTC levels patients are granted. If GPs diagnose dementia at a later stage, then the physical limitations of the dementia patient will be more severe, and higher SLTC levels will be granted. This would indicate that a diagnosis by an NP does not translate into an advantage for the patient. The result would then simply reflect how the German health care system works, and how dementia patients are channeled to GPs and NPs according to the severity of their dementia symptoms.

5.3 Migrant health in Germany

The physical health of Turkish nationals living in Germany has been found to be worse than that of native Germans, even though their life expectancy appears to be the same or higher. The extent to which these findings are attributable to the poor quality of the data on migrants in the official German Registry of Foreigners remains unclear. The first article by Marie Carnein and co-authors represents a new attempt to determine the life expectancy of Turkish migrants living in Germany, and to combine this information with survey data from the Gender and Generations Survey 2005 on health. The data for the life table calculations came from the Central Register of Foreigners 2005/06. Turkish migrants were defined by nationality, which is the only information available in the official data. The article opens with a careful discussion of the quality of the data. The authors noted that there may be biases in the official data on the stock of migrants due to the decentralized collection of data and the failure of migrants to report when they are leaving the country. The number of deaths may also be biased due to the non-reporting of the death of a foreign resident abroad. A combination of these two factors may lead to a downward bias in the mortality rate of migrants. Indeed, the authors found that the partial life expectancy between ages 50 and 79 of Turkish migrant men was more than one year higher than that of their native German counterparts, while the life expectancy of Turkish migrant women was around six months higher. However, the subjective health of the migrants measured in terms of limitations in the ability to carry out normal everyday activities (GALI) was worse. The authors concluded that the health gap between native Germans and migrants was not the result of differences in socioeconomic composition, as the gap remained even when the logistic regression models controlled for its influence. A series of possible factors reflecting the migration and the integration process were tested, as were factors that were unrelated to the experience of migration. Among them were access to coping resources, like family networks or financial well-being, which were found to reduce limitations among both Turkish migrants and native Germans. The German 2011 census provides new opportunities for making better estimates of the life expectancy of migrants on the basis of nationality. Future calculations should use the population data from the census to estimate death rates. The reliability of the high life expectancy levels for Turkish migrants reported in this study could then be tested.

The second article, which was by Nadja Milewski and a co-author, extended the question of migrant health to the mental health dimension and to different migrant groups. In this article, migrants were defined by their own migration background. The aim of the study was to explore whether international migrants and non-migrant Germans differed in their self-evaluation of mental health, and, if so, why. The study also looked at the question of whether migrants are positively or negatively selected according to their mental health. Contradictory hypotheses exist, with some authors arguing that most migrants are socially underprivileged, and that their mental health status is therefore worse; and other researchers pointing out that that migrants are positively selected by good physical health, which should be a reflection of their mental health. The study focused on health in the second half of life by following women and men born between 1922 and 1950 during the years 2002 to 2010 using data from the German Socio-economic Panel Study. Mental health was measured according to the SF12 scale, using the items that address the mental dimensions of health. The results of the panel regressions showed that migrants from Turkey, migrants from southern and southeastern European countries, and asylum seekers rated their mental health lower than native Germans; and lower than members of other migrant groups, who are mainly from other European or industrialized countries. Socioeconomic factors were important determinants of mental health, and contributed to the worse mental health rating of migrants. However, these factors could not fully explain the migrants' disadvantage relative to native Germans. Integration experiences may differ based on individual characteristics, but at a macro level, circumstances such as the general societal climate towards migrants groups, legal changes, and the strength of the economy may also vary. Future research should take these macro factors into account and explore their effects on migrant health and well-being.

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References

Christensen, K.; Doblhammer, G.; Rau, R.; Vaupel, J. W. (2009): Ageing populations: the challenges ahead. In: *The Lancet* 374, pp. 1196-1208.

Doblhammer, G.; Ziegler, U.; Muth, E. (2009): Trends und Muster in Lebenserwartung und Gesundheit und Prognose der Demenzerkrankungen in Deutschland bis 2050. In: Kumbier, E.; Teipel, S. J.; Herpertz, S. C. (Eds.): Ethik und Erinnerung. Zur Verantwortung der Psychiatrie in Vergangenheit und Gegenwart: Papst Science Publishers, pp. 91-108.

Fennelly, K. (2005): The 'Healthy Migrant' Effect. In: *Healthy Generations* 5 (3), pp. 1-4.

Kibele, E. U. B.; Jasilionis, D.; Shkolnikov, V. M. (2013): Widening socioeconomic differences in mortality among men aged 65 years and older in Germany. In: *Journal Epidemiol Community Health* 67, pp. 453-457.

Klein, T. (1996): Mortalität in Deutschland. Aktuelle Entwicklungen und soziale Unterschiede. In: Zapf, W.; Schupp, J.; Habich, R. (Eds.): Lebenslagen im Wandel. Sozialberichterstattung im Längsschnitt. Frankfurt am Main: Campus, pp. 366-377.

Krieger, N. (2008): Proximal, Distal, and the Politics of Causation: What's Level Got to Do With It? In: *American Journal of Public Health* 98 (2), pp. 221-230.

Kroll, L. E.; Lampert, T. (2009): Soziale Unterschiede in der Lebenserwartung. Datenquellen in Deutschland und Analysemöglichkeiten des SOEP. In: *Methoden - Daten - Analysen* 3 (1), pp. 3-30.

Mäki, N.; Martikainen, P.; Eikemo, T.; Menvielle, G.; Lundberg, O.; Östergren, O. et al. (2013): Educational differences in disability-free life expectancy: a comparative study of long-standing activity limiation in eight European countries. In: *Social Science & Medicine* 94, pp. 1-8.

Muennig, P.; Fahs, M. C. (2002): Health Status and Hospital Utilization of Recent Immigrants to New York City. In: *Preventive Medicine* 35, pp. 225-231.

Muth, E.; Kruse, A.; Doblhammer, G. (2008): Was das Leben Jahre kostet. Verhalten und soziale Bedingungen beeinflussen die Lebenserwartung von Älteren. In: *Demografische Forschung* 5 (3), pp. 1-2.

Ng, E. (2011): The healthy immigrant effect and mortality rates. In: *Health Reports* 22.

Rumbaut, R. G. (1997): Paradoxes of Assimilation. In: *Sociological Perspectives* 40 (3), pp. 483-511.

Singh, G. K.; Siahpush, M. (2001): All-Cause and Cause-Specific Mortality of All-Cause and Cause-Specific Mortality of Immigrants and Native Born in the United States. In: *American Journal of Public Health* 91 (3).

Statistische Ämter des Bundes und der Länder (2010): Demografischer Wandel in Deutschland. Auswirkungen auf Krankenhausbehandlungen und Pflegebedürftige im Bund und in den Ländern. Edited by Statistische Ämter des Bundes und der Länder. Wiesbaden.

Verbrugge, L. M.; Jette, A. M. (1994): The disablement process. In: *Social Science & Medicine* 38 (1), pp. 1-14.

Welfare state and disability. The relationship between stroke and disability depends on the health care system

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Abstract

Europe will be faced with an aging population, and thus with a growing incidence of stroke. Reducing the impact of stroke on limitations in daily activities could be an important part of a broader strategy to confront the challenges associated with future demographic shifts, as it would help to minimize the increase in the number of older people with these disabilities.

This study investigated country-level differences in Europe in the effect of stroke on disability in activities of daily living (ADL) using multilevel logistic regression models with data from the fourth wave of the Survey of Health, Ageing and Retirement in Europe. The pattern of the disabling impact of stroke was clustered regionally in Europe. The western and southern European countries formed two distinct, largely homogenous groups. Western European countries performed better than southern European countries. Among the northern countries, Sweden showed the best results while Denmark's performance was more similar to that of the southern countries. In Italy, stroke was associated with nearly four times the disability risk as in Sweden; and in Spain, the disability risk was three times as high as in Sweden. Even in countries like Germany or the Netherlands and the remaining western European region, stroke was associated with more than double the risk found in Sweden. To put these results in context, in Sweden, the impact of stroke on disability was even lower than the impact of diabetes. In western Europe, stroke increased the disability risk about as much as a depression, while the southern European countries had an increased ADL-disability risk comparable to 20 additional years of age.

Future research should concentrate on investigating the causal pathways in relation to the specific properties of health care systems, thereby identifying opportunities for targeted reform. This may help to decrease the inequalities found in the disabling effects of stroke, especially in the southern countries. To address the causes of disability in addition to stroke, and to further equalize the chances of having a healthy life in older age among Europe's aging population, the efforts of policy makers could be rooted in preventing the further spread of socioeconomic inequity and inequality.

1 Introduction

The absolute and relative number of older people in industrialized countries has increased in the last couple of decades due to rising life expectancy and low fertility (Christensen et al. 2009). Thus, issues concerning the health of the older population have attracted considerable attention in recent years. Institutional welfare, pension, and health care systems need to be adapted to cope with the growing number of retirees and the changing demand for medical services associated with this demographic shift (Schulz et al. 2004).

These changes also affect informal care patterns and the total care workload of families (Haberkern and Szydlik 2008). The ageing of the population (Christensen et al. 2009) leads to a greater number of older people afflicted with some form of chronic disease or other constraint on leading an independent life, which are the main causes of physical disability (Puts et al. 2008; Fried 1999). Therefore, not only developments in morbidity, but also in disability are of interest in assessments of later-life health. From an individual perspective focused on quality of life and overall well-being, as well as from a broader perspective focused on additional pressures on welfare systems, it is desirable to keep the aging population free from disability as long as possible and the need for formal and informal care as low as possible (Pluijm et al. 2005). Stroke is an important cause of functional disability that is expected to become more prevalent in the coming years (Ringelstein et al. 2007; Hoeymans et al. 2012, p. 165). In addition, as rates of survival after stroke have increased in recent years, more cases of disability related to stroke can be expected (Doblhammer et al. 2012; Deeg et al. 2013).

Therefore, we focus on stroke as a driver of older-age disability and assess whether there are country-level differences in its impact on disability in European countries.

The article is organized as follows. First, we give an overview of previous research on population-level health inequalities and their causes, including explanations involving the welfare regime perspective. We then explain why we focus on the comparison of the impact of stroke on disability from a comparative perspective. In chapter 2, we present our data, variables, and methods. In chapter 3 we report our results, which we then discuss in chapter 4.

1.1 State of research: health inequalities

Previous studies investigating aspects of health at older ages, specifically the prevalence of disease and its detrimental impact on physical function from a comparative perspective, have shown signs of inequalities in Europe. These inequalities have been found both in comparisons of population health measures between countries, and in health measures within countries that translate into country-level differences. For instance, Ploubidis et al. (2012) reported a north/south gradient for a measure of later life health in Europe modeled as a latent variable combining a total of nine self-rated and observer-measured health indicators, in which Scandinavian and western European countries (with considerable variation within this group) showed the best population health, while countries in the south exhibited the worst population health. Minicuci et al. (2004) compared the prevalence of disability in daily living activities and found that its prevalence is lower among seniors in the Netherlands than in Spain and Italy. Other studies posited lesser amounts of inequality for some northern or western European countries (Chung and Muntaner 2007; Eikemo et al. 2008) than elsewhere in Europe (Rostila 2007). Brennenstuhl et al. (2012) concluded in their literature review of health differences in Europe that the results of studies which either compared population health or tried to link welfare regimes or different measures of socioeconomic inequalities to health outcomes did not provide unambiguous conclusions regarding the relationship of the welfare regime and health outcomes because of the mixed nature of the results. They also noted that the results varied strongly depending on the measure of socioeconomic inequality or health outcome used, and that none of these previous studies focused solely on the disabling impact of a single disease, but rather compared net outcome measures.

A broad body of literature that has tried to explain such mixed results in terms of inequalities in health outcomes is available. Mackenbach (2012) pointed out that, even for western European nations commonly regarded as prosperous and developed in terms of welfare arrangements, socioeconomic stratification as measured by education, occupation, or income systematically translates into morbidity inequalities, regardless of the strength and scope of redistributive schemes, and even independent of the degree of equality of health care access. Eikemo et al. (2008) agreed with this conclusion. Minicuci et al. (2004) argued in a somewhat similar manner, pointing to marked differences in educational status between northern and southern European countries, which translate into differences in occupational and economic status, which are themselves determinants for health outcomes, and which are also related to individual lifestyle, health care utilization, and risk behavior. Avendano et al. (2009) emphasized that, for southern European countries, the association of socioeconomic status and education level with health status is especially strong, leading to less favorable results in the south. He concluded that, because there is less variation in these determinants in northern and western Europe, health inequalities are smaller in these countries than in the southern countries. But as in the rest of Europe, within the northern region, socioeconomic inequalities translate into health inequalities, as Lahelma and Lundberg (2009) have shown.

However, the question remains whether country differences in health are a genuine effect of different welfare regimes, or just the result of different compositions of influential determinants like socioeconomic status in the respective countries. Wendt (2009) observed in summary that most of the studies that have investigated welfare regime effects on health outcomes have attributed only a small part of the health variations between countries to welfare regime effects.

While no clear view on the relationship between welfare regimes and health outcomes has emerged in the literature, the diagnosis of health inequalities within European countries holds over time. Kunst (2005, p. 303) concluded that "socioeconomic inequalities in self-assessed health showed a high degree of stability in European countries."

Aside from describing health status as a consequence of socioeconomic position, various other explanations of the origins of health outcome differences have been offered. Minicuci et al. (2004), Plujim et al. (2005) and Rostila (2007, p. 235) argued in a similar vein that "[t]here could be crucial cultural differences in the way people of different nationalities and with different languages perceive their own health status and interpret questions about health and well-being." Thus, varying definitions of what actually constitutes a disability might influence reported levels of disability. Another potential problem which is, unfortunately, hard to assess is a tendency among older people to overreport their degree of physical limitations out of fear of losing the disability benefit payments they need to supplement their pensions. In addition, in countries where intra-familiar support is culturally valued and individually available, there might be a greater willingness to admit to having a disability, whereas in countries with cultural norms of independence and a tendency to underplay disabilities, there might be an underreporting of factual disability prevalence; with each behavior potentially clustered regionally (Minicuci et al. 2004).

1.2 State of research: welfare and health care regime typologies

Most researchers who compare health inequalities across European countries try to determine whether their results can be seen in terms of geographic proximity or the

similarities of the relevant institutions. Thus, most directly use or at least refer to welfare regime theory when explaining the different patterns of health across Europe. Welfare regimes are situated at an important intersection between the individual and social spheres, as they regulate and distribute the provision of goods such as wealth, status, social services, and, importantly, health care access and services; based on different paradigms between universal and equal entitlement and the corporatist allocation of individual claims derived from socioeconomic status.

The Esping-Andersen typology, which was first introduced in 1990, is still widely recognized. Esping-Andersen (1990) argued that Europe's welfare regimes can be analytically divided into *three worlds of welfare capitalism*: the liberal, social democratic, and conservative regime types. His view on welfare regime types focused on the degree of the decommodification of labor: that is, the extent to which a regime enables an individual to sustain a certain commonly acceptable standard of living without necessarily relying on the (labor) market, but rather on redistributive transfers from society as a whole. Thus, social stratification, at least from a financial perspective, is influenced by the welfare regime to varying degrees. The liberal welfare state mostly relies on individual market earnings and pension planning, only providing a means-tested basic standard of support. Thus, it is the provision of baseline security and not the reduction of inequality that the liberal state seeks to achieve. The social democratic state, on the other hand, focuses its efforts on providing equity and a just distribution of the resources needed to meet the needs that arise during the life course. In addition to establishing financial redistributive measures, the social democratic state provides a wide range of universally accessible social services, such as education, care for children and older people, and health care services. Between these types, Esping-Andersen placed the conservative welfare regime, which also provides a plethora of social services. But rather than focusing on equal access, conservative welfare states tend to replicate the existing social stratification, by, for example, linking pension levels to wages earned from the previous position in the labor market. Given the importance of the relationship between socioeconomic status and health, it could be argued that, as comparable welfare regimes redistribute resources which influence health status in a similar manner, they should also have comparable health outcomes.

While Esping-Andersen's typology has proven to be very useful as a framework for the study of all kinds of welfare regime effects, it lacks explanatory power concerning two aspects from the perspective of our study. First, the southern European countries are hard to place in the existing original framework (Ferrera 1996), and second, more importantly, a distinction should be made between the redistributive and social service aspects of welfare regimes and the subset of policies that constitute the health care system. Jensen observed that a distinction between general social services and health care provision is preferable to a direct application of the welfare regime framework for health outcome analyses, because health care expenditures are very similar across European countries, "while expenditure on social care services conforms to the regime typology of Esping-Andersen," (Jensen 2008, p. 151) leading him to posit that "health care seems disconnected from the traditional welfare state concepts." (Ibid., p. 152) Jensen concluded that analyses using classic welfare regime typologies to investigate health differences do not fare well because, in terms of expenditures, there are no distinct "regimes to be found." (Ibid., p. 156) Other researchers have reached similar conclusions about the applicability of the classic welfare regime framework in comparisons of health outcomes, pointing out that this framework may be a good tool for pinpointing differences in relative deprivation regarding wealth and poverty,

but is less useful in understanding health care provision, since there has been a convergence in the levels of overall health expenditure per capita across Europe (Lahelma and Lundberg 2009). Of course, this tendency toward harmonization mainly pertains to an aggregate mean of the financial input side, and ignores determinants of individual access and utilization, as well as other finer points of health care system characteristics. Thus, differences in other aspects of the health care system remain that should not be ignored. Several contributions, such as that of Wendt (2009), have noted the shortcomings of classical welfare regime theory in analyzing health outcomes, and have therefore focused on disentangling welfare regime characteristics from health care properties, taking into account the specifics of access regulation. In addition to taking health expenditure per capita (as percentage of gross domestic product or the fraction of out of pocket payments out of total health expenditure) into account, Wendt included measures of inpatient and outpatient health care provision, health care access entitlement, incentives for medical practitioners that might influence their behavior, and different aspects of access regulation and financial obstacles that might prevent direct contact with specialists (Wendt 2009). This refined analytical framework can be used to reveal the differences that exist beneath what appears to be a uniform pattern of European health care spending.

The application of health care system typologies, such as the one provided by Wendt, produces clustering that is generally in line with the classic welfare regions. For example, in his cluster analysis, the western European region encompasses the same countries as in previous welfare frameworks: i.e., the German-speaking countries, Belgium, and France. In the countries in this cluster, there are few to no restrictions in access to specialists, high levels of total health expenditure (most of which are publicly funded), and moderate private copayments. Another cluster includes the northern European countries of Sweden and Denmark, but also Italy. Relative to countries in the previous cluster, these national health service type countries have lower levels of health expenditure, lower levels of outpatient care, and strict regulations regarding access to doctors. Spain is placed in a third cluster together with Finland and Portugal. The countries in this cluster share low levels of health expenditure and high shares of private copayments, once again combined with dense regulations regarding specialist access and selection (ibid.). Thus, the European countries vary greatly, in terms of both their broad welfare regimes and the specific characteristics of their health care systems. These two typologies may be relevant in attempting to explain the ways in which people use the medical services that affect health outcomes, such as disability.

1.3 Why investigate a disability gradient for stroke?

Stroke is in large part a consequence of high blood pressure and atherosclerosis. Over the life course, accumulating deposits in arteries can block the blood flow and oxygen supply of vital organs. If this happens in blood vessels in the brain, a stroke can occur. Another cause is the rupturing of vessels. Because of its etiology, stroke has a sudden onset, and is more likely to occur in individuals who have an unhealthy lifestyle and who are older. If a stroke is not lethal, it leads to varying degrees of disability, depending on the time that elapses between the onset and the initial treatment, and the general level of medical care and recovery measures the individual subsequently receives (Ringelstein et al. 2007). As the areas of the brain that are most affected by a stroke control the motor and cognitive functions (Fried et al. 1994), patients may face limitations in performing self-care and the higher function tasks of daily living (Fried 1999). These drastic consequences make stroke

an interesting disease to examine in a study such as this one. Stroke occurs frequently enough to be represented in sufficiently large numbers in the population, and it also leads to severe limitations in activities of daily living in the absence of other constraining diseases.

Given of the general aging trend, and the general expectation that no major change in stroke incidence is likely, most researchers anticipate that stroke will be an increasing problem going forward. All over Europe, mortality caused by stroke and other cerebrovascular diseases is decreasing, not primarily because of lower incidence, but because the chances of surviving and the time of survival after the onset have increased. This means that cerebrovascular conditions, and specifically stroke, will increasingly become major drivers of long-term disability in older age (Doblhammer et al. 2012). Medical research is currently focused on reducing the disability risk following a stroke by means of innovative treatments, both pharmacological and otherwise (Hennerici et al. 2013). The findings have so far indicated that new, relatively low-risk clot-busting drug treatments can significantly improve disability and quality-of-life outcomes for one and a half years or longer, if they are administered quickly enough (The IST-3 coll. group 2013). The immediate management of the pre-hospital stroke response, which should provide a combination of the most effective treatments administered as quickly as possible, remains an important area of research. There is still considerable room for improvement in this area, and innovations in treatments will be needed (Fassbender et al. 2013). Thus, despite encouraging results in quick-response management and treatment options, stroke will continue to be a major cause of disability in the future. Therefore, comparative findings regarding the disabling impact of stroke will continue to be useful (Ringelstein et al. 2007).

Focusing on stroke, while still accounting for other health indicators and causes of disability, allows us to assess to what degree European welfare regions differ in terms of the moderating effects between disease and disability. In essence, we narrow our take on welfare regime effects from a broad comparison of, for example, disability prevalence across European countries, to the consequences of a single chronic disease in order to show whether, and to what degree, the outcomes differ.

Moreover, we can analyze to what extent the general variation in disability across Europe depends on the country of residence, all other things being equal.

If we can show that the impact of a chronic disease such as stroke on the ability to perform daily routine tasks varies between European welfare systems as an independent effect not caused simply by the compositional differences of the various populations, we might be able to recommend health care reform policies based on best practice models that can help to create a healthy, disability-free aging European society. By focusing on disability as related to a specific disease such as stroke, it might also be possible to provide more specific insights into the disease-disability relationship, rather than to simply point out gross differences in levels of disability in activities of daily living.

Based on the previous discussion, we develop the following hypotheses:

1) Controlling for relevant determinants, including stroke, as causes of disability, differences in levels of disability in activities of daily living exist across European countries, and the patterns are similar to those of previously developed welfare regime typologies.
2) Given that in the aftermath of stroke, health care utilization is especially frequent, differences in the impact of stroke on disability in activities of daily living are especially pronounced, and the patterns are similar to those of established welfare regime typologies.

2 Data and methods

2.1 Data

This analysis is based on the Survey of Health, Ageing and Retirement in Europe (SHARE), a multidisciplinary panel study of the life courses, health, and economic situations of Europeans ages 50+. It contains a broad selection of useful information, including details on health, care need, disability, family structure, finances, and demographics. This study primarily uses SHARE's most recent fourth wave, which was collected in 2011/12.[1] The average household response rate was at about 50%, while the average individual response rate was around 44% (Kneip 2013). Data from individuals ages 60 or older from Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, Spain, Sweden, and Switzerland are used.

Table 1: Sample size documentation

Coverscreen wave 4	83854
Reduction to wave 4 interviews	-24696
	59158
Reduction to countries in study	-22532
	36626
Missing information (year of birth)	-12
	36614
Reduction to desired age group (60+)	-11692
	24922
Reduction to population not in nursing homes	-291
	24631
Missing information (household structure)	-31
	24600
Removal of shortened end of live proxy interviews (remove deceased cases)	-800
	23800
Missing information for outcome variable ADL disability	-119
	23681
Missing information for independent variable Euro-D depression indicator	-11
	23670
Missing information for independent variable number of contacts with medical practitioner	-29
Final sample size	23641

Source: SHARE wave 4

[1] SHARE wave 1, conducted in 2004/05, was used for sensitivity analyses; as was wave 2 collected in 2006/07.

Out of 24,922 respondents meeting these criteria, 291 nursing home residents were excluded from our analyses, and 31 respondents were excluded due to missing basic information on household composition. Another 800 cases were end-of-life proxy interviews and therefore had to be dropped as well. Of the remaining cases, 119 had missing data on the dependent variable ADL disability, while another 11 cases were removed due to missing information on the depression scale. Finally, in 29 cases the respondent did not answer the questions regarding the consultation of medical practitioners. This left us with a final sample of 23,641 cases from 10 countries.

SHARE's sampling method generally aims for representativeness of the community-dwelling population ages 50 or older and their spouses of any age, in which both partners in each couple speak at least one common language of the respective country. The respondents who were interviewed in nursing homes result from panel follow-up or are located in the few countries where population registers could be used for the sample generation. The numbers and the degree of representativeness of the institutionalized respondents were far from sufficient to allow us to include them in this analysis (Lynn et al. 2013). Although this is the case in most studies based on survey data, by excluding people living in institutions such as nursing or retirement homes, the possibility of a healthy elderly bias is introduced, as individual health and care requirements are among the main reasons why people move to a care facility, stroke being a prime example (Schram et al. 2008). The number of nursing home beds per capita varies considerably among European countries[2], with Spain and Italy providing up to about 500 beds per 100,000 citizens, while Sweden offers about triple that number. This results in shares of up to 10% of the older population living in institutions, especially in the northern and western European countries, while the institutionalization rates are very low in southern Europe. It is also important to note that, as healthy individuals are more likely to participate in a rather lengthy survey than health-impaired individuals or people of high ages, the potential problem of bias goes beyond the population living in retirement homes. We aim to address this problem using a control variable, as described below.

We used variables at the individual level as well as at the country level. For the descriptive results in the following chapter as well as in Table 2, we categorized the regions as follows: northern Europe includes Sweden, Denmark, and the Netherlands; western Europe is comprised of Belgium, France, Austria, Germany, and Switzerland; while Spain and Italy make up the southern European region. Results of chi²-test for independence between the northern, western and southern regions are shown in the last column of Table 2. First, we describe the variables set at the individual level, beginning with the dependent variable: namely, the health outcome as measured by disability in the activities of daily living (ADL).

2 See WHO European health for all database (HFA-DB) indicator 5100 at http://data.euro.who.int/hfadb/

Table 2: Descriptive overview of included variables (% and 95% CI; chi² test for independence between regions)

	Northern Europe	Western Europe	Southern Europe	All regions	Chi² test statistic p-value
ADL disability					
no	90.6 [89.9 – 91.2]	86,6 [86,0 – 87,2]	84,1 [83,1 – 85,2]	87,3 [86,9 – 87,7]	115,51
yes	9.4 [8.8 – 10.1]	13,4 [12,8 – 14,0]	15,9 [14,8 – 16,9]	12,7 [12,3 – 13,1]	p < 0,0001
Stroke					
no	95.1 [94,6 – 95,6]	95,2 [94,8 – 95,6]	95,7 [95,1 – 96,3]	95,2 [95,0 – 95,5]	2,73
yes	4.9 [4,4 – 5,4]	4,8 [4,4 – 5,2]	4,3 [3,7 – 4,9]	4,7 [4,5 – 5,0]	p = 0,26
Age (categorized)					
60 – 64	27.9 [26,9 – 29,0]	27,0 [26,2 – 27,8]	23,3 [22,2 – 24,6]	26,6 [26,0 – 27,1]	104,40
65 – 69	24.9 [23,9 – 25,9]	22,1 [21,4 – 22,9]	21,4 [20,3 – 22,6]	22,8 [22,3 – 23,4]	p < 0,0001
70 – 74	18.0 [17,1 – 18,9]	20,5 [19,8 – 21,2]	20,5 [19,4 – 21,7]	19,8 [19,2 – 20,3]	
75 – 79	13.0 [12,3 – 13,8]	14,0 [13,4 – 14,7]	17,2 [16,2 – 18,3]	14,4 [13,9 – 14,8]	
80 – 84	9.3 [8,6 – 10,0]	10,0 [9,5 – 10,6]	10,5 [9,6 – 11,3]	9,9 [9,5 – 10,3]	
85 +	6.8 [6,2 – 7,4]	6,3 [5,8 – 6,7]	7,0 [6,3 – 7,7]	6,6 [6,3 – 6,9]	
Gender					
female	53,2 [52,1 – 54,4]	53,9 [53,0 – 54,8]	53,2 [51,8 – 54,6]	53,6 [52,9 – 54,2]	1,16
male	46,8 [45,6 – 48,0]	46,1 [45,2 – 47,0]	46,8 [45,3 – 48,2]	46,4 [45,8 – 47,1]	p = 0,56
Marital status					
single/widowed	27,8 [26,7 – 28,8]	30,9 [30,0 – 31,7]	23,8 [22,6 – 25,0]	28,5 [28,0 – 29,1]	85,02
living with spouse/partner	72,2 [71,2 – 73,3]	69,1 [68,3 – 70,0]	76,2 [75,0 – 77,4]	71,5 [70,9 – 72,0]	p < 0,0001
Living distance of closest child					
no (living) child	7,6 [7,0 – 8,3]	11,9 [11,3 – 12,5]	9,1 [8,3 – 10,0]	10,1 [9,7 – 10,5]	1794,31
same household/ building	19,8 [18,9 – 20,7]	23,2 [22,4 – 24,0]	48,9 [47,5 – 50,4]	27,3 [26,8 – 27,9]	p < 0,0001
> 1 to 5 km	36,1 [35,0 – 37,2]	32,1 [31,2 – 32,9]	29,8 [28,5 – 31,1]	32,8 [32,2 – 33,4]	
> 5 km	36,5 [35,3 – 37,6]	32,8 [32,0 – 33,7]	12,1 [11,1 – 13,0]	29,8 [29,2 – 30,3]	
Multiple strokes					
no	99,4 [99,2 – 99,6]	99,8 [99,7 – 99,8]	99,7 [99,6 – 99,9]	99,6 [99,6 – 99,7]	17,21
yes	0,6 [0,4 – 0,8]	0,2 [0,2 – 0,3]	0,3 [0,1 – 0,4]	0,4 [0,3 – 0,4]	p < 0,001
Diseases					
diabetes	11,0 [10,3 – 11,7]	12,7 [12,1 – 13,3]	18,4 [17,3 – 19,5]	13,3 [12,9 – 13,8]	143,29; p < 0,0001
hypertension	38,3 [37,2 – 39,5]	40,0 [39,1 – 40,9]	45,3 [43,8 – 46,7]	40,5 [39,9 – 41,2]	59,22; p < 0,0001
asthma	1,5 [1,2 – 1,8]	1,2 [1,0 – 1,4]	-	1,1 [0,9 – 1,2]	66,46; p < 0,0001
cataract	9,8 [9,1 – 10,5]	12,3 [11,7 – 12,9]	11,1 [10,2 – 12,0]	11,3 [10,9 – 11,7]	26,63; p < 0,0001
heart attack	13,9 [13,1 – 14,7]	13,6 [13,0 – 14,2]	14,3 [13,3 – 15,3]	13,8 [13,4 – 14,3]	1,33; p = 0,52
cancer	4,3 [3,9 – 4,8]	7,0 [6,6 – 7,5]	4,3 [3,7 – 4,9]	5,7 [5,4 – 6,0]	81,15; p < 0,0001
Depression					
no	82,7 [81,8 – 83,6]	74,4 [73,6 – 75,2]	62,7 [61,3 – 64,1]	74,5 [74,0 – 75,1]	598,08
yes	17,3 [16,4 – 18,2]	25,6 [24,8 – 26,4]	37,3 [35,9 – 38,7]	25,5 [24,9 – 26,0]	p < 0,0001
Other symptoms					
no symptoms	29,9 [28,8 – 31,0]	22,3 [21,6 – 23,1]	21,1 [19,9 – 22,2]	24,3 [23,8 – 24,9]	275,08
1-2 symptoms	47,4 [46,2 – 48,5]	47,1 [46,2 – 48,0]	45,3 [43,9 – 46,7]	46,8 [46,2 – 47,5]	p < 0,0001
3 or more symptoms	22,7 [21,7 – 23,7]	30,6 [29,7 – 31,4]	33,6 [32,3 – 35,0]	28,8 [28,2 – 29,4]	

	Northern Europe	Western Europe	Southern Europe	All regions	Chi² test statistic p-value
Education					
low	40,5 [39,3 – 41,6]	33,6 [32,8 – 34,5]	80,7 [79,5 – 81,8]	45,1 [44,4 – 45,7]	
average	26,7 [25,7 – 27,7]	38,6 [37,7 – 39,5]	10,1 [9,2 – 10,9]	29,3 [28,8 – 29,9]	
high	30,5 [29,4 – 31,5]	26,2 [25,4 – 27,0]	6,7 [6,0 – 7,4]	23,6 [23,0 – 24,1]	3440,25
missing	2,4 [2,0 – 2,7]	1,6 [1,3 – 1,8]	2,5 [2,1 – 3,0]	2,0 [1,8 – 2,2]	p < 0,0001
Contacts with medical doctor in the past year					
0 to 5 contacts	74,5 [73,5 – 75,5]	54,6 [53,7 – 55,5]	47,4 [45,9 – 48,8]	59,1 [58,5 – 59,7]	1062,88
> 5 contacts	25,5 [24,5 – 26,5]	45,4 [44,5 – 46,3]	52,6 [51,2 – 54,0]	40,9 [40,3 – 41,5]	p < 0,0001
Area of building					
city/suburbs/town	55,5 [54,3 – 56,6]	31,6 [30,7 – 32,4]	37,7 [36,3 – 39,1]	40,0 [39,3 – 40,6]	1088,98
small town/rural	39,2 [38,0 – 40,3]	62,0 [61,1 – 62,9]	55,3 [53,9 – 56,7]	53,8 [53,2 – 54,4]	p < 0,0001
missing information	5,4 [4,8 – 5,9]	6,4 [6,0 – 6,9]	7,0 [6,3 – 7,7]	6,2 [5,9 – 6,5]	

Source: own calculations

2.2 Health outcome: ADL disability

Since SHARE focuses on the aging population, it includes a rather extensive questionnaire on self-assessed and physician-diagnosed individual health status, as well as a standardized set of questions concerning the level of difficulty with activities of daily living. The ADL disability indicator is a binary variable based on the following activities: dressing (including putting on shoes and socks), walking across a room, bathing or showering, eating (such as cutting up food), getting in and out of bed, and using the toilet (including getting up or down). For each of these activities, the respondent is asked whether he has any difficulties because of a physical, mental, emotional, or memory problem. Respondents who admit to having limiting and longer-lasting difficulties in at least one of these activities are classified as ADL disabled.

Although 141 respondents did not answer this set of questions, it was possible in 22 of these cases to determine their ADL status using the item for self-perceived health as a proxy. Respondents who chose the worst possible health rating were classified as ADL disabled, whereas all respondents with a better than the worst self-rating were classified as not disabled in daily activities. The remaining 119 cases with missing information on ADL and self-perceived health were excluded.

Over all of the welfare regions, 12.7% of the sample reported having at least one ADL disability. Broken down by region, the results showed that 9.4% of respondents in the north had an ADL disability, compared with 13.4% in the western region and 15.9% in the southern region.

2.3 Determinants of health

2.3.1 Socio-demographic information

We used a set of socio-demographic variables comprised of individual characteristics and social support indicators as control variables for the multivariate analyses. They included age as a categorical variable (in six age groups: 60-64, 65-69, 70-74, 75-79, 80-84, 85 and

older) and binary variables for sex and partnership status (living as single or living with a partner/spouse). Overall, 28.5% reported living as single, although the share was slightly lower in the southern region, where 23.8% of respondents said they lived as single.

Education was used as a categorical variable grouped into low, medium, and high educational attainment based on the International Standard Classification of Education (ISCED-97) and a category for missing information. The lowest category includes individuals who obtained basic education up to eight years without further vocational training, or secondary education only. Respondents with secondary educational degrees (mostly of the kind that serve as a qualification for enrolling in college or university) and who had completed a vocational training course of about three years or more are classified as being at the medium level. The highest category is comprised of all respondents whose qualifications include a higher vocational degree or a college or university degree. If a respondent obtained more than one educational degree, only the highest is considered. Over all of the regions, the lowest category was the most common, with 45.1% of respondents having a low level of education. Meanwhile, 29.3% had a medium level of education and the remaining 23.6% had a high level of education. However, there were differences between the regions. The northern countries had the highest and the southern regions had the lowest shares of respondents with high educational status, of about 30.5% and 6.7%, respectively. The findings further indicated that 80.7% of the southern subsample fell into the lowest educational category, compared to 40.5% in the northern region and about 33.6% in the western countries.

The financial situation of each respondent is included as a three-fold categorical variable. In cases of missing information, we used the average of the five imputations SHARE provides for each respondent. The total values of financial reserves were split into terciles separately for each country. Thus, we obtained a country-specific measure for each respondent's financial situation. While by design this variable did not lend itself to descriptive inter-country or inter-regional comparisons, we found that, as expected, respondents in the southern countries had lower financial reserve levels than respondents in the other regions.

Another variable included in the categorical form was the distance to the closest living child, with four possible values. These were no living child, a child who is co-resident in the same household or building, a child living within a distance of between one to five kilometers, and a child living more than five kilometers away. Overall, the most frequent response was a child living between one and five kilometers away. A closer look reveals that cohabitation was common in the southern countries, where 48.9% of respondents reported that at least one of their children was living in their household or building. By contrast, in the northern countries, this was the case for about 20% of respondents. In the northern and western regions, the distance to the closest child was most likely to be greater than five kilometers.

We also included a categorical variable containing information on the area in which the respondent's place of residence is located within the categories of city, suburbs, or larger town; small town or rural area; and missing information. In total, a majority of respondents were living in small towns or rural areas (53.8%), while 40% were located in cities, towns, or suburban areas. The remaining 6.2% fell into the missing category.

2.3.2 Health situation

We included a zero-one variable for stroke (respondent did not suffer a stroke vs. respondent had one or more strokes, including cases with multiple strokes) and another binary variable that indicated only the cases with multiple strokes. To collect information on stroke as well as on the other chronic diseases, the respondents were asked whether a doctor had told them they had or have the specific condition, and whether they are being treated for or bothered by the condition.[3] Therefore, the data collected only covers specifically diagnosed and/or treated conditions. In the case of stroke, the question referred to stroke or cerebral vascular disease. Among the respondents who had suffered a stroke, 16% received help in answering the questions from another person present. Among the remaining cases, about 4% received help. Overall, 4.7% of respondents had experienced at least one stroke.

The frequency of medical consultations with a general practitioner or specialist (excluding dentists) was included as a binary variable, separating zero to five contacts per year from more than five consultations per year. In total, 59.1% of the sample fell into the former category of up to five medical consultations per year. However, the frequency was found to differ between the northern and southern countries. Just 25.5% of respondents reported having six or more consultations in the northern countries, compared to 45.4% in the western and 52.6% in the southern countries.

Also included were binary variables for diabetes (13.3%), hypertension (40.5%), asthma (1.1%), cataract (11.3%), heart attack (13.8%), and cancer (all kinds, 5.7%) that were analogous to the binary variable for stroke (all values over all regions).

In addition to these chronic diseases, we controlled for the number of symptoms of other, less severe, ailments, like back, knee, hip, or joint pain; heart trouble or chest pain; breathlessness; persistent cough; swollen legs; sleeping problems; (fear of) falling down; dizziness; faints or blackouts; stomach or intestine problems; incontinence; and fatigue. These symptoms were used as a proxy for the remaining overall health situation of the respondent. This information was collected by asking the respondents whether they had been bothered by any of those conditions in the six months prior to the interview. The categorical variable distinguishes between respondents with none of these symptoms (24.3%), those with one to two symptoms (46.8%), and those with three or more of these symptoms (28.8%, overall values). On a regional level, the southern countries appeared more often in the 3+ multi-morbidity category (33.6%) than the western (30.6%) and northern (22.7%) regions.

Finally, we included a binary indicator for depression (indication or no indication) based on the EuroD depression scale, using the cut-point suggested for EuroD of four or more positives on the standard set of 12 EuroD items (respondent was asked whether he/she had experienced the following within the last month/recently: sadness or depression, pessimism about the future, suicidal thoughts, a tendency toward guilt, trouble sleeping, a general lack of interest in things, an inability to maintain interest in things, irritability, a lack of appetite, a decline in food intake, a lack of energy in general, an inability to concentrate on entertainment or reading, a general lack of enjoyment, crying). While 25.5%

[3] The wording of the question is as follows: “Has a doctor ever told you that you had/Do you currently have any of the following conditions?” One of the listed conditions was “stroke or cerebral vascular disease”. In case a respondent needed further clarification, he was told: “By this we mean that a doctor has told you that you have this condition, and that you are either currently being treated for or are bothered by this condition”.

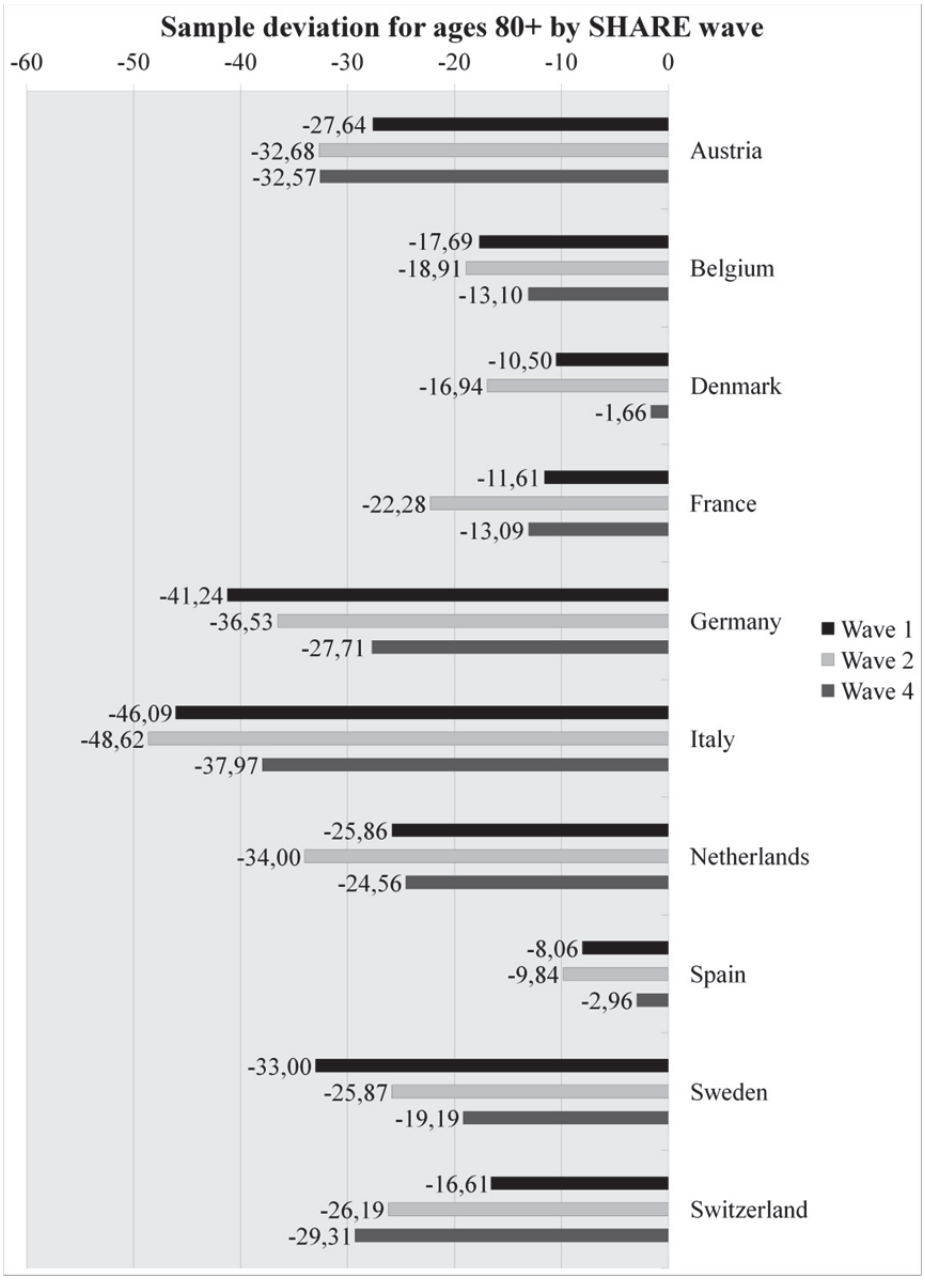
of all of the respondents showed signs of depression, differences were found between the regions, with 17.3% of respondents in the north showing signs of depression, compared to over 25.6% in the west and up to 37.3% in the south.

2.3.3 Country level

To account for the exclusion of the institutionalized population from the SHARE sample, as well as for the tendency of survey data to underrepresent the oldest age groups in general, we compared the composition of the national subsamples from SHARE to national population statistics (Eurostat, reference year 2010). First, the ratio of total population (60+) to sample size (60+) was calculated for each country. Then, the country-wise sample size was multiplied, with this factor split by age groups (60-64, 65-69, 70-74, 75-79, 80+). This allowed us to calculate the percentage of divergence between the 80+ age group of the SHARE sample we used and the total population of people ages 80 and above. This measure should have accounted for the exclusion of institutionalized people, as well as for other sampling losses. This variable was included as a percentage on the country level. We chose to concentrate on the 80+ age group because they are the primary clientele for nursing homes and are most likely to cause the sampling losses in the community-dwelling population due to ill health and other reasons for non-participation. This group might therefore influence our results. The lowest deviations were found in the Danish and Spanish subsamples, where the 80+ age group was underrepresented by about 1.66% and 2.96%, respectively. The greatest difference between the actual population and the sample was found in Italy, where the 80+ age group was underrepresented by about 38%. This contrasting result is quite surprising, given that Spain and Italy have the two lowest institutionalization rates. Up to age 74, the differences are generally rather low, and SHARE even tends to overrepresent the population between the ages of 60 and 69 in particular. The values are shown in Figure 1, which also presents similar calculations for SHARE waves 1 and 2 to illustrate the progress of the SHARE sampling from wave to wave.

This deviation measure varied rather substantially between the SHARE waves, and generally got smaller from waves 1 and 2 to wave 4. It is noteworthy that, especially relative to wave 2, wave 4 achieved much better results in terms of the representativeness of the 80+ age group in all of the countries except Switzerland.

Figure 1: SHARE sample deviation from official population statistics, age 80 plus for waves 1, 2 and 4



Source: SHARE, own calculations

2.4 Methods

All descriptive statistics that are reported at the level of welfare regions – e.g., in Table 2 and the variables chapter – showed weighted results adjusted for national sample sizes.

To examine the national-level variation – that is, the effect of differences between welfare regimes at the national level on stroke-related disabilities in activities of daily living – we used binary logistic multilevel regression. In multilevel models, individuals on the first level are grouped into countries on the second level. This allowed us not only to examine the amount of inter-group variation, but also to account for the nested data structure while controlling for the effects of all individual-level covariates on an individual's ADL disability status.

We used random effect models that included (a) a random intercept that allowed us to examine the amount of between-country variation for overall ADL disability and (b) a random slope component for the stroke variable. Therefore, all individual-level coefficients except the coefficient for stroke were found to be fixed effects; i.e., the effect of all of the individual-level variables but stroke were found to be the same for all countries in the sample. The stroke effect was composed of the fixed effect for stroke, which is the same for all countries as well, and the random part, which differs by country and was added to the fixed effect to calculate the country-specific coefficient. This random slope component allowed us to assess whether the effect of stroke on ADL varies depending on the country. In all cases, the country acted as the second level that structures the individual cases into 10 groups. The difference between the de facto population distribution and the sample population of the people ages 80 or older was included as a variable at the country level. All other variables were included on the first (= individual) level. The Stata 11.2 routine xtmelogit was used for all models.

This modeling approach results in the following regression equation for the log-odds that y_{ij} (individual *i* in group *j)* is ADL disabled:

$$\ln\frac{P(y_{ij}=1)}{1-P(y_{ij}=1)} = \hat{a}_0 + u_{1j}x_{1ij} + \hat{a}_{1i}\,x_{1ij} + \hat{a}_2 x_{2j} + u_{0j}$$

$\hat{a}_0$ is the overall intercept or constant that stands for the probability P(y_{ij} = 1) (ADL disability for individual *i* in group *j*) in the case that *x = 0* and *u = 0*; i.e., when all individual- or secondary-level explanatory terms equal zero and the random intercept component equals zero as well, as would be the case for a completely average country. In short, the equation would be reduced to P($y_{ij} = 1$) = $\hat{a}_0$.

u_{0j} is the random part of the intercept for a given country, j and is added to the overall intercept. Thus, due to the *randomly varying* value of u_{0j}, each country has its specific total intercept value. This is referred to as the group effect or random intercept.

On the individual level, $\hat{a}_{1i}$ is the coefficient of the independent variable *i* and contains the effect of a change of one unit in x_{1i} on the log-odds that y = 1, but under the condition that the group effect u is held constant (adjusted for). Thus, the value of the coefficient is the same across all countries. This is the same as in a standard one-level logistic regression model. This term would be replicated for all individual-level fixed effects in the model. For the sake of conciseness, the equation only contains this term once.

The term $u_{1j}x_{1ij}$ refers to the random slope part of the model that we use for the stroke variable. Here, we add the random term u_{1j} to the independent variable x_{1ij}. u_{1j} is the result of adding up the fixed part of the coefficient, as described above, with the group-

specific random part. Thus, as was already described for the random intercept, the resulting coefficient varies depending on the specific group j. Since the stroke variable is binary, this term either equals zero (no stroke) or takes the country-specific value shown in Figure 2. Again, the one in the subscript indicates that this term is set on the individual level.

Finally, the term $\hat{a}_2 x_{2j}$ refers to the independent variable part at the second, or group level of the model. This enables us to assess the effect of a group-level control, while still including random effects to capture the effect of unobserved group-level variables. In our model, we rely on a contextual effect when including the control variable for the divergence of the 80+ years population the SHARE sample. The two in the subscript refers to the fact that this explanatory variable is located at the second level; e.g., the percentage of divergence has the same value for all observations in a certain group, as they are all situated in the same country.

Our modeling strategy was as follows. In total, we presented three nested models. Due to their multilevel structure, all models allowed us to assess the amount of country-level effects on disability related to stroke, and related to all other characteristics except stroke. Model I included the stroke dummy, age group, and gender. This basic model mainly served as a starting point for quantifying the amount of variation present, and was also used as a comparison for the following models to assess whether and to what extent the observed variation between countries could be attributed to the characteristics that were included in the following models. Model II added information on an individual's education, financial situation, the potential for intra-familiar support, and a basic distinction of the area of residence. Here, our main intention was to assess whether the newly included variables were able to reduce the variation of disability both related and unrelated to stroke. Model III included all medical information, which we believed would contribute a major portion of the variance reduction of disability not related to stroke (later on referred to as overall between-region variation, OBRV). Since all of these variables were fixed effects, a decrease in the OBRV from model II to model III would indicate that the distribution of disability not related to stroke was rooted in the same determinants across all of the European countries we investigated. In other words, a decrease in the OBRV may be expected when the newly included variables are of explanatory power for most or all of the countries in our data for the part of ADL disability not related to stroke. Furthermore, model III included the group-level control for the sample deviation for the 80+ age group, which we included to control for possible issues related to the overrepresentation of older respondents who were not institutionalized and were otherwise healthy. This control was only included in model III because it tapped into the same general dimension as the health status variables.

All of the multilevel logistic regression models were run with ADL disability as the binary outcome variable. All of the models included a random part for the intercept and a random part for the stroke coefficient. Thus, all of the models allowed us to assess whether (1) there were between-country differences in remaining unexplained ADL disability risk, while controlling for cross-regional differences of the stroke effect; and whether (2) there were between-country differences in the specific effect of stroke on ADL disability, while controlling for all of the other causes of ADL disability, as well as for the confounders included in the model.

For each of these models we showed the amount of remaining variation between the countries regarding ADL disability, with the remaining variation indicating differences between the countries, as was posited in the hypotheses. First, we included the overall

between-region variation (OBRV), which is the variation of the random intercept, and which can be interpreted as the amount of between-country variation in ADL disability not related to the effect of stroke that is not explained by the other variables in our models. The lower the value, the better suited the individual level variables were to explaining the disability outcome, regardless of the European country in which the case was located. The higher the value, the greater the differences that were found between welfare regimes in ADL disability, despite the inclusion of the covariates. Second, we showed the stroke-related between-region variation (SBRV), which is the amount of variance of the random effect for the stroke coefficient. The SBRV showed whether and to what degree the isolated impact of stroke on ADL disability differed between countries, after controlling for all of the other variables in the respective model. The higher the value, the greater the differences in the strength of the stroke impact on ADL disability between the countries we investigated; while a low value indicated that stroke had the same effect on disability in all of the countries we observed, and could also be included as a fixed rather than a random effect.

As we added covariates to the models, comparing the amount of remaining variation allowed us to assess whether a certain block of variables was able to explain a change in the remaining variation. For instance, if additional health indicators were found to reduce the OBRV of ADL disability, it could be argued that health indicators were important determinants of disability in all of the European countries we observed.

To measure the extent to which an individual's overall odds for ADL disability (including the main effect of stroke) were determined by his country of residence in a way that allowed for a comparison of the strength of the individual covariates, we used the median odds ratio (MOR). This measure is based on the OBRV (Merlo et al., 2006) and allowed us to intuitively quantify the strength of contextual influences in the usual and easily interpretable odds ratio format. However, the MOR only showed the strength of the effect of between-country differences on ADL disability without incorporating the country-specific random part of the stroke effect. To assess if and how the impact of stroke differed between the countries, the direction and strength of each country's random effect of stroke on ADL disability are shown in the discussion of model III.

3 Results

Table 3: Odds of ADL disability. Individual and group level variables. Odds ratios and 95% CI from multilevel logistic regression.

Odds of ADL disability	Model I (no social context, no medical, stroke random effect)			Model II (no medical, stroke random effect)			Model III (all ind., stroke random effect, deviation 80+)		
Covariates *Individual level*	OR	p	95 % CI	OR	p	95 % CI	OR	p	95 % CI
Stroke [ref: no stroke]	**3,83**	0,000	2,87 - 5,12	**3,76**	0,000	2,84 - 4,98	**2,25**	0,000	1,70 - 2,99
Age group [ref: 60 – 64]									
65 - 69	**1,21**	0,010	1,05 - 1,40	**1,21**	0,012	1,04 - 1,40	1,11	0,200	0,95 - 1,29
70 - 74	**1,78**	0,000	1,55 - 2,04	**1,73**	0,000	1,51 - 2,00	**1,47**	0,000	1,27 - 1,70
75 - 79	**2,55**	0,000	2,22 - 2,93	**2,36**	0,000	2,04 - 2,72	**1,86**	0,000	1,60 - 2,16
80 - 84	**4,82**	0,000	4,19 - 5,53	**4,33**	0,000	3,75 - 5,00	**3,18**	0,000	2,73 - 3,72
85 +	**8,42**	0,000	7,28 - 9,76	**7,07**	0,000	6,05 - 8,26	**5,16**	0,000	4,37 - 6,10
Gender [ref: female]									
male	**0,8**	0,000	0,74 - 0,87	**0,91**	0,032	0,83 - 0,99	**1,25**	0,000	1,13 - 1,37
Partnership [ref: single/widowed]									
living with partner				**0,83**	0,000	0,76 - 0,91	**0,88**	0,014	0,80 - 0,98
Distance to closest child [ref: > 1 to 5 km]									
no (living) child				1,09	0,206	0,95 - 1,26	1,09	0,272	0,94 - 1,26
same household/building				1,09	0,122	0,98 - 1,21	**1,15**	0,016	1,03 - 1,28
> 5 km				0,95	0,324	0,85 - 1,05	0,96	0,435	0,85 - 1,07
Educational level [ref: low]									
average				**0,84**	0,002	0,75 - 0,94	0,92	0,151	0,82 - 1,03
high				**0,64**	0,000	0,56 - 0,73	**0,72**	0,000	0,63 - 0,82
missing information				0,9	0,500	0,66 - 1,23	0,87	0,426	0,63 - 1,22
Financial reserves [ref: low]									
average				**0,69**	0,000	0,63 - 0,76	**0,78**	0,000	0,70 - 0,86
high				**0,56**	0,000	0,50 - 0,62	**0,66**	0,000	0,59 - 0,74
Area of residence [ref: City/suburbs/town]									
small town/rural				1,03	0,449	0,94 - 1,13	1,08	0,113	0,98 - 1,19
missing information				**1,43**	0,000	1,20 - 1,71	**1,45**	0,000	1,20 - 1,76
Multiple strokes [ref: no]							**2,13**	0,012	1,18 - 3,85
Diseases [ref: disease no present]									
Diabetes							**1,43**	0,000	1,28 - 1,60
Hypertension							0,95	0,283	0,87 - 1,04
Asthma							1,14	0,428	0,83 - 1,55
Cataract							1,04	0,463	0,93 - 1,17
Heart attack							1,05	0,375	0,94 - 1,17
Cancer							**1,17**	0,047	1,00 - 1,37

Odds of ADL disability	Model I (no social context, no medical, stroke random effect)	Model II (no medical, stroke random effect)	Model III (all ind., stroke random effect, deviation 80+)
Other symptoms [ref: no symptoms]			
1 – 2 symptoms			**3,38** 0,000 2,73 - 4,18
3 or more symptoms			**9,72** 0,000 7,85 - 12,05
Contacts with medical doctor [ref: 0 – 5 contacts]			
> 5 contacts			**1,49** 0,000 1,35 - 1,63
Depression [ref: no depression]			**2,24** 0,000 2,05 - 2,46
Group level			
Deviation age 80+ p. %-point			1 0,646 0,99 - 1,01
	N = 23641	N = 23641	N = 23641
Overall between region variation (OBRV)	0,12	0,11	0,045
Median Odds Ratio (MOR)	1,39	1,37	1,22
Stroke between region variation (SBRV)	0,16	0,15	0,14
Log likelihood	-8208	-8064,45	-7006,04
Significance (likelihood ratio test)	0,0000	0,0000	0,0000

Source: own calculations

The baseline model I that included age, stroke, and gender produced the expected results (Table 3). Stroke increased disability risk almost fourfold (OR=3.83, p<0.001). Disability risk also significantly increased with age (OR=1.21, p=0.01 for age 65-69, up to OR=8.42, p<0.001 for ages 85+). In this basic model, men had a lower ADL disability risk than women (OR=0.8, p<0.001). The between-region variation for overall ADL disability had a moderate value of 0.12 and a corresponding median odds ratio of 1.39. This indicated that, when controlling for stroke, sex, and age, the OBRV was roughly comparable to the age effect for people ages 65-69 compared to the reference category (60-64). Of special interest was the extent of the SBRV. With a level of 0.16, this variation was higher than the OBRV (0.12). The country-specific direction and the strength of this effect are shown in more detail in the discussion of model III.

In model II, we included variables concerning household composition, education, financial assets, and area of residence. The stroke effect remained nearly unchanged in strength and direction (OR=3.76, p<0.001). Introducing an indicator for the relative household wealth yielded the expected results across all regions: more financial assets were associated with lower ADL disability risk. This finding supports claims that socioeconomic inequalities translate into health outcomes for all of the European welfare regime types. Similarly, when controlling for partnership status and education level, the analysis showed that the presence of a spouse or partner reduced disability risk. Having a higher educational level had the same effect, a result which also supports the claim that socioeconomic resources translate into health status. The partnership variable suggests that having a partner may have a positive influence, as it could indicate the presence of a potential care giver or that more attention is given to having a healthy lifestyle due to tighter social controls. However, introducing a variable containing information on the spatial distance of the

closest child indicated that, without controlling for individual health characteristics, which certainly play a role in the demand for intergenerational, intra-familiar care and support arrangements, the results were not significant. It should also be noted that the missing category for the variable indicating the area of residence showed a significant increase for ADL disability risk, whereas no difference between urban and rural areas emerged. Since there was no further information that might help us to identify what led to the missing information, no specific explanation can be offered at this point. Turning to the group level, we can see that both the OBRV and the SBRV remained basically unchanged. This indicates that beyond the basic socio-demographic and socioeconomic characteristics, other, yet unobserved factors that are heterogeneously distributed among European countries affect disability outcomes.

Model III further expanded the model with a block of individual-level health-related variables. These included the number of medical consultations and depression, as well as a list of specific chronic diseases and the number of additional symptoms related to other, less severe ailments. This reduced the effect of stroke on disability, although it still remained an influential predictor of disability (OR=2.25, $p<0.001$).

Not surprisingly, depression was found to be associated with a higher risk of ADL disability, with the causality potentially going both ways; i.e., depression may cause disability, but the need to adapt to disabilities can also put a strain on psychological well-being. The same could be said about the presence of further symptoms in addition to the covered chronic diseases. In particular, individuals who were burdened with a number of other physical limitations saw a big increase in their disability risk. This finding indicates that this variable captured residual aspects of individual health status, justifying its presence in the model alongside the other, more specific medical status variables. Another significant predictor for ADL disability was the number of medical consultations. The more consultations that were reported, the higher the associated ADL disability risk was. Thus, this variable captured the overall medical status from the perspective of demand due to present morbidity. Most of the variables that were already included in the previous model were still significant and exhibited effects in the same direction. Age remained an influential predictor (especially in the older age groups), although the strength of the age and stroke effects was clearly reduced somewhat by the newly introduced medical variables. This indicates the disability-promoting effects of rising morbidity prevalence in older age groups and the possible comorbidities of stroke. The positive effect that the presence of a partner or spouse exhibited on ADL disability remained even after controlling for all of the covariates. Unlike in the previous model, we could see a change in the variable concerning the distance of the closest child. Compared with having the closest child living between one and five kilometers away from the parents' place of residence, the co-residence of at least one child was associated with a higher risk of ADL disability. It is unlikely that the presence of the child actually caused ADL disability; instead, the parent and the child may have been living together because the parent needed the support. After the individual medical status had been accounted for, this effect emerged in the model. It could also be argued that the presence of potential caregivers and the acceptance of their support might lead people to more readily admit their difficulties in performing certain tasks of daily living. This might be the case especially in southern countries, where co-residence is a far more common pattern than in the other regions in our sample (Albertini and Kohli 2013). However, since this effect only appeared after the morbidity indicators were included, the first interpretation seems more likely. Also of interest was gender:

controlling for individual health status reversed its effect on ADL status, and indicated that males were subject to higher ADL risk than females. The categorical variable for educational level only showed a significant effect for the highest category, which suggests that some degree of variation in health-sensitive behavior associated with higher education was manifested in the health situation variables. The positive effect of greater affluence on our outcome remained mostly unchanged, with the coefficients getting only a little closer to one, which supports the assumption that the redistributive efforts of European welfare policies did not manage to neutralize the effects of wealth on health outcomes. The controls for other chronic diseases showed that only diabetes and cancer significantly increased the risk of ADL disability, but not as strongly as stroke. The general absence of substantial change between the models indicates that even when we take into consideration individual indicators − such as education, affluence, morbidity, psychological status, or family support − age and living situation are still the most important factors in ADL disability.

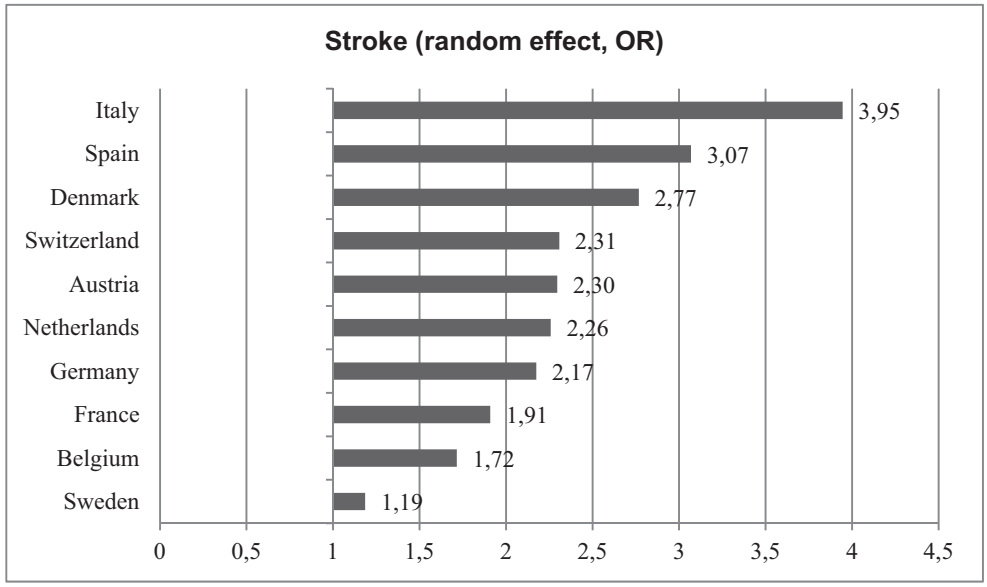
Introducing the medical variable block reduced the OBRV to 0.045 (MOR 1.22), while the SBRV remained almost unchanged, dropping by only 0.02 compared to the basic model. This indicates that even when controlling for individual demographic, socioeconomic, and health characteristics, a strong independent effect of country on the consequences of stroke for ADL disability exists. This remaining variation could be attributable to genuine health care system effects.

The last model also introduced a control at the group level: the underrepresentation of the 80+ age group in the SHARE sample. In sensitivity analyses using data from wave 1 and wave 2, this control exhibited a significant effect in the expected direction: the higher the underrepresentation of older people in a certain country, the lower the ADL disability risk. For wave 4, the significant effect disappeared, reflecting the better overall representation of older age groups in wave 4 compared to previous waves. A detailed discussion of the representation of individuals in the highest age groups can be found in the variables chapter. Alternatively, we used an indicator containing data on the relative number of nursing home beds, which represents only a portion of the potential sampling bias. The results (not shown) were the same as for the ages 80+ deviation variable. Both variants suggest that, relative to data from previous waves, wave 4 data provide the best representation of the whole age spectrum in our analysis on ADL disability.

Overall, model III further reduced the between-region variation in the overall levels of ADL disability between countries. A MOR of 1.22 remained, which indicates that for all ADL causes except stroke, a certain degree of variation between national welfare and health care regimes remains. However, the between-region variation for the stroke random effect was unchanged compared to the previous model, which indicates that even when the possible healthy elderly or other angles of bias introduced by different levels of institutionalization, health-related sample exclusion, or non-response were considered, the differences in the effects of stroke on ADL disability continued to be large between the countries in our sample.

Finally, we will look in detail at the random effect of stroke in order to assess whether and how the different welfare regions perform and potentially cluster together.

Figure 2: Total odds ratio for stroke by country, based on random effect component



Source: SHARE wave 4, own calculations

Figure 2 shows the country-specific random effect of stroke as country-specific odds ratios. Italy and Spain are at the top, with odds ratios of 3.95 and 3.07, respectively, which indicates that stroke had the most severe impact on ADL disability in these two countries. In Italy, the effect of stroke was nearly twice as big as in the western countries. Differences within the western European region were virtually nonexistent. Austria, Germany, France, Switzerland, and Belgium neatly cluster together in a range of between OR=2.31 (Switzerland) and OR=1.72 (Belgium), with only Belgium achieving an odds ratio somewhat lower than that of the other countries. The northern European group was mixed in terms of stroke impact. While Sweden achieved the lowest odds ratio by far, with 1.19; the Netherlands, with OR=2.26, appears to fit better in the western European cluster. Denmark's result (OR=2.77) was even closer to Spain's result than to that of any other country in the northern group, a finding which also demands interpretation.

4 Discussion

This is the first study investigating the country-level differences in Europe of the effect of stroke on the development of disability in the activities of daily living. Previous studies concerned with differences between welfare regimes in health outcomes have not looked into the disabling impact of a single disease, but have mostly approached the subject from a population health perspective (Brennenstuhl et al. 2012). Our study was the first that

investigated the disabling impact of stroke from a quantifiable comparative perspective, while controlling for other causes of disability. This study produced two main findings regarding the influence of different welfare regimes on disability in daily living activities.

First, we showed that the impact of stroke on ADL-disability differed markedly between the ten countries mostly along a north/south gradient. Second, we noted that the impact of other diseases related to disability was much more uniform across Europe and was not comparable to the degree of difference we observed for stroke.

The differences in the impact of stroke on disability mostly corresponded to geographical regions, especially for the western and southern European countries. The southern region consisting of Italy and Spain yielded the worst ADL-outcomes for stroke cases. The western countries of Belgium, France, Germany, Austria, and Switzerland were intermediate. Our results indicated that the latter group should definitely include the Netherlands, which was more similar to the western countries than to Sweden or Denmark. The results for the northern group were decidedly mixed, as Sweden performed best and Denmark was more similar to Italy and Spain than to Sweden or the western countries.

Regarding health care regime research, we can see that countries with low scores on access restriction measures (that is, a high degree of freedom of choice) (Reibling and Wendt 2010, p. 449) generally had low values in the stroke-specific effect on ADL disability. Countries like Denmark, Spain, and Italy have policies that greatly restrict access to specialists, while the western countries generally have more liberal policies (Wendt, 2009). The only outlier in this regard is Sweden, which also greatly restricts access to doctors. Countries with good results regarding the disabling impact of stroke generally also provide a good measure of outpatient care and low out-of-pocket copayments (Ibid.). Thus, health care regimes that provide direct specialist access at a relatively low price to the individual were found to have less stroke-related disability than countries with more highly regulated approaches. Indeed, Spain and Italy were the countries with the highest shares of private copayments to total medical expenditure per capita, and they were also the countries with the lowest financial household reserves - a combination that might discriminate in particular against older people with even fewer financial resources than those of working age. With its highly regulated and partly privatized medical sector, which has often been described as a type of late national health service (Ferrera 1996), this system seems less suited than other European systems to providing adequate recovery and disability-mitigating long-term care for stroke patients.

Overall, the question of whether there was an independent effect of the welfare regime on the disabling effects of stroke could be answered in the affirmative. Additionally, we found that, with the exception of Denmark, the strength of the disabling effect of stroke followed a north/south gradient in which Sweden showed the best outcomes, the western countries ranked in the middle, and southern Europe saw the largest increases in the disability risk for stroke cases.

The fact that Denmark fared badly, especially in relation to Sweden, is of interest as well. This might be explained at least to some degree by consulting a study by Leys et al. on the quality of stroke care provided in European hospitals. Based on primary data from an independently conducted survey among more than 800 European hospitals involved in acute stroke care, they concluded that as of 2005, Danish hospitals were not well equipped or very good at handling the immediate treatment of stroke patients. This suggests that the fast response needed to counteract the lasting consequences of stroke has not been adequately provided in Denmark. Except for Norway, no western, southern, or northern European country scored as low as Denmark regarding stroke care capabilities (Leys et al. 2007).

The second main finding concerned the between-country inequalities of the ADL disability not linked to stroke. The remaining impact of specific welfare systems in the saturated model III was very low, and was even insignificant for between-country differences. Thus, it could be argued that, even using fixed effects for all other health-related variables in the model, the health care regimes included in this analyses produced similar outcomes in that these individual-level predictors managed to reduce the remaining between-country variance to a very low level. This suggests that the hypothesis of convergence in a broader sense of the output side of European health care subsystems (at least in terms of ADL disability as a health outcome measure) was supported by our findings. This also indicates that differences in population health in Europe are, stroke excluded, largely due to within-country variations in relevant determinants of health, such as socioeconomic resources. Compared to stroke-related ADL disability, this suggests that there is a more indirect effect of the welfare regime through its redistributive measures on determinants of health than a direct effect of health care systems on disability outcomes in the case of stroke patients.

Looking at the fixed effects in the models, we can note that even in model III, the effect of household financial assets remained significant and unchanged in strength. This also supports claims like those made by Mackenbach (2012), who observed that socioeconomic inequalities translate into health outcomes independent of the welfare region. In our model, the fixed effects shown for socioeconomic stratification support this assertion: over all of the countries considered, the risk-reducing effect of relative wealth was shown to persist. The findings for the effect of education were similar: having a high level of education was found to reduce the risk of disability in all 10 countries. Regardless of the specifics of an individual's health status, the availability of support, companionship, or a caregiver was generally positive, although this was not the only causal pathway. It can also be argued that a partner provided more incentives to engage in physical activity, and also acted as a social control on individual risk behavior (Alber 2005). Socioeconomic stratification translated into ADL disability health outcomes in the same way, regardless of where these inequalities were found. In addition, the distinction between urban and rural areas remained significant as a fixed effect in the final model. Thus, for the ADL disabilities not related to stroke, it mattered little in which country an individual lived. In general, these findings can be interpreted as another sign of convergence in the process aspect of health care systems, not only in terms of input, as measured in total health expenditure; but also in terms of differences in health outcomes between health care systems when certain socio-demographic, economic, and health-related indicators are combined, such as those measured in ADL disability.

Limitations and alternative model specifications

It could of course be argued that some of those fixed effects might have turned out to vary between countries if the model had allowed them to. To account for this possibility, we performed a series of sensitivity analyses with alternative model specifications. Specifically, we tested whether stroke or other independent individual-level variables had the biggest influence on the reduction of the remaining between-region variation. To do this, we allowed the effects of variables other than stroke to vary across countries. The results showed that gender, partnership status, the frequency of consultations with a medical practitioner, the number of other symptoms, all other chronic diseases, and

depression did not exhibit as much between-region variation as stroke. In other words, the between-country variation of the random effects of all of those variables was generally much smaller than the variation of the random effect for stroke, often by an order of magnitude. This indicates that these predictors had basically the same effects in direction and strength across all of the countries in our sample, which justifies specifying them as fixed effects. While stroke proved to be a powerful predictor as a fixed effect, it was especially useful when it was allowed to vary between regions, as it was able to explain much more of the remaining between-region variation, and to shed light on how different welfare regions cope with the disabling consequences of this disease. This was not, however, found to be the case when we specified other individual-level predictors as random effects. In other words, for the other chronic diseases or determinants like wealth and education, very small differences between the countries were found to be present. Generally, however, and especially compared to the much bigger between-country difference of the stroke effect, these results support the general statement that the health care regimes within the European welfare systems are moving closer together in terms of the association between certain determinants like chronic diseases and ADL disability, with the exception of the impact of stroke on disability.

Another potential criticism of our study might be the use of stroke as a central variable. Stroke is somewhat different from the other medical indicators in our model, in that there is a relatively high mortality risk associated with stroke (Doblhammer et al. 2012). Thus, it might be argued that the observed difference in the stroke effect between countries is actually a difference in stroke-specific (or general) mortality. To assess this claim, another aspect of our sensitivity analyses consisted of including the percentage of mortality underestimation in SHARE as another variable on the group level. If different levels of stroke mortality had a significant influence, we would expect the amount of between-region variation of the stroke random effect to diminish. This was not the case, as it remained at the same value as before.

To further validate our results, we also replicated the models for samples from SHARE waves 1 and 2, with each producing results similar to those of wave 4 in terms of the effects of stroke on disability and the clusters that result from the country-specific coefficient. The most distinctive difference found was the effect of the group-level control for the underrepresentation of individuals ages 80+, which gained in significance and had a marginal impact when using data with a higher percentage of sample deviation. Overall, the reported results on older age disability status, both those related to stroke as well as in general, were supported by data from 2004 to 2011.

Finally, we were unable to include a point made by researchers like Minicuci et al. (2004), who argued that cultural influences – like differences in the definition of what actually constitutes a disability, or differences in tendencies to admit to or even to pretend to have a certain level of disability – contribute to the differences found in the overall shares of disability, or to the relative impact of certain conditions on disability between European regions. Factors such as varying individual definitions of disability or motivations to admit to having a disability are difficult to measure, and cannot be derived from SHARE data.

In addition, unobserved characteristics that might systematically cluster on the national population level, e.g. certain patterns of physical activity or lifestyle attitudes related to health, might influence the results. This is also true for contextual factors such as the availability of infrastructure for sports or community activities that can have an impact on health.

As with most empirical studies, a certain amount of unobserved heterogeneity always remains. However, given the magnitude of the stroke-related differences in the impact on disability that we found, it is unlikely that any one of these factors is responsible for all of the differences shown. It is more likely that on the whole, the impact of stroke on disability might have been a little higher in the north and a little lower in the south, but that the regional clustering in terms of the effect of the stroke would remain generally unchanged even when further expanding the model.

Given these findings, we would argue that, if the policy intention is to reduce overall health inequalities in Europe, policy makers should focus on the socioeconomic inequalities that are significant for health outcomes. If, however, the aim is to reduce the problem of stroke-related disability, policy makers could start by focusing on the health care system. In particular, the large increase in the risk of disability associated with stroke in the southern European countries points to the need for intervention, at both the level of acute treatment and the level of the treatment and care of stroke survivors. By identifying countries in which stroke patients face a relatively low disability risk, we provide a starting point from which the work of adapting good practice examples can begin. An effort to reduce the wide disparities in the impact of stroke on functional disability within Europe could thus help to eliminate a portion of the costly disability burden faced by aging European societies and welfare regimes in the coming decades.

References

Alber, J. (2005): Wer ist das schwache Geschlecht? Zur Sterblichkeit von Männern und Frauen innerhalb und außerhalb der Ehe. In: *Leviathan* 33 (1), pp. 3-39.

Albertini, M.; Kohli, M. (2013): The Generational Contract in the Family: An Analysis of Transfer Regimes in Europe. In: *European Sociological Review* 29 (4), pp. 828-840.

Avendano, M.; Jurges, H.; Mackenbach, J. P. (2009): Educational level and changes in health across Europe: longitudinal results from SHARE. In: *Journal of European Social Policy* 19 (4), pp. 301-316.

Brennenstuhl, S.; Quesnel-Vallee, A.; McDonough, P. (2012): Welfare regimes, population health and health inequalities: a research synthesis. In: *Journal of Epidemiology & Community Health* 66 (5), pp. 397-409.

Christensen, K.; Doblhammer, G.; Rau, R.; Vaupel, J. W. (2009): Ageing populations: the challenges ahead. In: *The Lancet* 374 (9696), pp. 1196-1208.

Chung, H.; Muntaner, C. (2007): Welfare state matters: A typological multilevel analysis of wealthy countries. In: *Health Policy* 80 (2), pp. 328-339.

Deeg, D. J. H.; van Vliet, M. J. G.; Kardaun, J. W. P. F.; Huisman, M. (2013): Understanding the Mortality Decline at Older Ages. Improved Life Course or Improved Present Period? In: *Annual Review of Gerontology and Geriatrics* 33, pp. 261-291.

Doblhammer, G.; Kreft, D.; Dethloff, A. (2012): Gewonnene Lebensjahre. In: *Bundesgesundheitsblatt* 55 (4), pp. 448-458.

Eikemo, T. A.; Bambra, C.; Judge, K.; Ringdal, K. (2008): Welfare state regimes and differences in self-perceived health in Europe: A multilevel analysis. In: *Social Science & Medicine* 66 (11), pp. 2281-2295.

Esping-Andersen, G. (1990): The Three Worlds of Welfare Capitalism. Cambridge, Princeton University Press.

Fassbender, K.; Balucani, C.; Walter, S.; Levine, Steven R.; Haass, A.; Grotta, J. (2013): Streamlining of prehospital stroke management: the golden hour. In: *The Lancet Neurology* 12 (6), pp. 585-596.

Ferrera, M. (1996): The 'Southern Model' of Welfare in Social Europe. In: *Journal of European Social Policy* 6 (1), pp. 17-37.

Fried, L. (1999): Association of Comorbidity with Disability in Older Women. The Women's Health and Aging Study. In: *Journal of Clinical Epidemiology* 52 (1), pp. 27-37.

Fried, L.; Ettinger, W. H.; Lind, B.; Newman, A. B.; Gardin, J. (1994): Physical disability in older adults: A physiological approach. In: *Journal of Clinical Epidemiology* 47 (7), pp. 747-760.

Haberkern, K.; Szydlik, M. (2008): Pflege der Eltern – Ein europäischer Vergleich. In: *KZfSS Kölner Zeitschrift für Soziologie und Sozialpsychologie* 60 (1), pp. 82-105.

Hennerici, M. G.; Kern, R.; Szabo, K. (2013): Non-pharmacological strategies for the treatment of acute ischaemic stroke. In: *The Lancet Neurology* 12 (6), pp. 572-584.

Hoeymans, N.; Wong, A.; van Gool, C. H.; Deeg, D. J. H.; Nusselder, W. J.; de Klerk, M. M. Y.; van Boxtel, M. P. J.; Picavet, S. J. (2012): The Disabling Effect of Diseases: A Study on Trends in Diseases, Activity Limitations, and Their Interrelationships. In: *American Journal of Public Health* 102 (1), pp. 163-170.

Jensen, C. (2008): Worlds of welfare services and transfers. In: *Journal of European Social Policy* 18 (2), pp. 151-162.

Kneip, T. (2013): Survey Participation in the Fourth Wave of SHARE. In: Abduladze, L. (Ed.): SHARE Wave 4. Innovations & Methodology, pp. 140-155.

Kunst, A. E. (2005): Trends in socioeconomic inequalities in self-assessed health in 10 European countries. In: *International Journal of Epidemiology* 34 (2), pp. 295-305.

Lahelma, E.; Lundberg, O. (2009): Health inequalities in European welfare states. In: *The European Journal of Public Health* 19 (5), pp. 445-446.

Leys, D.; Ringelstein, E. B.; Kaste, M.; Hacke, W. (2007): Facilities Available in European Hospitals Treating Stroke Patients. In: *Stroke* 38 (11), pp. 2985-2991.

Lynn, P.; De Luca, G.; Ganninger, M. (2013): Sample design in SHARE wave 4. In: Abduladze, L. (Ed.): SHARE Wave 4. Innovations & Methodology, pp. 74-123.

Mackenbach, J. P. (2012): The persistence of health inequalities in modern welfare states: The explanation of a paradox. In: *Social Science & Medicine* 75 (4), pp. 761-769.

Merlo, J.; Chaix, B.; Ohlsson, H.; Beckman, A.; Johnell, K.; Hjerpe, P. et al. (2006): A brief conceptual tutorial of multilevel analysis in social epidemiology: using measures of clustering in multilevel logistic regression to investigate contextual phenomena. In: *Journal of Epidemiology & Community Health* 60 (4), pp. 290-297.

Minicuci, N.; Noale, M.; Pluijm, S. M. F.; Zunzunegui, M. V.; Blumstein, T.; Deeg, D. J. H. et al. (2004): Disability-free life expectancy: a cross-national comparison of six longitudinal studies on aging. The CLESA project. In: *European Journal of Ageing* 1 (1), pp. 37-44.

Ploubidis, G. B.; Dale, C.; Grundy, E. (2012): Later life health in Europe: how important are country level influences? In: *European Journal of Ageing* 9 (1), pp. 5-13.

Pluijm, S. M. F; Bardage, C.; Nikula, S.; Blumstein, T.; Jylhä, M.; Minicuci, N. et al. (2005): A harmonized measure of activities of daily living was a reliable and valid instrument for comparing disability in older people across countries. In: *Journal of Clinical Epidemiology* 58 (10), pp. 1015-1023.

Puts, M. T. E.; Deeg, D. J. H.; Hoeymans, N.; Nusselder, W. J.; Schellevis, F. G. (2008): Changes in the prevalence of chronic disease and the association with disability in the older Dutch population between 1987 and 2001. In: *Age and Ageing* 37 (2), pp. 187-193.

Reibling, N.; Wendt, C. (2010): Bildungsniveau und Zugang zu Gesundheitsleistungen. In: *Das Gesundheitswesen* 72 (08/09), pp. 447-454.

Ringelstein, E. B.; Kaste, M.; Hacke, W.; Leys, D. (2007): Stroke Care in Europe – The Role of Stroke Units. In: *European Neurological Review*, pp. 24-26.

Rostila, M. (2007): Social capital and health in European welfare regimes: a multilevel approach. In: *Journal of European Social Policy* 17 (3), pp. 223-239.

Schram, M. T.; Frijters, D.; van de Lisdonk, E. H.; Ploemacher, J.; de Craen, A. J. M.; de Waal, M. W. M.; van Rooij, F. J.; Heeringa, J.; Hofman, A.; Deeg, D. J. H.; Schellevis, F. G. (2008): Setting and registry characteristics affect the prevalence and nature of multimorbidity in the elderly. In: *Journal of Clinical Epidemiology* 61, pp. 1104-1112.

Schulz, E.; Leidl, R.; König, H.-H. (2004): The impact of ageing on hospital care and long-term care – the example of Germany. In: *Health Policy* 67 (1), pp. 57-74.

The IST-3 collaborative group (2013): Effect of thrombolysis with alteplase within 6 h of acute ischaemic stroke on long-term outcomes (the third International Stroke Trial [IST-3]): 18-month follow-up of a randomised controlled trial. In: *The Lancet Neurology* 12 (8), pp. 768-776.

Wendt, C. (2009): Mapping European healthcare systems: a comparative analysis of financing, service provision and access to healthcare. In: *Journal of European Social Policy* 19 (5), pp. 432-445.

Spatial patterns of dementia prevalence and its vascular risk factors in Germany

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Abstract

This is the first study that explored spatial patterns in the prevalence of dementia in Germany. Results about sub-national differences in other countries have been inconclusive. We used health claims data from the largest public health insurer in Germany for ages 65 and above in the year 2007 consisting of 1,338,462 persons. Dementia diagnosis was defined according to ICD-10 codes G30, G31.0, G31.82, G23.1, F00, F01, F02, F03, and F05.1. We distinguished 95 regions according to the 2-digit postal code of the place of residence.

Using meta-regression models we found significant geographical differences in the age standardized prevalence of dementia. Dementia prevalence was higher in East than in West Germany. In East Germany the prevalence declined from the north to the south, in West Germany the prevalence was low in the north and particularly high in the north and eastern regions of Bavaria. The regional prevalences of dementia were significantly correlated with the regional prevalences of the three major vascular risk factors hypertension, hypercholesterolemia, and diabetes. Together the regional variation in the three risk factors explained about 50% of the regional variation in dementia prevalence.

The relationship between vascular risk factors and dementia has been repeatedly demonstrated on the individual level. Our results confirm that this relationship also exists on a regional level. We conclude by discussing possible limitations of the data and how they might bias the results.

1 Introduction

Dementia is one of the most common, yet incurable, diseases at old age. In Germany, dementia prevalence doubles about every 5 to 6 years from about 2% at age 65 to 30% - 40% at ages 90 to 100 (Doblhammer et al. 2013). After cardiovascular disease, cancer and cerebrovascular disease it is the fourth most common cause of death (Bickel 2003) and it is a major predictor of death (Baldereschi et al. 1999). Dementia is one of the most costly diseases at old age, primarily due to the high demand for care (Leicht et al. 2011). Information about prevalence and incidence of dementia in Germany at the population level has only recently become available (Doblhammer et al. 2012). However, no information exists about spatial patterns in the prevalence, with the exception of a study that showed higher prevalence in East than in West Germany (Ziegler and Doblhammer 2009), as well as a study that reported prevalence at the level of states (Doblhammer et al. 2012).

The knowledge about spatial variation in dementia prevalence can help to identify socioeconomic determinants of dementia risks, it may support etiological investigations (Steele and McGeer 2008) and it is important for policy makers when dealing with the consequences of the disease for the health care system in general and the long-term care system in particular. Thus a series of studies have tried to establish the existence of sub-national variation in dementia prevalence.

A recent meta-study suggests a geographical clustering of dementia rates in terms of rural and urban living-circumstances in developed countries (Russ et al. 2012). Rural living at old age increased the risk of dementia, particularly Alzheimer's disease. Early-life rural living seemed to exacerbate this risk. Most evidence, however, is based on the comparison of dementia across studies that contrast geographical locations such as urban and rural areas, or different countries (Jorm et al. 1987; Ineichen 2000; Fratiglioni et al. 1999). As Russ et al. (2012) pointed out in their comprehensive review of geographical differences in dementia, these studies are difficult to compare since different diagnostic criteria or differences in their operationalization may bias the results. Single studies exploring the geographical distribution of dementia prevalence are, however, still rare and results are inconsistent (Russ et al. 2012). Two Canadian studies did not find differences in dementia prevalence across Canada (Canadian Study of Health and Aging Working Group 1994; Hébert et al. 2000; Manfreda 1995) but suggested the existence of regional differences in dementia subtypes. US-studies found regional differences in Alzheimer's disease prevalence (Steenland et al. 2009; Laditka et al. 2006a; Laditka et al. 2008; Laditka et al. 2006b), in Puerto Rico dementia prevalence varied between the eight regions (Figueroa et al. 2008), in China a north-south gradient as well as a weaker east-west gradient existed (Zhang et al. 2005; Zhang et al. 2006). Differences in dementia prevalence were also found in Spain and Finland (Russ et al 2012), as well as in the eastern and western part of Germany (Ziegler and Doblhammer 2009). On the contrary, a study that used identical methodology in five different sites across the United Kingdom did not find evidence of geographical variation in dementia incidence (Matthews et al. 2005). Studies comparing geographical variation in dementia deaths found marked regional differences in dementia and AD mortality in the US (Gillum et al. 2011), in Australia (Jorm et al. 1989), and in AD mortality in Japan (Imaizumi 1992).

Vascular risk factors have been identified as major risk factors of dementia (Breteler, Monique M. B. 2000; Forette et al. 1998). Thus, regional variation in dementia should reflect regional variation in these risk factors which vary across Europe and within European sites (Day et al. 1999). Matthews et al. 2005, however, did not find evidence that regional variation in vascular risk factors was correlated with dementia incidence. Also regional variation in Alzheimer's disease mortality in the US (Gillum et al. 2011) appeared not to be correlated with mortality from cardio-vascular disease.

Our study aimed to explore spatial differences in the prevalence of dementia in Germany and to analyze regional correlations with the three major vascular risk factors of dementia, namely hypertension, hypercholesterolemia and diabetes.

Hypertension is one of the most important risk factors of stroke and coronary heart disease, and of vascular dementia (Breteler 2000); the link with Alzheimer's disease is less clear. Longitudinal studies showed that Alzheimer's disease was correlated with increased systolic and diastolic blood pressure ten to 15 years before the onset of the disease (Slooter and van Duijn 1997). On the contrary, cross-sectional studies reported that lower blood pressure was associated with lower cognitive performance or dementia (Kontula et al. 1995;

Lee 1994; Skoog et al. 1996). Breteler and others pointed out that over a long time period hypertension might indeed increase the risk of Alzheimer's disease, but prior to the clinical onset of the disease blood pressure level start to decline, and decline even further with further progression of the disease (Qiu et al. 2005; Skoog and Gustafson 2006). There is even evidence for an association of midlife hypertension with pathological hallmarks of Alzheimer's disease upon brain autopsy (Petrovitch et al. 2000). Gorelick (2004) assumed that treating hypertension might be the most promising long-term intervention to reduce the risk of vascular dementia and possibly of Alzheimer's disease. Both longitudinal and cross-sectional studies showed that diabetes increased the risk of Alzheimer's disease while the mechanisms are not entire clear, yet (for an overview see Breteler 2000; Gorelick 2004). Plasma cholesterol levels may influence the risk of Alzheimer's disease in relation to the APOE4 gene, which is a major risk factor of both, Alzheimer's disease and of increased plasma cholesterol, low-density lipoprotein levels, atherosclerosis, and cardiovascular disease (for an overview see Breteler 2000; Gorelick 2004).

Based on above findings we hypothesized that dementia prevalence in Germany differs between geographical regions. Following the distribution of vascular risk factors, the prevalence of dementia should be higher in East than in West Germany and should differ within these two regions. We used health claims data from the largest public health insurer in Germany. Given the large number of observations we were able to explore variation in dementia prevalence across 95 regions across the whole of Germany defined by the two-digit postal code (PC). To our knowledge this is the first study that explored spatial variation in dementia prevalence in Germany.

2 Data and methods

We used claims data of the AOK (Allgemeine Ortskrankenkasse), the largest public health insurance company in Germany which covers about one-third of the total population aged 50+, and more than 50% among the oldest-old. The claims data include complete records of the inpatient (§ 301 (2), SGB V) and outpatient treatment (§ 295 (2), SGB V) received by each insured person with at least one day of insurance coverage by the AOK. The data are compiled on a quarterly basis, and include all plan members, regardless whether they sought medical treatment or not. Diagnoses may stem from both outpatient and inpatient treatment and are coded according to the 10th Revision of the International Classification of Diseases and Related Health Problems (ICD-10). A detailed description of the data, its advantages and disadvantages, can be found in the chapter of Fink in this issue.

An age-stratified sample of all insured persons aged 65 and above in the first quarter of 2007 was drawn which consisted of 1,338,462 persons. These individuals were followed over the four quarters of the year 2007. Dementia was defined by the ICD numbers G30, G31.0, G31.82, G23.1, F00, F01, F02, F03, and F05.1. We did not further distinguish dementia according to etiology. All plan members of the sample with at least one insured day in 2007 and with a dementia diagnosis were defined as prevalent dementia cases measured in person-days. The nominator of the prevalence was thus defined as the number of days with a valid dementia diagnosis. Since data were on a quarterly basis, each quarter with a valid dementia diagnosis contributed 91.25 days. In case of the event of mortality or of the exit from the AOK the number of days of the quarter until the event was taken. The

population at risk, the denominator of the prevalence, was also based on the stratified sample and contained the number of AOK-insured person-days. Both prevalent dementia cases and the population at risk were aggregated by sex, age, and the place of residence. All calculations were based on insured person-years derived from the person-days. Over all insured individuals aged 65 and above the 467,834,506 insured person-days at risk amounted to 1,281,738 insured person-years at risk (Table 1).

The place of residence was defined by the two-digit level postal code. These are 95 regions with a minimum of 1,459, and a maximum of 33,297 insured person-years. The age-specific prevalence of dementia at age x in region i were calculated by:

$$Prevalence_{x,i} = \frac{insured\ person-years\ with\ dementia\ diagnosis_{x,i}}{total\ insured\ person-years_{x,i}}$$

The estimation of the prevalences of the vascular risk factors diabetes, hypertension and hypercholesterolemia followed the same procedure. Diabetes mellitus diagnoses were based on ICD-10 numbers E10 to E14, hypercholesterolemia on E78.0, and hypertension was identified based on ICD-10 numbers I10 to I13, and I15.

Table 1: Number of exposures (population at risk) and cases (in person-years) by 1-digit postal code in 2007, ages 65+

1-digit postal code	Exposures	Cases			
		Dementia	Hypertension	Hypercholesterolemia	Diabetes
0	179,039	17,609	124,876	23,639	57,701
1	130,111	14,319	92,411	19,404	41,357
2	116,527	9,689	71,479	20,094	26,604
3	143,865	12,920	93,754	25,950	37,727
4	106,619	9,100	65,793	21,899	26,381
5	110,219	9,157	68,519	21,054	27,119
6	99,991	8,765	63,298	18,953	26,966
7	145,265	11,792	88,266	30,050	35,732
8	111,716	9,751	67,615	25,077	28,331
9	138,386	13,295	93,214	30,812	42,793
Total	1,281,738	116,397	829,225	236,932	350,711
Minimum	1,459(PC 20)	102(PC 20)	862(PC 20)	250(PC 20)	336(PC 20)
Maximum	33,297(PC 6)	3,375(PC 6)	23,671(PC 6)	5,284(PC 1)	11,216(PC 6)

Source: AOK claims data 2007, own calculations

Note: PC = Postal Code; PC 20 = Hamburg Mitte; PC 1 = Dresden, Riesa, Meißen, Bischofswerda; PC 6 = Halle (Saale), Dessau-Roßlau, Quedlinburg, Zeitz

For the sake of brevity Table 1 gives an overview of the risk population and the cases on a one-digit postal code level albeit all calculations are performed on the two-digit level. For each region we calculated age-standardized prevalence by applying direct age

standardization. We defined seven five-year age-groups for the ages 65-69, 70-74, 75-79, 80-84, 85-89, 90-94, 95+. The minimum number of valid person-years with dementia was 2.8 at age 65-69 in postal code region 20 (Hamburg Mitte), the maximum was 862 person-years with dementia at age 80-84 in postal code region 6 (Halle (Saale), Dessau-Roßlau, Quedlinburg, Zeitz). German population data from 2007 for five-year age groups and both sexes combined from the Human Mortality Database (2013) served as the reference population.

We conducted spatial analyses by using maps to illustrate regional differences in the prevalence. In addition we calculated regional correlations between dementia and the three vascular risk factors by using random-effects meta-regression models. We assumed that the age-standardized prevalence of region *i*, y_i, can be modelled as a normally distributed linear prediction from the risk factors x_i and their unknown parameters β (Harbord and Higgins 2008):

$$\gamma_i \sim N(x_i\beta, \sigma_i^2 + r^2)$$

For the estimation of the parameters each region was weighted by its precision, $1/\sigma_i^2$, where σ_i^2 is the within-region variance of the age-standardized prevalences; y_i; r^2 is the between-region variance allowing for between-region heterogeneity not explained by the covariates and is estimated from the data by applying the REML algorithm (Thompson and Sharp 1999). All calculations were performed in Stata 12.1 using the "metareg" command.

For better comparison of the effect sizes prevalence of the three explanatory diseases were standardized by their mean and standard deviation, and multiplied by a factor of 100. Thus, the resulting coefficients can be interpreted as the percentage increase in regional dementia prevalence when the respective risk factor increases by one standard deviation.

In the claims data for each diagnosis, an indicator reflects the validity of the diagnosis as assigned by the medical doctor. In the outpatient sector, the indicator distinguishes between diagnoses which were "verified", and those which were assigned in cases of "suspicion of", "condition after", or "exclusion of". In the inpatient sector, distinctions were made between admission, referral, discharge, and secondary diagnosis. In this study only diagnoses indicated as "verified" in the outpatient sector, and only the discharge and secondary diagnoses from the inpatient sector were considered.

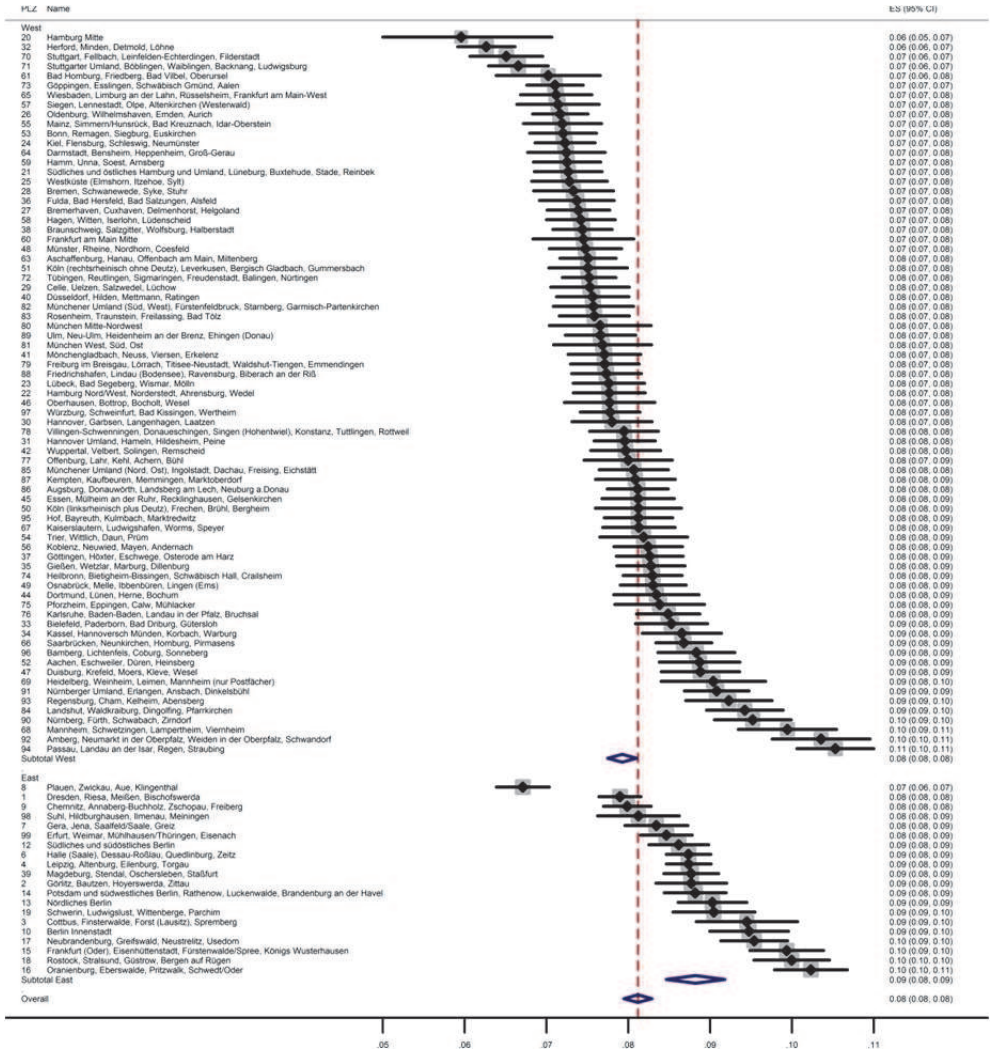
3 Results

All prevalences presented here were age standardized for ages 65 and above and refer to 100 person-years of risk. For the sake of brevity we refer to prevalence only.

In Germany considerable spatial differences existed in the prevalence of dementia. In West Germany they ranged between 0.06 (PC 20: Hamburg Mitte) and 0.11 (PC 94: Passau, Landau an der Isar, Regen, Straubing), in East Germany they extended from 0.07 (PC 8: Plauen, Zwickau, Aue, Klingenthal) to 0.10 (PC 16: Oranienburg, Eberswalde, Pritzwalk, Schwedt/Oder) as depicted in Figure 1. Over all regions, the weighted prevalence was 0.081. Prevalence clustered in regions, first of all they differed between East and West Germany but also within these two regions. In East Germany 16 out of the 19 regions were above the German average, in West Germany 22 out of 54. In East

Germany we found a distinct north-south gradient with prevalence declining from the north to the south (Figure 2). In West Germany prevalence was low in the southern regions around Stuttgart, Frankfurt, Mainz, in central Germany around Köln-Bonn, in the northern state of Schleswig-Holstein and Niedersachsen. Regional prevalence was particularly high in north and eastern Bavaria, the Ruhr-area as well as in Saarland.

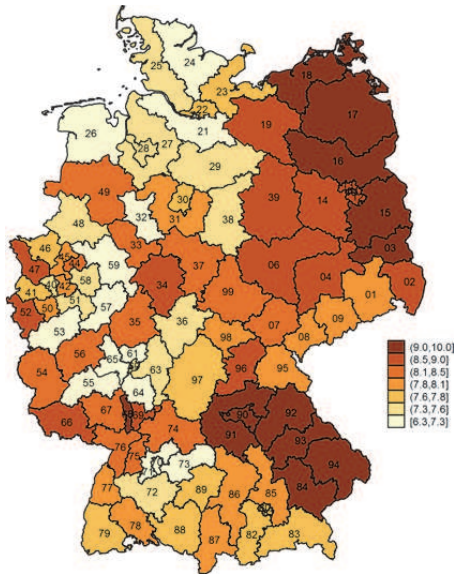
Figure 1: Age-standardized prevalence of dementia ages 65+ and confidence intervals by 2-digit postal code for both sexes combined; Weighted regional average for the AOK population in West Germany, East Germany and Total Germany



Source: AOK claims data 2007, own calculations

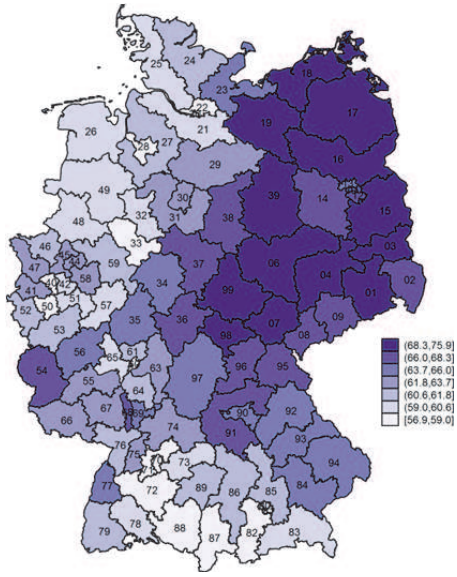
This figure in high quality: http://www.budrich-academic.de/de/bevoelkerungswissenschaft/

Figure 2: Age-standardized prevalence of dementia ages 65+ by 2-digit postal code for both sexes combined; AOK population in Germany 2007



Source: AOK claims data 2007

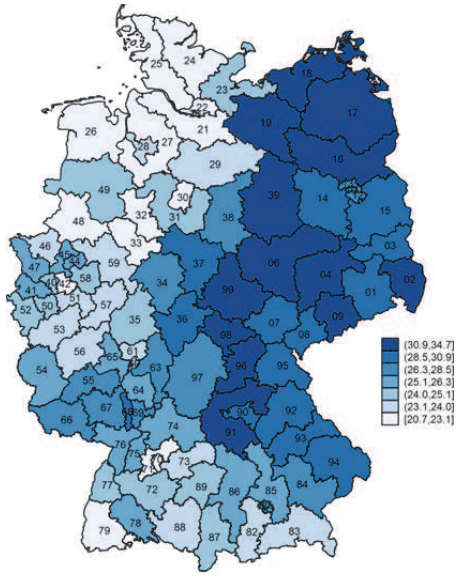
Figure 3: Age-standardized prevalence of hypertension ages 65+ by 2-digit postal code for both sexes combined; AOK population in Germany 2007



Source: AOK claims data 2007

Similar patterns existed for the three vascular risk factors. Hypertension (Figure 3) and diabetes mellitus (Figure 4) revealed a strong east-west gradient with higher prevalence in East Germany. In East Germany prevalence declined from the north to the south, in West Germany the north and the south stood out with low prevalence. North and eastern Bavaria, Saarland and the Ruhr-area had comparatively high rates.

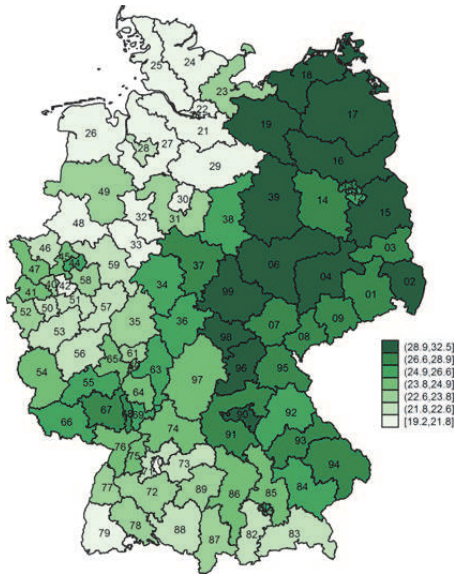
Figure 4: Age-standardized prevalence of diabetes mellitus ages 65+ by 2-digit postal code for both sexes combined; AOK population in Germany 2007



Source: AOK claims data 2007

The pattern is different for hypercholesterolemia (Figure 5). Here, East Germany was characterized by low prevalence with no particular north-south gradient. In West Germany, the north again revealed low levels whereas the south, particularly Bavaria, was characterized by high levels.

Figure 5: Age-standardized prevalence of hypercholesterolemia ages 65+ by 2-digit postal code for both sexes combined; AOK population in Germany 2007

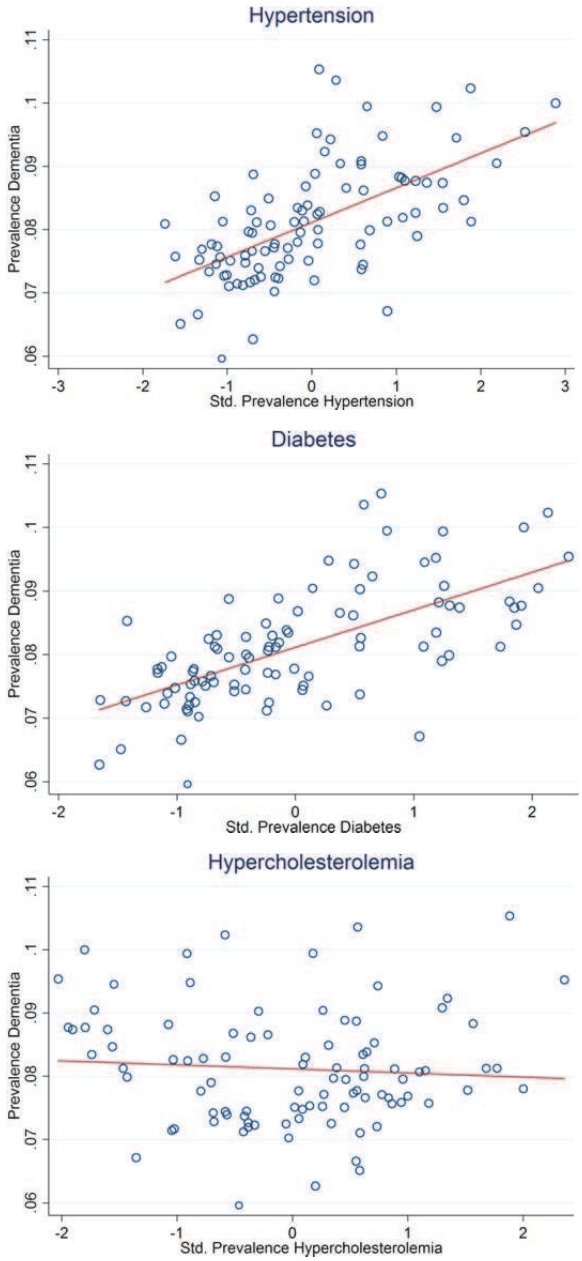


Source: AOK claims data 2007

Based on meta-regression we found a strong positive bivariate correlation of b=0.55 (p<=0.001) between the regional prevalences of dementia and of hypertension. This correlation implies that the prevalence of dementia increases by about half a percentage point, when the prevalence of hypertension increases by one standard deviation (Figure 6).

Measured by the adjusted R^2 the regional variation in hypertension explained 39.5% of the regional variation in dementia. We found an equally strong bivariate correlation between diabetes mellitus and dementia. Here the bivariate correlation was b=0.59 (p<=0.001) and the explanatory power of the model was 47.1%. Contrary to these findings, the bivariate correlation between hypercholesterolemia and dementia was statistically not significant. Only when we controlled for the overall level of hypercholesterolemia in East and West Germany by introducing an East/West indicator variable we found a positive correlation of b=0.34 (p=0.003). The model explained 25.6% of the regional variation in dementia prevalence.

Figure 6: Regional correlation between dementia and hypertension, diabetes mellitus and hypercholesterolemia; age standardized prevalence for ages 65 +, AOK population 2007



Source: AOK claims data 2007, own calculations

A meta-regression model that included all three risk factors was able to explain 53.9% of the regional variation in dementia prevalence (Table 2). The regional prevalence of hypertension and diabetes were highly correlated, thus combining them into one model reduced their effect sizes to b=0.38 (p=0.017) for hypertension, and b=0.38 (p=0.008) for diabetes. They were then comparable to the effect size of hypercholesterolemia b=0.30 (p=0.000).

Table 2: Meta-regression of the regional correlation between dementia prevalence and the standardized prevalence of hypertension, hypercholesterolemia and diabetes

	Univariate models			Multivariate model	
Risk factor	Coefficient*100	p-value	adj. R^2	Coefficient*100	p-value
	0.547			0.380	
Hypertension	0.400 - 0.693	0.000	39.54%	0.069 - 0.691	0.017
	-0.065			0.302	
Hypercholesterolemia	-0.249 - 0.120	0.489	-0.54%	0.141 - 0.101	0.000
	0.591			0.379	
Diabetes	0.453 - 0.728	0.000	47.05%	0.101 - 0.659	0.008
adj. R2	-			53.89%	
N			95		
Exposures			1,281,738		
Cases Dementia			116,397		
Hypertension			829,225		
Hypercholesterolemia			236,932		
Diabetes			350,710		

Source: AOK claims data 2007, own calculations

In sensitivity analyses we performed separate calculations for men and women. While the prevalence of dementia was significantly higher for women than for men (not shown), the spatial pattern as well as the correlation between dementia and the three cardiovascular risk factors remained unchanged.

4 Discussion

This is the first study to explore spatial differences in dementia prevalence in Germany. We found distinct geographical patterns in dementia prevalence which were significantly correlated with the regional distribution of the three major vascular risk factors hypertension, hypercholesterolemia and diabetes mellitus. A series of studies (for an overview see Breteler, 2000) has previously linked these risk factors with the incidence and prevalence of dementia on an individual level; here we show that this link also exists on a regional level.

Given the lack of regional studies about dementia prevalence in Germany it was not possible to validate our finding with earlier studies. However, results from regional population-based cohort studies support the geographic patterns we found for the three risk factors hypertension, hypercholesterolemia, and diabetes.

Blood pressure has been continuously found higher in the East than in the West (Marti et al. 1990; Heinemann and Greiser 1993; Thamm 1999; Fischer et al. 2000) with signs of convergence during the 1990s (Thamm 1999). The comparison of the prevalence of hypertension in the Study of Health in Pomerania (SHIP) in the north-eastern region of Pomerania with the level in the MONICA/KORA study in the south-western city of Augsburg, based on nearly identical study designs and similar definitions of hypertension, showed considerable differences at ages 25 to 64. Hypertension among men in the SHIP study was 60%, in the MONICA/KORA study 41%. Among women the respective values were 39% and 29% (Meisinger et al. 2006).

Schipf et al. 2012 compared the age-standardized prevalence of diabetes mellitus at age 45 to 74 in the SHIP-study in the northeast, the CARLA-study in the east, the HNR-study and the DHS-study in the west, and the KORA S4-study in the south of Germany. Additionally, data from the nationwide German National Health Interview and Examination Survey 1998 were included. All of the studies used similar methods regarding the study design, selection of the study population, and the definition of type 2 diabetes resulting in similar response rates. The results showed a southwest-to-northeast gradient with the highest prevalence in the east (12.0%) and the lowest in the South (5.8%).

Little information about the regional distribution of hypercholesterolemia is available. Supporting our results, a study based on the analysis of serum-lipid levels of outpatient patients found that the prevalence of increased high-density lipoprotein cholesterol (HDL-C) levels was lower among East than West German men; levels were only slightly higher among East than West German women (Moebus et al. 2008). We will discuss this study below in more detail.

Finally, we turn to the regional pattern of the metabolic syndrome which is a generic term for the co-occurrence of different diseases (Rosak 2003) including central obesity, impaired glucose tolerance, essential arterial hypertension and dyslipoproteinemia (Haak and Palitzsch 2012). The metabolic syndrome results in high morbidity and mortality by coronary, cerebral, and vascular diseases (Rosak 2003), as well as an increased risk of diabetes mellitus (Laaksonen et al. 2002; Lorenzo et al. 2003). In 2005, a study of more than 30.000 outpatient patients in 397 of 438 German counties found significant regional differences in the age-standardized prevalence of the metabolic syndrome (Moebus et al. 2008). Prevalence was highest in the East German states of Mecklenburg-Vorpommern, Brandenburg, and Saxony-Anhalt. In East Germany only Saxony reached West German levels. Among women the prevalence was lowest in Hamburg, Schleswig-Holstein and Hessen, and highest in the three East German states mentioned above. Among men a similar pattern emerged albeit at a generally higher level than among women. Prevalence was lowest in Saarland, Schleswig-Holstein, Hamburg and Bremen, and highest in Brandenburg, Thuringia, and Saxony-Anhalt.

We used health claims data for the study of spatial patterns in dementia and its vascular risk factors. The primary aim of medical claims is cost calculation which leads to limitations in the data that might result in a biased geographical pattern.

First, in the German medical system, only diagnoses leading to treatment are relevant for the purposes of cost calculation. Thus, a patient's cognitive impairment may not be documented if no further treatment is given. This might be particularly true for mild cases of dementia and cognitive impairment. There might be regional differences in the diagnosis and the treatment of dementia, as well as of the vascular risk factors. Note however, the geographical pattern of the vascular risk factors found in this study was supported by

results from population-based cohort studies, which also lends credibility to the regional dementia pattern.

Second, regional differences in the proportion of individuals covered by the AOK insurance might bias the geographical pattern. This, however, would not bias the regional correlation between the dementia prevalence and the vascular risk factors. We estimated the AOK-insured population in each postal code region and included this information in our analysis. We found that regional dementia prevalence was weakly and statistically not significantly correlated with the proportion of the AOK-insured population in the West, and not correlated at all in the East. The regional correlation between the dementia prevalence and the vascular risk factors remained unchanged.

Third, geographical patterns at the highest ages might be affected by the proportion of people living in nursing homes (Doblhammer et al. 2012). In these facilities, medical doctors might refrain from diagnosing dementia and prescribing treatment due to health rationing at old ages (Brockmann 2002), or because they realise that, at present, little can be done to halt the further development of the disease (Wagner and Abholz 2002). Regional differences in the proportion of elderly living in nursing homes might therefore bias the results.

Fourth, regional patterns in the distribution of the software used for cost-calculation might bias our results.

Fifth, the diagnoses in medical claims data are neither specific nor standardised. Unlike the data used in community-based epidemiological studies, in which diagnoses are made during face-to-face examinations performed by specialists such as neurologists or psychiatrists who use defined protocols, health claims data contain diagnoses from all medical doctors, including from general practitioners. Thus, the different sub-types of dementia can not be meaningfully distinguished. In the AOK data, 45 per cent of the dementia diagnoses were of unspecified dementia. Only 27 per cent of these cases were diagnoses of Alzheimer's disease, a figure that appears to be much too low given the findings of other studies (Bickel 2000; Ott et al. 1995; Weyerer 2005). Nevertheless, after comparing the prevalence of dementia based on medical claims data with national and international meta-studies of dementia prevalence, we found that our rates fit well in the overall picture. This implies that, while medical claims data are not useful in studies that seek to determine the etiology of dementia, they are useful for the surveillance of the functional status of dementia irrespective of its cause for public health purposes (Launer 2011).

Finally, the regional correlation between dementia prevalence and the vascular risk factors might be an artefact caused by a correlation in the awareness of medical doctors for any of the four diseases. In other words, medical doctors that are more likely to diagnose the three vascular risk factors are also more likely to diagnose dementia. We tested this by exploring the regional correlation between dementia prevalence and the prevalence of smoking-related cancer on the one hand, and between dementia prevalence and non-smoking related cancer on the other hand. In the claims data the diagnosis of cancer should not be biased by differences in regional awareness of cancer nor of dementia. Smoking has been linked to an increased risk of Alzheimer's disease (Peters et al. 2008), thus, the geographical pattern of smoking-related cancer should be correlated with dementia, which is indeed the case in our data. Furthermore, our data showed no correlation between non-smoking related cancer and dementia (results not shown).

Despite these shortcomings, health claims data carry also major advantages. The study of spatial patterns requires large numbers of observations, particularly at the highest ages. The AOK claims data cover the total population, including people who live in institutions,

such as assisted living or nursing homes. In many community-based epidemiological studies, the institutionalised elderly are missing. This leads to a large bias, as the prevalence of dementia is four times higher among elderly people living in nursing homes than among older people who live in the community (Jakob et al. 2002). In the AOK population, 36 per cent of the women but only 24 per cent of the men with a dementia diagnosis at age 85 were living in a nursing home.

Since the AOK claims data contain the total insured population, there was no possibility that the study design or self-selection into the study could have introduced a bias in the results. While the socio-economic status of the AOK population is lower than that of the general population (Geyer and Peter 2000), the difference is larger among people at younger than at older ages, as up to 50 per cent of the elderly German population are insured under the AOK plan.

This study provides strong evidence for the existence of geographical patterns in dementia prevalence in Germany. A better understanding of these differences might be gained if not only the relationship with vascular risk factors were explored. Future studies should therefore aim at including regional context information. Information about geographical variation in the prevalence of dementia is important from a public health point of view. The identification of modifiable socio-economic and medical risk factors might help in delaying or even preventing dementia onset.

References

Baldereschi, M.; Di Carlo, A.; Maggi, S.; Grigoletto, F.; Scarlato, G.; Amaducci, L.; Inzitari, D. (1999): Dementia is a major predictor of death among the Italian elderly. ILSA Working Group. Italian Longitudinal Study on Aging. In: *Neurology* 44: 52 (4), pp. 709-713.

Bickel, H.: Epidemiologie psychischer Erkrankungen im Alter. In: Förstl, G. (Hg.) *Lehrbuch der Gerontopsychiatrie und -psychotherapie*. Stuttgart: Thieme Verlag, 2003, pp. 11-26.

Bickel, H. (2000): Demenzsyndrom und Alzheimer Krankheit: Eine Schätzung des Krankenbestandes und der jährlichen Neuerkrankungen in Deutschland. In: *Das Gesundheitswesen* 62 (4), pp. 211-218.

Breteler, M. M. B. (2000): Vascular risk factors for Alzheimer's disease: An epidemiologic perspective. In: *Neurobiology of aging* 21, pp. 153-160.

Brockmann, H. (2002): Why is less money spent on health care for the elderly than for the rest of the population? Health care rationing in German hospitals. In: *Social Science & Medicine* 55 (4), pp. 593-608.

Canadian Study of Health and Aging Working Group (1994): Canadian Study of Health and Aging: study methods and prevalence of dementia. In: *Canadian Medical Association Journal* 150 (6), pp. 899-913. Online verfügbar unter http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1486712/pdf/cmaj00286-0095.pdf.

Day, N.; Oakes, S.; Luben, R.; Khaw, K. T.; Bingham, S.; Welch, A.; Wareham, N. (1999): EPIC-Norfolk: study design and characteristics of the cohort. European Prospective Investigation of Cancer. In: *British Journal of Cancer* 80 (suppl. 1), pp. 95-103. Online verfügbar unter http://www.srl.cam.ac.uk/epic/publications/day_bjc_1999_clean.pdf.

Doblhammer, G.; Schulz, A.; Steinberg, J.; Ziegler, U. (2012): Demografie der Demenz. Bern: Verlag Hans Huber, Hofgrefe AG.

Doblhammer, G., Fink, A., Fritze, T. (2013) The Demography and Epidemiology of Dementia. In: *Geriatric Mental Health Care* 1(2): 29-33. [DOI: 10.1016/j.gmhc.2013.04.002]

Figueroa, R.; Steenland, K.; MacNeil, J.; Levey, A. I.; Vega, I. E. (2008): Geographical Differences in the Occurrence of Alzheimer's Disease Mortality: United States Versus Puerto Rico. In: *American Journal of Alzheimer's Disease & Other Dementias* 23 (5), pp. 462-469. Online verfügbar unter http://aja.sagepub.com/content/23/5/462.full.pdf.

Fischer, F.; Schiele, R.; Zahn, R.; et al. (2000): Myocardial infarction in 1996-1998: a comparison between the "old" and "new" Lands of Germany. In: *Deutsche Medizinische Wochenschrift* 125 (1), pp. 181-185.

Forette, F.; Seux, M. L.; Staessen, J. A.; Thijs, L.; Birkenhäger, W. H.; Babarskiene, M. R. et al. (1998): Prevention fo dementia in randomised double-blind placebo-controlled Systolic Hypertension in Europe (Sys-Eur) trial. In: *The Lancet* 24 (9137), pp. 1347-1351.

Fratiglioni, L.; Ronchi, D. de; Aguero-Torres, H. (1999): Worldwide prevalence and incidence of dementia. In: *Drugs & Aging* 15 (5), pp. 365-375. Online verfügbar unter http://www.gwern.net/docs/1999-fratiglioni.pdf.

Geyer, S.; Peter, R. (2000): Income, occupational position, qualification and health inequalities – competing risks? (Comparing indicators of social status). In: *Journal Epidemiol Community Health* 54, pp. 299-305.

Gillum, R. F.; Yorrick, R.; Obisesan, T. O. (2011): Population Surveillance of Dementia Mortality. In: *International Journal of Environmental Research and Public Health* 8 (4), pp. 1244-1257. Online verfügbar unter http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3118887/?report=reader.

Gorelick, P. B. (2004): Risk Factors for Vascular Dementia and Alzheimer Disease. In: *Stroke* 35 (suppl. 1), pp. 2620-2622.

Haak, T.; Palitzsch, K.-D. (Hrsg.) (2012): Diabetologie für die Praxis. Fallorientierte Darstellung – Diagnostik und Therapie. Stuttgart, New York: Thieme Verlag. Online verfügbar unter 978-3-13-162191-7.

Harbord, R. M.; Higgins, J. P. T. (2008): Meta-regression in Stata. In: *The Stata Journal* 8 (4), pp. 493-519.

Hébert, R.; Lindsay, J.; Verreault, R.; Rockwood, K.; Hill, G.; Dubois, M. F. (2000): Vascular dementia: incidence and risk factors in the Canadian study of health and aging. In: *Stroke* 31 (7), pp. 1487-1493. Online verfügbar unter http://www.ncbi.nlm.nih.gov/pubmed/10884442.

Heinemann, L. A.; Greiser, E. M. (1993): Blood pressure, hypertension, and other risk factors in East and West Germany. In: *Ann Epidemiol* 3 (suppl.), pp. 90-95.

Imaizumi, Y. (1992): Mortality rate of Alzheimer's disease in Japan: secular trends, marital status, and geographical variations. In: *Acta Psychiatrica Scandinavica* 86 (5), pp. 501-505.

Ineichen, B. (2000): The epidemiology of dementia in Africa: a review. In: *Social Science & Medicine* 50 (11), pp. 1673-1677.

Jakob, A.; Busse, A.; Riedel-Heller, S. G.; Pavlicek, M.; Angermeyer, M. C. (2002): Prävalenz und Inzidenz von Demenzerkrankungen in Alten- und Altenpflegeheimen im Vergleich mit Privathaushalten. In: *Zeitschrift für Gerontologie und Geriatrie* 35 (5), pp. 474-481.

Jorm, A. F.; Henderson, A. S.; Jacomb, P. A. (1989): Regional differences in mortality from dementia in Australia: an analysis of death certificate data. In: *Acta Psychiatrica Scandinavica* 79 (2), pp. 179-185.

Jorm, A. F.; Korten, A. E.; Henderson, A. S. (1987): The prevalence of dementia: a quantitative integration of the literature. In: *Acta Psychiatrica Scandinavica* 76 (5), pp. 465-479.

Kontula, K.; Ylikorkala, A.; Miettinen, H.; Vuorio, A.; Kauppinen Makelin, R.; Hamalainen, L. et al. (1995): Arg506Gln factor V mutation in patients with ischaemic cerebrovascular disease and survivors of myocardial infarction. In: *Thrombosis & Haemostasis* 73 (4), pp. 558-560.

Laaksonen, D. E.; Lakka, H. M.; Niskanen, L. K.; Kaplan, G. A.; Salonen, J. T.; Lakka, T. A. (2002): Metabolic syndrome and development of diabetes mellitus: application and validation of recently suggested definitions of the metabolic syndrome in a prospective cohort study. In: *American Journal of Epidemiology* 156 (11), pp. 1070-1077.

Laditka, J. N.; Laditka, S. B.; Cornman, C. B.; Porter, C. N.; Davis, D. R. (2006a): High variation in both Alzheimer's disease (AD) prevalence and factors associated with prevalence suggest a need for national AD surveillance in the United States. 10th International Conference on Alzheimer's Disease and Related Disorders (ICAD 2006). Madrid, Spain.

Laditka, J. N.; Laditka, S. B.; Eleazer, G. P.; Cornman, C. B.; Porter, C. N.; Davis, D. R. (2008): High variation in Alzheimer's disease prevalence among South Carolina countries. In: *Journal of South Carolina Medical Association* 104 (7), pp. 215-218.

Laditka, S. B.; Laditka, J. N.; Cornman, C. B.; Porter, C. N.; Davis, D. R. (2006b): Age-specific prevalence of Alzheimer's disease in a U.S. state with high population risks: Is South Carolina a harbinger of future national prevalence? 10th International Conference on Alzheimer's Disease and Related Disorders (ICAD 2006). Madrid, Spain.

Launer, L. J. (2011): Counting dementia: There is no one "best" way. In: *Alzheimer's & Dementia* 7 (1), pp. 10-14.

Lee, P. N. (1994): Smoking and Alzheimer's disease: a review of the epidemiological evidence. In: *Neuroepidemiology* 13 (4), pp. 131-144.

Leicht, H.; Heinrich, S.; Heider, D.; Bachmann, C.; Bickel, H.; van den Bussche, H. et al. (2011): Net costs of dementia by disease stage. In: *Acta Psychiatrica Scandinavica* 124 (5), pp. 384-395.

Lorenzo, C.; Okoloise, M.; Williams, K.; Stern, M. P.; Haffner, S. M. (2003): The metabolic syndrome as predictor of type 2 diabetes: the San Antonio heart study. In: *Diabetes Care* 26 (11), pp. 3153-3159.

Manfreda, J.: The epidemiologic challenge: inter-regional and urban-rural differences. In: Wood, T. (ed.): The Challenge of Dementia in Canada - From Research to Practice. Aylmer, Que´bec: Health Canada, 1995.

Marti, B.; Rickenbach, M.; Keil, U.; Stieber, J.; Greiser, E.; Herman, B. et al. (1990): Variation in coronary risk factor levels of men and women between the German-speaking MONICA centres. In: *Rev Epidemiol Sante Publique* 38 (5-6), pp. 479-486.

Matthews, F.; Brayne, C.; Medical Research Council Cognitive Function and Ageing Study Investigators (2005): The Incidence of Dementia in England and Wales: Findings from the Five Identical Sites of the MRC CFA Study. In: *PLoS Medicine* 2 (8), pp. 753-763.

Meisinger, C.; Heier, M.; Völzke, H.; Löwel, H.; Mitusch, R.; Hense, H.-W.; Lüdemann, J. (2006): Regional disparities of hypertension prevalence and management within Germany. In: *Journal of Hypertension* 24 (2), pp. 293-299.

Moebus, S.; Hanisch, J.; Bramlage, P.; Lösch, C.; Hauner, H.; Wasem, J.; Jöckel, K.-H. (2008): Regional unterschiedliche Prävalenz des metabolischen Syndroms. In: *Deutsches Ärzteblatt* 105 (12), pp. 207-213.

Ott, A.; Breteler, M. M. B.; van Harskamp, F.; Claus, J. J.; Van der Cammen, T. J. M.; Grobbee, D. E.; Hofman, A. (1995): Prevalence of Alzheimer's disease and vascular dementia: association with education. The Rotterdam study. In: *British Medical Journal* 310 (6985), pp. 970-973.

Peters, R.; Poulter, R.; Warner, J.; Beckett, N.; Burch, L.; Bulpitt, C. (2008): Smoking, dementia and cognitive decline in the elderly, a systematic review. In: *BMC Geriatrics* 8 (1), pp. 36.

Petrovitch, H.; White, L. R.; Izmirilian, G.; Ross, G. W.; Havlik, R. J.; Markesbery, W. et al. (2000): Midlife blood pressure and neuritic plaques, neurofibrillary tangles, and brain weight at death: the HAAS. Honolulu-Asia aging Study. In: *Neurobiology of aging* 21 (1), pp. 57-62.

Qiu, C.; Winblad, B.; Fratiglioni, L. (2005): The age-dependent relation of blood pressure to cognitive function and dementia. In: *Lancet Neurology* 4 (8), pp. 487-499.

Rosak, C. (2003): Angewandte Diabetologie. 3. Aufl. Bremen [u.a.]: Uni-Med-Verlag.

Russ, T. C.; Batty, G. D.; Hearnshaw, G. F.; Fenton, C.; Starr, J. M. (2012): Geographical variation in dementia: systematic review with meta-analysis. In: *International Journal of Epidemiology* 41, pp. 1012-1032.

Schipf, S.; Werner, A.; Tamayo, T.; Holle, R.; Schunk, M.; Maier, W. et al. (2012): Regional differences in the prevalence of known Type 2 diabetes mellitus in 45-74 years old individuals: results from six population-based studies in Germany (DIAB-CORE Consortium). In: *Diabetic Medicine* 29 (7), pp. 88-95.

Skoog, I.; Gustafson, D. (2006): Update on hypertension and Alzheimer's disease. In: *Neurol Res* 28 (6), pp. 605-611.

Skoog, I.; Lernfelt, B.; Landahl, S.; Palmertz, B.; Andreasson, L. A.; Nilsson, L. et al. (1996): 15-year longitudinal study of blood pressure and dementia. In: *Lancet Neurology* 347 (9009), pp. 1141-1145.

Slooter, A. J. C.; van Duijn, C. M. (1997): Genetic epidemiology of Alzheimer's disease. In: *Epidemiologic Reviews* 19 (1), pp. 107-119. Online verfügbar unter http://epirev.oxfordjournals.org/content/19/1/107.long.

Steele, J. C.; McGeer, P. L. (2008): The ALS/PDC syndrome of Guam and the cycad hypothesis. In: *Neurology 44:* 70 (21), pp. 1984-1990.

Steenland, K.; MacNeil, J.; Vega, I.; Levey, A. (2009): Recent Trends in Alzheimer's Disease Mortality in the United States, 1999-2004. In: *Alzheimer Disease and Associated Disorders* 23 (2), pp. 165-170. Online verfügbar unter http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2719973/.

Thamm, M. (1999): Blood pressure in Germany - update review of state and trends. In: *Gesundheitswesen* 61 (suppl.), pp. 90-93.

Thompson, S. G.; Sharp, S. J. (1999): Explaining heterogeneity in meta-analysis: a comparison of methods. In: *Statistics in Medicine* 18 (20), pp. 2693-2708.

Wagner, G.; Abholz, H-H. (2002): Diagnose und Therapiemanagement der Demenz in der Hausarztpraxis 78 (5), pp. 239-244.

Weyerer, S. (2005): Altersdemenz. Gesundheitsberichterstattung des Bundes. Robert Koch-Institut. Berlin.

Zhang, Z. X.; Zahner, G. E.; Román, G. C.; Liu, J.; Hong, Z.; Qu, Q. M. et al. (2005): Dementia subtypes in China: prevalence in Beijing, Xian, Shanghai, and Chengdu. In: *Archives of Neurology* 62 (3), pp. 447-453.

Zhang, Z. X.; Zahner, G. E.; Román, G. C.; Liu, X. H.; Wu, C. B.; Hong, Z. et al. (2006): Socio-demographic variation of dementia subtypes in china: Methodology and results of a prevalence study in Beijing, Chengdu, Shanghai, and Xian. In: *Neuroepidemiology* 27 (4), pp. 177-187.

Ziegler, U.; Doblhammer, G. (2009): Prävalenz und Inzidenz von Demenz in Deutschland. Eine Studie auf Basis von Daten der gesetzlichen Krankenversicherungen von 2002. In: *Das Gesundheitswesen* 71, pp. 281-290.

Community, volunteering, and health in mid- and older adulthood: Evidence from a longitudinal sample of the German Ageing Survey (DEAS)

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Abstract

The study observes the cross-level effects of social and demographic structures of the community on the individual-level associations of formal volunteering and informal helping with subjective health and depressive symptoms in mid- and older adulthood. 1,741 respondents from a longitudinal sample of the German Ageing Survey aged 40 years and over in 2002 and 2008 were included in the analysis. The individual-level data was supplemented by community-level variables from the Microm data set. Multiple random coefficient models were employed for the statistical analyses. A health promoting effect on subjective health was found for informal helping (estimate: 0.21, $p<5\%$) but not for volunteering. The health effects of these activities did not vary by community characteristics. Rather, individual-level socioeconomic resources as well as community deprivation showed an independent association with subjective health. Inconsistent effects regarding depressive symptoms were observed for volunteering and informal helping. Being in a partnership markedly lowered the degree of depressive symptoms (estimate: -1.22, $p<0.1\%$) as well as car ownership or a high formal education. Only the perceived condition of the community showed a weak protective effect at the community-level. The findings suggest that the health effects of volunteering and informal helping in mid- and older adulthood are not moderated by community characteristics. Rather, the variables of both levels show an independent effect on the health outcomes. Among these, individual-level resources show comparatively stronger associations. Thus, they are regarded as the primary target for health promoting strategies.

1 Introduction

1.1 Volunteering and health of seniors

Most European countries are about to face a profound increase of older people in the course of demographic change, particularly in the following decades. Thus, questions concerning

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the individual and social determinants of healthy ageing[1] become increasingly important in scientific as well as in political debates. Against this background, a growing body of gerontologic and public health literature has emerged in the recent years concerning the salubrious influences of formal and informal volunteering among older adults. Volunteering can be defined as "…any activity in which time is given freely to benefit another person, group or cause" (Wilson 2000). Thus, volunteering is a form of helping behaviour, which requires more planning and commitment than spontaneous helping, e.g. in the case of an accident.

There is evidence that volunteering activities are not only beneficial for the recipient and the civil society, but also have a positive impact on the health and longevity of the volunteer (Burr et al. 2011; Lum and Lightfood 2005; Hinterlong et al. 2007; Wahrendorf and Siegrist 2008; Tang 2009; Thoits and Hewitt 2001; van Willigen 2000; Morrow-Howell et al. 2003; Luoh and Herzog 2002; Musick et al. 1999; Harris and Thoresen 2005). However, health selection might be an explanation for these findings, but a recent research review concludes that both effects are operative – that is, older adults with better health are more likely to volunteer than persons with ill heath and additionally receive positive health effects due to those activities (Morrow-Howell 2010). Explanations for the health benefits of volunteering on the individual-level often refer to psychosocial resources that are strengthened by those activities, like a high self-esteem or a stronger sense of mastery and control over one's life (Thoits and Hewitt 2001).

In addition to the health benefit of volunteering, it offers older people the chance of social participation and integration as well as an opportunity to disseminate their knowledge to the members of younger age groups. Moreover, research on volunteering seems especially promising because not only the individual benefits from it but also ageing societies (Lum and Lightfood 2005; Morrow-Howell 2010), since they are increasingly dependent on productive capacities of older people. Therefore, the willingness of the elders to volunteer plays a vital role to meet the challenges of the demographic change.

The chances of formal and informal volunteering are not equally distributed in modern societies. Human capital (e.g. education or income), social resources (e.g. personal networks or family relations) as well as sociodemographic characteristics (e.g. age or gender) are associated with different forms of volunteering (Wilson 2000; Wilson and Musick 1997). The evidence available for European countries point towards age, subjective health, education and employment status as individual-level predictors of volunteering, informal helping and caring in the second half of life (Erlinghagen and Hank 2006; Hank 2011; Hank and Erlinghagen 2010). Those studies reveal that being more than 75 years old, being (self-) employed, having a low educational degree or reporting a relatively poor health markedly lowers the probability of volunteering at older ages. Since human capital, socioeconomic resources and age are also associated with health among older people (Dalstraa et al. 2006; Grundy and Sloggett 2003; Knesebeck 2007), these factors are considered as individual-level confounders in the analysis.

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[1] Healthy ageing is a multidimensional concept which comprises different concepts like autonomy, self-dependence or resilience (Hansen-Kyle 2005). The authors of the "Healthy Ageing"-Project of the European Public Health Programme define the concept as "…the process of optimizing opportunities for physical, social and mental health and to enable older people to take an active part in society without discrimination and to enjoy an independent and good quality of life" (The Swedish National Institute of Public Health 2006). More complex definitions of healthy ageing address different but parallel levels of analysis, namely the biological, the biomedical as well as the behavioural level (Ryff and Singer 2008).

1.2 Community characteristics and volunteering

Despite the significance of volunteering in ageing societies, relatively little effort has been made regarding the social and spatial context of those activities (Wilson 2000; Musick and Wilson 2008). The focus of research was more on the individual-level and life course determinants of formal and informal volunteering (Tang 2006). However, the social and physical conditions of the community or the neighbourhood may supplement individual and life course related factors because most of the volunteer activities are typically conducted in such small scale contexts. One reason is that most volunteer activities address local problems; another reason is that people who decide to volunteer do so in response to an invitation of someone they know or an organization which targets relates to issues of their everyday life. Thus, volunteering is likely to be practiced in the proximity to one's home, namely the community or the neighbourhood context (Musick and Wilson 2008).

The existing evidence indicates that several community characteristics like residential stability, a high share of home owners, a widespread sense of trust and attachment among the residents, neighbourliness or economic privilege seem to foster volunteering (Musick and Wilson 2008), even though the findings remain inconsistent (Wilson 2008). In the case of older people, a community perspective on volunteering and health seems especially relevant because spatial mobility decreases with age, particularly when people enter retirement (Yen et al. 2009). This, combined with other factors like a longer duration of exposure, increased physical and mental vulnerability and an increasing reliance on access to community sources of integration (e.g. senior centres) makes the community play a more significant role for the everyday life of older people as they become more vulnerable to community-level factors (Glass and Balfour 2003; Aneshensel et al. 2007; Wight et al. 2009). Additionally, predictors of volunteering like tenure status, attachment to the community, economic deprivation and duration of residence are positively associated with the age of the residents. This distinguishes older people from young, single people, newly arrived immigrants as well as native members of minorities which have relatively low shares of volunteers (Musick and Wilson 2008).

1.3 Community characteristics and health

In contrast to the field of volunteering, there is a notable amount of empirical evidence on the effects of community characteristics and the health of older people. Several studies from the US and Great Britain point towards an impact of socioeconomic and demographic features of neighbourhoods and communities on the health and well-being of people above 50 years of age (Yen et al. 2009; White et al. 2010; Wight et al. 2009; Subramanian et al. 2006; Beard et al. 2009; Bowling and Stafford 2007). The predictors of morbidity and mortality in this age group include the age structure of the community (share of residents over 64 years of age), the degree of socioeconomic deprivation, residential stability (share of residents that have lived in the same household at least for the last 5 years), the amount of social capital, the ethnic structure (share of black and Hispanic residents) and the quality of the physical environment (Cagney et al. 2005; Kubzansky et al. 2005; Feldman and Staptoe 2004; Aneshensel et al. 2007; Bowling and Stafford 2007; Freedman et al. 2008; Beard et al. 2009; Wight et al. 2006; Wight et al. 2009; Wight et al. 2010; Balfour and Kaplan 2002). Most of the evidence concerning the effect of neighbourhood environment

and the health of older adults is from cross-sectional studies (Yen et al. 2009). Thus, in order to address issues of change and causality that are especially relevant in the field of ageing, longitudinal study designs are needed. Moreover, some of the evidence supports the assumption that neighbourhood effects on the mental health of older people are largely compositional in nature because most of those associations became statistically insignificant after controlling for individual-level characteristics (Wight et al. 2009; Aneshensel et al. 2007).

Some studies solely employed subjective perceptions of the neighbourhood environment (Bowling et al. 2006; Balfour and Kaplan 2002) while others explicitly compare the effects of subjective and objective neighbourhood environment on individual health (Wen et al. 2006). Evidence lends support to the assumption that objective community context and subjective perceptions of such small scale contexts capture distinct pathways from place to health, with perceived physical environment being a stronger predictor of subjective health among people aged 50 years and above (Wen et al. 2006). This finding is supported by several studies, leading to the suggestion to include perceived as well as objective measures of neighbourhood environment in future studies (Yen et al. 2009).

The spatial unit of observation in the US studies is the census tract which is used as a proxy for the neighbourhood environment (Wen et al. 2006; Balfour and Kaplan 2002; Wight et al. 2010; Beard et al. 2009; Wight et al. 2009; Aneshensel et al. 2007). In a study from the UK, the British postcode sectors were used as an indicator of the neighbourhood environment, including between one and eight persons per sector (Bowling et al. 2006). In contrast to these approaches which use distinct administrative areas to measure neighbourhood environment, other studies use indicators of perceived areas drawn from survey data (Yen et al. 2009).

Different indicators for health were used in these studies, namely the overall subjective health (Wen et al. 2006; Bowling and Stafford 2007), functional health and disability (Balfour and Kaplan 2002; Keysor et al. 2010) as well as the Centre for Epidemiologic Studies Depression Scale (CES-D) as a proxy for mental health (Wight et al. 2009; Aneshensel et al. 2007). Evidence on objective health outcomes is scarce because mainly survey data was employed.[2]

In sum, the evidence provides limited support that community-level characteristics are primary predictors of health outcomes among older people (Yen et al. 2009). Thus, cross-level effect modification or indirect cross-level effects of community-level proxies with individual-level pathways (Blakely and Woodward 2000) to health outcomes in the second half of life seem to be a promising approach for further research, especially on the basis of prospective panel data.

1.4 Aim of the study, etiological pathways, and hypotheses

Against the background of the current empirical evidence and the concepts presented in the previous sections, the complex interplay of health-related factors located at different spatial and social levels becomes apparent. In order to understand the mechanisms that link

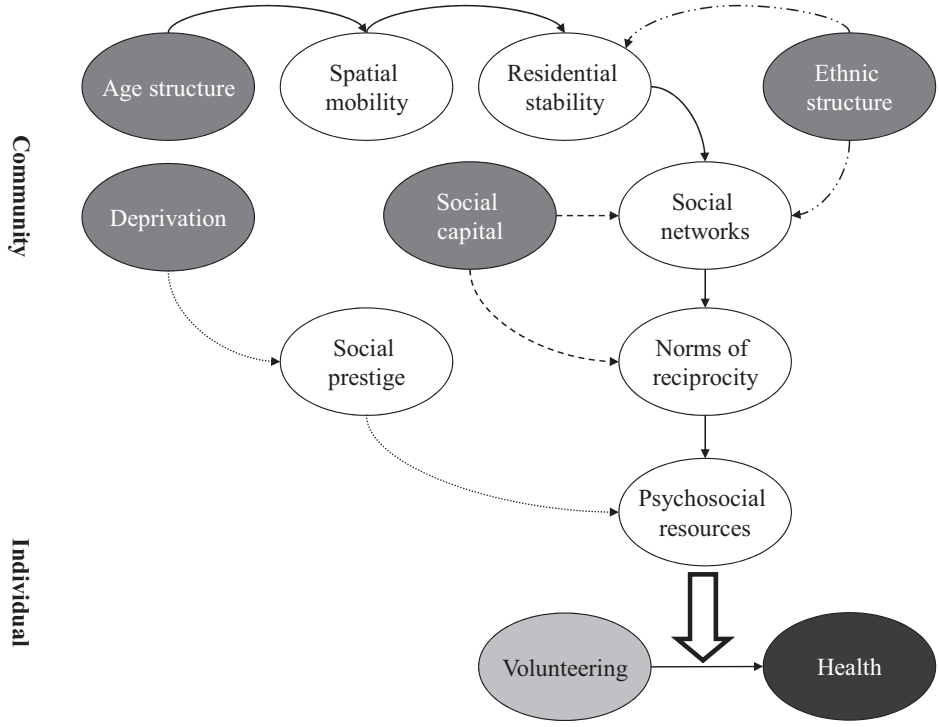
[2] An exception is the study from Nordstrom et al. which observes the association of individual and community socioeconomic indicators with subclinical cardiovascular disease in a cohort of people aged 65 years and over (Nordstrom et al. 2004).

volunteering to healthy ageing, it is important to take a multi-level perspective and to disentangle the underlying pathways, especially with regard to older age groups.

The aim of the present study is to observe whether social or demographic characteristics of the community operate as cross-level effect modifiers (Blakely and Subramanian 2006; Blakely and Woodward 2000) with regard to the health-related consequences of formal and informal volunteering in mid- and older adulthood besides other individual and household resources. As a consequence, the present study combines the approaches of "healthy ageing" and "productive ageing", which were largely separated discourses in Gerontology so far.

Considering the effects of the demographic and socioeconomic characteristics of the community on volunteering and health, several hypotheses can be derived from the empirical evidence (Musick and Wilson 2008; Yen et al. 2009). First, the age structure of the community can affect the availability of resources and opportunities for activities. Thus, it can be considered an important proxy for direct and indirect effects on health (Cagney 2006). Regarding the age structure of the community, I expect that the salubrious effects of formal and informal volunteering are more pronounced in neighbourhoods with a higher share of older people aged 60 years and over (hypothesis 1). The starting point of the etiologic pathway to support this hypothesis is the assumption, that the higher the share of older residents within a community, the lower is the spatial mobility in this area due to a decrease of job-related mobility as the people retire. Additionally, the increasing age-related frailty constrains the spatial mobility within a community with a high share of older residents. As a result of a lower spatial mobility, the residential stability within older communities is higher compared to communities with younger residents or with a higher share of migrants, which makes formal and informal volunteering more likely. Moreover, communities with low residential fluctuation have a better chance to establish stable social networks. This enhances the control of norms of reciprocity within social interactions in the context of those social networks. The stronger the norms of reciprocity, the more likely equity in the exchange of material and immaterial goods can be achieved and maintained. The equity in the exchange of goods within social interactions is a prerequisite for the subjective balance between one's effort and the rewards perceived for volunteering. If such a balance is achieved, the positive psychosocial effects may promote the subjective and the mental health of older people. Figure 1 illustrates the etiological pathways that are expected to be relevant for a cross-level effect modification between community characteristics, volunteering and health in the second half of life.

Figure 1: Community-level characteristics, etiological pathways, and the association between volunteering and health



Source: Own presentation

I expect similar etiological pathways for the ethnic structure of the community and its social capital. The concept of social capital refers to features of social relationships that facilitate collective action, like the level of interpersonal trust, mutual aid and norms of reciprocity (Kawachi 1999; Rostila 2010). Thus, it is closely linked to the concept of volunteering as well as individual health outcomes, even though the pathways that link social capital to health are still largely unknown (Hunter et al. 2011). Against the background of the existing evidence on the health benefits of social capital (Kawachi et al. 1999; Knesebeck et al. 2005; Nummela et al. 2009; Pollack and Knesebeck 2004), I expect the health effects of volunteering to be higher in communities with a high level of social capital (hypothesis 2).

In contrast to the positive effect of an age structure with a high share of older people and a high level of local social capital, I assume that a heterogeneous ethnic structure decreases the salubrious effect of volunteering in mid- and older adulthood (hypothesis 3).

Multicultural communities are characterised by a higher fluctuation and segregation of residents compared to ethnically homogeneous communities with a high share of indigenous residents, which increases the risk of less stable social networks (Musick and Wilson 2008). Additionally, cultural differences between ethnic groups are likely to decrease norms of reciprocity which may lead to a negative effort-reward-balance of volunteers. This is expected to lower the amount of positive psychosocial resources that are assumed to be one of the main modifiers for the association between volunteering and health on the individual-level (Wahrendorf and Siegrist 2008).

The socioeconomic condition of the community is one of the main predictors of volunteering and health (Wen et al. 2006; Wight et al. 2010; Beard et al. 2009; Yen et al. 2009; Musick and Wilson 2008). Regarding the level of deprivation of the community, I expect the effect on volunteering on health to be more pronounced in privileged communities (hypothesis 4). The social prestige associated with volunteering activities in privileged neighbourhoods is assumed to be an important etiological pathway for this hypothesis, linking socioeconomic deprivation to psychosocial resources (figure 1). The higher the social prestige, the higher are the psychosocial resources that can be drawn from volunteering activities, which eventually modify the association with health.

A number of studies also analyse the (perceived) quality of the infrastructure or the environmental strains imposed to the residents of a community by noise or air pollution as predictors of the health of older people (Balfour and Kaplan 2002; Bowling et al. 2006; Wen et al. 2006; Freedman et al. 2008; White et al. 2010; Keysor et al. 2010). Since the present study focuses on the socioeconomic and demographic features of communities, those environmental factors were not included in figure 1. However, since the empirical evidence points to the fact that the physical environment of a community is likely to affect both volunteering and the health of older adults, those characteristics will be integrated in the analysis as confounders.

2 Methods

2.1 Data

This study used two waves from the public release of the German Ageing Survey (DEAS), a representative survey of adult respondents aged 40 years and older living in private households in Germany. The data is provided by the Research Data Centre (FDZ-DEAS) of the German Centre of Gerontology (DZA). The community-level variables referring to street sections were selected from the database of the Microm Micromarketing Systems and Consult GmbH. On average, a street section in the DEAS comprised 70 households in the year 2002 and 78 households in the year 2008, respectively. The data available for these small scale units were selected as proxy measures for social and demographic characteristics of the community. Since this data is only available for the years 2002 and 2008, the individual-level longitudinal data from the DEAS was used for the same time points. The initial sample size of 1,001 persons that were questioned in the years 2002 and 2008 was supplemented by 740 respondents that were already comprised in the Panel from the year 1996 onward. Thus, the study cohort comprised a total of 1,741 respondents with 3,842 observations. The study cohort only comprises respondents who were questioned in

the years 2002 and 2008. Since the panel samples of the DEAS are characterized by high attrition rates (68.5% from the first wave in 1996 to the second wave in 2002 and 67.5% from the second wave in 2002 to the third wave in 2008), a comparison of sociodemographic characteristics of the study cohort with the data of the official statistics in Germany is conducted to estimate potential bias. In the case of item-nonresponse, the missing values on the individual as well as on the community level were imputed using the data from the available time point, respectively. Cases of unit-nonresponse were not imputed and remained in the unbalanced study cohort. For descriptive analyses, a longitudinal weight designed by the DZA was employed.

2.2 Variables

Health as the main outcome of the analysis was measured using two indicators as proxies for physical and mental health which allow a comparison to the results of previous studies. First, the subjective health of the respondents was used as an overall measure for subjective well-being. Information on subjective health is available for all waves of the DEAS. The respondents were asked to rate their current state of health using a Likert-scale from 1 "very good" to 5 "very bad". The values of subjective health were transformed for the analysis using z-scores with a mean of 0 and a standard deviation of 1 (Field 2013). Secondly, the degree of depressive symptoms was indicated using an additive index on the basis of the Centre for Epidemiologic Studies Depression Scale (CES-D). The DEAS comprises 15 items of the CES-D (e.g. "I was bothered by things that usually don't bother me" and "I was depressed"). The respondents were asked about their prevailing mental state during the last week for each item with 1 indicating "seldom or never" to 4 "mostly or all of the time".

Informal helping as a non-institutionalized form of volunteering was measured as a dichotomous variable using an indicator of neighbourly help given by the respondents for persons outside the household during the last 12 months. A construct variable was employed for formal volunteering indicating a respondents' non-paid function and activities within an organization of the civil society (e.g. sports club, political party). Thus, two typical yet distinct forms of volunteer activities were used in the analysis.

To adjust for confounding, individual resources and demographic characteristics were considered. The monthly net equivalent income of the household was calculated using the modified weights recommended by the Organisation for Economic Co-operation and Development (OECD). The indicator of the highest educational degree comprised a scale of three hierarchical levels (low, middle and high education) of formal educational degrees on the basis of the International Standard Classification of Education (ISCED). The age of the respondents was measured for descriptive purposes as a categorical variable with age groups 40 to 64 years, 65 to 79 years and 80 years and older. For analytic purposes, age was centred on the grand mean of the study cohort. In order to analyse curvilinear trends in the outcome variables, a variable for quadratic age was calculated using the centred age. On the basis of the construct variable provided by the DZA, a dichotomous variable was calculated to account for the migration background of the respondents with no regard to their own migration experience. The partnership status of the respondents was calculated as a dichotomous variable using a categorical construct variable from the DZA. The dichotomous variable provides information whether a respondent lives in a partnership or not with no regard whether the partner lives in the same household or not. The size of the respondent's social network was included in the analysis as a continuous variable of the

number of close friends and relatives. In order to measure monetary as well as property assets of the respondent's household, three proxies of socioeconomic position were included in the analysis. While net worth was a continuous measure, home and car ownership were coded as dichotomous variables.

Some indicators of community-level characteristics were also provided by the DEAS and included in the analysis. These include subjective evaluations of the respondents concerning the quality of the shopping facilities, the amount of doctor's surgeries and drugstores in the community as well as the connection to public transport. Those items are measured by dichotomous variables indicating either approval or disapproval of the respondent. The exposure to noise or the fear of crime and the attachment to the community as well as the interactions with neighbours were rated by the respondents. The latter question used a Likert-scale with four values to rate the quality of interactions with neighbours, ranging from 1"very close" to 4 "only fleeting". After z-transformation, these variables were combined into three additive indexes of the subjective quality of the infrastructure, the exposure to noise and crime and the amount of local social capital. Additionally, the interviewers rated the neighbourhood of the respondents regarding its location, the type of buildings as well as the condition of buildings, open spaces etc. These data were included into the analysis as separate indicators at the community-level.

Additionally, four indicators on the level of street sections from the Microm Consumer Marketing GmbH were merged to the study cohort. A street section served as a proxy for community-level features. These variables comprised the mean socioeconomic position of households based on education, occupation and income of the residents, the dominant family structure from single person households to families with children, an indicator of the share of residents without the German citizenship and the dominant share of people aged 60 years and older within a street section.

2.3 Statistical analysis

To examine the effect of individual-level and the community-level predictors on health outcomes in the observation period, multiple random coefficient models (growth curve models) were estimated. Growth curve models assume a hierarchical data structure of at least two interdependent levels of observation, e.g. several time points measured for each study participant. Thus, these models are especially suited to estimate individual outcomes with time-dependent covariates (West et al. 2007). An individual outcome in a hypothetic longitudinal data set is estimated by the following basic model:

$$Y_{ti} = ß_1 * X_{ti}^{(1)} + ß_2 * X_{ti}^{(2)} + ß_3 * X_{ti}^{(3)} + \ldots + ß_p * X_{ti}^{(p)} + u_{1i} * Z_{ti}^{(1)} + \ldots + u_{qi} * Z_{ti}^{(q)} + \varepsilon_{ti}$$

The value t (t=1,…, n) is an index of the n_i longitudinal observation of the dependent variable on the individual level. The value i (i=1,…, m) indicates a study participant as the observational unit of analysis. The general model includes two groups of covariates, namely X and Z. The first group comprises p covariates, $X^{(1)},\ldots, X^{(p)}$ that are associated with the fixed effects. The second group includes q covariates $Z^{(1)},\ldots, Z^{(q)}$ which are associated with the random effects $u_{1i},\ldots, u_{qi}$, that are specified for each unit of observation. Additionally, the parameter ε_{ti} denotes residual values, which are associated with each observation of a study participant (West et al. 2007).

On the basis of these general assumptions, four growth curve models were calculated using maximum likelihood for each health outcome separately. Model 1 or the null model was calculated to estimate the intercept and the total residual variance for both health outcomes, respectively. The second model was calculated as an unconditional mean model without regard to time in order to examine the individual variance in the outcome variables using the intraclass correlation coefficient. No predictors were included in model 2. Model 3 adjusted for the fixed effects of the predictors on the individual-level and the community-level without regard to interactions. Interactions of formal volunteering and informal helping with community-level characteristics were added to the fixed effects in model 4 which presents the estimates of the final model. Fixed effects and interactions in the models 3 and 4 that improved the fit of the model according to -2 log likelihood, the Akaike information criterion (AIC), the Hurvich and Tsai criterion (AICC) and the Bayes criterion (BIC) were included in the estimation. Additionally, sensitivity analysis was carried out for a sub-sample of the study cohort excluding respondents who changed their place of residence during the observation period. Predictive Analytic Software (PASW) Statistics 18 was employed for the analysis.

3 Results

3.1 Descriptive findings

The subjective health of the respondents deteriorates markedly from 2002 and 2008 with an about 25% lower score in the follow-up (table 1), indicating that subjective health is sensitive to the age of the respondents. In contrast, the median number of depressive symptoms remains stable during the period of observation. The low median score indicates that most of the respondents report a high level of mental health with little or no depressive symptoms.

Table 1: Health outcomes

Health outcomes	Year	
	2002	2008
Subjective health		
N	1,728	1,728
Median	0.5	-0.7
Skewness	-0.5	-0.5
Minimum	-3.3	-3.3
Maximum	1.8	1.8
Depressive symptoms		
N	1,726	1,726
Median	5.0	5.0
Skewness	1.6	1.8
Minimum	0.0	0.0
Maximum	39.0	43.0

Source: German Ageing Survey (DEAS), Panel 2002 to 2008 and Panel 1996 to 2008; the values are based on longitudinally weighted data from the DEAS

Table 2: Descriptive individual- and community-level characteristics of the study cohort

Characteristics of the study cohort	Year 2002 (N=1,728) % or M (SD)	 2008 (N=1,728) % or M (SD)
Individual-level characteristics		
Age 40-64	64.2	45.2
Age 65-79	31.6	39.4
Age 80 and older	4.2	15.4
Sex (female)	52.2	52.2
Migration	9.7	9.7
Formal Volunteering	17.4	19.4
Informal helping	28.8	33.9
Employed	40.2	29.3
Not employed	15.8	12.2
Retired	44.0	58.5
Low education	14.9	14.9
Medium education	56.4	56.4
High education	28.7	28.7
Partnership	78.3	72.3
Own car	83.8	80.7
Residential property	67.0	67.3
Income	1,350.0 (1,531.5)	1,333.3 (2,079.0)
Assets	5.0 (2.5)	5.0 (2.6)
Social networks	5.0 (2.6)	4.0 (2.8)
Perceived quality of the infrastructure	-0.4 (2.2)	1.7 (2.2)
Perceived environmental strains	-1.0 (1.4)	-1.0 (1.6)
Perceived social capital	-0.2 (1.3)	-0.2 (1.2)
Community-level characteristics		
Location of the community (centre)	37.0	36.3
Condition of the community	0.2 (1.0)	0.2 (1.0)
Type of community (single or two family home)	60.7	61.1
Community deprivation	5.1 (2.5)	5.5 (2.5)
Family structure	5.0 (2.7)	6.0 (2.5)
Ethnic structure	4.0 (2.6)	4.0 (2.2)
Age structure	5.0 (2.1)	6.0 (3.5)

Source: German Ageing Survey (DEAS), Panel 2002 to 2008 and Panel 1996 to 2008; the number of cases, the percentages and the median values are based on longitudinally weighted data from the DEAS; standard deviations in brackets; values for subjective health and perceived neighbourhood conditions were transformed into z-scores

Regarding the descriptive results for the individual-level characteristics of the DEAS study cohort in table 2, around 64% of the study cohort had not reached retirement age at baseline in the year 2002. Only a relatively small share of 4.2% of the respondents were 80 years and older. As the cohort aged, these age distributions markedly changed in the follow-up of the year 2008, with the share of the highest age group now reaching over 15%. As expected, the share of female respondents is slightly higher compared to males. When comparing these

numbers with the data from the German Federal Institute of Statistics of the total German population in the year 2002 in the same age groups (data not shown), the study cohort does not markedly deviate with regard to age and sex or the share of people living in a partnership even though the highest age group and the share of actively employed persons is underrepresented at baseline. Thus, a relatively high generalisability of the results can be expected.

The shares for both formal volunteering and informal helping rise from baseline to follow-up. In the starting year 2002, over 17% of the respondents were engaged in formal volunteering and around 29% had helped people outside their own household within the last 12 months. In 2008, these numbers changed slightly for formal volunteering (19.4%) and considerably for informal helping, which was carried out by around 34% of the respondents.

3.2 Multivariate results

With regard to subjective heath, the intraclass correlation coefficient of the unconditional mean model (model 2a) suggests that about 44% of the total variation in the outcome measure was due to interindividual differences (table 3). This finding suggests that growth curve analysis performs adequately in estimating fixed effects for the present data.

Table 3: Null model and unconditional mean model for subjective health

Parameters	Null model (1a)		Unconditional mean model (2a)	
	b	(s.e.)	b	(s.e.)
Fixed effects				
Intercept	0.01	(0.02)	0.01	(0.02)
Random effects				
Residual	1.00***	(0.03)	0.56***	(0.02)
Intercept			0.44***	(0.03)
Intraclass correlation (in %)			44.00	
Information criteria				
-2 log likelihood (-2LL)	8,758.54		8,427.84	
Akaike's information criterion (AIC)	8,762.54		8,433.84	
N (observations)	3,083		3,083	

Source: German Ageing Survey (DEAS), Panel 2002 to 2008 and Panel 1996 to 2008; non-standardized estimates and standard errors are shown; *: p<5%, **: p<1%; ***: p<0.1%.

The results of the full models 3a and 4a suggest that even though formal volunteering had a positive association with subjective health, it remained statistically insignificant (table 4). In contrast, informal helping showed a beneficial effect in model 3a and an even stronger health promoting effect in model 4a that was significant on the level of α=5%.

Table 4: Individual- and community-level predictors of subjective health

Level	Parameter	Subjective health			
		Model 3a		Model 4a	
		b	(s.e.)	b	(s.e.)
Individual	Intercept	-0.62***	(0.11)	-0.67***	(0.11)
	Age (centred)	-0.01***	(0.002)	-0.01***	(0.002)
	Year (2002)	0.10**	(0.03)	0.10**	(0.03)
	Formal volunteering (1 = yes)	0.07	(0.04)	0.06	(0.03)
	Informal helping (1 = yes)	0.06+	(0.04)	0.21*	(0.10)
	Sex (1 = female)	0.14**	(0.04)	0.14**	(0.04)
	Migration (1 = yes)	0.05	(0.07)	0.05	(0.07)
	Income (centred)	0.06**	(0.02)	0.06**	(0.02)
	Income (square)	<0.001*	(<0.001)	<0.001*	(<0.001)
	Low education	-0.22*	(0.09)	-0.22*	(0.09)
	Medium education	-0.03	(0.04)	-0.03	(0.04)
	Assets	0.02+	(0,01)	0.02+	(0,01)
	Residential property (1 = yes)	0.12*	(0.05)	0.12*	(0.05)
	Own car (1 = yes)	0.14*	(0.06)	0.15*	(0.06)
	Perceived environmental strains	-0.03*	(0.01)	-0.03+	(0.02)
Community	Condition of the community	0.04*	(0.02)	0.04+	(0.02)
	Location of the community (1 = centre)	0.04	(0.04)	0.07	(0.05)
	Type of community (1 = single or two family home)	-0.05	(0.05)	-0.04	(0.05)
	Community deprivation	0.01*	(0.007)	0.02*	(0.01)
Interactions	Formal volunteering* perceived strains			-0.02	(0.03)
	Informal helping* perceived strains			-0.01	(0.02)
	Formal volunteering* location of the community			-0.07	(0.09)
	Informal helping* location of the community			-0.06	(0.07)
	Formal volunteering* community condition			-0.01	(0.04)
	Informal helping* community condition			0.001	(0.04)
	Formal volunteering* type of community			0.11	(0.10)
	Informal helping* type of community			-0.11	(0.08)
	Formal volunteering* community deprivation			-0.004	(0.02)
	Informal helping* community deprivation			-0.007	(0.01)
Covariance parameters	Residual				
	Intercept	0.38***	(0.03)	0.38***	(0.03)
	Repeated measures (year=2002)	0.45***	(0.03)	0.45***	(0.03)
	Repeated measures (year=2008)	0.64***	(0.03)	0.64***	(0.03)
Information criteria	-2 log likelihood (-2LL)	8,198.52		8,192.34	
	Akaike's information criterion (AIC)	8,242.52		8,256.34	
	Hurvich and Tsai (AICC)	8,242.86		8,257.04	
	Bayes criterion (BIC)	8,375.26		8,449.42	
N (observations)		3,083		3,083	

Source: German Ageing Survey (DEAS), Panel 2002 to 2008 and Panel 1996 to 2008; Non-standardised estimates of the random coefficient models are shown; standard errors in brackets; age square, employment status, size of the social network and partnership status as well as age, ethnic and family structure, social capital and perceived infrastructure of the community were removed from models 3a and 4a; +: p<10%, *: p<5%, **: p<1%, ***: p<0.1%.

A negative effect of the linear age term on subjective health is observed (estimate in model 4a: -0.01, p<0.1%), indicating a steady decrease of the outcome measure in the course of ageing. Sex was also a significant predictor of subjective health, with women reporting a better overall health status than men (estimate in model 4a: 0.14, p<1%). A health gradient associated with the amount of socioeconomic resources, like the monthly equivalent income of the respondent's household (estimates in model 4a: 0.06, p<1% for the linear term and <0.001, p<5% for the quadratic term, respectively) and the level of formal education could be observed. Particularly low education shows a comparatively strong negative effect on subjective health (estimate in model 4a: -0.22, p<5%). Additionally, the level of wealth indicated by assets, residential property and car ownership had a positive effect on subjective health. The higher the perceived environmental strains of the community the lower was the respondent's subjective health (estimate in model 4a: -0.03, p<10%). At the community-level, the quality of the area's buildings and green spaces (condition of the community) and its level of deprivation had an effect on the outcome variable even after controlling for individual-level socioeconomic resources (estimates in model 4a: 0.04, p<5% and 0.01, p<5%, respectively). Like some of the individual-level predictors mentioned above (age, income and assets), the community-level factors show remarkably low coefficients and low levels of statistical significance in models 3a and 4a. This suggests that at least some of the associations in these models are methodical artefacts. None of the interaction effects of community-level characteristics with formal volunteering and informal helping showed a statistically significant association on the level α=5%. Thus, the effects of those activities on the subjective health of the respondents were not modified by features of the community-level context.

The estimates for the degree of depressive symptoms in the null model (model 1b) and the unconditional mean model (model 2b) suggest that about 41% of the variation of the outcome measure could be explained by the variation between the subjects (table 5). Thus, growth curve modelling seems to be an appropriate method of analysis of the outcome measure.

Table 5: Null model and unconditional mean model for depressive symptoms

Parameters	Null model (1b)		Unconditional mean model (2b)	
	b	(s.e.)	b	(s.e.)
Fixed effects				
Intercept	6.19***	(0.10)	6.19***	(0.12)
Random effects				
Residual	32.58***	(0.83)	19.08***	(0.69)
Intercept			13.47***	(0.90)
Intraclass correlation (in %)			41.34	
Information criteria				
-2 log likelihood (-2LL)	19,438.51		19,151.03	
Akaike's information criterion (AIC)	19,442.51		19,157.03	
N (observations)	3,075		3,075	

Source: German Ageing Survey (DEAS), Panel 2002 to 2008 and Panel 1996 to 2008; non-standardized estimates and standard errors are shown; *: p<5%, **: p<1%; ***: p<0.1%.

After adjusting for the fixed effects of the predictors in model 3b and the interactions in model 4b, the impact of formal volunteering and informal helping on depressive symptoms is inconsistent (table 6). Both activities lower the degree of depressive symptoms in model 3b and 4b, respectively. But only the effect of informal helping is statistically significant on the level of α=10% in model 4b (estimate in model 4b: -0.90, p<10%). The age specific development of the outcome measure is indicated by a quadratic term. This suggests that the degree of depressive symptoms follow a u-shaped curve that slightly declines as the respondents approach the retirement age and gradually rises again after the age of 80 (estimate in model 4b: 0.002, p<1%). In contrast to subjective health, women of the study cohort reported a higher level of depressive symptoms than male respondents (estimate in model 4b: 0.54, p<5%). A migration background seems to lower depressive symptoms regardless whether it refers to the respondent's own migration experience or not (estimate in model 4b: -0.95, p<5%). Respondents with higher socioeconomic resources in terms of household income, formal education and car ownership report lower degrees of depressive symptoms. Especially low education is a strong predictor for a higher degree of depressive symptoms (estimates in model 4b: 1.26, p<5%). Being in a partnership is one of the most significant protective factors on the individual-level (estimate in model 4b: -1.22, p<0.1%).

Table 6: Individual- and community-level predictors of depressive symptoms

Level	Parameter	Depressive symptoms			
		Model 3b		Model 4b	
		b	(s.e.)	b	(s.e.)
Individual	Intercept	6.82***	(0.65)	6.98***	(0.68)
	Age (square)	0.002**	(0.001)	0.002**	(0.001)
	Year (2002)	0.79***	(0.16)	0.80***	(0.16)
	Formal volunteering (1= yes)	-0.45+	(0.26)	-0.06	(0.71)
	Informal helping (1 = yes)	-0.20	(0.21)	-0.90+	(0.54)
	Sex (1 = female)	0.54*	(0.25)	0.54*	(0.25)
	Migration (1 = yes)	-0.91*	(0.41)	-0.95*	(0.41)
	Income (centred)	-0.11*	(0.05)	-0.11*	(0.05)
	Low education	1.24*	(0.49)	1.26**	(0.49)
	Medium education	0.50+	(0.26)	0.52*	(0.26)
	Partnership (1 = yes)	-1.22***	(0.31)	-1.22***	(0.31)
	Assets	-0.07	(0.05)	-0.07	(0.05)
	Residential property (1 = yes)	0.001	(0.28)	0.01	(0.28)
	Own car (1 = yes)	-0.80*	(0.35)	-0.80*	(0.35)
	Perceived infrastructure	-0,12*	(0.05)	-0,17*	(0.07)
	Perceived environmental strains	0.25***	(0.07)	0.22*	(0.09)
	Social capital	0.14+	(0.08)	0.12	(0.10)
Community	Condition of the community	-0.17+	(0.11)	-0.24+	(0.13)
	Location of the community (1 = centre)	-0.11	(0.22)	-0.18	(0.28)
	Type of community (1 = single or two family home)	0.19	(0.27)	0.06	(0.33)
	Ethnic structure	-0.07	(0.04)	-0.08	(0.05)

Level	Parameter	Depressive symptoms			
		Model 3b		Model 4b	
		b	(s.e.)	b	(s.e.)
Interactions	Formal volunteering* perceived infrastructure			-0.04	(0.12)
	Informal helping* perceived infrastructure			0.19+	(0.10)
	Formal volunteering* perceived strains			0.16	(0.17)
	Informal helping* perceived strains			0.03	(0.14)
	Formal volunteering* social capital			0.18	(0.21)
	Informal helping* social capital			-0.04	(0.16)
	Formal volunteering* location of the community			0.10	(0.51)
	Informal helping* location of the community			0.16	(0.43)
	Formal volunteering* community condition			0.33	(0.26)
	Informal helping* community condition			-0.02	(0.21)
	Formal volunteering* type of community			-0.30	(0.58)
	Informal helping* type of community			0.54	(0.45)
	Formal volunteering* ethnic structure			-0.06	(0.10)
	Informal helping* ethnic structure			0.06	(0.08)
Covariance parameters	Residual				
	Intercept	12.27***	(0.85)	12.14***	(0.86)
	Repeated measures (year=2002)	20.51***	(1.04)	20.58***	(1.05)
	Repeated measures (year=2008)	16.78***	(0.95)	16.94***	(0.96)
Information criteria	-2 log likelihood (-2LL)	19,046.28		19,055.77	
	Akaike's information criterion (AIC)	19,052.28		19,061.77	
	Hurvich and Tsai (AICC)	19,052.29		19,061.78	
	Bayes criterion (BIC)	19,070.36		19,079.83	
N (observations)		3,075		3,075	

Source: German Ageing Survey (DEAS), Panel 2002 to 2008 and Panel 1996 to 2008; Non-standardised estimates of the random coefficient models are shown; standard errors in brackets; age, employment status and the size of the social network on the individual level as well as age structure and family structure and the degree of deprivation on the community-level were removed from models 3b and 4b; +: p<10%, *: p<5%, **: p<1%, ***: p<0.1%

The perceived quality of infrastructure and the environmental strains were associated with the outcome measure. Regarding the community-level variables, only the community's condition was associated with a lower degree of depression on the level α=10% (estimate in model 4b: -0.24). With one exception (estimate for the interaction between informal helping and the perceived quality of the infrastructure: 0.19, p<10%), the interactions of formal volunteering and informal helping with the community-level characteristics were not statistically significant. The association suggests that informal helpers in a community with a high quality infrastructure report a higher degree of depressive symptoms. An explanation for this unexpected finding might be health-related differences between rural and urban areas in Germany with the latter ones typically having a higher quality of the infrastructure. Altogether, the findings do not suggest that the effect of informal helping on depression is modified by community-level characteristics.

Regarding the results of the sensitivity analyses carried out by a sub-sample of the respondents who stayed in their place of residence during the observation period, the estimates did not change markedly compared to the whole sample which also includes spatially mobile persons (data not shown).

4 Discussion

The results of the study show that social and demographic characteristics of the community did not modify the health consequences of formal volunteering and informal helping in a study cohort aged 40 years and older. Rather, direct health effects could be observed on the individual- and the community-level simultaneously. This finding suggests that formal volunteering and informal helping as well as individual resources and social and demographic features of the community are independently associated with subjective health and depressive symptoms in mid- and older adulthood. However, the effects of individual-level resources were stronger and more consistent compared to the community-level.

Most of the findings on the health effects of community-level characteristics comply with the results of previous studies. Several studies found socioeconomic deprivation at the community-level to be a predictor of subjective health (Wen et al. 2006) and depression (Kubzansky et al. 2005), even though the association became weaker or even statistically insignificant after controlling for individual characteristics (Aneshensel et al. 2007; Wight et al. 2009). Ethnic heterogeneity had no significant effect on depressive symptoms which is in line with the findings from two studies of older adults in the US (Kubzansky et al. 2005; Aneshensel et al. 2007). Regarding the age structure of the community, no statistically significant associations were found in the present study. Similar findings were reported by a study based on a sample of people aged 70 years and older (Wight et al. 2009). In contrast, a previous study reported that the presence of more elderly people in the community is associated with better mental health of people aged 65 years and older (Kubzansky et al. 2005). Thus, the association of the age structure of the community with the mental health of older adults yet remains unclear and provides a field of research for future studies. The perception of the quality of the infrastructure of the community were also found to be predictors of subjective health of older people after controlling for individual characteristics by previous studies (Bowling et al. 2006; Wen et al. 2006). Thus, the findings support the assumption that the perception of the physical environment is a confounder of the association of volunteering and health in the second half of life.

Subjective health was positively associated with formal volunteering after adjusting for individual- and community-level variables. This finding is in line with studies using longitudinal data from the US (Lum and Lightfood 2005; Hinterlong et al. 2007; Tang 2009). Regarding the inconsistent effects of formal volunteering and informal helping on the degree of depressive symptoms, the findings comply with the analysis of cross-sectional data using the SHARE (Wahrendorf and Siegrist 2008) and a study using longitudinal data from the Americans' Changing Life Study (Hinterlong et al. 2007). Models 3 and 4 suggest that volunteering predicts the initial level of subjective health and depression. Moreover, the health effect of volunteering remained stable independent of the respondent's age. Regarding the effect on the initial level of depression, these findings comply with the evidence from an analysis of the Americans' Changing Lives Study (Joongbaeck and Manacy 2010). The DEAS does not contain information on the degree to which norms of reciprocity are followed in social interactions or the perceived appreciation of volunteer activities by the respondents which seems to be an important confounder on the individual-level (Wahrendorf and Siegrist 2008). Thus, the results of the models 3 and 4 in tables 4 and 6 might be explained by the fact that the effect of reciprocity could not be controlled for in the present analysis. Since the DEAS does not contain information on most of the etiological pathways displayed in figure 1, the nature of the study was explorative.

Regarding the health effects of other individual-level variables, the findings mostly comply with the existing evidence (Aneshensel et al. 2007; Wen et al. 2006; Bowling et al. 2006; Wight et al. 2009; Kubzansky et al. 2005). Models 3a and 4a indicate that the subjective health of women is higher compared to men (table 4). This finding is in line with the results reported in previous studies (Bowling et al. 2006). However, other studies report a better subjective health among older men (Wen et al. 2006). Since the evidence from those studies on the association between sex and self reported health is mixed, one cannot clearly attribute this finding to selectivity of the study cohort.

Depressive symptoms were lower for migrants compared to the autochthonous German population (table 6). This finding differs from the results of previous studies which reported a higher risk for depressive symptoms and other mental disorders among migrants, even if the association can be explained by differences in socioeconomic status in the case of older Turkish migrants in Germany (Sahyazici and Huxhold 2012). However, the associations differ between groups of migrants with some groups reporting lower levels of depressive symptoms (Bhugra 2003). Moreover, a healthy migrant effect may also be operative in the present study (Razum and Spallek 2012), leading to a positive selection of the mental health status of the migrants interviewed in the DEAS.

Although individual-level variables, like marital status, education or income were also adjusted in previous studies on volunteering and health of older people (Tang 2009; Wahrendorf and Siegrist 2008; Lum and Lightfood 2005; Hinterlong et al. 2007), the unique feature of the present study is the supplement of those individual-level variables by subjective and objective community-level predictors of health. Yet, those multi-level predictors do not totally explain the association between formal volunteering or informal helping and health. Moreover, the effect of those activities on both outcomes does not significantly vary by community-level characteristics, as indicated by the interaction terms (tables 4 and 6). Thus, positive health effects of such activities can be expected regardless of the level of deprivation or the demographic characteristics of a community. However, the explanatory power of the community-level effects is weaker and more inconsistent compared to the individual-level predictors for both health outcomes. With regard to health promoting strategies in the second half of life, individual-level social and economic resources as well as formal volunteering and informal helping seem to be the primary targets for interventions even though the health impact of community deprivation should not be neglected.

There are some limitations of the study regarding sample characteristics, indicators and methods. The measures of formal volunteering and informal helping are dichotomous indicators, which do not differentiate between different forms of activities or their duration and the amount of volunteer hours. Thus, the measures employed only provide rough proxies of the multitude of volunteer activities. Since the study cohort does not include persons in nursing homes, the overall health status is likely to be positively selected. This can especially be expected for the respondents aged 80 years and older, who reached an age at which the share of persons living at home starts to decline. Even though this selectivity only accounts for a small share of the study cohort, the results cannot be generalised for the highest age groups. Additionally, the high attrition rates of the DEAS may account for selectivity of the health status in the study cohort which only comprises respondents who were interviewed in both waves. This is especially true for higher age groups, were panel attrition due to mortality is more common compared to younger age groups. Thus, the significance of the results is lower for the highest age groups (80 years and older).

Even though the street sections provide an adequate proxy for the community-level, it was not possible to determine the number of respondents by street section on the basis of the Microm data or the DEAS. Thus, the effects of the community context could not be modelled separately from the individual-level effects by means of multi-level analysis. Therefore, the results of the analysis provide no evidence whether the direct associations between community deprivation and the health outcomes are contextual or compositional effects. Furthermore, during the observation period of six years only two waves of the DEAS were collected. This could affect the validity of the estimate of time as well as the change in the outcome measures in the growth curve models. Additionally, some of the non-standardised estimates of the growth curve models are rather small (e.g. income, assets and community deprivation as well as perceived environmental strains and condition of the community in models 3a and 4a), suggesting that the statistically significant effects of those individual- and community-level variables are artificial.

In sum, the present study provides evidence that overall subjective and mental health in mid- and older adulthood is simultaneously affected by individual-level factors, including informal helping and formal volunteering, socioeconomic resources and partnership status as well as community-level deprivation. Since the complex interplay between health, volunteering, individual resources and place of residence at older ages is far from being disentangled, it remains a fruitful field of research for future studies. This is especially true for the effect of socioeconomic deprivation, which shows a consistent health effect in present analysis. To supplement the large amount of descriptive evidence, more explanatory research is needed to address the etiological pathways of health on different spatial and social levels. To conduct multi-level studies in health research in Germany, appropriate primary data is needed to catch up with the international state of research.

References

Aneshensel, Carol S.; Wight, Richard G.; Miller-Martinez, Dana; Botticello, Amanda L.; Karlamangla, Arun S.; Seeman, Teresa E. (2007): Urban neighborhoods and depressive symptoms among older adults. In: *Journals of Gerontology* Series B: Psychological Sciences and Social Sciences 62B, pp. 52-59.

Balfour, J. L.; Kaplan, G. A. (2002): Neighborhood environment and loss of physical function in older adults: evidence from the Alameda County Study. In: *American Journal of Epidemiology* 155, pp. 507-515.

Beard, J. R.; Blaney, S.; Cerda, M.; Frye, V.; Lovasi, G. S.; Ompad, D.; Rundle, A. V. D. (2009): Neighborhood characteristics and disability in older adults. In: *Journals of Gerontology* Series B: Psychological Sciences and Social Sciences 64B, pp. 252-257.

Bhugra, D. (2003): Migration and depression. In: *Acta psychiatrica Scandinavica.* Supplementum 418, pp. 67-72.

Blakely, T. A.; Subramanian, S. V. (2006): Multilevel studies. In: Oakes, M. J., Kaufman, J. S. (Eds.): Methods in social epidemiology. Jossey-Bass, San Francisco, pp. 316-340.

Blakely, T. A.; Woodward, A. J. (2000): Ecological effects in multi-level studies. In: *Journal of Epidemiology and Community Health* 54, pp. 367-374.

Bowling, A.; Stafford, M.; (2007): How do objective and subjective assessments of neighbourhood influence social and physical functioning in older age? Findings from a British survey of ageing. In: *Social Science & Medicine* 64, pp. 2533-2549.

Burr, J. A.; Tavares, J.; Mutchler, J. E. (2011): Volunteering and hypertension risk in later life. In: *Journal of Aging and Health* 23, pp. 24-51.

Cagney, K. A. (2006): Neighborhood age structure and its implications for health. In: *Journal of Urban Health*: Bulletin of the New York Academy of Medicine 83, pp. 827-834.

Cagney, K. A.; Browning, C. A.; Wen, M. (2005): Racial disparities in self-rated health at older ages: what difference does the neighborhood make? In: *Journals of Gerontology* Series B: Psychological Sciences and Social Sciences 60B, pp. 181-190.

Dalstraa, J. A. A.; Kunst, A. E.; Mackenbach, J. P. (2006): A comparative appraisal of the relationship of education, income and housing tenure with less than good health among the elderly in Europe. In: *Social Science & Medicine* 62, pp. 2046-2060.

Erlinghagen, M.; Hank, K. (2006): The participation of older Europeans in volunteer work. In: *Ageing & Society* 26, pp. 567-584.

Feldman, P. J.; Steptoe, A. (2004): How neighborhoods and physical functioning are related: the roles of neighborhood socioeconomic status, perceived neighborhood strain, and individual health risk factors. In: *Annals of Behavioral Medicine* 27, pp. 91-99.

Field, A. (2013): Discovering statistics using IBM SPSS Statistics. Sage Publications, London

Freedman, V. A.; Grafova, I. B.; Schoeni, R. F.; Rogowski, J. (2008): Neighborhoods and disability in later life. In: *Social Science & Medicine* 66, pp. 2253-2267.

Glass, T. A.; Balfour, J. L. (2003): Neighborhoods, aging, and functional limitations. In: Kawachi, I.; Berkman, L. F. (Eds.): Neighborhoods and health. Oxford University Press, Oxford, pp. 303-334

Grundy, E.; Sloggett, A. (2003): Health inequalities in the older population: the role of personal capital, social resources and socio-economic circumstances. In: *Social Science & Medicine* 56, pp. 935-947.

Hank, K. (2011): Societal determinants of productive aging: a multilevel analysis across 11 European countries. In: *European Sociological Review* 27, pp. 526-541.

Hank, K.; Erlinghagen, M. (2010): Volunteering in "old" Europe: patterns, potentials, limitations. In: *Journal of Applied Gerontology* 29, pp. 3-20.

Hansen-Kyle, L. (2005): A concept analysis of healthy ageing. In: *Nursing Forum* 40, pp. 45-57.

Harris, A. H. S.; Thoresen, C. E. (2005): Volunteering is associated with delayed mortality in older people: analysis of the longitudinal study of aging. In: *Journal of Health Psychology* 10, pp. 739-752.

Hinterlong, J. E.; Morrow-Howell, N.; Rozario, P. A. (2007): Productive engagement and late life physical and mental health: findings from a nationally representative panel study. In: *Research on Aging* 29, pp. 348-370.

Hunter, B. D.; Neiger, B.; West, J. (2011): The importance of addressing social determinants of health at the local level: the case for social capital. In: *Health and Social Care in the Community* 19, pp. 522-530.

Joongbaeck, K.; Manacy P. (2010): Volunteering and trajectories of depression. In: *Journal of Aging and Health* 22, pp. 84-105.

Kawach, I. (1999): Social capital and community effects on population and individual health. In: *Annals of the New York Academy of Sciences* 896, pp. 120-130.

Kawach, I.; Kennedy, B. P.; Glass, R. (1999): Social capital and self-rated health: a contextual analysis. In: *American Journal of Public Health* 89, pp. 1187-1193.

Keysor, J. J.; Jette, A. M.; LaValley, M. P.; Lewis, C. E.; Torner, J. C.; Nevitt, M. C.; Felson, D. T. (2010): Community environmental factors are associated with disability in older adults with functional limitations: the MOST study. In: *Journal of Gerontology* Series A: Medical Sciences 65A, pp. 393-399.

Knesebeck, O. v. d.; Dragano, N.; Siegrist, J. (2005): Social capital and self-rated health in 21 European countries. In: *Psycho-Social-Medicine* 2, pp. 1-9.

Knesebeck, O. v. d.; Wahrendorf, M.; Hyde, M.; Siegrist, J. (2007): Socio-economic position and quality of life among older people in 10 European countries: results of the SHARE study. In: *Aging and Society* 27, pp. 269-284.

Kubzansky, L. D.; Subramanian, S. V.; Kawachi, I.: Fay, M. E.; Soobader, M. J.; Berkman, L. F. (2005): Neighborhood contextual influences on depressive symptoms in the elderly. In: *American Journal of Epidemiology* 162, pp. 253-260.

Lum, E. Y.; Lightfood, E. (2005): The effects of formal volunteering on the physical and mental health of older people. In: *Research on Aging* 27, pp. 31-55.

Luoh, M. C.; Herzog, A. R. (2002): Individual consequences of volunteer and paid work in old age: health and mortality. In: *Journal of Health and Social Behavior* 43, pp. 490-509.

Morrow-Howell, N. (2010): Formal volunteering in later life: research frontiers. In: *Journals of Gerontology* Series B: Psychological Sciences and Social Sciences 65B, pp. 461-469.

Morrow-Howell, N.; Hinterlong, J.; Rozario, P. A.; Tang, F. (2003): Effects of volunteering on the well-being of older adults. In: *Journals of Gerontology* Series B: Psychological Sciences and Social Sciences 58B, pp. 137-145.

Musick, M. A.; Herzog, A. R.; House, J. S. (1999): Volunteering and mortality among older adults: findings from a national sample. In: *Journals of Gerontology* Series B: Psychological Sciences and Social Sciences 54B, pp. 173-180.

Musick, M. A.; Wilson, J. (2008): Volunteers. A social profile. Indiana University Press, Bloomington

Nordstrom, C. K.; Diez, R. A. V.; Jackson, S. A.; Gardin, J. M. (2004): The association of personal and neighborhood socioeconomic indicators with subclinical cardiovascular disease in an elderly cohort. The cardiovascular health study. In: *Social Science & Medicine* 59, pp. 2139-2147.

Nummela, O.; Sulander, T.; Karisto, A.; Uutela, A. (2009): Self-rated health and social capital among aging people across the urban-rural dimension. In: *International Journal of Behavioral Medicine* 16, pp. 189-194.

Pollack, C. E.; Knesebeck, O. v. d. (2004): Social capital and health among the aged: comparisons between the United States and Germany. In: *Health & Place* 10, pp. 383-391.

Razum, O.; Spallek, J. (2012): Erklärungsmodelle zum Zusammenhang zwischen Migration und Gesundheit im Alter. In: Baykara-Krumme, H.; Motel-Klingebiel, A.; Schimany, P. (Eds.): Viele Welten des Alterns. Ältere Migranten im alternden Deutschland. Springer VS, Wiesbaden, pp. 161-180.

Rostila, M. (2010): The facets of social capital. In: *Journal for the Theory of Social Behaviour* 41, pp. 308-325.

Ryff, C. D.; Singer, B. (2009): Understanding healthy aging: key components and their integration. In: Bengston, V. L.; Gans, D.; Putney, N.; Silverstein, M. (Eds.): Handbook of Theories of Aging. 2. Edition, Springer, New York, pp. 117-144.

Sahyazici, F.; Huxhold, O. (2012): Depressive Symptome bei älteren türkischen Migrantinnen und Migranten. In: Baykara-Krumme, H.; Motel-Klingebiel, A.; Schimany, P. (Eds.): Viele Welten des Alterns. Ältere Migranten im alternden Deutschland. Springer VS, Wiesbaden, pp. 181-200.

Subramanian, S. V.; Kubzansky, L.; Berkman, L.; Fay, M.; Kawachi, I. (2006): Neighborhood effects on the self-rated health of elders: uncovering the relative importance of structural and service-related neighborhood environments. In: *Journals of Gerontology* Series B: Psychological Sciences and Social Sciences 61B, pp. 153-160.

Tang, F. (2006): What resources are needed for volunteerism? A life course perspective. In: *Journal of Applied Gerontology* 25, pp. 375-390.

Tang, F. (2009): Late-life volunteering and trajectories of physical health. In: *Journal of Applied Gerontology* 28, pp. 524-533.

The Swedish National Institute of Public Health (2006): Healthy ageing - a challenge for Europe. Online (28.06.2011): http://www.fhi.se/PageFiles/4173/Healthy_ageing.pdf

Thoits, P. A.; Hewitt, L. N. (2001): Volunteer work and well-being. In: *Journal of Health and Social Behavior* 42, pp. 115-131.

Van Willigen, M. (2000): Differential benefits of volunteering across the life course. In: *Journals of Gerontology* Series B: Psychological Sciences and Social Sciences 55B, pp. 308-318.

Wahrendorf, M.; Siegrist, J. (2008): Soziale Produktivität und Wohlbefinden im höheren Lebensalter. In: Erlinghagen, M.; Hank, K. (Eds.): Produktives Altern und informelle Arbeit in modernen Gesellschaften. Theoretische Perspektiven und empirische Befunde. VS Verlag für Sozialwissenschaften, Wiesbaden, pp. 51-74.

Wen, M.; Hawley, L. C.; Caciopoppo, J. T. (2006): Objective and perceived neighborhood environment, individual SES and psychosocial factors, and self-rated health: An analysis of older adults in Cook Country, Illinois. In: *Social Science & Medicine* 63, pp. 2575-2590.

West, B. T.; Welch, K. B.; Galecki, A. T. (2007): Linear mixed models: a practical guide using statistical software. Chapman & Hall/CRC, London, New York

White, D. K.; Jette, A. M.; Felson, D. T.; LaValley, M. P.; Lewis, C. E.; Torner, J. C.; Nevitt, M. C.; Keysor, J. J. et al. (2010): Are features of the neighborhood environment associated with disability in older adults? In: *Disability and Rehabilitation* 32, pp. 639-645.

Wight, R. G.; Aneshensel, C. S.; Miller-Martinez, D.; Botticello, A. L.; Cummings, J. R.; Karlamangla, A. S.; Seeman, T. E. (2006): Urban neighborhood context, educational attainment, and cognitive function among older adults. In: *American Journal of Epidemiology* 163, pp. 1071-1078

Wight, R. G.; Cummings, J. R.; Karlamangla, A. S.; Aneshensel, C. S. (2009): Urban neighborhood context and change in depressive symptoms in late life. In: *Journals of Gerontology* Series B: Psychological Sciences and Social Sciences 64B, pp. 247-251.

Wight, R. G.; Cummings, J. R.; Karlamangla, A. S.; Aneshensel, C. S. (2010): Urban neighborhood context and mortality in late life. In: *Journal of Aging and Health* 22, pp. 197-218.

Wilson, J. (2000): Formal volunteering. In: *Annual Review of Sociology* 26, pp. 215-240.

Wilson, J.; Musick, M. A. (1997): Who cares? Toward an integrated theory of volunteer work. In: American Sociological Review 62, pp. 694-713.

Yen, I. H.; Michael, Y. L.; Perdue, L. (2009): Neighborhood environment in studies of health of older adults. In: *American Journal of Preventive Medicine* 37, pp. 455-463.

Do education levels influence incidence and prevalence of long-term care among the elderly in Germany? Evidence from the German Microcensus Panel data (2001-2004)

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Abstract

As the proportion of elderly increases, the problems of long-term care provision and utilization are increasingly attracting the attention of researchers and policy makers. Individual health status, living and financial arrangements, and community resources are all expected to have an impact on care use. Drawing from German Microcensus Panel data (2001-2004), this paper analyzes the impact of socioeconomic status by means of education on the transition to statutory long-term care among the elderly in Germany. The sample used for the analysis is restricted to individuals aged 65 years and above; whereby men and women and western and eastern parts of Germany are studied separately. The sample size employs almost 25,000 elderly in the analysis of incidence in care use, while more than 26,000 cases are considered for the study of prevalence in care utilization. The paper examines the transition to care by using the receipt of cash benefits for home care ("Pflegegeld") as a proxy. Eligibility for benefits depends on a subjective physical assessment of the applicants and is based on an evaluation of limitations in daily living activities (not disability per se). The incidence in care use is defined here as newly reported cases receiving benefits for the first time during 2002-2004, whereas prevalence corresponds to the proportion of people receiving benefits throughout the period 2001-2004. Despite deviations between estimates of Microcensus data and official aggregated long-term care statistics, these are the only data available to study the association between education and long-term care use among the elderly living in private households and staying in the institutions. The paper discusses the advantages and disadvantages of using these data and "Pflegegeld" as the proxy for the estimations of care incidence and prevalence. Also, a panel logit model is used to assess the impact of explanatory variables on the first use of care and the Generalized Estimation Equations (GEE) model is applied to study the factors' influence on the prevalence in care utilization. The overall incidence was 18.7 cases per thousand people aged 65 and above. On the whole, about 4.5% of the elderly received benefits during the four years of the analyzed period. The results also reveal that education does matter for both incidence and prevalence in long-term care use. Regardless of sex or region, the rates for the highly educated are lower. The logit regression results demonstrate that education has an impact on the transition to care for men and people from western Germany. When GEE model is applied, education has a strong impact on the use of care for both men and women as well as for people residing in both regions.

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1 Introduction

Eurostat estimates show that the share of people aged 65 and above in Germany will increase from 16% in 2000 to 32% by 2050; the proportion of people 80 and above will increase from 4% to 14% (Europop 2010)[1]. The German Institute for Economic Research (DIW Berlin) predicts that between 2006 and 2050 there will be a two and a half-fold increase in the number of beneficiaries of statutory long-term care (SLTC) aged 65 and above (Schulz 2008). Additionally, the projection shows that in 2050 there will be about 4.1 million elderly people who need care but who will not receive any such benefits; nearly two-fold higher than in 2006 (Schulz 2010a).

This considerable projected increase in the number of SLTC beneficiaries demands an immediate policy response to solve the problem of care provision. The German Long-Term Care Insurance introduced in 1995/96 has already been amended several times in an attempt to offer better care (by increasing the amounts of benefits) and to become financially sustainable (by increasing the contribution rates). As of 2013, additional changes were introduced to cover not only changes in the benefits and contribution but also the definition of care dependency (Law on the Reorganization of Care[2]). Whereas before this the SLTC eligibility criteria were based on functional impairments and largely neglected people with cognitive problems (such as dementia), from 2013 these people should have wider access to care (German Parliament 2012). As a consequence, this may lead to higher SLTC expenses.

In general, the development of a cost-effective long-term care scheme and other related programs cannot be complete without detailed knowledge of the entire set of individual's characteristics affecting the use of these services. A person's health status, living and financial arrangements, and the community resources available all play a role in determining care utilization. Because the German SLTC was designed to provide only partial support, with additional care expenses to be borne privately (Theobald 2010; Rothgang 2010), an individual's socioeconomic status (SES) considerably affects the use of care.

Existing research on long-term care conducted worldwide has mainly focused on those factors influencing the transition to (or exit from) nursing homes (Greene and Ondrich 1990; Wolinsky et al. 1992; Tomiak et al. 2000). In addition to age, specific medical conditions play an influential role on the decision to use these facilities (Tomiak et al. 2000; Greene and Ondrich 1990). The existing evidence also suggests an impact by marital status, living arrangements, and a number of socioeconomic factors. The findings on the later are, however, contradictory. A number of studies show an inverse relationship between income and entry into nursing homes (Nihtilä and Martikainen 2007; Himes et al. 2000), while other studies do not illustrate any significant association (Tomiak et al. 2000; Greene and Ondrich 1990).

Several studies on long-term care utilization have been carried out for Germany. It has been shown that the percentage of people in need is particularly high for women at older ages (Pfaff 2010; Hoffmann and Nachtmann 2010). There are also regional differences in respect to the availability of home-based and residential care providers, and to the costs of services (Pfaff 2010; Roth and Reichert 2003; Rothgang 2010; Theobald 2011). The results of studies on the determinants of SLTC use are consistent with those conducted elsewhere.

1 http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Population_projections

2 PflegeNeuausrichtungsGesetz 2012. http://bmg.bund.de/glossarbegriffe/p-q/pflege-neuausrichtungs-gesetz.html

There are differences in incidence in use of care between men and women as well as by age (Kliebsch et al. 1998; Himes et al. 2001; Schultz 2012). The studies also illustrate that dementia, multiple sclerosis, and Parkinson-Syndrome play determining roles in utilizing of care for both men and women (Rothgang et al. 2011).

Among several SES proxies of long-term care utilization, the aspect of education has received insufficient attention, partially because suitable data on educational attainment are not available. While insurance companies generally have very detailed data on an individual's health status and use of services, there is no information on the individual's educational status. Previous research has generated a number of controversial findings regarding the impact of education on the use of care, but it uses the risk of institutionalization as the proxy rather than receipt of SLTC benefits which is considered in this paper. Some studies demonstrate that it is associated with the risk of the transition to care (Nihtilä 2005; Mustard et al. 1999), while others show no effect at all (Greene and Ondrich 1990; Wolinsky et al. 1992; Kempen and Suurmeijer 1991; Cai et al. 2009), or that there is only an effect for men (Nihtilä and Martikainen 2007) or for women (Tomiak et al. 2000).

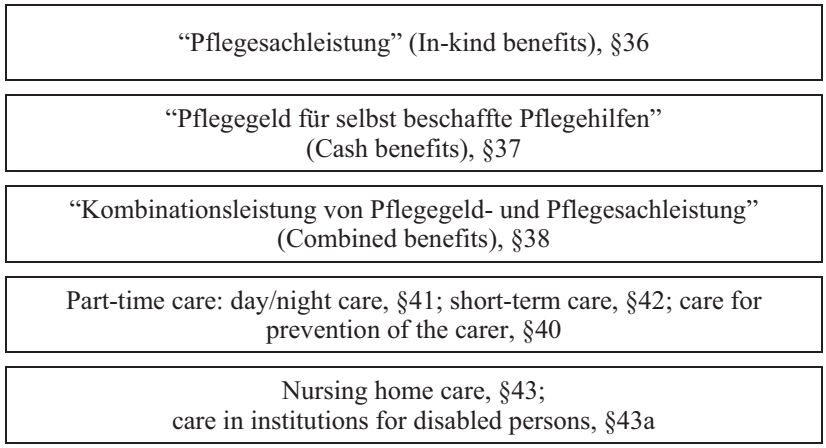
Keeping in mind that education is a reliable predictor for health and mortality (Liao, et al. 1999), its role as a potential long-term care determinant deserves closer scrutiny. This is the main reason for selecting education rather than other SES indicators in this study. The choice is also supported by the fact that education, in contrast to income, occupation, or living arrangements, remains relatively constant throughout life (Elo and Preston 1996). Also, when compared to such factors as marital status or age, it is perhaps possible to intervene and make changes in education levels in earlier years of life, which may pay off more for the community in the long-term. In her work Schulz (2010a) mentioned that an increase in educational attainment, together with positive changes in health behavior and medical technological progress, will support the improved health status of the elderly in the future, which in turn may decrease the prevalence of the need for care.

This analysis differs from earlier in several respects. In contrast to previous studies, the analysis is not restricted to people living in nursing homes. Also, not everyone in need of care is considered a care user, but instead a constricted and specific measure is applied as the proxy: receipt of SLTC benefits. This measure includes mainly cash benefits ("Pflegegeld"), in-kind benefits ("Pflegesachleistung"), or a combination of two ("Kombinationsleistung"), and thus represents only partial coverage of people in need of care who obtain SLTC assistance in Germany (Figure 1).

In addition this study is based on a large national sample of the German Microcensus, which is the only data source to provide information simultaneously on education and care use among people not only living in private households but also staying in the institutions. Also, this study pays attention not only to the incidence but also to the prevalence of transition to care.

The present article contributes to the literature by testing the following hypotheses: there is a strong causal link between education and long-term care use in a way that less-educated people have a higher incidence (1) and prevalence (2) in transition to care. It is assumed to be true for both sexes and without regard to regional differences.

Figure 1: The types of German SLTC services/benefits



Source: Social Code Book, XI

2 Overview of the Statutory Long-term Care system in Germany

The German Long-term Care Insurance was enacted in two stages (separately for outpatient and inpatient care) by the Social Long-term Care Insurance Act ("Pflegeversicherungsgesetz" 1994) as the fifth pillar of the social security system (Social Code Book ("Sozialgesetzbuch") part XI). It stipulated that in order to be eligible for the SLTC services, a beneficiary should be in need of frequent or substantial help in carrying out daily and recurring activities of everyday life over a time period of no less than 6 months (§14).

In order to identify whether and to what extent a person needs care, the Medical Review Board ("Medizinische Dienst der Krankenversicherung", MDK) of the Statutory Health Insurance Funds performs a physical assessment of the applicant (Schulz 2010b). If the applicant has private medical insurance, the assessment is carried out by Mediproof, a private company. The evaluation is primarily done by trained geriatric nurses and physicians who assess the limitations a person has in performing activities of daily living or instrumental activities. The examination is based on a number of routine activities in the fields of personal hygiene, feeding, mobility, and housekeeping (Geraedts et al. 2000; Wilbers 2000 in Webb 2003). Three criteria are applied when developing an indicator for care needs: the number of necessary care activities, frequency of activities, and time needed for care provision (for more details see Theobald 2011). The estimated indicator is then compared with legal eligibility criteria and one of three care levels is subsequently assigned. The detailed information on eligibility criteria for each category is provided in Appendix 1. The recipient may choose either home or inpatient care. The first option is split into in-kind benefits for community care, a cash allowance (to arrange care provision privately), or a combination of both. Partial (day and night care) and short-term care is also available. The aggregated SLTC statistics reveal the clear predominance of cash benefits, although this is declining over time (Table 1).

Table 1: Percentage distribution of the recipients of the German SLTC by the type of services/benefits, 1999-2011

	1999	2001	2003	2005	2007	2009	2011
In-kind benefits ("Pflegesachleistung")	8.1	8.4	8.6	8.6	8.8	7.9	7.0
Cash benefits ("Pflegegeld für selbst beschaffte Pflegehilfen")	52.0	50.0	49.0	47.9	46.9	45.5	44.5
Combined benefits("Kombinationsleistung von Pflegegeld- und Pflegesachleistung")	10.2	10.5	10.3	10.2	10.4	12.5	13.7
Day/night care ("Tages- oder Nachtpflege")	0.5	0.6	0.7	0.8	0.8	1.3	1.7
Short-term care ("Kurzzeitpflege")	0.4	0.4	0.5	0.6	0.6	0.7	0.7
Home care for prevention of the carer ("Häusliche Pflege bei Verhinderung der Pflegeperson")	0.3	0.4	0.5	0.7	1.1	1.5	2.4
Nursing home care ("Vollstationäre Pflege")	25.7	26.7	27.3	27.9	28.0	27.0	26.5
Care in institutions for disabled persons ("Vollstationäre Pflege in Behindertenheimen")	2.8	3.0	3.1	3.3	3.4	3.6	3.4

Source: Federal Statistical Office (2013a); own estimates

The levels of benefits fixed by law are also provided in Appendix 1. The assessment does not focus on income or assets, but socioeconomic status is, in fact, very important because the SLTC is designed to provide only limited support and requires additional, private co-payments (Theobald 2010). More on the SLTC insurance in Germany can be found in: Arntz et al. 2007; Rothgang and Igl 2007; Theobald 2004, or Schulz 2010b.

The aggregated official statistics on long-term care provided by the Federal Statistical Office show that between 1999 and 2011 approximately 700 thousand people applied for the first time to the Medical Review Board to be evaluated for their level of care needs. Roughly 30% were not considered to be needing help and other 70% were assigned to one of the three care levels (the Information System of the Federal Health Monitoring of the Federal Statistical Office 2013a).

The aggregated statistics also reveal that 2.5 million people were in need of care in Germany in December 2011. Women made up 65% of this group and 83% were 65 years and older while 36% were 85 years and older (Federal Statistical Office 2013b). The number of elderly eligible for care/benefits increased by 29.2%, from 1.61 million to 2.08 million between 1999 and 2011 (Federal Statistical Office 2001; Federal Statistical Office 2013b). These statistics are based exclusively on the legal concept of dependency as described in the Social Long-term Care Insurance Act and do not cover people in need who do not fulfill these eligibility criteria. It has been suggested that the actual number of people requiring help is higher (Hoffmann and Nachtmann 2010). The number of people requiring help but not receiving SLTC assistance is estimated to be about 3 million (Schulz 2010b).

According to the aggregated statistics, in 2011 more than a half of people in need of care were assigned to the lowest care level, roughly one-third received level 2, and the remaining 12% were placed in the level 3 category (Federal Statistical Office 2013b). There

is a very clear variation on the share of beneficiaries by sex, related to the higher life expectancy among women. As limitations in daily life activities are usually associated with higher ages and the share of elderly women is larger than that of men, more women must rely on long-term care facilities or other services.

The aggregated statistics also illustrate that about 45% of people who received the benefits of the social long-term care insurance choose "Pflegegeld" rather than other SLTC services available. There is a dominant role of cash for men and beneficiaries at care level 1, where roughly half prefer such benefits (Federal Statistical Office 2013a). This tendency to choose cash might be explained by the specific culture of providing care in Germany (Evers 1997). Until the introduction of the insurance, the main care givers were families, and domestic care is also highly prioritized by the current SLTC scheme (Theobald 2010; Theobald 2011).

3 Data

The analysis is based on the German Microcensus Panel (GMCP) data (2001-2004) provided by the Federal Statistical Office of Germany. The GMCP is a rotating panel in which respondents are interviewed once a year for four consecutive years. Each year a quarter of the sample districts are replaced. In general, the Microcensus represents a 1% sample of the population residing in Germany. For this analysis, however, we employed the 'scientific-use file' containing 70% of the original sample.

In addition to its large sample size, the Microcensus has one other important advantage. Because participation is mandatory (although some questions are optional), the non-response rate is minimal (Basic et al. 2005). Another particular advantage of this dataset for the present study is the availability of information on the institutionalized individuals.

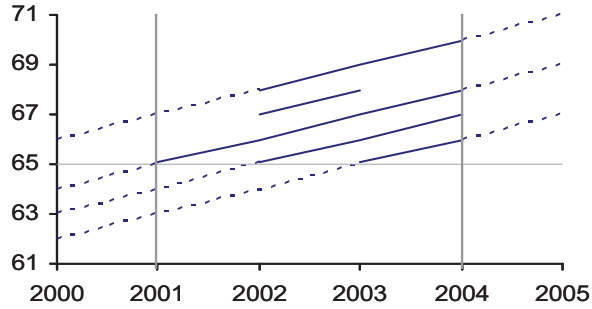
There are at least two serious limitations of the data set. The first is related to panel attrition. The Microcensus is based on an extensive regional stratification sampling in which small districts consisting of an approximate average of nine neighboring dwellings (neither individuals nor households) represent the sampling units. Those respondents who leave the sampled areas are replaced by individuals who move into the respective area. This results in a loss of longitudinal information on individuals who move. When the reasons for moving are correlated to the variable of interest, there is a potential bias due to non-coverage (Basic et al. 2005).

In order to examine if the GMCP data are representative of German population, they were compared with the data from the Human Mortality Database (HMD) by computing a simple age-sex distribution of individuals for both datasets. The results (not shown here) illustrate that overall the GMCP data are consistent, particularly for the elderly. The only group that is slightly underrepresented in the GMCP is men aged 65-70 years.

The second disadvantage is associated with the lack of health-related variables for all years except 2003. In general, the German Microcensus is designed to provide information mainly on the economic and social situation of population. Because health-related factors are the most important factor in defining the amount and type of care use, this lack prevents from evaluating the impact of changes in individual's health status on the utilization of care.

The sample for this analysis is restricted to those individuals who participated at least in two years of the GMCP and who were 65 or older in 2001-2004. Respondents were observed after their first interview and were censored at the end of the follow-up if they had not previously reported the use of SLTC services (Figure 2). All observations with incomplete information on censoring or dependent variable are excluded.

Figure 2: Lexis diagram of the study



Source: own diagram

About 63% of all respondents remained under observation during the entire four-year period, while 19% and 18% were interviewed during only three or two years, respectively.

The age at interview does not correspond to the exact age of a person but rather to the age at the time of the last birthday. To eliminate this problem, a half year is added to the age at the first interview and age at censoring. Similarly, the exact age when person starts using the SLTC services is unspecified; it is only assumed that this begins at some point in the two consecutive years. To adjust for this, a half year is subtracted from the age at the time of the event.

There are different variables available in GMCP data that can be used to estimate the number of people using the SLTC assistance: receipt of cash benefits ("Pflegegeld"), receipt of long-term care benefits ("Leistungen aus Pflegeversicherung"), the numerical level of care an individual has ("Pflegestufe"), as well as particular areas for which care is needed (personal hygiene, nutrition, mobility, etc). Unfortunately, the detailed set of questions on care use is available only for the year 2003, and the only variable that can be obtained for the whole period and used as a dependent variable is receipt of "Pflegegeld" (cash benefits). As discussed above, there are a number of long-term care benefits offered to an applicant but the "Pflegegeld" is the most popular. Despite the fact that GMCP asks exactly about the receipt of the "Pflegegeld", the comparative results with the official aggregated statistics on long-term care reveal that other kinds of benefits/services might be also reported here as cash benefits (for more details see "Discussion").

The official aggregated statistics on German long-term care (available biennially since 1999) were downloaded from the Information System of the Federal Health Monitoring (Das Informationssystem der Gesundheitsberichterstattung des Bundes[3)] conducted by the Federal Statistical Office and the Robert Koch Institute.

[3] Statistisches Bundesamt (Die Gesundheitsberichterstattung des Bundes), Wiesbaden 2006, available at: http://www.gbe-bund.de/gbe10/pkg_isgbe5.prc_isgbe?p_uid=gast&p_aid=57689708&p_sprache=D

4 Methods

The dependent variable (receiving "Pflegegeld" or "benefits" henceforth) is a dichotomous measure indicating whether an individual received benefits at any time after the first interview and up through the period of observation. The analysis of incidence in SLTC is limited to the first event (the first time receiving benefits).

To assess the associations between potential predictors and the risk of receiving benefits, panel logit regression and generalized estimation equations (GEE) models are applied. The former method considers only the first use of care, while the GEE model (proposed by Liang and Zeger 1986) takes into account the reoccurrence of the event. It "accommodates the statistical dependence among the repeated observations within subjects" and assesses "the population-averaged estimates while accounting for the dependency between the repeated measurements" in longitudinal studies (Hu et al. 1998, p.695). The method is recently gaining more and more popularity in the analysis of longitudinal data, but studies on nursing still mainly use the traditional methods (Liu et al. 2009).

The analysis is performed using StataIC12, with *xtlogit* and *xtgee* commands for two regressions, correspondingly. Identical covariates are used in both regressions. The first one is *age* of the respondent at the time of receiving benefits or censoring. It is split into the following groups: 65-69, 70-74, 75-79, 80-84, 85-89 and 90 years and above.

The second covariate is *the highest level of educational attainment*, which separates those with lower secondary or secondary education, and those with post-secondary education. The indicator is based on two questions in the GMCP that take into account both general and vocational education ("*Art des höchsten allgemeinbildenden Schulabschlusses*" and *"Art des höchsten beruflichen Ausbildungsabschlusses"*). For the categorization the International Standard Classification of Education (ISCED-1997) is utilized (more can be found in Schroedter, et al. 2006). Only two categories are used here because of the small number of cases when models are applied for sub-samples.

Because it is widely assumed that being in a situation with no spousal support increases the risk of utilizing care, the variable *marital status* is introduced here. It is divided into five categories: single, married, divorced, widowed, and changed status, whereby the last category captures any change in an individual's marital status throughout the period of observation.

Sex (men/women) and *region* (western/eastern Germany) are two variables introduced only into the full model. Individuals residing in Berlin are split into western and eastern parts of the city accordingly.

The time variable (*year*) is entered into the GEE model to check for the period effect. As the repeated observations within one subject are dependent on each other, a correction is made for these within subject correlations. An unstructured working correlation structure is used, which assumes that there is a marked decrease in correlation coefficient values with the corresponding increase in measurement within panel time intervals. The decision to use this structure is supported by the quasilikelihood under the independence model criterion (QIC, for more details see Cui 2007). The robust (sandwich) variance estimator is used to adjust the standard errors (to adjust for eventual correlation misspecifications). The summary statistics for both regressions are given in Appendix 2.

5 Results

Before looking at the results, some comparative analysis is necessary to determine if the GMCP data on SLTC are representative. The Federal Statistical Office provides data on the number of people in need of care, estimated from the 2003 Microcensus data and the official aggregated statistics on long-term care (Federal Statistical Office 2004; Federal Statistical Office 2005). The results of the reports illustrate some deviations at older ages, particularly for women. For ages 85-90, the Microcensus data show a higher prevalence of care use, while for people older than 90 the prevalence is greater from the official data.

In addition, for the years 2001 and 2003 the age distribution of the institutionalized elderly and the distribution of SLTC beneficiaries by the level of care are computed from the GMCP and compared to the aggregated statistics. The results (not shown here) illustrate that GMCP data are in agreement with the official aggregated statistics on long-term care.

The following part of the paper first provides the analysis of the incidence of care use together with an evaluation of factors influencing the incidence. Next a similar analysis is given for the prevalence of the use of care.

5.1 Incidence in SLTC use

According to the GMCP results, the incidence rate for the transition to the SLTC services is higher among women than men and is higher in eastern Germany than in the western part (Table 2). Regardless of sex, the rate is higher for people with less education (Table 3).

Table 2: Incidence rates for transition to the SLTC during 2002-2004 among the elderly (per 1000 person-years)

	All	Age groups		
		65-74	75-84	85 and above
Total	18.70 *(17.65;19.82)*	7.28 *(6.43;8.23)*	22.33 *(20.44;24.39)*	86.30 *(78.25;95.18)*
Men	13.23 *(11.88;14.74)*	7.42 *(6.19;8.88)*	19.35 *(16.49;22.69)*	49.65 *(38.63;63.82)*
Women	22.46 *(20.97;24.06)*	7.15 *(6.04;8.48)*	23.96 *(21.55;26.63)*	99.47 *(89.44;110.63)*
Secondary or lower education	19.23 *(18.02;20.52)*	7.52 *(6.54;8.65)*	22.81 *(20.68;25.16)*	85.10 *(76.20;95.04)*
Post-secondary education	11.68 *(9.94;13.74)*	5.42 *(3.99;7.36)*	13.95 *(10.78;18.04)*	60.53 *(45.48;80.56)*
Western Germany	18.10 *(16.96;19.33)*	7.11 *(6.18;8.17)*	21.24 *(19.23;23.47)*	82.06 *(73.49;91.62)*
Eastern Germany	21.26 *(18.77;24.08)*	7.95 *(6.11;10.36)*	27.38 *(22.65;33.09)*	106.85 *(86.39;132.16)*

Note: 95% confidence limits are given in parentheses

Source: Federal Statistical Office of Germany, GMCP, 2001-2004, own estimates

Table 3: Incidence rates for transition to the SLTC during 2002-2004 among the elderly men and women (per 1000 person-years)

	All	Age groups		
		65-74	75-84	85 and above
Men				
Secondary or lower education	14.92 *(13.15;16.92)*	8.01 *(6.46;9.93)*	23.56 *(19.67;28.22)*	51.35 *(37.66;70.00)*
Post-secondary education	8.89 *(7.08;11.16)*	5.53 *(3.85;7.96)*	10.51 *(7.26;15.22)*	40.43 *(25.13;65.03)*
Women				
Secondary or lower education	21.46 *(19.89;23.15)*	7.21 *(6.00;8.66)*	22.51 *(20.02;25.30)*	94.10 *(83.61;105.90)*
Post-secondary education	17.26 *(13.70;21.75)*	5.17 *(2.94;9.10)*	20.08 *(14.04;28.72)*	84.27 *(58.92;120.53)*

Note: 95% confidence limits are given in parentheses

Source: Federal Statistical Office of Germany, GMCP, 2001-2004, own estimates

Table 4 below provides incidence rates for people living in two different parts of Germany. The rates are lower for people with higher education in both eastern and western parts.

Table 4: Incidence rates for transition to the SLTC during 2002-2004 among the elderly living in western and eastern Germany (per 1000 person-years)

	All	Age groups		
		65-74	75-84	85 and above
Western Germany				
Secondary or lower education	18.15 *(16.86;19.55)*	7.19 *(6.13;8.43)*	21.45 *(19.19;23.99)*	79.00 *(69.59;89.67)*
Post-secondary education	11.55 *(9.61;13.89)*	5.39 *(3.79;7.67)*	13.06 *(9.72;17.55)*	57.06 *(41.52;78.41)*
Eastern Germany				
Secondary lower education	23.94 *(20.92;27.40)*	8.92 *(6.66;11.94)*	29.12 *(23.68;35.80)*	112.43 *(89.79;140.77)*
Post-secondary education	12.17 *(8.65;17.12)*	5.52 *(2.97;10.26)*	17.74 *(10.51;29.96)*	81.45 *(42.38;156.54)*

Note: 95% confidence limits are given in parentheses

Source: Federal Statistical Office of Germany, GMCP, 2001-2004, own estimates

Table 5 provides the summary of the logit regression. Increasing age is a strong and consistent predictor of the transition to SLTC services, particularly for women. Compared to those aged 65-69, women aged 90 and above are almost 23 times more likely to receive benefits. Gender is found to have no association with the transition to care, and education predicts the transition to SLTC only for men and respondents from the western part of Germany.

Table 5: Logit model results on the incidence in SLTC use; 2002-2004

Variables	All individuals		Men		Women		Western Germany		Eastern Germany	
	odds ratio	p-value	odds ratio	p-value	odds ratio	p-value	odds ratio	p-value	odds ratio	p-value
Age										
65-69	1		1		1		1		1	
70-74	1.51	0.001	1.56	0.015	1.52	0.016	1.44	0.011	1.79	0.034
	(1.18;1.94)		*(1.09;2.25)*		*(1.08;2.15)*		*(1.09;1.91)*		*(1. 05;3.08)*	
75-79	3.03	0.000	3.33	0.000	3.06	0.000	2.92	0.000	3.44	0.000
	(2.41;3.81)		*(2.37;4.68)*		*(2.23;4.18)*		*(2.26;3.77)*		*(2.07;5.70)*	
80-84	5.40	0.000	4.83	0.000	6.10	0.000	5.21	0.000	6.18	0.000
	(4.31;6.77)		*(3.36;6.96)*		*(4.50;8.27)*		*(4.04;6.71)*		*(3.77;10.12)*	
85 -89	11.62	0.000	8.90	0.000	13.55	0.000	10.98	0.000	14.22	0.000
	(9.17;14.73)		*(5.83;13.58)*		*(9.90;18.55)*		*(8.41;14.35)*		*(8.53;23.72)*	
90 and above	19.18	0.000	12.62	0.000	22.96	0.000	19.21	0.000	18.88	0.000
	(14.94;24.61)		*(7.47;21.33)*		*(16.63;31.70)*		*(14.54;25.39)*		*(10.79;33.03)*	
Sex										
Men	1						1		1	
Women	1.03	0.665					1.08	0.370	0.88	0.468
	(0.89;1.20)						*(0.91;1.27)*		*(0.63;1.24)*	
Highest level of education										
Secondary or lower	1		1		1		1		1	
Post-secondary	0.72	0.000	0.58	0.000	0.89	0.355	0.72	0.003	0.70	0.108
	(0.60;0.86)		*(0.45;0.76)*		*(0.69;1.14)*		*(0.59;0.89)*		*(0.47;1.04)*	
Marital status										
Single	1.48	0.004	2.30	0.001	1.28	0.124	1.36	0.040	2.12	0.023
	(1.13;1.93)		*(1.43;3.70)*		*(0.93;1.77)*		*(1.01;1.81)*		*(1.11;4.06)*	
Married	1		1		1		1		1	
Widowed	1.26	0.003	0.91	0.581	1.31	0.007	1.16	0.088	1.68	0.002
	(1.08;1.46)		*(0.66;1.26)*		*(1.08;1.60)*		*(0.98;1.38)*		*(1.22;2.32)*	
Divorced	1.29	0.127	1.32	0.384	1.27	0.223	1.30	0.174	1.39	0.293
	(0.93;1.77)		*(0.71;2.47)*		*(0.86;1.88)*		*(0.89;1.90)*		*(0.75;2.59)*	
Changed status	1.91	0.000	2.65	0.000	1.70	0.003	1.86	0.000	1.96	0.083
	(1.43;2.55)		*(1.62;4.35)*		*(1.20;2.42)*		*(1.36;2.54)*		*(0.91;4.22)*	
Region										
Western Germany	1		1		1					
Eastern Germany	1.30	0.000	1.36	0.027	1.29	0.003				
	(1.12;1.50)		*(1.03;1.78)*		*(1.09;1.53)*					
Number of observations	85880		35009		50871		69434		16446	
Number of individuals	24936		10131		14805		20134		4802	
Pseudo R^2	0.1010		0.0604		0.1157		0.1000		0.1073	

Source: Federal Statistical Office of Germany, GMCP, 2001-2004, own estimates

Notes: The category for missing education was added to all models, the results are not shown here. 95% confidence limits are given in parentheses.

Change in marital status during the period of observation nearly doubles the risk of transition to care, regardless of the model applied. Men and women differ considerably with respect to their marital status. Being a single man increases the risk of transition by 2.3 compared to married men. Widowhood increases the risk for women; they are 1.3 times more likely to receive benefits than married women. Lack of a spouse has an impact on the use of care in eastern Germany, while for the residence of the western part it is the change in the marital status that matters most.

Place of residence plays a role in determining the use of care: people from eastern Germany are at higher risk of receiving benefits than people from the western part, which is also true for both genders.

5.2 Prevalence in SLTC use

According to the GMCP results, the use of SLTC increases considerably with age (Table 6). Whereas only 1.6% of people age 65-74 received the benefits, the proportion among people 85 and above increases to 20.6%.

Table 6: Percent of the elderly receiving benefits; 2001-2004

	All	Age groups		
		65-74	75-84	85 and above
Total	4.51 *(4.37;4.65)*	1.61 *(1.50;1.72)*	5.27 *(5.02;5.52)*	20.58 *(19.68;21.47)*
Men	2.89 *(2.71;3.06)*	1.63 *(1.47;1.79)*	4.30 *(3.91;4.69)*	11.18 *(9.73;12.64)*
Women	5.60 *(5.40;5.79)*	1.60 *(1.45;1.74)*	5.78 *(5.45;6.10)*	23.38 *(22.31;24.45)*
Secondary or lower education	4.33 *(4.18;4.49)*	1.61 *(1.49;1.74)*	5.07 *(4.79;5.34)*	18.90 *(17.91;19.88)*
Post-secondary education	2.18 *(1.96;2.39)*	0.90 *(0.73;1.08)*	2.82 *(2.38;3.25)*	11.44 *(9.60;13.29)*
Western Germany	4.51 *(4.36;4.66)*	1.58 *(1.46;1.70)*	5.23 *(4.96;5.51)*	20.31 *(19.33;21.30)*
Eastern Germany	4.52 *(4.21;4.83)*	1.72 *(1.47;1.97)*	5.42 *(4.82;6.02)*	21.79 *(19.62;23.95)*

Source: Federal Statistical Office of Germany, GMCP, 2001-2004, own estimates

Note: 95% confidence limits are given in parentheses

Similarly to the incidence in SLTC use regardless of sex, highly educated people have lower prevalence rates of use of care (Table 7).

Table 7: Percent of the elderly men and women receiving benefits; 2001-2004

	All	Age groups		
		65-74	75-84	85 and above
Men				
Secondary or lower education	3.26 *(3.04;3.49)*	1.88 *(1.66;2.09)*	5.08 *(4.56;5.60)*	11.20 *(9.37;13.03)*
Post-secondary education	1.50 *(1.28;1.72)*	0.81 *(0.61;1.01)*	2.17 *(1.69;2.66)*	6.77 *(4.72;8.82)*
Women				
Secondary or lower education	4.88 *(4.69;5.08)*	1.44 *(1.29;1.59)*	5.06 *(4.73;5.39)*	20.67 *(19.54;21.80)*
Post-secondary education	3.49 *(3.03;3.95)*	1.12 *(0.76;1.47)*	3.92 *(3.08;4.76)*	16.17 *(13.14;19.20)*

Source: Federal Statistical Office of Germany, GMCP, 2001-2004, own estimates

Note: 95% confidence limits are given in parentheses

The results also reveal that prevalence rates are higher among less educated in western and eastern Germany (Table 8).

Table 8: Percent of the elderly living in western and eastern Germany and receiving benefits; 2001-2004

	All	Age groups		
		65-74	75-84	85 and above
Western Germany				
Secondary or lower education	4.14 *(3.98;4.31)*	1.54 *(1.40;1.67)*	4.88 *(4.58;5.18)*	17.97 *(16.90;19.05)*
Post-secondary education	2.23 *(1.98;2.47)*	0.88 *(0.68;1.08)*	2.80 *(2.32;3.29)*	11.22 *(9.25;13.20)*
Eastern Germany				
Secondary or lower education	5.15 *(4.78;5.53)*	1.93 *(1.62;2.24)*	5.93 *(5.23;6.64)*	22.63 *(20.27;24.98)*
Post-secondary education	1.99 *(1.55;2.44)*	0.98 *(0.61;1.36)*	2.87 *(1.86;3.88)*	12.73 *(7.62;17.83)*

Source: Federal Statistical Office of Germany, GMCP, 2001-2004, own estimates

Note: 95% confidence limits are given in parentheses

The results of the GEE regression are shown in Table 9. The odds ratios stand for the average effect across the entire population. In fact, the interpretation of the results in the GEE model is not straightforward as the magnitude of the ratios reflects both the "longitudinal" (within-subject) and "cross-sectional" (between-subject) relationships, and it is not clear which is the most important component. Some precaution should be taken when interpreting the results.

Similarly to the previous results, there is a very clear and strong impact of age on the dependent variable, while again no statistically significant association is found between care utilization and sex.

When the recurrence is taken into consideration, education is found to be associated with the use of care for both men and women, as well as for people from both parts of Germany. Elderly people with higher educational levels have a considerably lower risk of receiving benefits than do those with secondary levels or less. The association between education and SLTC use is stronger for men than for women, and stronger for the residents of eastern Germany compared to the western part.

As compared to the previous models, being single has the strongest effect on the care use, particularly for men *(OR=2.98; p=0.000)*. On average, the presence of a spouse reduces the risk of the transition to SLTC.

The period effect reveals that in all models the levels are higher in the year 2003. One possible explanation is that in 2003 the large health and long-term care modules were introduced to the GMCP, which might consequently increase the frequency and quality of reporting of the benefits received by the respondents in this year.

Table 9: GEE model results on the prevalence in SLTC use; 2001-2004

Variables	All individuals		Men		Women		Western Germany		Eastern Germany	
	odds ratio	p-value	odds ratio	p-value	odds ratio	p-value	odds ratio	p-value	odds ratio	p-value
Age										
65-69	1		1		1		1		1	
70-74	1.37	0.000	1.39	0.003	1.40	0.001	1.38	0.000	1.29	0.121
	(1.18;1.59)		*(1.12;1.74)*		*(1.15;1.70)*		*(1.17;1.63)*		*(0.93;1.79)*	
75-79	2.40	0.000	2.47	0.000	2.52	0.000	2. 41	0.000	2.36	0.000
	(2.06;2.80)		*(1.95;3.13)*		*(2.06;3.08)*		*(2.03;2.85)*		*(1.67;3.33)*	
80-84	4.76	0.000	4. 42	0.000	5.32	0.000	4.85	0.000	4.42	0.000
	(4.09;5.54)		*(3.44;5.67)*		*(4.36;6.49)*		*(4.09;5.74)*		*(3.13;6.26)*	
85 -89	9.63	0.000	7.35	0.000	11.37	0.000	9.26	0.000	10.85	0.000
	(8.20;11.31)		*(5.50;9.83)*		*(9.24;13.99)*		*(7.73;11.09)*		*(7.62;15.43)*	
90 and above	17.60	0.000	9.46	0.000	21.94	0.000	17.85	0.000	16.27	0.000
	(14.83;20.89)		*(6.57;13.62)*		*(17.67;27.25)*		*(14.76;21.59)*		*(10.98;24.10)*	
Sex										
Men	1						1		1	
Women	1.03	0.696					1.07	0.326	0.84	0.221
	(0.91;1.16)						*(0.93;1.23)*		*(0.63;1.11)*	
Highest level of education										
Secondary or lower	1		1		1		1		1	
Post-secondary	0.60	0.000	0.45	0.000	0.78	0.023	0.62	0.000	0.53	0.001
	(0.51;0.71)		*(0.35;0.57)*		*(0.63;0.97)*		*(0.52;0.75)*		*(0.37;0.76)*	
Marital status										
Single	2.18	0.000	2. 98	0.000	1.90	0.000	2.10	0.000	2.70	0.000
	(1.79;2.65)		*(2.10;4.22)*		*(1.50;2.40)*		*(1.69;2.59)*		*(1.69;4.32)*	
Married	1		1		1		1		1	
Widowed	1.52	0.000	1.46	0.001	1.48	0.000	1.47	0.000	1.80	0.000
	(1.35;1.72)		*(1.16;1.85)*		*(1.27;1.72)*		*(1.29;1.69)*		*(1.37;2.36)*	
Divorced	1.29	0.042	1.56	0.053	1.16	0.317	1.29	0.078	1.38	0.234
	(1.01;1.65)		*(0.99;2.43)*		*(0.86;1.57)*		*(0.97;1.70)*		*(0.81;2.36)*	
Changed status	1.50	0.000	1.63	0.005	1.41	0.001	1.56	0.000	1.19	0.504
	(1.26;1.78)		*(1.16;2.31)*		*(1.15;1.74)*		*(1.30;1.88)*		*(0.71;2.01)*	
Region										
Western Germany	1		1		1					
Eastern Germany	1.25	0.000	1.37	0.006	1.23	0.005				
	(1.11;1.41)		*(1.09;1.72)*		*(1.06;1.42)*					
Year										
2001	1		1		1		1		1	
2002	1.02	0.000	1.10	0.157	0.99	0.730	0.99	0.897	1.12	0.150
	(0.95;1.09)		*(0.96;1.27)*		*(0.91;1.07)*		*(0.92;1.08)*		*(0.96;1.32)*	
2003	1.36	0.000	1.44	0.000	1.33	0.000	1. 27	0.000	1.74	0.000
	(1.26;1.46)		*(1.25;1.65)*		*(1.22;1.44)*		*(1.17;1.38)*		*(1.48;2.05)*	
2004	1.17	0.000	1.19	0.016	1.16	0.002	1.13	0.004	1.32	0.003
	(1.08;1.26)		*(1.03;1.38)*		*(1.05;1.27)*		*(1.04;1.23)*		*(1.10;1.58)*	
Number of observations	89842		36017		53825		72665		17177	
Number of individuals	26030		10394		15636		21039		4991	

Source: Federal Statistical Office of Germany, GMCP, 2001-2004, own estimates

Notes: The category for missing education was added to all models, the results are not shown here. 95% confidence limits are given in parentheses.

6 Discussion

This is the first study to analyze the effect of education on the use of statutory long-term care among the elderly in Germany. The SLTC utilization is estimated from Microcensus panel data (2001-2004) based on receiving "Pflegegeld" variable.

The results show that education certainly matters for use of care by the elderly in that people with lower education levels have higher incidences of and prevalence in utilizing care. The effect is stronger for the prevalence than for the incidence, and the same is true for both genders and regions.

Turning specifically to the effect of education on the incidence in care, the odds of using SLTC are about 30% lower for the elderly with post-secondary education than those with secondary or less education. This effect is even more pronounced in men *(OR=0.58, p=0.000)*. No statistical significance between education and incidence in care use for women is found, which might be due to their educational structure. The majority of elderly women (88.3%) have a secondary education or lower, so there are too few highly educated women to produce statistically significant results.

As in case of women, there is a lack of statistical significance for the influence of education on the incidence in the use of SLTC for the eastern Germans, which is also assumed to be closely related to the lower numbers of cases. The direction of association is, however, as expected: the more educated a person is, the less often he/she receives benefits.

Looking at the association between education and prevalence in care use, the results of the GEE model reveal the strong effect of educational attainment. The strongest impact is found among men and those residing in the eastern part of Germany *(OR=0.45 and 0.53 respectively).* The statistical significance is present in all five models, regardless of gender or regional distinction.

These results differ from a number of previous studies that reported no association between education and transition to care (Greene and Ondrich 1990; Wolinsky et al. 1992; Kempen and Suurmeijer 1991; Cai et al. 2009). This may be primarily due to the different ways of approximating the use of care. This study applies the receipt of benefits, not the transition to the care institutions. The variation in the results illustrates the importance of the choice of the dependent variable in the analysis.

Comparing the effect of education on the incidence of and prevalence in use of care, it is found to be smaller on the incidence. One possible reason is that the prevalence in general represents the product of the two factors: the new cases (or the incidence per se) and the survival component (the number of deaths among those in care). Castro (2012) conducted an analysis in which he decomposed the prevalence of six health conditions, taking into account the educational differentials. His results suggested that educational differentials in "incidence rather than excess mortality explain most of the educational differentials in the prevalence of chronic conditions" (Castro 2012, p. 351). In light of the results presented here, it might be assumed that in the case of the relationship between education and the use of care, the educational differences are larger in the mortality rather than in the incidence component.

The larger effect of education for men might be associated with the generally greater magnitude of the educational differentials in morbidity and mortality among men (Mackenbach et al. 1999, Koskinen and Martelin 1994) and with the disparities in health development of men and women. As socioeconomic inequalities in health tend to be greater in men than in women and the use of care strongly depends on an individual's health status, the educational gradient is likely to be stronger among males.

Similar to the gender differences, this greater impact of education on prevalence over incidence is found for residents in both parts of Germany. The literature dealing with the analysis of the impact of the SES on health and mortality in Germany suggests a stronger decline of morbidity and mortality with increasing socioeconomic status. However, such studies are not often available for the two regions separately, at least not in English, mainly due to unavailability of data. Taking the variation in socioeconomic developments of both states into consideration, one can assume that educational differences and their impact were more pronounced in the western part. However, the study of Mielck et al. (2000) suggests that there were only small variations between East and West in terms of educational differences and morbidity. Also Shkolnikov et al. (2007) found in their study of the German pensioners that socioeconomic mortality differentials for the year 2003 were similar in both parts of Germany. In fact, as Luy (2004) and Gjonca et al. (2000) discussed in their works, it is the differences in medical care, particularly in nursing, which influenced mortality levels in the two states. Mortality in East Germany was higher before reunification, but caught up to the western standard shortly thereafter. Looking at the prevalence in use of care, the results presented here show no differences now, which signifies the enormous improvements in medical services in the East.

Looking at the effect of other explanatory variables on the use of care, it is somewhat surprisingly that no statistical association is found between the use of SLTC and sex (neither in logit nor in the GEE model). This might be partially explained by the nature of the dependent variable ("Pflegegeld"). In general, men are more likely to apply for cash benefits (54% of applicants in 2009 versus 42% of women), while women are more likely to choose residential care services. This in turn is related to the fact that women have a longer life expectancy, and at older age they have higher needs for care (due to more frequent rates of chronic illnesses) but have less family support than men. Despite the fact that the dependent variable used here consists not only of pure cash benefits ("Pflegegeld"), but also of other types of SLTC assistance, the share of the first would be very high and gender differences in choosing the type of benefits might be still present. Studies dealing with the analysis of the factors influencing nursing home admissions illustrate that sex was among the most influential determinants; being female increases the risk of transition (Grundy and Glaser 1997; Breeze et al. 1999). More research would be needed to examine gender differentiation in the use of care.

The impact of marital status on use of care supports earlier research findings. Disparities in the transition to care according to marital status show the importance of spousal support (Palmore 1976; Grundy 1992; Grundy and Glaser 1997; Nihtilä 2005). The presence of a spouse reduces the risk of transition mainly because more informal assistance and emotional support are available for those in need of care.

This study applies GMCP data for the years 2001-2004, the only available data source combining information on SLTC use and education for people living in private households and staying in the institutions. Despite the fact that there is a number of longitudinal surveys with the more recent data available for Germany, the older GMCP data are particularly advantageous for this study. As compared, for instance, to the German Ageing Survey (DEAS) or the Survey of Health, Ageing and Retirement (SHARE) the sample size is about 25 times bigger in the GMCP. In addition, information on the institutionalized elderly is also included in the GMCP, which is not the case for the other surveys. In the contrast to the German Socioeconomic Panel, the use of these GMCP is supported by the availability of data on the SLTC rather than on the individual's subjective evaluation of health status.

Disadvantages include the problem of missing data, which requires special attention before running the GEE models (Zorn 2001; Liu et al. 2009). To see if these data are missing completely at random (MCAR), individual characteristics of participants in every single year are compared with characteristics of those who remained under observation for the entire four-year period. No large variation in percentage distributions was found and it can therefore be assumed that data are MCAR. Additionally, in order to minimize the bias from loss to follow-up, a dichotomous variable representing attrition is added to the models at the initial stage (Haan et al. 1999; Stommel et al. 2004; Liu et al. 2009). However, no statistically significant association and no change in the estimated regression coefficients were found.

The unavailability of the health-related variables in the GMCP data (the "health module" is only introduced for the year 2003) is another data limitation. Absence of such information doesn't allow controlling for individual's health status at the baseline and thus the study misses a very important predictor for the use of long-term care services.

The next shortcoming of the data concerns the specifics of the dependent variable: the receipt of "Pflegegeld". Because longitudinal data are required for the analysis of incidence and the evaluation of causality between the variables, this is the only possible variable to be considered as a proxy for the SLTC utilization and as a dependent variable. There are a number of long-term care benefits offered to an applicant but the "Pflegegeld" is the most popular. At first glance, the use of this variable is fine because of its objective nature (to be eligible for a benefit requires that a person has passed the physical assessment test). On the other hand, some methodological problems arise from the use of this variable from the GMCP. The comparison of the percentage of the elderly using the SLTC calculated from the panel data with the official aggregated long-term care statistics reveals considerable deviations at older ages, particularly among women (Appendix 3). For instance, according to the aggregated statistics among people 90 years and older about 18% received "Pflegegeld" in 2003, whereas the percentage estimated from the GMCP data is 31%.

These results indicate that although the GMCP specifically asks about receipt of "Pflegegeld" which is only granted for home care, the question might be misinterpreted by respondents living in both private households and in the institutions. Some might mistakenly report other kinds of SLTC benefits/services as being "Pflegegeld", in particular the "Pflegesachleistungen" (in-kind benefits) or the "Kombinationsleistung von Pflegegeld- und Pflegesachleistung" (combination of cash and in-kind benefits). The positive side of misinterpretation of this question is that it gives us the possibility to explore in the analysis people living not only in private households but also in the institutions.

It should be noted that the results presented here must be examined carefully, taking into consideration this paper aims not to evaluate the levels of incidence and prevalence in SLTC use which can be obtained from the official aggregated SLTC statistics, but rather it tries to analyze the relationship between education and utilization of care, looking at the existence of association, its direction and strength. It is argued that for this purpose it is possible to use the GMCP data and the variable on the receipt of "Pflegegeld" as a valid proxy of SLTC use in particular.

These results can be relevant for care providers. Firstly, the negative impact of a lack of spouse on transition to care may have a considerable effect on care planning. Being in a situation with no psychological or practical support increases the use of formal care, whereas having a spouse may considerably reduce the need for it.

Secondly, the results illustrate that the knowledge of the educational structure and impact of education on the use of care may help estimate potential care needs and evaluate the necessary costs. More research is, however, needed. Despite the enormous amount of valuable literature on education-health/mortality associations, it is not easy to know if people with higher education levels will require cheaper care (since they are assumed to be healthier) or more expensive (as they are predicted to live longer) in comparison to individuals with less education. Some studies dealing with the comparison of changes in life expectancy and disability-free expectancy have shown that the trends in duration do not always correspond to extension of healthy life (Guralnik et al. 1993 and Crimmins et al. 1989 in Liao et al. 1999). Verbrugge, for instance, illustrated that increasing life expectancy may in fact produce longer lives but worse health (Verbrugge 1984).

Some studies imply that about one third of an individual's total lifetime use of acute health care services occurs during the last two years of life (Hoover et al. 2002; Wanless 2002). Whether this will be the same for the use of long-term care services and for individuals with different educational background is a question for further research. In seeking answers, proximity to death must be taken into consideration.

In sum, this paper confirms that there is a strong association between the level of educational and use of long-term care among the elderly. However, much more research will be needed in order to present a clear picture of how this association may help to accommodate the potential growing number of elderly so that their basic care needs can be fulfilled.

References

Arntz, M. et al. (2007): The German social long-term care insurance: structure and reform options. ZEW Mannheim, discussion paper 2625. Available online at http://ftp.iza.org/dp2625.pdf

Basic, E. et al. (2005): The German Microcensus as a tool for longitudinal data analysis: an evaluation using SOEP data. DESTATIS working paper, 3. Available online at https://www.destatis.de/DE/Methoden/Methodenpapiere/Mikrozensus/Arbeitspapiere/Arbeitspapier3.pdf?__blob=publicationFile

Breeze, E. et al. (1999): Socioeconomic and demographic predictors of mortality and institutional residence among middle aged and older people: results from the longitudinal study. In: *Journal of Epidemiology and Community Health* 53, pp. 756-774.

Cai, Q. et al. (2009): Factors associated with long-stay nursing home admissions among the U.S. elderly population: comparison of logistic regression and the Cox proportional hazard model with policy implications for social work. In: *Social Work in Health Care* 48, pp. 154-168.

Castro, R. (2012): Educational differences in chronic conditions and their role in the educational differences in overall mortality. In: *Demographic Research* 27, article 12, pp. 339-364.

Crimmins, E. M. et al. (1989): Changes in life expectancy and disability-free life expectancy in the United States. In: *Population and Development Review* 15, pp. 235-267.

Cui, J. (2007): QIC program and model selection in GEE analyses. In: *The Stata Journal* 7 (2), pp. 209-220.

Elo, I.T.; Preston, S.H. (1996): Educational differentials in mortality: United States, 1979-85. In: *Social Science and Medicine* 42 (1), pp. 47-57.

Evers, A. (1997): Geld oder Dienste? In: *WSI-Mitteilungen* 7, pp. 510-518.

Federal Statistical Office of Germany, GMCP, 2001-2004, own estimates.

Federal Statistical Office of Germany (2001): Kurzbericht: Pflegestatistik 1999. [Short Report: Long-term care statistics 1999]. Available online at https://www.destatis.de/DE/Publikationen/Thematisch/Gesundheit/Pflege/PflegeDeutschlandergebnisse5224001999004.pdf?__blob=publicationFile

Federal Statistical Office of Germany (2004): Sonderbericht: Lebenslagen der Pflegebedürftigen. Das Mikrozensus 2003. [Special Report: Situation of People in Care Needs, Micro Census 2003]. Available online at https://www.destatis.de/DE/Publikationen/Thematisch/Soziales/SozialpflegeLebenslagePflegebeduerft_2003.pdf?__blob=publicationFile

Federal Statistical Office of Germany (2005): Pflegestatistik 2003. [Long-term care statistics 2003]. Available online at https://www.destatis.de/DE/Publikationen/Thematisch/Soziales/Sozialpflege1Bericht2003.pdf?__blob=publicationFile

Federal Statistical Office of Germany (2013a): The information System of the Federal Health Monitoring. Available online at http://www.gbe-bund.de/gbe10/pkg_isgbe5.prc_isgbe?p_uid=gastd&p_aid=96705746&p_sprache=E, accessed in April, 2013.

Federal Statistical Office of Germany (2013b): Pflegestatistik 2011. [Long-term care statistics 2011]. Available online at https://www.destatis.de/DE/Publikationen/Thematisch/Gesundheit/Pflege/PflegeDeutschlandergebnisse5224001119004.pdf?__blob=publicationFile

Geraedts, M. et al. (2000): Germany's long-term care insurance: putting a social insurance model into practice. In: *The Milbank Quarterly* 78 (3), pp. 375-401.

German Parliament (Deutscher Bundestag) (2012): Entwurf eines Gesetzes zur Neuausrichtung der Pflegeversicherung [A legislative Proposal for the reorganization of the long-term care]. Printed issue 17/9369. Available online at http://dip21.bundestag.de/dip21/btd/17/093/1709369.pdf

Gjonca, A. et al. (2000): Old-age mortality in Germany prior and after reunification. In: *Demographic Research* 3 (1).

Greene, V. L.; Ondrich, J. L. (1990): Risk factors for nursing home admissions and exits: a discrete-time hazard function approach. In: *Journal of Gerontology* 45 (6), pp. 250-258.

Grundy, E. (1992): Socio-demographic variations in rates of movement into institutions among elderly people in England and Wales: an analysis of linked census and mortality data 1971-1985. In: *Population Studies* 46 (1), pp. 65-84.

Grundy, E.; Glaser K. (1997): Trends in, and transitions to, institutional residence among older people in England and Wales, 1971-91. In: *Journal of Epidemiology and Community Health* 51, pp. 531-540.

Guralnik, J. M. et al. (1993): Educational status and active life expectancy among older blacks and whites. In: *New England Journal of Medicine* 329, pp. 110-116.

Haan, M. N. et al. (1999): The role of APOE 4 in modulating effects of other risk factors for cognitive decline in elderly persons. In: *Journal of American Medical Association* 252, pp. 40-46.

Himes, C. et al. (2000): Nursing home entry in Germany and the United States. In: *Journal of Cross-Cultural Gerontology* 15, pp. 99-118.

Himes, C. et al. (2001): The dynamics of long-term care service use in Germany. Vierteljahrshefte zur Wirtschaftsforschung. 70. Jahrgang, Heft 1/2001, pp. 153-158

Hoffmann, E.; Nachtmann, J. (2010): Old age, the need of long-term care and healthy life expectancy. In: Doblhammer, G.; Scholz, R. (Eds.): Ageing, care need and quality of life: the perspective of care givers and people in need of care, pp. 163-176.

Hoover, D. R. et al. (2002): Medical expenditures during the last year of life: findings from 1992-1996, Medicare current beneficiary survey. In: *Health Service Research* 37 (6), pp. 1625-1642.

Hu, F. B. et al. (1998): Comparison of population-averaged and subject-specific approaches for analyzing repeated binary outcomes. In: *American Journal of Epidemiology* 147 (7), pp. 694-703.

Human Mortality Database. University of California, Berkeley (USA), and Max Planck Institute for Demographic Research (Germany). Available online at www.mortality.org. Accessed in 2010.

Kempen, G. I. J. M.; Suurmeijer, Th. P. B. M. (1991): Professional home care for the elderly: an application of the Andersen-Newman model in the Netherlands. In: *Social Science and Medicine* 33 (9), pp. 1081-1089.

Kliebsh, U. et al. (1998): Risk factors of institutionalization in an elderly disabled population. In: *European Journal of Public Health* 8 (2), pp. 106-112.

Koskinen, S.; Martelin, T. (1994): Why are socioeconomic mortality differences smaller among women than among men? In: *Social Science and Medicine* 38 (10), pp. 1385-1396.

Liang, K.-Y.; Zeger, S. L. (1986): Longitudinal data analysis using generalized linear models. In: *Biometrika* 73, pp. 13-22.

Liao, Y. et al. (1999): Socioeconomic status and morbidity in the last years of life. In: *American Journal of Public Health* 89 (#4), pp. 569-572.

Liu, S. et al. (2009): Using Generalizes Estimating Equations to analyze longitudinal data in nursing research. In: *Western Journal of Nursing Research* 31 (7), pp. 948-964.

Luy, M. (2004): Mortality differences between western and eastern Germany before and after reunification. a macro and micro level analysis of developments and responsible factors. In: *Genus LX* (3-4), pp. 99-104.

Mackenbach, J. P. et al. (1999): Socioeconomic inequalities in mortality among women and among men: an international study. In: *American Journal of Public Health* 89 (12), pp. 1800-1806.

Mielck, A. et al. (2000): Comparison of health inequalities between East and West Germany. In: *European Journal of Public Health* 10 (4), pp. 262-267.

Mustard, C. et al. (1999): What determines the need for nursing home admission in a universally insured population? In: *Journal of Health Services & Research Policy* 4 (4), pp. 197-203.

Nihtilä, E. (2005): Socioeconomic determinants of long-term institutionalization in a community-dwelling elderly population. Conference paper, 25th IUSSP International Population Conference. Available online at http://iussp2005.princeton.edu/download.aspx?submissionId=51169

Nihtilä, E.; Martikainen, P. (2007): Household income and other socio-economic determinants of long-term institutional care among older adults in Finland. In: *Population Studies* 61 (3), pp. 299-314.

Palmore, E. (1976): Total chance of institutionalization among the aged. In: *The Gerontologist* 16 (6), pp. 504-507.

Pfaff, H. (2010): People in need of long-term care: the present and the future. In: Doblhammer, G.; Scholz, R. (Eds.): Ageing, care need and quality of life: the perspective of care givers and people in need of care, pp. 14-41.

Roth, G.; Reichert, M. (2003): Providing integrated health and social care for older persons in Germany. PROCARE. National Report Germany. Institute of Gerontology at the University of Dortmund. Available online at http://www.imsersomayores.csic.es/documentos/documentos/procare-providinggermany-01.pdf.

Rothgang, H. (2010): Social insurance for long-term care: an evaluation of the German model. In: *Social Policy and Administration* 44 (4), pp. 436-460.

Rothgang, H.; Igl, G. (2007): Long-term care in Germany. In: *The Japanese Journal of Social Security Policy* 6 (1), pp. 54-83. Available online at http://www.ipss.go.jp/webj-ad/WebJournal.files/SocialSecurity/2007/Spring/Rothgang%20&%20Igl%20final.pdf

Rothgang, H. et al. (2011): BARMER GEK Pflegereport 2011. In: *Schriftenreihe zur Gesundheitsanalyse*, Band 11, November. Asgard-Verlag. [BARMER GEK Care Report 2011. Series for Health Analysis, Volume 11, November].

Schroedter, J. H. et al. (2006): Die Umsetzung der Bildungsskala ISCED-1997 für die Volkszählung 1970, die Mikrozensus Zusatzerhebung 1971 und die Mikrozensen 1976-2004. In: *ZUMA-Methodenbericht* 2006/8, ISSN 1610-9953. [Application of the ISCED-1997 for the Census 1970 and micro census 1971, 1976-2004. ZUMA Methods Protocol 2006/8].

Schulz, E. (2008). Zahl der Pflegefälle wird deutlich steigen. [Number of the nursing cases will clearly rise]. In: *Wochenbericht des DIW Berlin* 47, pp. 736-744.

Schulz, E. (2010a): Projection of care need and family resources in Germany. In: Doblhammer, G.; Scholz, R. (Eds.): Ageing, care need and quality of life: the perspective of care givers and people in need of care, pp. 61-81.

Schulz, E. (2010b): The long-term care system for the elderly in Germany. In: *ENEPRI Research Report* 78.

Schulz, E. (2012): Determinants of institutional long-term care in Germany. In: *ENEPRI Research Report* 115.

Shkolnikov, V. M. et al. (2007): Length of life and the pensions of five million retired German men. In: *The European Journal of Public Health* 18 (3), pp. 264-269.

Social Code Book XI, Long-term care insurance, Bundesgesetzblatt, 1994 I:1014, Version 2012. Available online at http://www.sozialgesetzbuch-sgb.de/sgbxi/1.html

Stommel, M. et al. (2004): A longitudinal analysis of the course of depressive symptomatology in geriatric patients with cancer of the breast, colon, lung or prostate. In: *Health Psychology* 23 (6), pp. 564-573.

Theobald, H. (2004): Care services for the elderly in Germany. Infrastructure, access and utilization from the perspective of different user groups. Working paper #SP I 2004-302, WZB.

Theobald, H. (2010): Conditions and challenges of Germany's long-term care insurance: care policies and inequalities based on gender, socioeconomic class and ethnicity. In: *Journal of Asian Women's Studies* 8, pp. 1-23.

Theobald, H. (2011): Long-term care insurance in Germany. Assessments, benefits, care arrangements and funding. Working paper 13, Institute for Future Studies, Stockholm. Available online at http://www.framtidsstudier.se/eng/publikationer/long-term-care-insurance-in-germany/

Tomiak, M. et al. (2000): Factors associated with nursing-home entry for elders in Manotiba, Canada. In: *The Journals of Gerontology*, series A 55 (5), pp. M279-M287.

Verbrugge, L. M. (1984): Longer life but worsening health? Trends in health and mortality of midlle-aged and older persons. The Milbank Memorial Fund Quarterly. In: *Health and Society* 62 (3), pp. 475-519.

Wanless, D. (2002): Securing the future health: taking a long-term view. Final report. Available online at http://si.easp.es/derechosciudadania/wp-content/uploads/2009/10/4.Informe-Wanless.pdf

Webb, P. (2003): Legislating for care: a comparative analysis of long-term care insurance laws in Japan and Germany. In: *Social Science Japan Journal* 6(1), pp. 39-56.

Wilbers, J. (2000): Long-term care Insurance in Germany. In: Long Term Care Insurance (Ed.): The Experience of Two Nations. New York: International Longevity Center: 1-24.

Wolinsky, F. et al. (1992): The risk of nursing home placement and subsequent death among older adults. In: *Journal of Gerontology: Social Science* 47 (4), pp. 173-182.

Zorn, Ch. (2001): Generalized Estimating Equation Models for Correlated Data: A Review with Applications. In: *American Journal of Political Science* 45 (2), pp. 470-490.

Appendix 1

Definition of care dependency levels and corresponding amounts of benefits

	Level I	Level II	Level III
Care needed for what tasks and how often	Help with personal care, nutrition, or mobility at least once a day for at least two tasks in one or more areas; and additional assistance several times per week in performing household chores	Help with personal care, nutrition, and mobility at least three times a day at different times of the day; as well as additional assistance several times per week for household chores	Help with personal care, nutrition, and mobility around the clock; and additional assistance several times a week with household chores.
Total time per day	90 min	3 hours	5 hours
Minimum time for personal care, per day	45 min	2 hours	4 hours
Amount of monthly benefits (through July 2008):			
Home care			
Cash benefits	205	410	665
In-kind benefits	384	921	1432
Nursing home care	1023	1279	1432

Source: Social Code Book, XI

Appendix 2

Summary statistics of the variables used in logit and GEE models

	Logit model					GEE model				
	All	Men	Women	Western Germany	Eastern Germany	All	Men	Women	Western Germany	Eastern Germany
Total number of cases	24936	10131	14805	19529	4511	26030	10394	15636	20409	4686
Age, %										
65-69	33.3	38.5	29.7	33.0	34.8	32.3	38.0	28.5	32.0	33.8
70-74	25.6	28.0	24.0	25.2	27.1	25.0	27.8	23.2	24.7	26.5
75-79	20.4	18.9	21.5	20.7	19.1	20.2	18.9	21.1	20.5	18.9
80-84	13.4	10.1	15.6	13.6	12.3	13.8	10.4	16.0	14.0	12.7
85 -89	4.9	3.2	6.0	5.0	4.5	5.4	3.4	6.8	5.5	5.2
90 and above	2.4	1.3	3.2	2.5	2.2	3.3	1.5	4.4	3.3	2.9
Mean age, years	73.8	72.6	74.6	73.9	73.5	74.1	72.8	75.1	74.2	73.8
St.d., years	6.7	6.1	7.0	6.7	6.6	6.9	6.2	7.3	7.0	6.8
Median age, years	73	71	74	73	72	73	72	74	73	72
Gender, %										
Men	40.8			41.1	39.4	40.1			40.4	38.8
Women	59.2			58.9	60.6	59.9			59.6	61.2
Region, %										
Western Germany	81.4	82.0	80.9			81.4	82.0	81.0		
Eastern Germany	18.6	18.0	19.1			18.6	18.0	19.0		
Marital status, %										
Single	4.9	3.4	6.0	5.2	3.7	5.1	3.6	6.2	5.5	3.8
Married	58.8	80.7	43.6	58.8	58.7	57.3	80.1	42.1	57.3	57.4
Widowed	29.6	10.7	42.7	29.4	30.5	30.8	11.0	44.0	30.6	31.6
Divorced	4.1	3.3	4.6	3.8	5.1	4.0	3.3	4.5	3.8	5.1
Changed status	2.6	1.9	3.1	2.8	2.0	2.8	2.0	3.2	2.8	2.1
Education, %										
Secondary or lower	79.2	66.2	88.3	79.8	76.8	79.6	66.6	88.4	80.2	77.3
Post-secondary	20.8	33.8	11.7	20.2	23.2	20.4	33.4	11.6	19.8	22.7

Source: Federal Statistical Office of Germany, GMCP, 2001-2004, own estimates

Note: St.d. is standard deviation

Appendix 3

Prevalence rates in SLTC use among the elderly based on different variables and from the GMCP and official long-term care statistics, 2003

Age groups	Microcensus panel data			Official statistics		
	Based on the "Pflegegeld"	Based on all SLTC benefits	Based on care levels (1-3)	Based on all SLTC benefits (social insurance)	Based on the number of people in need of care	Based on the "Pflegegeld"
Both sexes						
65-69	1.39	1.81	1.48	2.43	2.7	1.54
70-74	2.20	3.61	3.01	4.51	5.1	2.75
75-79	3.93	6.58	5.71	8.47	9.8	4.56
80-84	8.30	13.80	11.56	17.76	20.6	8.16
85-89	15.79	27.98	23.35	34.33	39.9	13.94
90 and above	31.23	48.56	38.16	52.59	59.40	17.92
Men						
65-69	1.44	1.95	1.58	2.60	2.9	1.73
70-74	2.13	3.64	3.13	4.53	5.1	3.00
75-79	3.59	5.86	5.09	7.32	8.5	4.61
80-84	6.89	11.64	10.14	13.51	16.1	7.64
85-89	10.18	18.52	15.61	23.93	29.4	12.23
90 and above	18.17	34.71	25.79	33.02	39.66	14.23
Women						
65-69	1.35	1.67	1.37	2.28	2.5	1.37
70-74	2.26	3.58	2.92	4.50	5.1	2.54
75-79	4.13	7.05	6.10	9.17	10.6	4.53
80-84	8.94	14.76	12.18	19.55	22.5	8.39
85-89	17.79	31.50	26.16	37.82	43.4	14.52
90 and above	34.64	52.14	41.47	58.36	65.22	19.01

Sources: Estimated from GMCP 2003 and from the data from Federal Statistical Office; the Information System of the Federal Health Monitoring

Spatial patterns in German long-term care and their relationship with socioeconomic factors

Daniel Kreft

Abstract

The ongoing rise in life expectancy implies larger numbers of dependent elderly, with an increased demand for long-term assistance and care services. The severity of the limitations for the individuals, the psychosocial and financial burdens for their families, and the mounting structural and financial challenges for the welfare system suggest an urgent need to identify the risk factors of long-term care.

This study explores spatial disparities in long-term care in Germany using the health ratio which is the proportion of disability-free life years to total remaining life years. Disability is defined as receiving benefits from the German statutory long-term care insurance system. Data from the official census of all beneficiaries, the German Statutory Long-Term Care (SLTC) Census 2009, are combined with county-level life table estimates and socioeconomic indicators from the regional database of the German National Statistical Office.

The health ratios reveal pronounced spatial clusters which extended beyond the borders of federal states and are linked to the socioeconomic conditions in the respective counties. The cross-sectional perspective suggests that high life expectancy in a county goes together with a high number and large proportion of healthy years spent without disability. The positive correlations are stronger in the West German counties than in the East German counties. Results from meta-regression suggest a significant relationship between a county's health ratio and the county's socioeconomic performance, socioeconomic composition, level of urbanization, and health care structure. A high household income per capita, a low long-term unemployment rate, a high population density, and a low level of premature mortality in a county are significantly linked to a high health ratio.

This is the first study that shows the existence of spatial differentials in care need and the resulting health ratio for Germany. Even more important, the study shows that these differentials are linked to the socioeconomic structure and performance of the county, which should provide guidance in designing appropriate policy interventions.

1 Introduction

Healthy aging has become one of the main challenges in aging societies. The long-term decrease in mortality, which was initiated by various behavioral changes, medical improvements, and enhancements in socioeconomic conditions, has resulted in a continuous rise in the number of people who reach old and oldest ages (Christensen et al. 2009). Degenerative disorders and diseases, such as sensory disorders, neoplasms, and mental and behavioral disorders, as well as diseases of the circulatory system, the

musculoskeletal system and the nervous system, are highly concentrated in these highest age groups. Thus, the share of the aging population who are in poor health is likely to expand (Olshansky and Ault 1986). Although an increase in morbidity prevalence can be seen in all highly developed countries, the pace and extent of the changes differ between (Muszyńska and Rau 2012) and within countries (Porell and Miltiades 2002).

Because of its position as one of the forerunners of population aging (Muszyńska and Rau 2012) and because it has an extensive social welfare system (Barr 2004), Germany is an interesting context in which to investigate trends in healthy aging. Recent studies have shown that there are marked socioeconomic, demographic, and health disparities in Germany (Breckenkamp et al. 2007; Voigtländer et al. 2008; Voigtländer et al. 2010a; Voigtländer et al. 2010b; Diehl and Schneider 2011; Kroll and Lampert 2012).

This study focused on spatial patterns in disability in Germany, with disability defined as receiving benefits from the German system of Statutory Long-Term Care (SLTC) insurance (SGB 1995). The data came from the SLTC Census of the year 2009 which contained basic anonymized information on the more than two million beneficiaries in Germany in 2009. The county-specific health ratio (HR) was used as the main health outcome. The county-specific HR was defined as the proportion of the county-specific disability-free life expectancy (DFLE) to the county-specific life expectancy (LE). Thus, the relative measure HR combined two well-established measures of mortality and health with the advantage that it was independent from the absolute level of the LE.

This study had three aims. First, the spatial patterns of long-term care in Germany were identified. Second, the question was explored whether higher life expectancy was associated with improved health or with increased disability. Third, the study tried to identify the macro-level determinants of the spatial health disparities measured by the health ratio.

2 Background

Numerous studies have examined country-specific trends and cross-country differences based on the concept of the disability-free life expectancy, which is more generally referred to as healthy life years (Bickel 2001; Robine et al. 2003; Lievre et al. 2007; Jagger et al. 2008; Hoffmann and Nachtmann 2010; Jagger et al. 2011). One fundamental objective in health research is to investigate the association of life expectancy with disability-free life expectancy, and the association of life expectancy with disabled life years (DLY). Mathers et al. (2001) estimated the disability-free life expectancy of 191 countries based on global data from 1999. The cross-sectional study revealed a close positive correlation between the disability-free life expectancy and the corresponding life expectancy and a negative relationship of the disabled life years with life expectancy. In the case of European countries, Robine et al. (2009) also found a positive, but weaker correlation between values of the life expectancy and values of the disability-free life expectancy for the year 2006.

One obstacle with using country-specific data is that researchers are confronted with problems related to variations in health policy systems and cultural differences in defining and reporting health (Jagger et al. 2011). Using small-area data for the evaluation of the relationship between county-level life expectancy and the disability-free life expectancy within a country has substantial advantages compared to cross-country evaluations. The

problem of regional cultural differences in health perception and the intervening effects of differences in health policies and health care systems can be assumed to be small.

Despite these advantages, only a few studies have used spatial disability-free life expectancy estimates. However, these studies revealed profound sub-national health disparities, albeit with varying health definitions, in France (Robine et al. 1998), Spain (Gutiérrez-Fisac et al. 2000), Denmark (Brønnum-Hansen et al. 2003), the Netherlands (Groenewegen et al. 2003), Japan (Fukuda et al. 2005; Seko et al. 2012), China (Liu et al. 2010), Italy (Burgio et al. 2009), Belgium (van Oyen et al. 1996; Karakaya 2009), Scotland (Wood et al. 2006), England (Smith et al. 2011), and the German federal state of North Rhine-Westphalia (Pinheiro and Krämer 2009). Until now no study has examined small-area disparities in the disability-free life expectancy or in the health ratio in Germany in total.

As interest in the investigation of the effects of the living context – abbreviated as contextual effects – on health has grown in recent years, the number of empirical studies using an ecological design (Gutiérrez-Fisac et al. 2000; Groenewegen et al. 2003; Fukuda et al. 2005; van Lenthe 2006; Fantini et al. 2012) or using a multilevel design (Pickett and Pearl 2001; Kawachi and Berkman 2003; Riva et al. 2007; Yen et al. 2009) has increased rapidly. It is a long-standing practice in the study of contextual effects on health to establish a comprehensive conceptual (Diez-Roux 2003) and theoretical framework (Lawton and Nahemow 1973) to define the causal pathways between macro-level characteristics and micro-level outcomes (e.g. individual health status or aggregated health measures).

One of these frameworks is the causal model of neighborhood effects on aging by Glass and Balfour (2003). They differentiated between four factors of the living environment: "socioeconomic conditions," "social integration," "physical aspects of place," and "services and resources." These factors are directly and indirectly linked with health and functioning. In this model, socioeconomic conditions are the most influential determinants affecting, confounding, and mediating the three other dimensions. The relationship between neighborhood deprivation and poor health is well-studied (Gutiérrez-Fisac et al. 2000; Pickett and Pearl 2001; Glass and Balfour 2003; Groenewegen et al. 2003; Fukuda et al. 2005; Riva et al. 2007; Yen et al. 2009; Voigtländer et al. 2010a; Gordon 2003). Two pathways that explain the relationship of area deprivation and population's health status are discussed: On the one hand, community health is related to the socioeconomic composition of the region's population, which in turn is influenced by selective migration (Kibele and Janssen 2013). A high prevalence of morbidity in a region may be the result of a high concentration of persons with attributes related to a high risk of ill-health, e.g. higher age, lower socioeconomic status, or riskier lifestyle behaviors. On the other hand, the general context of the region's wealth and social climate affects the health situation of the individuals – and by aggregation of the regions (van Lenthe 2006).

In addition to the direct compositional and contextual effects of socioeconomic conditions, Glass and Balfour (2003) highlighted the role of built environment and (health care) services on health status. Diez-Roux and Mair (2010) gave an overview of the importance of the physical environment for various dimensions on health (e.g., physical activity, social integration, depression, and hypertension), but reported varying results for the particular health outcomes. Fukuda et al. (2005) found a negative impact of population density on health in municipalities in Japan. The greater environmental hazards and psychosocial stress in highly urbanized regions, which could have a negative impact on health, may explain these findings (Voigtländer et al. 2010a).

In contrast, Diehl and Schneider (2011) concluded that rurality is positively linked with ill health. Glass and Balfour (2003) attributed the positive effect of urbanity on health to the dimension of services and resources. Following Glass and Balfour (2003), the expectation is that rural, peripheral areas with low economic performance are at high risk of having comprehensive structural problems, e.g., in terms of the quality of the health care services and the infrastructure. In the literature, amendable mortality is a reliable indicator for measuring regional disparities in the quality of health care services, and it has a highly negative association with disability-free life expectancy (Fantini et al. 2012).

There is no prior research on the relationship of regional disability and life expectancy in terms of county-specific LE and DFLE, LE and DLY, LE and HR, and LE and the age standardized prevalence (ASP) of care need. However, based on studies on the country level, a positive correlation between LE and DFLE and a negative correlation between LE and DLY is assumed. No specific hypotheses were formulated concerning the association of the LE and the HR, or the association of the LE and the ASP.

Hypotheses about the effects of the living context were formulated based on the above literature: First, counties with good socioeconomic conditions and compositions, and those with favorable health care situations in terms of premature mortality should reveal a higher health ratio. Second, the physical environment and the urbanity may have both negative and positive effects on the health ratio, as has been demonstrated by the inconsistent results of earlier studies.

3 Data

This study used the most recent data from the German SLTC Census ("*Pflegestatistik*") of 2009. The SLTC Census is conducted every two years, and it is an official mandatory census of all care facilities, all mobile nursing services, and all individuals in Germany who are legally attested to be severely limited in their activities of daily living (Pfaff 2010; Hoffmann and Nachtmann 2010). For a detailed overview of the German SLTC insurance, see Grigorieva in this issue.

Over 2 million beneficiaries were extracted, who were then classified by county of residence (NUTS 3 level), sex, and age group (65-69, 70-74, 75-79, 80-84, 85+). The last interval was defined as 85+ in order to avoid having groups with too few cases, and to prevent privacy violations.

In order to calculate the age- and sex-specific prevalence of disability, information about the population at risk stratified by county of residence, sex, and age groups was required. The population at risk was defined as the average of the total population at the end of the year 2008 and at the end of the year 2009. Moreover, data on the death counts were used to make life table estimations. The information on the death counts and the population at risk, stratified by age, county, and sex, were taken from the regional database of the German National Statistical Office.

In addition, the analysis included information indicating particular dimensions of the attributes of the counties: the economic performance, the social composition, the grade of urbanization, and the health care condition. The decision to use these dimensions was inspired by the "causal model of neighborhood effects on aging" (Glass and Balfour 2003).

To measure these dimensions, four indicators were chosen:

1) the disposable income of the private households (indicating the socioeconomic conditions),
2) the long-term unemployment rate (indicating the social composition and the degree of social cohesion),
3) the population density (indicating the physical aspects of the place), and
4) the level of premature mortality at ages 1-44 (indicating the health and medical care conditions).

Table 1: Overview of computation of county-level indicators

Group of indicator	Indicator	Year	Computation
Socioeconomic conditions and composition	Disposable income of private households per capita	2009	No computation needed (official indicator in the regional statistics database)
	Long-term unemployment rate	2009*	Persons in unemployment lasting one year or longer divided by all persons at age 15-65
Physical and health care conditions	Population density	2009	Total population divided by area of the county
	Level of premature mortality	2009	Number of deaths in the life table population between age 1 and 45 per 100,000 persons

Note: * Because there are no available data for 2009 on the long-term unemployed in the city of Wiesbaden, data for 2010 are used.

The first and third macro factors are official indicators of the National Statistical Office, while the second and fourth factors are composite variables. To calculate the level of premature mortality, infant mortality was excluded and the total number of deaths (of the overall life table population) at all ages up to Germany's population mean age of about 44 years was covered.

The four covariates were categorized into quintiles, with the first category (lowest disposable income, lowest long-term unemployment rate, lowest population density, and lowest premature mortality level) used as the reference group.

4 Methods

First, the abridged county-, age-, and sex-specific life tables (Chiang 1984) were computed, along with the county-, age-, and sex-specific prevalence of disability.

Second, based on the Sullivan (1971) method, the prevalence and the life tables by counties were used to calculate the DFLE and the DLY at the NUTS-3 level. Additionally, age standardized prevalence (ASP) was computed for age 65+ using the county-, age-, and sex-specific prevalence and the old European standard population as the population at risk.

Third, the DFLE and the LE were used to calculate the county-, age-, and sex-specific HR, the proportion of DFLE to LE. Higher values of the HR indicate a better health situation of a population. The resulting HR was the health outcome used in the regression models shown below.

The aim of the multivariate analysis in the main part of this study was to explain the spatial variance in the health outcome HR by factors of living context. Multiple linear meta-regression models were estimated that included selected proxies for specific health-relevant characteristics of a county. A linear random effects meta-regression model is an extension of the simple OLS regression. The advantage is the option of including uncertainty in the estimation of county's HR, and of including county-level variables and analyzing residual heterogeneity (Harbord and Higgins 2008). The general formula of a random effects linear meta-regression is

$$y_i=x_i\beta+u_i+\epsilon_i, \text{ where } u_i\sim N(0,\tau^2) \text{ and } \epsilon_i\sim N\left(0,\sigma_i^2\right) \text{ (Harbord and Higgins 2008),}$$

where y_i is the estimated HR of county i when x_i, the county-level attribute, is given. Unlike in the OLS regressions, there are two error terms (u_i and ε_i), and the coefficients β are estimated by the REML (residual/restricted maximum likelihood) method after weighting each observation by $1/\left(\sigma_i^2+\tau^2\right)$, where σ is the standard error of the estimated spatial HR and τ^2 is the between-county variance (Thompson and Sharp 1999; Harbord and Higgins 2008).

The standard errors σ of the HR are calculated based on the assumption that the DLFE is a random variable (Jagger et al. 2007), and that the LE is a scalar variable.[1] To meet this assumption and to lessen the impact of short-term random fluctuations in the LE, small-area life expectancies were calculated by using pooled data on the death counts and the population at risk from the last five available years (2006-2010).

Sex-specific and region-specific (East German counties vs. West German counties) models for the HR (65+) were estimated and results for the age group 65+ were presented. All of the estimates were performed using STATA 12.1 and the "metareg" routine (Harbord and Higgins 2008).

5 Results

In 2009, 2,338,252 persons received benefits from SLTC insurance in Germany. The median age of the recipients was 76.2 years, and 55% were 75 to 84 years old. One-third were males (median age 70.6) and 67% were females (median age 78.3).

[1] $\sigma(HR_x)=\sqrt{1/LE_x^2\cdot Var(DFLE_x)}$

Table 2: Median life expectancy (LE), median disability-free life expectancy (DFLE), median health ratio (HR), and selected statistical measures of dispersion of the HR for males and females in 2009 based on 412 counties (not weighted by population size)

Age	Median LE (years)	Median DFLE (years)	Median HR (%)	Q1(HR) (%)	Q3(HR) (%)	Min (HR) (%)	Max (HR) (%)	N
Males								
65+	17.47	15.69	89.58	88.40	90.74	81.83	93.64	412
75+	10.78	8.86	82.14	79.86	84.38	67.77	88.70	412
85+	6.16	4.16	67.98	62.70	72.11	40.68	80.81	412
Females								
65+	20.66	17.20	83.77	81.57	85.53	72.19	89.72	412
75+	12.56	9.09	72.73	69.18	75.82	53.52	82.71	412
85+	6.50	3.23	49.42	43.66	54.84	24.81	66.25	412

Source: Statistische Ämter des Bundes und der Länder; SLTC Census 2009; author's calculations

Table 2 shows the sex-specific age profiles in the unweighted[2] median HR for the 412 counties and for selected ages. At all ages the HR was lower for females than for males. At age 65 it was 83.8% (IQR: 3.96PP) for females and 89.6% (IQR: 2.34PP) for males, which implies that slightly more than 80 percent of the remaining LE of a woman and almost 90 percent of a man will be without disability. The HR decreased with increasing age, and at age 85 the HR was 49.4% (IQR: 11.18PP) for females and 68.0% (IQR: 9.41PP) for males.[3]

5.1 The county-level relationship between life expectancy and disability

In absolute terms, the elderly in counties with high life expectancy had a higher number of years without disability (DFLE) and lived fewer or an equal number of years with disability (DLY). There was a significant and positive linear relationship between LE and DFLE (β[4]=0.88, $p<0.001$) which was higher in the 325 West German counties ($\beta=0.89$, $p<0.001$) than in the 87 East German counties ($\beta=0.77$, $p<0.001$) (Figure 1a). In contrast, there was a weak negative correlation between DLY and LE in the West German counties ($\beta=-0.24$, $p<0.001$), and there was no linear relationship between the two indicators in the East German counties ($\beta=0.02$, $p=0.849$) (Figure 1b). Both the weak correlation in the West and the missing correlation in the East were the results of the high number of counties with an average LE but a high DLY (circles in the top center).

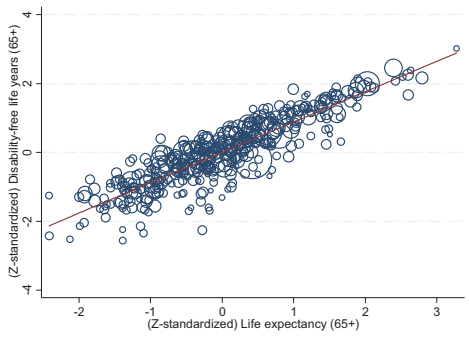
2 The median HR is not weighted by the county's population size, which is why it slightly differs from the total HR of Germany (females at age 65: 83.6%; males at age 65: 89.6%).

3 IQR = Interquartile range (third quartile Q3 minus first quartile Q1).

4 β = Coefficient in the meta-regression

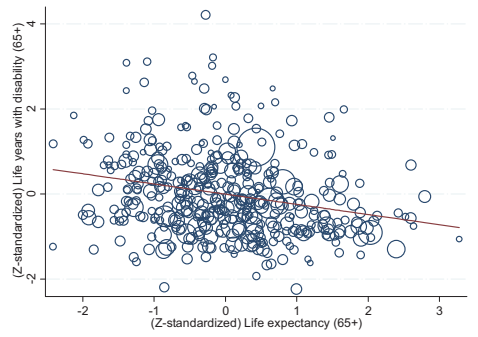
Figure 1: Life expectancy at age 65+ compared with disability-free life expectancy (65+), life years with disability (65+), age-standardized prevalence rate (65+) and health ratio (65+) for German counties in 2009 (z-standardized values, (larger) size of the single marker/circle indicates the (higher) particular precision of estimation)

Figure 1a: Disability-free life expectancy and life expectancy



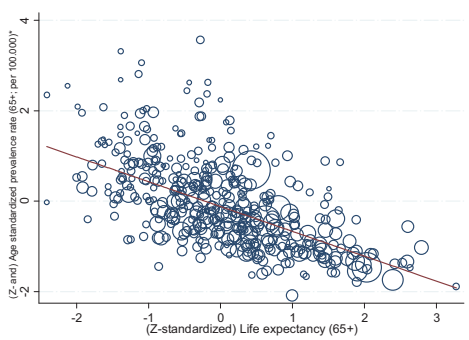
β=0.88 (p<0.001)
West: β=0.89 (p<0.001)
East: β=0.77 (p<0.001)

Figure 1b: Life years with disability and life expectancy



β=-0.24 (p<0.001)
West: β=-0.20 (p<0.001)
East: β=-0.02 (p=0.849)

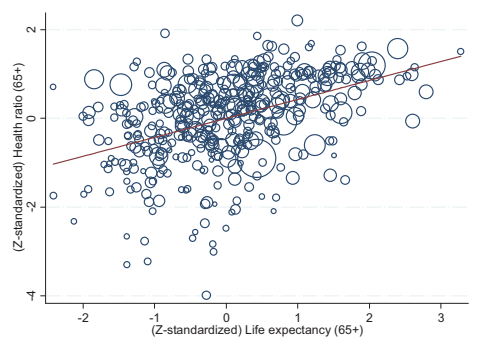
Figure 1c: Age-standardized prevalence rate* and life expectancy



Note: * Old European standard population

β=-0.60 (p<0.001)
West: β=-0.59 (p<0.001)
East: β=-0.41 (p<0.001)

Figure 1d: Health ratio and life expectancy



β=0.43 (p<0.001)
West: β=0.40 (p<0.001)
East: β=0.20 (p=0.060)

Source: Statistische Ämter des Bundes und der Länder; SLTC Census 2009; author's calculations and plotting

In relative terms, the proportion of years without disability (HR) was slightly higher in counties with high life expectancy as the latter was combined with a lower prevalence of disability (ASP). The correlation between the LE and the ASP was linear and significantly negative (β=-0.58, $p<0.001$), although the strength of the correlation differed in the East and the West (Figure 1c). In West Germany, there was a higher negative correlation of LE with the ASP (β=-0.57, $p<0.001$) than in East Germany (β=-0.39, $p<0.001$). There was a weaker (positive) correlation between the HR and the LE in East Germany (β=0.20, $p=0.060$) than in West Germany (β=0.40, $p<0.001$) (Figure 1d). Both findings can be explained by the large number of counties with very low LE but high ASP, resulting in a low HR. The table in the appendix displays the values of the LE, the DFLE, the DLY, the HR and the ASP for the 40 counties with the highest overall HR and the 40 counties with lowest overall HR.

5.2 Living context as a factor of spatial disability patterns

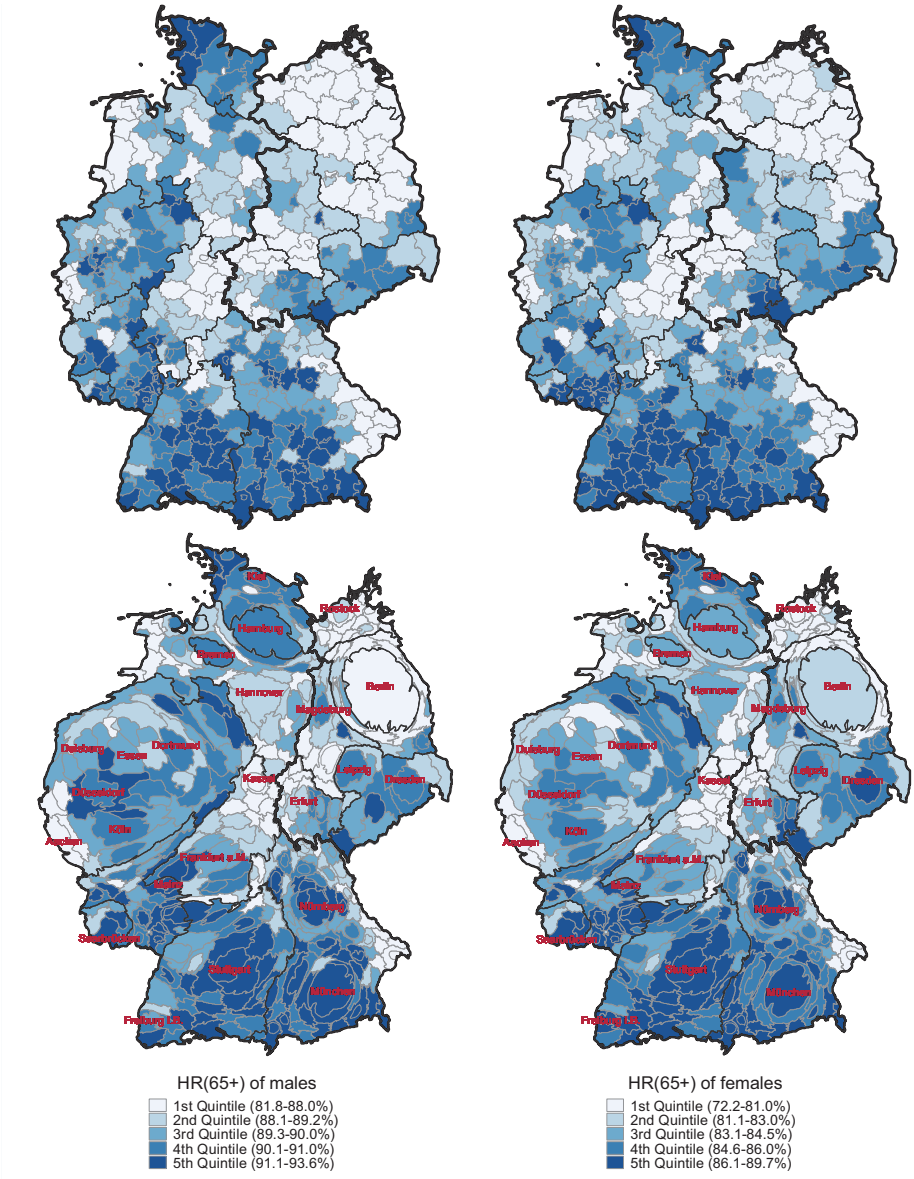
The spatial mapping of HR (see Figure 2) showed clear geographical patterns of high (dark blue) and low (light blue) HR for males and females at age 65+. The first row of Figure 2 displays the HR by using two administrative maps denoting the political boundaries, while the second row shows two isodemographic maps[5] that have been weighted and resized by the male and female populations at age 65+.

The clusters of very low HR were in the northeastern, northwestern, and central counties of Germany, as well as in eastern Bavaria (in the south). The clusters of very high HR were concentrated in the most northwestern part of Germany, and in the southern and southwestern counties. The clusters were independent of the borders of the federal states. The male and female patterns of HR showed only slight differences.

The isodemographic maps showed that the largest population with the lowest HR in Germany was concentrated in Berlin, in the Northern Ruhr region, in Aachen and Kassel and the surrounding areas.

[5] Isodemographic maps are useful for highlighting the absolute concentration of persons by specific characteristics.

Figure 2: Spatial mapping of the health ratio (HR) at ages 65+ of males (left) and females (right) in 2009; categorized in quintiles



Source: Statistische Ämter des Bundes und der Länder; SLTC Census 2009; author's calculations and plotting. Base map: Bundesamt für Kartographie und Geodäsie

Note: First row: unweighted, second row: weighted by population at age 65+; shape of East and West Germany in bold black lines and shapes of the federal states in thin black lines. This figure in high quality: http://www.budrich-academic.de/de/bevoelkerungswissenschaft/

The unweighted mean disposable income of the private households per capita in the 412 German counties was 18,590 Euros, with a standard deviation (SD) of 2,390 Euros, which indicates a relatively low degree of county-level heterogeneity (Table 3). The mean long-term unemployment rate was 19.75 per 10,000 persons, and had a relatively high standard deviation of 16.71 persons. The mean and the standard deviations of the population density (519.55 inhabitants per km²; SD: 672.80 inhabitants per km²) indicated that most counties are sparsely populated, while a few counties (e.g., Munich, Berlin, and Herne, with more than 3,000 inhabitants/km²) showed a very high level of urbanization. For the synthetic indicator of the level of premature mortality, the life table showed a mean value of about 1,445 (or 1.4%) deaths per 100,000 persons, with a standard deviation of 388 deaths (or 0.39PP), which was moderate compared to the standard deviations of the last two indicators.

Table 3: Descriptive overview of the covariates (SD=standard deviation)

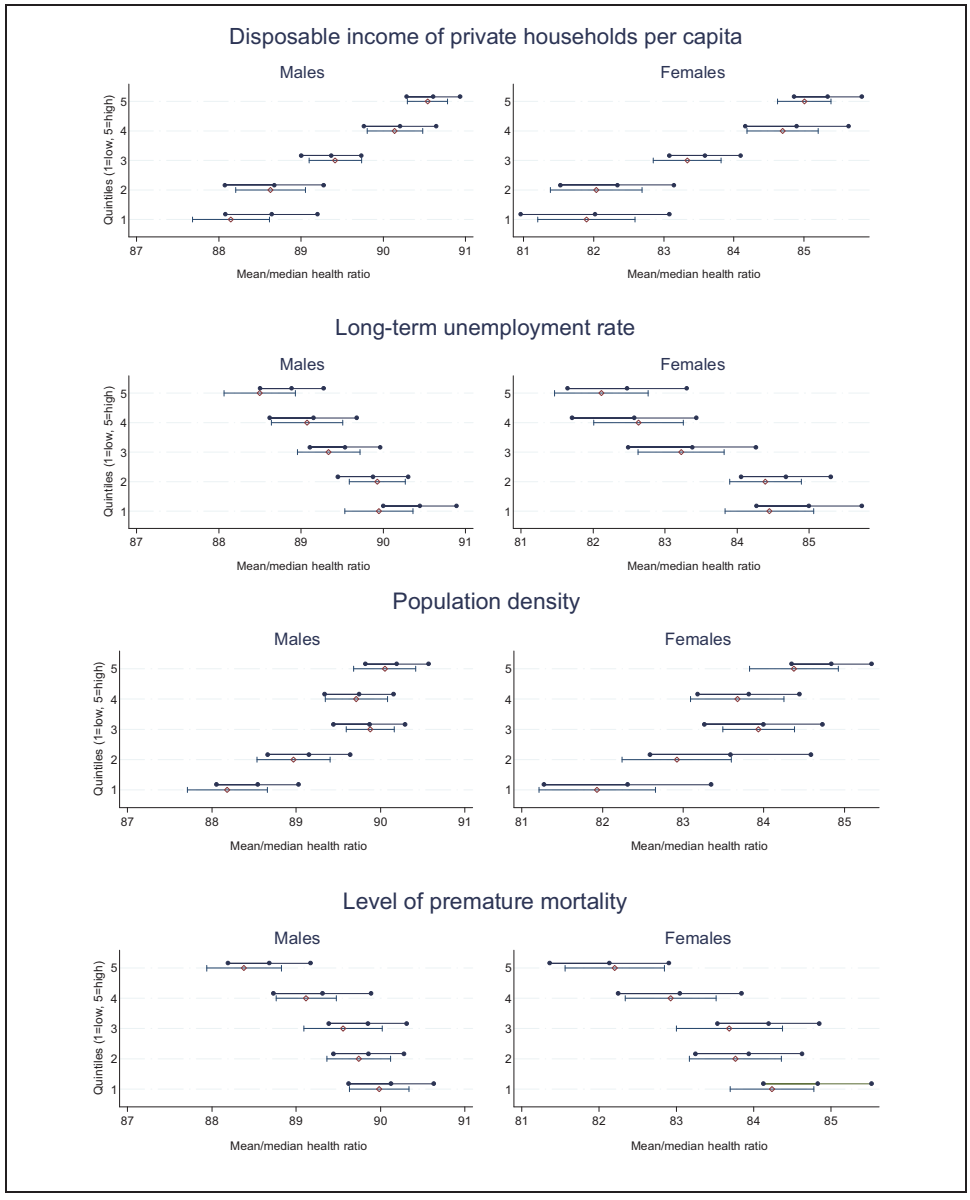
Covariates	Mean (SD)	Median	Minimum	Maximum	N
Disposable income of the private households per capita (in 1,000 Euro)	18.59 (2.39)	18.44	13.90	31.02	412
Population density (in inhabitants per km²)	519.55 (672.80)	198.64	37.59	4,282.21	412
Unemployment rate (in %)	7.92 (3.57)	7.00	2.20	18.30	412
Level of premature mortality (in deaths in age 1 - <45 per 100,000)	1,445.99 (388.80)	1,412.43	168.92	2,741.47	412

Source: Statistische Ämter des Bundes und der Länder; Regional database 2013

To identify potential problems of colinearity, the correlation matrices of the indicators were examined. Generally, the correlations (not shown here) were found to be weak (0.31 and lower); only for long-term unemployment rate and population density was a moderate correlation of 0.49 shown.

For both sexes, there was a significant correlation between the covariates and the HR, although the quintile groups of counties were shown to be more homogeneous in terms of health conditions for males than for females. Wealthier counties measured by “disposable income of the private households per capita” generally showed higher mean and median HR than did poorer counties (Figure 3). A higher concentration of long-term unemployed people was generally correlated with lower average HR. The mean and median HR were significantly lower in counties with a lower population density and in counties with a higher level of premature mortality.

Figure 3: Mean health ratios (95% confidence intervals; red squares) and median health ratios (95% confidence intervals; blue circles) by quintiles of the macro factors in 2009 (not weighted by population size)



Source: Statistische Ämter des Bundes und der Länder; SLTC Census 2009; Regional database 2013; author's calculations and plotting

To analyze the effects of the four indicators simultaneously, multivariate meta-regression models by sex were estimated. These models (Table 4) showed higher HR levels for counties with higher disposable household income. These differences were significant for males and females. Those living in the wealthiest counties had a 1.27PP (men) and a 1.28PP (women) higher HR than their counterparts in the most deprived counties. For both sexes the effects of the long-term unemployment rate were consistent and highly significant. Females in the counties with the highest long-term unemployment rate had a 2.24PP lower HR than did females in the counties with the lowest rate. For males the effect was negative 1.08PP.

Table 4: Meta-regression models of the health ratio for males (left) and females (right) at ages 65+ in 2009

		Males (65+)			Females (65+)		
Covariates		Coefficient	95% CI	p-value	Coefficient	95% CI	p-value
Constant		88.81	(88.10 - 89.52)	<0.001	83.51	(82.43 - 82.43)	<0.001
Disposable income of private households per capita (quintiles)	1st - lowest	Ref			Ref		
	2nd	0.10	(-0.44 - 0.64)	0.722	-0.62	(-1.45 - 0.20)	0.139
	3rd	0.71	(0.09 - 1.32)	0.024	0.33	(-0.61 - 1.27)	0.488
	4th	1.07	(0.41 - 1.73)	0.002	1.20	(0.19 - 2.21)	0.020
	5th - highest	1.27	(0.61 - 1.93)	<0.001	1.28	(0.28 - 2.29)	0.013
Long-term unemployment rate (quintiles)	1st - lowest	Ref			Ref		
	2nd	-0.29	(-0.81 - 0.23)	0.278	-0.38	(-1.17 - 0.41)	0.349
	3rd	-0.81	(-1.34 - -0.28)	0.003	-1.47	(-2.28 - -0.67)	<0.001
	4th	-0.68	(-1.25 - -0.10)	0.021	-1.65	(-2.52 - -0.78)	<0.001
	5th - highest	-1.08	(-1.75 - -0.41)	0.002	-2.24	(-3.26 - -1.22)	<0.001
Population density (quintiles)	1st - lowest	Ref			Ref		
	2nd	0.36	(-0.15 - 0.87)	0.167	0.37	(-0.40 - 1.15)	0.345
	3rd	0.78	(0.22 - 1.34)	0.007	0.66	(-0.19 - 1.51)	0.129
	4th	0.96	(0.40 - 1.51)	<0.001	1.04	(0.19 - 1.89)	0.016
	5th - highest	1.53	(0.95 - 2.11)	<0.001	2.19	(1.31 - 3.08)	<0.001
Level of premature mortality (quintiles)	1st - lowest	Ref			Ref		
	2nd	-0.19	(-0.69 - 0.31)	0.461	-0.38	(-1.14 - 0.39)	0.331
	3rd	0.09	(-0.42 - 0.60)	0.726	0.28	(-0.50 - 1.06)	0.479
	4th	-0.31	(-0.82 - 0.20)	0.231	-0.46	(-1.24 - 0.31)	0.242
	5th - highest	-0.72	(-1.25 - -0.20)	0.007	-0.80	(-1.60 - 0.00)	0.051
Adjusted R^2			28.46%			26.74%	

Source: Statistische Ämter des Bundes und der Länder; SLTC Census 2009; Regional database 2013; author's calculations

The effects of population density were also highly significant in that both men and women in highly urbanized counties were found to have a more favorable HR than those in less densely populated rural areas. The effects were stronger for females (2.19PP) than for males (1.53PP). Measured in terms of the improvements in model fit, the level of premature

mortality was the weakest indicator in the analysis. The HR in counties with the highest degree of premature mortality was 0.72PP lower for men and 0.80PP lower for women than in counties with the most favorable level of premature mortality.

In recognition of the fact that there were still marked societal and economic differences between the counties in the former German Democratic Republic[6] and the counties in West Germany, separate region-specific regression models were additionally estimated for both regions (Table 5).

Table 5: Meta-regression models of the health ratio of the West German counties (left, n=325) and of the East German counties (right, n=87) at ages 65+ in 2009

		West Germany			East Germany		
Covariates		Coefficient	95% CI	p-value	Coefficient	95% CI	p-value
Constant		85.53	(84.67 - 86.40)	<0.001	81.40	(79.53 - 79.53)	<0.001
Disposable income of private households per capita (quintiles)	1st - lowest	Ref			Ref		
	2nd	-0.05	(-0.73 - 0.62)	0.874	1.73	(-0.03 - 3.48)	0.053
	3rd	0.81	(0.11 - 1.50)	0.023	3.09	(1.32 - 4.86)	<0.001
	4th	1.57	(0.83 - 2.31)	<0.001	2.96	(1.13 - 4.78)	0.002
	5th - highest	1.57	(0.61 - 1.93)	<0.001	1.40	(-0.45 - 3.25)	0.137
Long-term unemployment rate (quintiles)	1st - lowest	Ref			Ref		
	2nd	-0.09	(-0.77 - 0.59)	0.790	0.37	(-1.25 - 2.00)	0.648
	3rd	-0.68	(-1.37 - 0.02)	0.057	-0.17	(-1.80 - 1.45)	0.832
	4th	-0.90	(-1.61 - -0.19)	0.014	-0.61	(-2.28 - 1.06)	0.470
	5th - highest	-1.45	(-2.28 - -0.61)	<0.001	-0.31	(-1.39 - 2.02)	0.714
Population density (quintiles)	1st - lowest	Ref			Ref		
	2nd	0.06	(-0.63 - 0.75)	0.865	1.29	(-0.52 - 3.11)	0.159
	3rd	0.12	(-0.62 - 0.86)	0.747	1.36	(-0.27 - 2.99)	0.101
	4th	0.56	(-0.19 - 1.30)	0.143	3.03	(1.18 - 4.88)	0.002
	5th - highest	1.48	(0.68 - 2.29)	<0.001	1.50	(-0.26 - 3.26)	0.093
Level of premature mortality (quintiles)	1st - lowest	Ref			Ref		
	2nd	-0.31	(-0.97 - 0.36)	0.366	-0.93	(-2.58 - 0.72)	0.264
	3rd	0.24	(-0.43 - 0.92)	0.479	-0.87	(-2.49 - 0.76)	0.292
	4th	-0.10	(-0.78 - 0.58)	0.774	-1.14	(-2.78 - 0.50)	0.170
	5th - highest	-0.49	(-1.19 - 0.22)	0.177	-1.65	(-3.44 - 0.15)	0.071
Adjusted R^2			23.41%			27.37%	

Source: Statistische Ämter des Bundes und der Länder; SLTC Census 2009; Regional database 2013; author's calculations

Given the imbalance in the number of counties in the East (87) and in the West (325), it was apparent that most of the effects of the covariates in the West German counties were similar to the effects in the overall sex-specific models. The correlation between socioeconomic

6 Including the city of Berlin.

wealth and the health of the population seemed to be log-linear in the West, while it was a U-shaped relationship in the East. The counties with the highest HR were the counties of the two highest income quintiles in the West and the average-income counties in the East.

A profound negative correlation between long-term unemployment and the HR was found in the West German counties, but no significant correlation was found in East German counties. For the indicators of physical and health care conditions, divergent effects were identified for both German regions. In the East, the most favorable health ratios were found for counties in the fourth quintile of population density. Compared to this group, the most densely populated counties in the East had lower HR. The regression models showed a borderline significant effect of premature mortality for the most disadvantaged East German counties, but no effect for the West German counties.

The results of region-specific regression models by sex (not shown here) were consistent with the findings of the models separated by sex and region.

Table 6: Goodness of fit (adjusted R^2 and tau^2) by type of model and sex

	Between county-variance tau^2 (relative change)				Adjusted R^2	
	Males		Females		Males	Females
		%		%	%	%
Modell 0	3.64		8.24			
Modell I	2.84	-28	6.59	-25	21.78	19.96
Modell II	2.85	0	6.50	-1	21.61	21.10
Modell III	2.65	-8	6.11	-6	27.08	25.81
Modell IV	2.60	-2	6.04	-1	28.46	26.74

Source: Statistische Ämter des Bundes und der Länder; SLTC Census 2009; Regional database 2013; author's calculations

Note: model 0 = Baseline model without covariates; model I = model 0 + disposable income; model II = model I + long-term unemployment rate; model III = model II + population density; model IV = model III + premature mortality

Table 7: Goodness of fit (adjusted R^2 and tau^2) by type of model and region

	Between county-variance tau^2 (relative change)				Adjusted R^2	
	West Germany		East Germany		West Germany	East Germany
		%		%	%	%
Modell 0	4.60		7.50			
Modell I	3.71	-24	5.73	-31	19.38	23.59
Modell II	3.71	0	5.97	4	19.33	20.36
Modell III	3.54	-5	5.43	-10	23.09	27.61
Modell IV	3.52	0	5.45	0	23.41	27.37

Source: Statistische Ämter des Bundes und der Länder; SLTC Census 2009; Regional database 2013; author's calculations

Note: model 0 = Baseline model without covariates; model I = model 0 + disposable income; model II = model I + long-term unemployment rate; model III = model II + population density; model IV = model III + premature mortality

The goodness of fit, measured by the adjusted R^2, generally increased with the inclusion of the additional macro factors, whereas the between-county variance decreased in both the sex-specific (Table 6) and the region-specific models (Table 7). A lack of improvements of model fit existed for the indicator of the long-term unemployment rate. The adjusted R^2 of the final model (model IV) differed slightly between the subgroups. The explained between-county variance was higher for males than for females, and it was higher for East German counties than for West German counties. The adjusted R^2 implied, however, that more than 70% of the regional heterogeneity was not explained by these indicators.

6 Discussion

This is the first study that combines census data and advanced healthy-aging measures to investigate spatial patterns in disability in Germany, and to explore their relationship to life expectancy and to socioeconomic factors. The results show a high positive correlation between the life expectancy and the disability-free life expectancy at age 65 in East and West Germany. The population of a county with a high life expectancy tends to have a higher disability-free life expectancy as well. This was also found to be true for the health ratio: A higher life expectancy is associated with a higher health ratio. The strength of the correlation differs between East and West German counties, with a stronger correlation in the West than in the East. By contrast, the findings show a weak positive correlation between life expectancy and disabled life years in the West German counties, and no relationship in the East German counties.

The relationships of the four measures of long-term care with the life expectancy can be interpreted in two ways: from the individual perspective and from a societal or public health perspective. From the individual's point of view, the absolute measures of the disability-free life expectancy and the disabled life years are of higher interest than the relative measures. This study confirmed the conclusions of Mathers et al. (2001) and Robine et al. (2009) to also be true on the level of counties. Thus, a person who lives in a county with a high life expectancy can also expect to live absolutely more years without disability and absolutely fewer disabled years in the lifetime. From the societal or public health perspective, the relative measures of the health ratio and the age standardized prevalence are of interest. Both measures indirectly indicate the proportion of a number of disabled persons to a hypothetical number of caregivers or to a hypothetical number of contributors to the SLTC insurance. The results showed a favorable higher proportion and a higher prevalence of persons without disability in counties with a higher life expectancy, however, there were also inconsistent findings in absolute and relative terms. A comparison of the four counties Rügen, Passau, Kaiserslautern, and Stuttgart shows the inconsistency: The elder population of Rügen, a county in the northeast of Mecklenburg-Western Pomerania, shows nearly the same health ratio as the elderly of Passau, a city county in Eastern Bavaria (about 79.4% to 79.8%; see Table in the appendix). However, the elderly in Passau were expected to live a total of about 1.5 years (19.2 years) longer than persons at age 65+ residing in the county of Rügen (17.8 years). In comparison, e.g. the elderly living in the city of Kaiserslautern in Rhineland-Palatinate had a significantly higher health ratio (90.2%) than did those in the county of Rügen (79.8%), Passau (79.4%) and the city of Stuttgart (89.4%). However, the elderly in Kaiserslautern had fewer years to live (18.6

years) than their counterparts in Passau (19.2 years) and in Stuttgart (20.9 years). Thus, the correct interpretation depends on the adequate choice of the measure.

There are three potential explanations for the disparities found in the East and West German counties. First, the political reunification led to various societal and economical changes in the East German counties that in return had significant contradictory effects on diverse health relevant conditions. For example, there were enormous improvements in the medical infrastructure and the health care provision, and these resulted in rapid gains in life expectancy. In contrast, the reorganization of the economic system and labor market caused large-scale unemployment and a short-term lack of perspectives. These trends were often indirectly linked to unfavorable changes in lifestyle behavior such as alcohol consumption, physical inactivity, and smoking, all of which are potential determinants of the risk of long-term care in later life. Second, there was a different pace in the process of reorganization of the health care infrastructure and the job market in the East German counties that, furthermore, resulted in a different pace in the catch-up process of the life expectancy and of the disability-free life expectancy. The counties in Saxony were the forerunners hereof, while counties in Mecklenburg Western-Pomerania, Brandenburg, and Thuringia did not keep pace. Third, selective migration of healthy, younger elderly and their relatives in the years after reunification may have caused a divergent composition of population in the East German counties. Because most counties in the East are sparsely populated, migration has a generally higher effect on the composition of a population than it does on those of populous counties. Further research is needed to evaluate the effects of health selection in migration.

There is one outstanding conclusion of the spatial mapping, in that that disparities in the health ratio within East (IQR: 4.5PP) and West Germany (IQR: 3.1PP) were higher than the disparities between the two regions (median difference: 2.2PP). By further considering the absolute number of each county's population, the study confirmed that the highest number of persons with low HR was not in the cluster of counties in the northeast of Germany but rather in Berlin, in the Northern Ruhr region, in Aachen and Kassel and the surrounding areas.

This study stated that spatial health differentials in Germany were associated with the level of urbanization, the socioeconomic performance and composition, and, to a small extent, the regional health structure. The most pronounced gradients on health existed for population density and socioeconomic factors. While the short term policy intervention options are limited for the first factor, the socioeconomic factors are affected directly and indirectly by economic and policy measures. However, even if population density cannot be changed in the short term, health policies targeted differently at urban and rural areas should be developed, and their effectiveness should be evaluated.

The study detected different associations between the macro factors and health in both German regions. The relationship between disposable income and health in the West German counties resembles the relationship between gross domestic product and life expectancy reported by Preston (1975), who found large differences in life expectancy between countries with low gross domestic product levels and small differences between the wealthiest countries. The relationship found in this study in the West German counties was similar to such a function, which is also known as the Preston curve. In East Germany, by contrast, disposable incomes are shown to have a U-shaped relationship with health, with the best health situations found in counties with an average disposable income.

Long-term unemployment as an indicator for an unfavorable socioeconomic composition and a weak social cohesion (Berger-Schmitt 2002) is closely linked with poorer health in the

West German counties. However, it has no effect on health in East Germany. Further investigations are needed to explain the latter finding.

The study shows a positive correlation between population density and health in the West German counties. Counties with a high concentration of population have better health than sparsely populated counties. In contrast, the multivariate regression analysis reveals a U-shaped relationship with urbanity in the East German counties. Thus, the results for population density confirm the findings of Diehl and Schneider (2011) for West Germany; but not for East Germany. The U-shaped association of population density with health was also found by Barnett et al. (2001) when analyzing the county-specific prevalence of premature limiting long-term illness in the southwest of England. Because the region is rural and is among the most deprived in England, the two settings are comparable in terms of socioeconomic conditions and physical structure.

The relationship of premature mortality and the health ratio was pronounced in East Germany, whereas no relationship was found in West Germany. One possible explanation for this finding is the low spatial variability in premature mortality. As a result, only the extremes differ significantly. Because these disparities of premature mortality are slightly larger in East (IQR: 605.2 deaths) than in West Germany (IQR: 465.3 deaths), the relationship is stronger in the East than in the West. In the case of East Germany, the findings confirm those of Fantini et al. (2012), who concluded that a high level of premature mortality is linked with low disability-free life expectancy.

This study has four major strengths. The first is the use of census data with the large number of beneficiaries permitting the analysis of counties. All STLC beneficiaries, regardless of whether they are a member of a private or public health plan, are part of the census, which means there is no bias due to undercoverage, missing records, or self-selection into or drop-out from the study.

The second strength is the use of an objective health measure. Disability is diagnosed by experts employed through the health insurance plans and disability status is based on a nationally standardized evaluation.

The third strength is the regional homogeneity of the German health care system in terms of long-term care regulations. There are no, or only very small, culture-specific health definitions that may negatively affect the comparability of the findings. In contrast to cross-country surveys, the SLTC Census is a highly harmonized data source. Because care need regulations are binding for each German county, even changes in these regulations do not bias the spatial disparities.

The fourth strength is the selected health outcome. The HR is a synthetic, composite measure combining two synthetic, composite measures, the DFLE and the LE. Both measures are based on a hypothetical cohort with constant sex- and age-specific mortality rates (as in 2006-2010) and morbidity rates (as in 2009). The calculation method of the cohort, respectively the LE and the DFLE, is simple, as only basic cross-sectional data is required. Both the DFLE and the LE are independent of the size and age structure of the population, as is the resulting HR. Furthermore, the interpretation of the HR is easy to understand. In addition, the HR is independent of the absolute level of the LE. This standardization makes it possible to compare counties even if they are at different levels in terms of the absolute measures. The correlation of the DFLE with the LE depends on the overall level of the disability prevalence. The lower the prevalence, the higher the correlation between the DFLE and the LE because all differences between the counties are driven by differential life expectancy. In terms of the multivariate analysis, the use of the

HR implies that the relationship of the macro factors with the HR is not overlaid by the relationship between the macro factors and LE. Thus, the HR is particularly suited for comparisons of small-area health conditions and their relationship to the macro factors.

However, the study also has some limitations, most of which stem from the ecological design of the study. The units under study are counties, not individuals. The health outcome HR is a synthetic aggregate measure of health at the individual level. Because only basic demographic data (sex and age) are available in the census and there is no other socioeconomic or demographic information on the individuals, there is also no direct information about the social composition of the population in the counties. Hence it is impossible to separate the effects of composition and context (van Lenthe 2006). Thus, while it is feasible to detect correlations, it is not possible to identify causality.

In addition, in the interpretation of the effects, ecological failures must be avoided; all relationships have to be interpreted as relationships at the level of counties only, and not at the individual level. Moreover, only one dimension of health, severe disability, is considered in this study. The findings of previous studies have varied according to the health indicators used. Severe disability in this study may be influenced by problems with legal eligibility for long-term care allowances, health care-seeking behaviors, or the ability to cope with health problems.

Further, the choice of the macro indicators must also be viewed with caution. Each indicator selected was treated as a single proxy of a particular broad dimension of the living context in this analysis. Because the causal effects of the contextual dimensions on heath outcome are complex and mediated by various latent factors, the interpretation has to be prudent. Population density, for example, was used as an indicator of physical environment in this study, but this is a simplification. Population density can be interpreted in various ways, e.g. in terms of access to services and resources, residential attractiveness, lifestyle, stress, or social networks. Furthermore, the population density – as well as other macro-level characteristics – of a county is directly influenced by the historically, politically, or economically established demarcation of the county. Thus, the heterogeneity of living contexts within a county cannot be validly reflected by a single indicator. The problem of overlaid heterogeneity is more urgent for larger counties in terms of surface area.

In this study, most of the variability in the health ratio between the counties is not explained by the selected indicators. Further analyses that include additional macro factors are needed in order to explain the residual regional variance, e.g. indirect indicators of health behavior such as cause-specific mortality data. Interaction effects between the indicators may also be considered in order to investigate mediating influences. Including geographical distances between the counties by using spatial regression models that control for spatial autocorrelation might further improve the analysis.

All of these ideas may help to improve the understanding of the determinants of healthy aging, and may help ensure universal and equitable access to high-quality health care and the attainment of equal living conditions. According to the German constitution, such equal conditions are among the fundamental objectives of the national social and health policies in Germany.

References

Barnett, S.; Roderick, P.; Martin, D.; Diamond, I. (2001): A multilevel analysis of the effects of rurality and social deprivation on premature limiting long term illness. In: *Journal of Epidemiology & Community Health* 55, pp. 44-51.

Barr, N. (2004): Economics of the welfare state. New York: Oxford University Press.

Berger-Schmitt, R. (2002): Considering Social Cohesion in Quality of Life Assessments: Concept and Measurement. In: *Social Indicators Research* 58, pp. 403-428.

Bickel, H. (2001): Lebenserwartung und Pflegebedürftigkeit in Deutschland. In: *Das Gesundheitswesen* 63 (1), pp. 9-14.

Breckenkamp, J.; Mielck, A.; Razum, O. (2007): Health inequalities in Germany: do regional-level variables explain differentials in cardiovascular risk? *BMC Public Health* 7, p. 132.

Brønnum-Hansen, H.; Davidsen, M.; Kjølle, M. (2003): Tresårige danskeres forventede levetid uden funktionsindskraenkning. In: *Ugeskr Laeger* 165 (23), pp. 2395-2398.

Burgio, A.; Murianni, L.; Folino-Gallo, P. (2009): Differences in Life Expectancy and Disability Free Life Expectancy in Italy. A Challenge to Health Systems. In: *Social Indicators Research* 92 (1), pp. 1-11. [DOI: 10.1007/s11205-008-9283-y]

Chiang, C. L. (1984): The life table and its applications. Malabar, Florida: Robert E. Krieger.

Christensen, K.; Doblhammer, G.; Rau, R.; Vaupel, J. W. (2009): Ageing populations: the challenges ahead. In: *The Lancet* 374, pp. 1196-1208.

Diehl, K.; Schneider, S. (2011): How relevant are district characteristics in explaining subjective health in Germany? – A multilevel analysis. In: *Social Science & Medicine* 72 (7), pp. 1205-1210. [DOI: 10.1016/j.socscimed.2011.02.013]

Diez-Roux, A. V. (2003): The Examination of Neighborhood Effects on Health: Conceptual and Methodological Issues Related to the Presence of Multiple Levels of Organization. In: Kawachi, Ichiro; Berkman, L. F. (Eds.): *Neighborhoods and Health*. New York: Oxford University Press, pp. 45-61.

Diez-Roux, A. V.; Mair, C. (2010): Neighborhoods and health. In: *Annals of the New York Academy of Sciences* 1186 (1), pp. 125-145. [DOI: 10.1111/j.1749-6632.2009.05333.x]

Fantini, M. P.; Lenzi, J.; Franchino, G.; Rainieri, C.; Burgio, A.; Frova, L. et al. (2012): Amenable mortality as a performance indicator of Italian health-care services. In: *BMC Health Services Research* 12 (1), p. 310. [DOI: 10.1186/1472-6963-12-310]

Fukuda, Y.; Nakamura, K.; Takano, T. (2005): Municipal health expectancy in Japan: decreased healthy longevity of older people in socioeconomically disadvantaged areas Municipal health expectancy in Japan: decreased healthy l of older people in socioeconomically disadvantaged areas. In: *BMC Public Health* 5 (1), p. 65. [DOI: 10.1186/1471-2458-5-65]

Glass, T. A.; Balfour, J. L. (2003): Neighborhoods, Aging, and Functional Limitations. In: Kawachi, Ichiro; Berkman, L. F. (Eds.): *Neighborhoods and Health*. New York: Oxford University Press, pp. 303-334.

Gordon, D. (2003): Area based deprivation measures: A UK Perspective. In: Kawachi, I.; Berkman, L. (Eds.): Neighborhoods and Health, Oxford University Press, pp. 179-207.

Groenewegen, P. P.; Westert, G. P.; Boshuizen, H. C. (2003): Regional differences in healthy life expectancy in the Netherlands. In: *Public Health* 117 (6), pp. 424-429.

Gutiérrez-Fisac, J. L.; Gispert, R.; Solà, J. (2000): Factors explaining the geographical differences in Disability Free Life Expectancy in Spain. In: *Journal of Epidemiology & Community Health* 54, pp. 451-455.

Harbord, R. M.; Higgins, J. P. T. (2008): Meta-regression in Stata. In: *The Stata Journal* 8 (4), pp. 493-519.

Hoffmann, E.; Nachtmann, N. (2010): Old age, the need of long-term care and healthy life expectancy. In: Doblhammer, G.; Scholz, R. (Eds.): Ageing, Care Need and Quality of Life. The Perspectives of Care Givers and People in Need of Care. Wiesbaden: Springer VS Research, pp. 162-176.

Jagger, C.; Cox, B.; Le Roy, S. et al. (2007): Health Expectancy Calculation by the Sullivan Method: A Practical Guide. European health expectancy monitoring unit (EHEMU), Technical Report 3 (2006)

Jagger, C.; Gillies, C.; Moscone, F.; Cambois, E.; van Oyen, H.; Nusselder, W. et al. (2008): Inequalities in healthy life years in the 25 countries of the European Union in 2005: a cross-national meta-regression analysis. In: *The Lancet* 372 (9656), pp. 2124-2131.

Jagger, C.; Weston, C.; Cambois, E.; van Oyen, H.; Nusselder, W.; Doblhammer, G.; et al. (2011): Inequalities in health expectancies at older ages in the European Union: findings from the Survey of Health and Retirement in Europe (SHARE). In: *Journal of Epidemiology and Community Health* 65 (11), pp. 1030-1035.

Karakaya, G. (2009): Long-term care: Regional disparities in Belgium. In: *Journal of Applied Economic Sciences* 4 (1(7)), pp. 58-79.

Kawachi, Ichiro; Berkman, L. F. (Eds.) (2003): Neighborhoods and Health. New York: Oxford University Press.

Kibele, E.; Janssen, F. (2013): Distortion of regional old-age mortality due to late-life migration in the Netherlands. In: *Demographic Research* 29 (5), pp. 105-132.

Kroll, L. E.; Lampert, T. (2012): Regionalisierung von Gesundheitsindikatoren Ergebnisse aus der GEDA-Studie 2009. Bundesgesundheitsblatt 55, pp. 129-140. [DOI 10.1007/s00103-011-1403-1]

Lawton, M. P.; Nahemow, L. (1973): Ecology and the aging process. In: Eisdorfer, C.; Lawton, M. P. (Eds.): *The psychology of adult development and aging.* Washington, DC: American Psychological Association, pp. 619-674.

Lievre, A.; Jusot, F.; Barnay, T.; Sermet, C.; Brouard, N.; Robine, J.-M. et al. (2007): Healthy working life expectancies at age 50 in Europe: a new indicator. In: *Journal of Nutrition, Health & Aging* 11 (6), pp. 508-514.

Liu, J.; Chen, G.; Chi, I.; Wu, J.; Pei, L.; Song, X. et al. (2010): Regional variations in and correlates of disability-free life expectancy among older adults in China. In: *BMC Public Health* 10, p. 446. [DOI: 10.1186/1471-2458-10-446.

Mathers, C. D.; Sadana, R.; Salomon, J. A.; Murray, C. J. L.; Lopez, A. D. (2001): Healthy life expectancy in 191 countries, 1999. In: *The Lancet* 357 (9269), pp. 1685-1691. [DOI: 10.1016/S0140-6736(00)04824-8]

Muszyńska, M. M.; Rau, R. (2012): The Old-Age Healthy Dependency Ratio in Europe. In: *Journal of Population Ageing* 5 (3), pp. 151-162. [DOI: 10.1007/s12062-012-9068-6]

Olshansky, S. J.; Ault, A. B. (1986): The Fourth Stage of the Epidemiologic Transition: The Age of Delayed Degenerative Diseases. In: *The Milbank Quarterly* 64 (3), pp. 355-391.

Pfaff, H. (2010): People in Need of Long-term Care: The Present and the Future. In: Doblhammer, G.; Scholz, R. (Eds.): *Ageing, Care Need and Quality of Life*. The Perspectives of Care Givers and People in Need of Care. Wiesbaden: Springer VS Research, pp. 14-28.

Pickett, K. E.; Pearl, M. (2001): Multilevel analyses of neighbourhood socioeconomic context and health out Multilevel analyses of neighbourhood socioeconomic context and health outcomes: a critical review socioeconomic critical review. In: *Journal of Epidemiology & Community Health* 55, pp. 111-122.

Pinheiro, P.; Krämer, A. (2009): Calculation of health expectancies with administrative data for North Rhine-Westphalia, a Federal State of Germany, 1999-2005. In: *Population Health Metrics* 7, p. 4. [DOI: 10.1186/1478-7954-7-4]

Porell, F. W.; Miltiades, H. B. (2002): Regional differences in functional status among the aged. In: *Social Science & Medicine* 54, pp. 1181-1198.

Preston, S. H. (1975): The Changing Relation between Mortality and level of Economic Development (29).

Riva, M.; Gauvin, L.; Barnett, T. A. (2007): Toward the next generation of research into small area effects on health: a synthesis of multilevel investigations published since July 1998. In: *Journal of Epidemiology & Community Health* 61 (10), pp. 853-861. [DOI: 10.1136/jech.2006.050740]

Robine, J.-M.; Cambois, E.; Romieu, I.; Mormiche, P. (1998): Variations régionales de l'espérance de vie sans incapacités entre 1982 et 1990. *Note au haut Comité de Santé Publique*, pp. 99-140.

Robine, J.-M.; Saito, Y.; Jagger, C. (2009): The relationship between longevity and healthy life expectancy. In: *Quality in Ageing* 10 (2), pp. 5-14.

Robine, Jean-Marie; Jagger, C.; Mathers, C.; Crimmins, E.; Suzman, R. (Eds.) (2003): Determining health expectancies. Chichester, Hoboken, NJ: J. Wiley.

Seko, R.; Hashimoto, S.; Kawado, M.; Murakami, Y.; Hayashi, M.; Kato, M. et al. (2012): Trends in Life Expectancy With Care Needs Based on Long-term Care Insurance Data in Japan. In: *Journal of Epidemiology*. [DOI: 10.2188/jea.JE20110069]

SGB (1995): Elftes Buch Sozialgesetzbuch - Soziale Pflegeversicherung. SGB XI.

Smith, M. P.; Olatunde, O.; White Chris (2011): Disability-free life expectancy: comparison of sources and small area estimates in England, 2006-2008. In: *Health Statistics Quarterly* 50, pp. 40-78.

Sullivan, D. F. (1971): A Single Index of Mortality and Morbidity. In: *HSMHA Health Reports* 86 (4), pp. 347-354.

Thompson, S. G.; Sharp, S. J. (1999): Explaining heterogeneity in meta-analysis: a comparison of methods. In: *Statistics in Medicine* 18 (20), pp. 2693-2708. [DOI: 10.1002/(SICI)1097-0258(19991030)18:20<2693::AID-SIM235>3.0.CO;2-V]

van Lenthe, F. (2006): Aggregate deprivation and effects on health. In: Siegrist, J.; Marmot, M. (Eds.): *Social inequalities in health*. New evidence and policy implications. New York: Oxford University Press, pp. 167-192.

van Oyen, H.; Tofforeau, J.; Roelands, M. (1996): Regional Inequities in Health Expectancy in Belgium. In: *Social Science & Medicine* 43 (11), pp. 1673-1678. [DOI: 10.1016/S0277-9536(96)00080-9]

Voigtländer, S., Berg-Beckhoff, G.; Razum, O. (2008): Gesundheitliche Ungleichheit. Der Beitrag kontextueller Merkmale. Frankfurt am Main, Berlin, Bern, Bruxelles, New York, Oxford, Wien. Challenges in Public Health 55.

Voigtländer, S., Berger, U.; Razum, O. (2010a): The impact of regional and neighbourhood deprivation on physical health in Germany: a multilevel study. *BMC Public Health* 10(1): 403.

Voigtländer, S, Berger, U.; Razum, O. (2010b): Increasing regional disparities in living conditions in Germany and their role in the explanation of health inequalities. In: *Gesundheitswesen* 72(5), pp. 301-308. [DOI: 10.1055/s-0029-1233487]

Wood, R.; Sutton, M.; Clark, D.; McKeon, A.; Bain, M. (2006): Measuring inequalities in health: the case for healthy life expectancy. In: *Journal of Epidemiology & Community Health* 60 (12), pp. 1089-1092. [DOI: 10.1136/jech.2005.044941]

Yen, I. H.; Michael, Y. L.; Perdue, L. (2009): Neighborhood Environment in Studies of Health of Older Adults. A Systematic Review. In: *American Journal of Preventive Medicine* 37 (5), pp. 455-463. [DOI: 10.1016/j.amepre.2009.06.022]

Appendix

Overview of the overall values of the LE, the DFLE, the DLY, the HR, and the ASP at age 65+ for 40 counties with the lowest (first part) and the highest HR (second part) in 2009 (sorted by LE)

County	Federal state	LE (65+) years	DFLE (65+) years	DLY (65+) years	HR (65+) (%)	ASP (65+) (per 100k)
Kyffhäuserkreis	Thüringen	17.56	14.26	3.29	81.23	14.80
Rügen, Kreis	Mecklenburg-Vorpommern	17.76	14.17	3.59	79.80	15.21
Uecker-Randow, Kreis	Mecklenburg-Vorpommern	17.85	14.52	3.33	81.32	14.29
Unstrut-Hainich-Kreis	Thüringen	17.90	14.60	3.29	81.60	14.02
Cloppenburg, Landkreis	Niedersachsen	18.10	14.74	3.36	81.45	14.26
Kronach, Landkreis	Bayern	18.27	14.98	3.28	82.03	13.39
Stralsund, Kreisfreie Stadt	Mecklenburg-Vorpommern	18.27	14.43	3.84	78.97	15.48
Freyung-Grafenau, Landkreis	Bayern	18.27	14.14	4.13	77.40	16.75
Nordhausen, Kreis	Thüringen	18.30	14.93	3.37	81.57	13.91
Aurich, Landkreis	Niedersachsen	18.36	15.00	3.36	81.69	13.43
Uckermark, Landkreis	Brandenburg	18.44	14.51	3.93	78.71	15.73
Oberhavel, Landkreis	Brandenburg	18.46	15.01	3.45	81.32	13.98
Nordvorpommern, Kreis	Mecklenburg-Vorpommern	18.47	14.33	4.14	77.58	16.24
Werra-Meißner-Kreis	Hessen	18.48	14.95	3.53	80.89	14.11
Heinsberg, Kreis	Nordrhein-Westfalen	18.50	15.16	3.33	81.97	13.41
Prignitz, Landkreis	Brandenburg	18.52	14.88	3.64	80.37	14.19
Deggendorf, Landkreis	Bayern	18.52	15.19	3.33	82.03	13.28
Emsland, Landkreis	Niedersachsen	18.58	15.04	3.54	80.94	14.03
Regen, Landkreis	Bayern	18.79	15.33	3.47	81.56	13.32
Demmin, Kreis	Mecklenburg-Vorpommern	18.84	15.36	3.48	81.53	13.09
Nordwestmecklenburg, Kreis	Mecklenburg-Vorpommern	18.85	15.39	3.47	81.61	13.11
Güstrow, Kreis	Mecklenburg-Vorpommern	18.90	14.91	4.00	78.86	15.00
Müritz, Kreis	Mecklenburg-Vorpommern	18.93	14.99	3.93	79.21	15.36
Märkisch-Oderland, Landkreis	Brandenburg	19.02	15.16	3.86	79.70	14.47
Oder-Spree, Landkreis	Brandenburg	19.03	15.37	3.66	80.76	13.85
Barnim, Landkreis	Brandenburg	19.03	14.41	4.62	75.71	17.25
Schwalm-Eder-Kreis	Hessen	19.04	15.40	3.64	80.87	13.87
Ostprignitz-Ruppin, Landkreis	Brandenburg	19.10	15.00	4.10	78.55	14.86
Eichsfeld, Kreis	Thüringen	19.11	14.92	4.18	78.11	15.37
Greifswald, Kreisfreie Stadt	Mecklenburg-Vorpommern	19.12	15.44	3.68	80.77	12.80
Osterode am Harz, Landkreis	Niedersachsen	19.15	15.66	3.48	81.81	12.80
Passau	Bayern	19.23	15.27	3.96	79.42	14.58
Weimar, krsfr. Stadt	Thüringen	19.28	15.49	3.79	80.32	13.59
Passau, Landkreis	Bayern	19.32	15.55	3.77	80.48	13.67
Rottal-Inn, Landkreis	Bayern	19.33	15.65	3.68	80.96	13.23
Dahme-Spreewald, Landkreis	Brandenburg	19.45	15.89	3.56	81.71	12.37
Delmenhorst, Kreisfreie Stadt	Niedersachsen	19.57	15.89	3.68	81.18	12.51
Wittmund, Landkreis	Niedersachsen	19.68	15.82	3.86	80.37	12.55
Schwerin, Kreisfreie Stadt	Mecklenburg-Vorpommern	19.71	15.99	3.72	81.12	13.00
Vogelsbergkreis	Hessen	20.38	16.73	3.65	82.09	11.83

County	Federal state	LE (65+) years	DFLE (65+) years	DLY (65+) years	HR (65+) (%)	ASP (65+) (per 100k)
Fürth	Bayern	18.34	16.21	2.13	88.39	8.38
Worms, Kreisfreie Stadt	Rheinland-Pfalz	18.36	16.28	2.08	88.67	8.41
Kaiserslautern, Kreisfreie Stadt	Rheinland-Pfalz	18.63	16.82	1.82	90.24	7.21
Bad Dürkheim, Landkreis	Rheinland-Pfalz	18.86	16.75	2.11	88.81	7.89
Donau-Ries, Landkreis	Bayern	19.04	16.91	2.13	88.81	7.58
Rhein-Pfalz-Kreis	Rheinland-Pfalz	19.09	16.87	2.22	88.36	8.00
Günzburg, Landkreis	Bayern	19.21	16.99	2.22	88.42	8.11
Memmingen	Bayern	19.29	17.07	2.22	88.50	8.14
Lippe, Kreis	Nordrhein-Westfalen	19.31	17.06	2.25	88.35	8.01
Kaufbeuren	Bayern	19.31	17.15	2.16	88.82	7.71
Herford, Kreis	Nordrhein-Westfalen	19.38	17.12	2.26	88.35	7.91
Dessau-Roßlau, Kreisfreie Stadt	Sachsen-Anhalt	19.49	17.23	2.26	88.40	7.83
Nordfriesland, Landkreis	Schleswig-Holstein	19.49	17.25	2.24	88.49	7.70
Kempten (Allgäu)	Bayern	19.53	17.59	1.93	90.10	6.83
Alb-Donau-Kreis	Baden-Württemberg	19.54	17.33	2.21	88.71	7.77
Trier, Kreisfreie Stadt	Rheinland-Pfalz	19.58	17.31	2.27	88.41	7.52
Göppingen, Landkreis	Baden-Württemberg	19.59	17.38	2.21	88.73	7.68
Südliche Weinstraße, Landkreis	Rheinland-Pfalz	19.59	17.32	2.28	88.38	7.71
Neu-Ulm, Landkreis	Bayern	19.63	17.58	2.05	89.57	6.89
Unterallgäu, Landkreis	Bayern	19.63	17.46	2.17	88.94	7.44
Ostallgäu, Landkreis	Bayern	19.67	17.61	2.06	89.52	7.01
Schweinfurt, Landkreis	Bayern	19.69	17.40	2.29	88.38	8.04
Ludwigshafen am Rhein, Kreisfreie Stadt	Rheinland-Pfalz	19.78	17.68	2.10	89.36	7.06
Freising, Landkreis	Bayern	19.82	17.53	2.29	88.45	7.66
Erding, Landkreis	Bayern	19.85	17.61	2.24	88.71	7.34
Heilbronn, Kreisfreie Stadt	Baden-Württemberg	19.89	17.69	2.20	88.93	7.35
Oberallgäu, Landkreis	Bayern	19.91	18.12	1.80	90.96	5.92
Rosenheim	Bayern	20.03	17.92	2.11	89.48	6.87
Frankenthal (Pfalz), Kreisfreie Stadt	Rheinland-Pfalz	20.05	17.98	2.07	89.68	6.77
Garmisch-Partenkirchen, Landkreis	Bayern	20.20	17.85	2.35	88.35	7.71
Heidelberg, Kreisfreie Stadt	Baden-Württemberg	20.28	17.94	2.35	88.43	7.31
Miesbach, Landkreis	Bayern	20.30	18.02	2.28	88.77	6.95
Berchtesgadener Land, Landkreis	Bayern	20.33	18.16	2.17	89.31	6.92
Erlangen	Bayern	20.54	18.39	2.15	89.53	6.51
Ludwigsburg, Landkreis	Baden-Württemberg	20.54	18.22	2.32	88.71	7.00
München, Landeshauptstadt	Bayern	20.63	18.25	2.38	88.46	7.16
Bad Tölz-Wolfratshausen, Landkreis	Bayern	20.64	18.31	2.33	88.72	7.09
Stuttgart, Kreisfreie Stadt	Baden-Württemberg	20.88	18.67	2.21	89.41	6.60
Baden-Baden, Kreisfreie Stadt	Baden-Württemberg	21.05	18.60	2.45	88.36	7.15
Neustadt a.d. Weinstraße, Kreisfreie Stadt	Rheinland-Pfalz	21.49	19.18	2.31	89.24	6.32

Source: Statistische Ämter des Bundes und der Länder; SLTC Census 2009; author's calculations

Dementia and long-term care – an analysis based on German health insurance data

Anne Fink

Abstract

The aim of this study is to investigate patients' transitions to long-term care (LTC) following a diagnosis of incident dementia, and to determine whether these transitions differ depending on the type of physician who made the initial diagnosis: a general practitioner (GP) or a neurologist/psychiatrist (NP).

Longitudinal claims data of the AOK are analyzed using a Kaplan-Meier estimator, a piecewise constant model, and temporary life table computations for the risk of needing LTC after the diagnosis of dementia incidence based on the diagnosing physician and the antidementia drug treatment prescribed.

NP patients have a significantly reduced risk of needing LTC relative to GP patients. After a diagnosis of incident dementia, NP patients live two to 5.2 months longer without LTC than GP patients. Antidementia drug treatment has an adverse effect on LTC, while patients who are prescribed antidementia medication have an increased risk of needing LTC.

Patients diagnosed by an NP have certain advantages relative to patients diagnosed by a GP. Further research is needed to determine whether these advantages are attributable to earlier detection or to different treatment regimens.

1 Introduction

Dementia is one of the most common diseases in the elderly, with a prevalence of 1% at age 60 to 64, up to almost 40% at the highest ages of 100 years and above (Schulz and Doblhammer 2012; Ziegler 2011) In 2010, 1.4 million people were affected by this syndrome in Germany alone (Schulz and Doblhammer 2012). There is some evidence of a decline in the incidence and prevalence of dementia (Rocca et al. 2011; Schrijvers et al. 2012). Nevertheless, the number of people with dementia is expected to multiply in the next 40 years. In the context of rising life expectancy and an increasing share of people reaching the highest ages, an estimated two to three million people in Germany will have dementia in the year 2050 (Doblhammer et al. 2012; Schulz and Doblhammer 2012; Ziegler and Doblhammer 2010).

Dementia is a very care-intensive illness. Rothgang et al. (2010) have shown that 90% of all demented persons will require long-term care (LTC). Dementia and cognitive impairments are leading factors in the development of functional limitations, and, subsequently, in the need for LTC (Agüero-Torres et al. 1998; Barberger-Gateau and Fabrigoule 1997; Campbell et al. 1983; Moritz et al. 1995; Sauvaget et al. 2002). Dementia patients not only require more intensive forms of care, they also tend to need care for longer periods than care-dependent persons without dementia (Rothgang et al. 2010).

Dementia is therefore one of the most expensive illnesses that is common among the elderly (Leicht and König 2012). Cost-of-illness statistics show that 9.229 billion euros were spent on the care of demented persons ages 65 and above in 2008 (Statistisches Bundesamt 2010). The costs of dementia largely depend on the stage of the illness (Leicht et al. 2011; Quentin et al. 2010). Leicht et al. (2011) estimated that the annual net costs of dementia care are 15,000 euros for mild cases, 32,000 euros for moderate cases, and 42,000 euros for severe cases. Unlike among non-demented control subjects, the majority of the costs associated with treating demented patients arise from nursing care, including informal care. The cost of medications is also significantly higher for dementia patients than for non-demented persons, but the average number of drugs taken does not differ (Leicht et al. 2011).

The ambulatory health care sector is an essential source of medical care for dementia patients. In Germany, the ambulatory and the hospital sectors are separate. Therefore, except in cases of dementia-related accidents or comorbidities, dementia patients are not treated in hospitals. The ambulatory sector provides patients with free access to all specialists. Nevertheless, the majority of people, and especially the elderly, tend to consult their general practitioner (GP) first. Self-referrals to specialists such as neurologists or psychiatrists in suspected cases of dementia are possible, but patients are most often referred to these specialists by their GP (Eisele et al. 2010).

In Germany, cholinesterase inhibitors and memantine have been approved for treating dementia. Cholinesterase inhibitors are used for the treatment of mild to moderate Alzheimer's disease, and memantine is used to treat the severe forms (Förstl 2008). Because dementia currently cannot be cured, alleviating the symptoms of the disease and preserving the cognitive and functional status of the patient are the main goals of a pharmaceutical treatment with antidementia drugs (Atri et al. 2013). There are some contraindications for the use of cholinesterase inhibitors in the case of multimorbid and polypharmaceutical patients. The intake of memantine is less often connected with contraindications or side effects (Förstl 2008).

Studies have shown that the use of antidementia drugs (cholinesterase inhibitors and/or memantine) can significantly slow the decline in cognition and global function of patients with Alzheimer's disease (Atri et al. 2013; Förstl 2008; Koch et al. 2005; Lopez et al. 2002; Reisberg et al. 2003; Rogers et al. 1998; Sano et al. 2003). Caregiver hours and the overall burdens on caregivers are reduced when these drugs are administered. Furthermore, the entry into a nursing home can be delayed for patients treated with antidementia drugs (Feldman et al. 2009; Geldmacher et al. 2003; Lopez et al. 2009). A study by Kiencke et al. (2010) revealed that, on average, patients treated with memantine have lower care levels than untreated patients. Moreover, patients undergoing antidementia therapy are less likely to transition to a higher care level or to die over the course of one year.

However, the prescription rates for antidementia medication are rather low in Germany: only about one-quarter of all patients diagnosed with dementia are treated with dementia-specific drugs (Jeschke et al. 2011; van den Bussche et al. 2011a), and only 8% receive the appropriate medication based on the guidelines (van den Bussche et al. 2011). There are considerable differences in the prescribing behaviors of GPs and specialists. Neurologists/psychiatrists (NPs) prescribe antidementia drugs more frequently than GPs (Jeschke et al. 2011; Riepe and Gaudig 2010; van den Bussche et al. 2011a): only 7% of dementia patients receive dementia-specific drugs if their initial dementia diagnosis was made by a GP, whereas 26% of NP dementia patients are prescribed antidementia drugs.

This share is higher (45%) if the diagnosis was made by a GP and an NP simultaneously (van den Bussche et al. 2011a). The low prescription rate among GPs may arise from their perception that dementia-specific drugs are largely ineffective and offer few therapeutic benefits (Pentzek and Abholz 2004; van den Bussche and Kaduszkiewicz 2005). Budgetary restrictions may also lead to reduced prescription rates (Pentzek and Abholz 2004).

Many studies have examined the amount of time that elapses between a dementia diagnosis and long-term institutionalization, and the related factors, as a systematic review by Luppa et al. (2008) has shown. In a German population-based sample, the median time to institutionalization after the onset of dementia is 2.8 years (Luck et al. 2008). By contrast, an American study found that the median period of time between a dementia diagnosis and a nursing home placement is 5.3 years (Smith et al. 2001). Both studies used Cox modeling, which does not allow for an analysis of the distribution of the risk of institutionalization over time. But the study by Luck et al. (2008) showed that 33% of all nursing home placements within six years occurred in the first six months after diagnosis. The risk of institutionalization seems to be particularly high in the first few months.

In Germany, however, two-thirds of the care-dependent population are cared for in a private home setting (Statistisches Bundesamt 2013a). Therefore, the purpose of the present study is to analyze the transition to receiving benefits from statutory long-term care insurance among newly diagnosed dementia patients, and the potential determinants of this process. For the sake of brevity, this transition process is referred to in the following as the risk of LTC. We assume that the need for LTC arises prior to placement in a nursing home. In addition, we focus on the pathway of the risk of LTC based on the time elapsed since the incident dementia diagnosis (H1).

In this study, we also look at the effect of the diagnosing physician. Given the differences in the antidementia drug and treatment prescription patterns of GPs and NPs, we assume that NP patients have a lower risk of LTC than GP patients (H2).

Moreover, the treatment effect of antidementia drugs on the risk of LTC is analyzed. We hypothesize that patients receiving any antidementia drug will have a delayed transition to LTC compared to patients undergoing no antidementia drug treatments (H3).

2 Material and methods

2.1 Study design and sample

The analyses are based on the routine data of the German largest public sickness fund AOK of the years 2004 until 2010. About one-third of the German population are insured by the AOK, and the proportion rises with increasing age (Schulz and Doblhammer 2012). We used a 5% stratified sample of 422,489 insured persons born prior to 1945 with at least one insured day in the first quarter of 2004. The data contain information on medical diagnoses coded by ICD-10 of the ambulatory and stationary sectors. The following ICD-10 codes were used to identify dementia diagnoses: G30, G31.0, G31.82, G23.1, F00, F01, F02, F03, and F05.1. Since a high proportion of the dementia diagnoses were coded as “unspecified dementia” (45%), no differentiation by dementia subtype was made. There are substantial advantages to using routine data. Our analysis is based on a large number of cases. The fact that a unique key is assigned to each insured person allows us to conduct longitudinal

analyses over several periods. There is no bias due to sampling design or self-selection into the study which can be confirmed by the comparable gender and age distribution of the AOK sample in 2004 and the German population on January 1st, 2004.

Table 1: Comparison of the AOK study population with Human Mortality Database (HMD) regarding gender and age distribution, figures in percent.

	HMD	AOK
Gender		
Males	43.1	43.7
Females	56.9	56.3
Age, years		
≤ 69	55.2	52.8
70-79	29.4	32.8
80-89	12.9	12.3
≤ 90	2.5	2.1

Source: AOK claims data 2004-2010; Human Mortality Database (www.mortality.org)

The whole population is covered, including the institutionalized population, which is particularly important for the analysis of dementia. The prevalence and incidence of dementia are many times higher in institutions than in the population living in the private home setting (Jakob et al. 2002). There are, however, also some disadvantages to our approach. Since medical diagnoses are not documented unless a physician or hospital files a claim, the underrepresentation or overrepresentation of diagnoses is possible. Moreover, the documentation may be subject to legal changes. Because an external validation of the diagnoses is not possible, an internal validation is needed (Doblhammer et al. 2012; Schubert et al. 2010; Swart and Ihle 2005). Nevertheless, routine claims data are a suitable data source for the analysis of dementia, as previous studies have shown (Doblhammer et al. 2012; Schubert et al. 2010; Schulz and Doblhammer 2012; Ziegler and Doblhammer 2009).

A diagnosis-free period of at least two years was chosen to distinguish prevalent cases from incident cases. All cases with at least one valid dementia diagnosis in 2004 or 2005 were excluded. This led to a reduction of the data set to 382,366 persons under risk. Each new case with a dementia diagnosis was defined as an incident dementia case. In the data set, 22,665 persons with an incident dementia diagnosis between the first quarter of 2006 and the last quarter of 2008 were identified. We followed those individuals up to the last quarter of 2010 in order to find out whether they underwent a transition to LTC. Incident cases after 2008 were not considered, as the observation period after the incident dementia diagnosis was not sufficiently long.

2.2 Validation of diagnoses

A two-stage validation procedure was applied in order to internally validate the diagnoses. First, diagnoses from the ambulatory sector were taken into account only if they were marked with the modifier “verified”. Diagnoses from the stationary sector had to be either

discharge or secondary diagnoses. Second, dementia diagnoses were confirmed by co-occurrence. Diagnoses were considered valid if they occurred simultaneously in the ambulatory and stationary sectors, or if at least two physicians made a diagnosis of dementia in the same quarter (a GP and an NP, a GP and another specialist, or an NP and another specialist). Furthermore, dementia diagnoses were confirmed by a co-occurrence over time, with all seven years being used as the validation period; e.g., a dementia diagnosis made in 2005 could be validated by a second diagnosis in 2009. If the patient died during the quarter in which the first dementia diagnosis was made, the case was considered valid even though the initial diagnosis could not be confirmed by a second diagnosis.

2.3 Dependent variable: long-term care

In the current study, LTC is defined as receiving benefits or services from the German statutory long-term care insurance scheme. Statutory long-term care insurance was established in 1995, and is financed by a pay-as-you-go system. The entitlement to benefits is based on impairments in the activities of daily living (ADL). After a positive assessment by the Medical Review Board, applicants are assigned to one of three care levels based on their need for support. Care-dependent persons can then choose between benefits in cash or benefits in kind (Federal Ministry of Health Germany 2013). In the analyses, no differentiation was made between the care levels. Information on LTC was documented by quarter.

2.4 Medical and demographic variables

The medical data we used consisted of information on the physician who diagnosed the case, a history of the prescription antidementia drugs the patient was taking, and each patient's history of cardiovascular comorbidities, including diabetes mellitus, cerebrovascular diseases, hypertension, ischemic heart diseases, atrial fibrillation, and hypercholesterolemia (Eisele et al. 2010; Kwok et al. 2011; Ziegler 2011).

We differentiated between four possible combinations of diagnosing physicians: 1. the patient's dementia was diagnosed by the GP only; 2. the dementia was diagnosed by an NP only; 3. the patient's GP and an NP both diagnosed the dementia in the same quarter; and 4. "all other", a category which includes all other possible combinations of diagnosing physicians (another specialist only, the GP and another specialist, an NP and another specialist) and cases in which the dementia diagnoses were first coded in hospitals. The variables covering the prescription of antidementia drugs and the comorbidities were included in the model as time-dependent variables, taking the value of one from the first time the patient was on a medication or a comorbidity was noted in the data, and of zero otherwise.

The demographic data contain gender and age at the time of the initial dementia diagnosis in 10-year age groups beginning at age 60. The highest age group is 90+. All of the information is on a quarterly basis.

As a baseline hazard, the time since the first dementia diagnosis is included in the model as a time-dependent variable. The duration is defined as 10 indicator variables taking the value of one for each of the time periods (1-6 months, 7-12 months, 13-18 months, 19-24 months, 25-30 months, 31-36 months, 37-42 months, 43-48 months, 49-54 months, 55-57 months), and of zero otherwise.

2.5 Statistical analyses

Between the first quarter of 2006 and the last quarter of 2008, 13,446 persons out of 22,665 incident dementia cases lived in a private dwelling and did not receive any benefits or services from statutory long-term care insurance in the quarter before the incident dementia diagnosis. The dependent variable was the time to LTC. A Kaplan-Meier estimator was used to estimate the transition to LTC (Klein & Moeschberger 2003: 92). A piecewise exponential model was performed for the analysis of the determinants for the risk of LTC (Klein & Moeschberger 2003: 48, 296):

$$h_{LTC}\left[t \mid \mathbf{Z}(t)\right] = h_0(t)\exp\left[\sum_{k=1}^{p}\beta_k Z_k(t) + \sum_{j=1}^{q}\delta_j Z_j(t)\right] \quad ,$$

where $h_{LTC}[t|\mathbf{Z}(t)]$ was the hazard rate at time t of needing LTC depending on the variables "diagnosing physician" and "antidementia drugs" $Z_k(t)$ and the covariates $Z_j(t)$. $h_0(t)$ was the baseline hazard rate following the exponential distribution, which represented the time since the first diagnosis of dementia. The baseline hazard was split into 10 time intervals in which different levels of the rate were allowed. Between two cut points the rate was assumed to be constant. The maximum observation time was 57 months. There was no left-truncation, as all individuals started at time zero, which was the middle of the incidence quarter. The analysis time was 0.75 for people who experienced the transition to LTC in the quarter in which the dementia was diagnosed. Later transitions took place in the middle of the quarter. People were followed until censoring or death, whichever occurred first. The censoring time was set in the middle of the last observed quarter, and the deaths were assumed to have been in the middle of the month of death.

Subsequently, the estimated hazard rates were entered into a life table computation in order to calculate the temporary life expectancy (Arriaga 1984) without LTC in the months after an incident dementia diagnosis based on the diagnosing physician, the antidementia drugs prescribed, and the age at diagnosis.

3 Results

3.1 Descriptive results

At the time of the first dementia diagnosis, the 13,446 insured persons were, on average, 79.2 years old. The highest age at dementia diagnosis was 100 years. Of the cases in the sample, 65% were female and 35% were male. NP patients were, on average, younger than patients diagnosed by GPs. The share of NP incident cases at ages 60-69 was twice as high as for GP patients. Half of the NP patients were 70 to 79 years old, whereas the majority of the GP patients were 80 to 89 years old (Table 2).

Table 2: Characteristics of the 13,446 incident dementia cases without LTC at the time of the dementia diagnosis.

	GP		NP		GP&NP		All other		Total	
	n	%	n	%	n	%	n	%	n	%
Gender										
Males	1,753	31.3	622	38.8	120	36.8	2,169	36.6	4,664	34.7
Females	3,840	68.7	983	61.2	206	63.2	3,753	63.4	8,782	65.3
Age, years										
≤ 69	499	8.9	281	17.5	30	9.2	546	9.2	1,356	10.1
70-79	2,070	37.0	823	51.3	166	50.9	2,252	38.0	5,311	39.5
80-89	2,608	46.6	465	29.0	119	36.5	2,681	45.3	5,873	43.7
90+	416	7.4	36	2.2	11	3.4	443	7.5	906	6.7
Mean age	79.7		76.0		78.2		79.7		79.2	

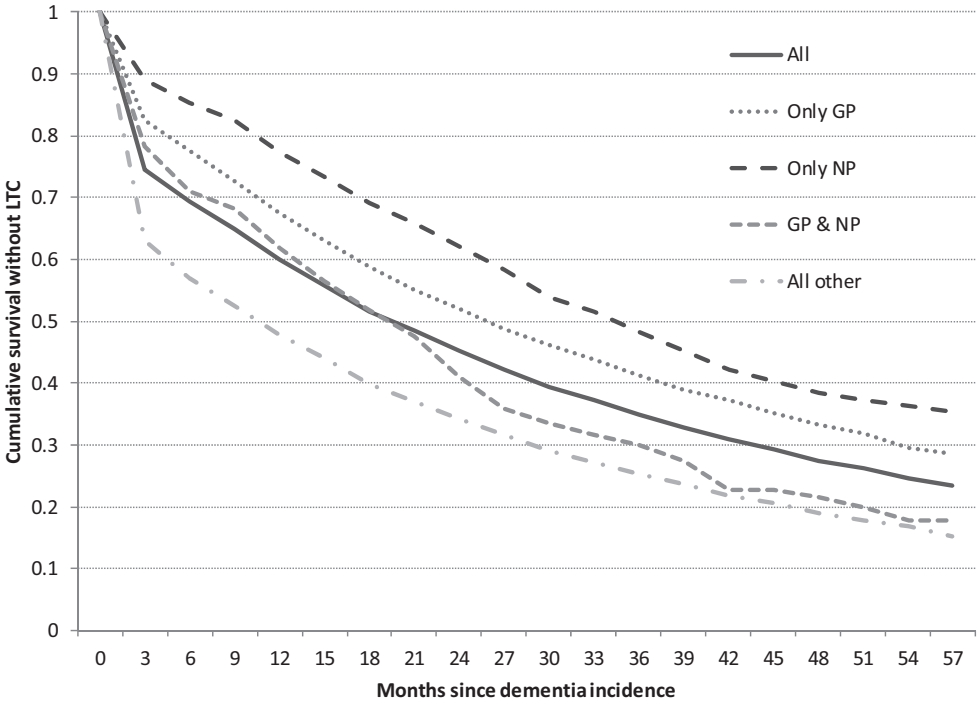
Source: AOK Claims Data 2004-2010

42% of the dementia cases were initially diagnosed by the patient's GP, and 12% were diagnosed by an NP. Only 2% of the cases received a dementia diagnosis from both a GP and an NP in the same quarter. 44% of cases were diagnosed by some other combination of physicians, while 66% of those diagnoses were made in the stationary sector.

When we look at the cases 57 months after the initial incident dementia diagnosis, we can see that 77% of those who did not require LTC prior to developing dementia experienced a transition to LTC (Figure 1). The rates of transition to LTC were particularly high in the months immediately following the diagnosis. One-quarter of all of the incident dementia cases needed LTC after three months. After 21 months, 50% of all of the people with dementia were in need of LTC. At time of the transition to LTC, the dementia patients were, on average, 81.6 years old.

The people with dementia who had been diagnosed by both a GP and an NP and by other physicians (including diagnoses from the hospital) experienced the transition to LTC earlier. Almost five years after receiving a dementia diagnosis, over 80% of patients (GP & NP: 85%; all other: 82%) needed LTC. Meanwhile, 71% of people diagnosed by a GP only and 65% of people diagnosed by an NP only were in need of care after 57 months. The Logrank and Wilcoxon test for the equality of the survivor function across groups showed that there were highly significant differences between the four groups.

Figure 1: Kaplan-Meier estimator, time until LTC after incident dementia diagnosis by diagnosing physician, men and women, Germany, 2006-2010

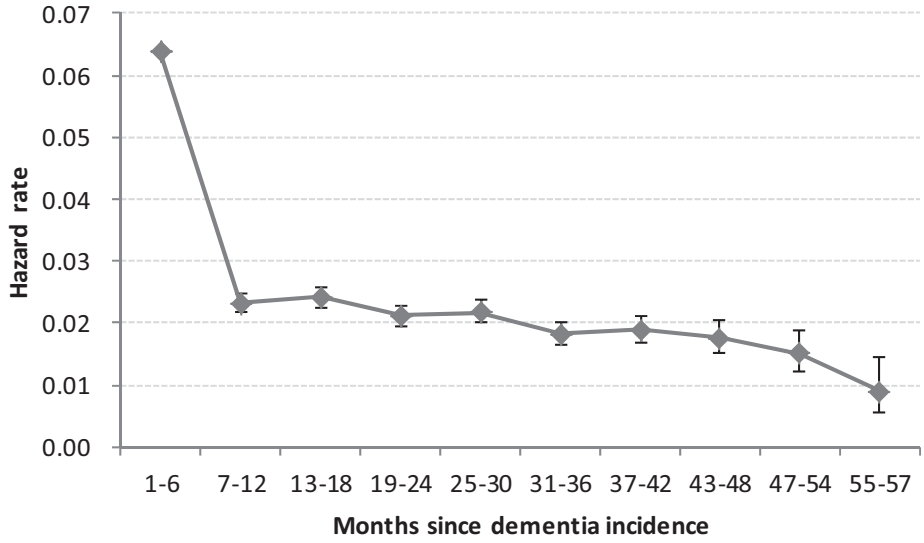


Source: AOK Claims Data 2004-2010

3.2 Model results

Figure 2 shows the baseline hazard rate for the risk of LTC after an incident dementia diagnosis. In the first six months after diagnosis, there was a hazard rate of 0.064 for LTC, which means that each month 64 people out of 1,000 dementia incident cases required LTC for the first time. The risk of LTC decreased significantly in the following months to reach a relatively stable rate of about 0.02. All of the confidence intervals overlapped with each other. After 47 months, the risk decreased slightly to a rate of 0.01. However, the risk of needing LTC was highest in the first half year after receiving the dementia diagnosis.

Figure 2: Baseline hazard rate for the risk of LTC after incident dementia with 95% confidence interval, reference: one to six months after the initial diagnosis, Germany, 2006-2010



Source: AOK Claims Data 2004-2010

Table 3 presents the results of the regression analysis. Patients diagnosed by an NP had a significantly reduced risk of LTC relative to the reference group who received their diagnosis from a GP. If the diagnosis was made by the GP in conjunction with an NP, the risk of LTC was slightly higher than in the reference group. The risk was significantly higher when the dementia diagnosis was made by any other type of physician, including doctors in the stationary sector.

Patients who underwent an antidementia treatment showed an increased risk of LTC relative to those who received no antidementia medication. This was true for all patients, regardless of whether the diagnosis was made by a GP or an NP (see Figure 3).

There was a strong age effect. The older the person was at time of the incident dementia diagnosis, the higher the risk that he or she would need LTC in the following five years. The hazard ratio for the age group 90+ was four times higher than for the youngest age group. The risk of LTC among demented women was significantly higher than among demented men. The presence of diabetes mellitus, cerebrovascular diseases, and atrial fibrillation were shown to have increased the risk of LTC, but no effect was found for hypertension and ischemic heart diseases. By contrast, demented persons with hypercholesterolemia had a significantly reduced risk of LTC.

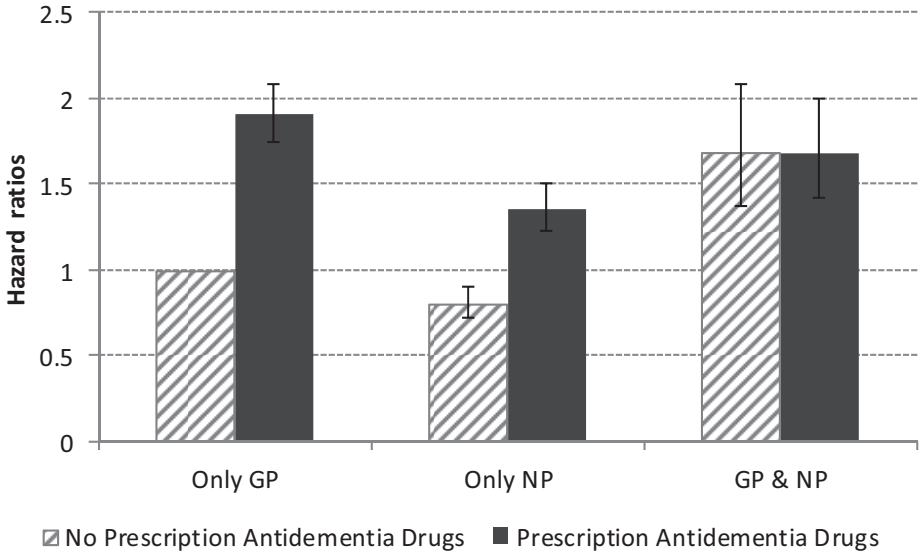
Table 3: Hazard Ratios, risk of LTC after incident dementia diagnosis, Germany, 2006-2010

Variable		Hazard Ratios (95% Conf. Intervall)	p-value
Diagnosing Physician (Ref.: Only GP)	Only NP	0.801 (0.740-0.867)	0.000
	GP & NP	1.194 (1.040-1.370)	0.012
	All other	1.657 (1.583-1.735)	0.000
Antidementia Drugs (Ref.: No)	Yes	1.615 (1.532-1.701)	0.000
Age (Ref.: 60-69)	70-79	1.432 (1.309-1.565)	0.000
	80-89	2.448 (2.241-2.675)	0.000
	90+	4.386 (3.922-4.905)	0.000
Gender (Ref.: Male)	Female	1.073 (1.025-1.124)	0.003
Comorbidities			
Diabetes mellitus (Ref.: No)	Yes	1.126 (1.077-1.78)	0.000
Cerebrovascular Diseases (Ref.: No)	Yes	1.364 (1.206-1.425)	0.000
Hypertension (Ref.: No)	Yes	1.048 (0.990-1.110)	0.108
Ischemic Heart Diseases (Ref.: No)	Yes	1.010 (0.966-1.056)	0.668
Atrial Fibrillation (Ref.: No)	Yes	1.334 (1.269-1.203)	0.000
Hypercholesterolemia (Ref.: No)	Yes	0.846 (0.803-0.892)	0.000
Constant		0.027 (0.024-0.031)	0.000

Source: AOK Claims Data 2004-2010

Note: Coefficients for baseline hazard are not shown here

Figure 3: Effect of physician and medication on the risk of LTC, hazard ratios and 95 % confidence interval, men and women, Germany, 2006-2010



Source: AOK Claims Data 2004-2010

3.3 LTC-free time after an incident dementia diagnosis

The translation from hazard rates to life table computations leads to the indicator months without LTC after having received the first dementia diagnosis. Patients who were diagnosed by a GP alone, an NP and a GP together, and an NP alone were compared.

Table 4 shows that NP patients who were diagnosed at between 60 and 69 years of age lived, on average, 42.7 months without LTC if they did not receive antidementia medication. By contrast, patients who were diagnosed by a GP needed LTC after only 40.7 months on average ($p<0.05$). This means that GP patients aged 60 to 69 had a significant disadvantage of two months. This disadvantage increased with age. At ages 90+, GP patients needed LTC 3.2 months earlier than NP patients. This effect was even stronger for demented persons who were treated with antidementia drugs. In this case, the disadvantage of patients diagnosed by a GP ranged from 3.7 months for people aged 90+ to 5.2 months for patients aged 70 to 89. Although differences were statistically not significant, the chances of spending longer periods of time without the need for LTC seemed to be particularly low for patients who had received a dementia diagnosis from both a GP and an NP in the same quarter. These patients required LTC 8.4 to 11.7 months earlier than NP patients if they received no antidementia drug treatments. The difference declined to 2.4 to 3.3 months for patients who underwent antidementia drug therapies. Those figures are as well not statistically different to those of NP patients. In this group, the use of antidementia medications did not seem to influence the length of the LTC-free time period.

Table 4: Months without LTC after incident dementia diagnosis, men and women, Germany, 2006-2010

Age	Only NP	Only GP	GP & NP	Disadvantage "Only GP vs. Only NP" in month	Disadvantage "GP & NP vs. Only NP" in month
No Prescription Antidementia Drugs					
60-69	42.7	40.7	34.2	**-2.0**	-8.4
70-79	38.1	35.6	27.8	**-2.5**	-10.3
80-89	30.0	26.8	18.3	**-3.2**	-11.7
90+	20.4	17.2	10.1	**-3.2**	-10.3
Prescription Antidementia Drugs					
60-69	36.6	32.1	33.9	**-4.5**	-2.8
70-79	30.6	25.4	27.4	**-5.2**	-3.2
80-89	21.2	16.0	17.9	**-5.2**	-3.3
90+	12.3	8.6	9.8	**-3.7**	-2.4

Source: AOK Claims Data 2004-2010

Note: Bold figures indicate significant differences ($p<0.05$)

4 Discussion

The findings of the present study demonstrate that dementia is a very care-intensive illness. Before the first dementia diagnosis, almost 40% of all patients already needed LTC and/or lived in an institution. Of those who were not in need of LTC before the quarter in which they were diagnosed, 77% experienced a transition to LTC in the following 57 months. As expected, we found that median time until LTC became necessary was shorter than the median time until institutionalization (H1). Luck et al. (2008) reported a median time of 2.8 years until a nursing home placement was made. In our analysis, the median amount of time that elapsed between the diagnosis and the need for LTC arose was 21 months, or 1.75 years. The risk of transitioning to LTC was highest in the first three to six months after the incident dementia diagnosis. In the following months, the risk decreased and remained significantly lower than it was in the first six months. This result is independent of the age at which the incident diagnosis occurred.

In line with our hypothesis H2, the analysis revealed that patients who were first diagnosed by an NP had a significantly reduced risk of LTC compared to patients who received their first diagnosis from a GP. Among GP patients, the disadvantage in terms of time spent without LTC after a dementia diagnosis ranged from two to 5.2 months. Despite our initial assumption (H3), this result was not attributable to differing antidementia drug prescription patterns. There are two possible explanations for this finding. First, several studies have shown that GPs have difficulties in diagnosing dementia, especially the mild cases (Mitchell et al. 2011; Pentzek and Abholz 2004; Pentzek et al. 2009). This lack of expertise would result in a delayed diagnosis of dementia patients. Although NP patients

and GP patients spend the same amount of time in LTC, GP patients tend to be diagnosed at a later stage of the disease. The second explanation is that the difference between NP patients and GP patients in terms of the amount of time it takes them to transition to LTC is attributable to the different treatments they receive. A diagnostic workup by an NP is more likely to conform to the guidelines, which may lead to a more accurate diagnosis of the dementia type (Stoppe et al. 2007), and thus to a more appropriate treatment being prescribed. The present study only looks at the effect of the diagnosing physician in the quarter in which the initial diagnosis was made. It is possible that patients who were first diagnosed by a GP only were referred to and treated by a specialist in the following quarters. A study by van den Bussche et al. (2011b) showed that one-third of all incident dementia patients saw an NP during the year of incidence. We can therefore assume that the real difference between GP patients and NP patients may have been even greater, since the group of GP patients included patients who were referred to an NP after the incidence quarter.

Contrary to the initial hypothesis that patients who received antidementia drug treatment had a lower risk of LTC, the analysis showed that patients who underwent antidementia drug therapies had an increased risk of LTC. This was found to be the case for both GP and NP patients. Other studies have shown that antidementia drugs protect against cognitive and functional decline (Atri et al. 2013; Förstl 2008; Koch et al. 2005; Lopez et al. 2002; Reisberg et al. 2003; Rogers et al. 1998; Sano et al. 2003). One possible explanation for our finding is that the prescription of antidementia drugs was an indicator of the severity of the disease: i.e., that the patients in our study who were more affected by dementia were more likely to be prescribed antidementia drugs, but also had an increased risk of LTC. Moreover, our study did not distinguish between the use of cholinesterase inhibitor and memantine therapies. Whereas cholinesterase inhibitors are approved for mild to moderate Alzheimer's disease, memantine is used to treat the more severe forms (Förstl 2008). Thus, if it was possible to differentiate between these two medications, using them as indicators for the severity of the illness, we may be able to resolve this apparent contradiction. However, a study by van den Bussche et al. (2011a) showed that only 8% of all treated patients received an appropriate dose of either cholinesterase inhibitor or memantine, which leads us to assume that the increased risk of LTC may have been a result of a high proportion of patients receiving inappropriate antidementia drug treatments.

We found a strong age effect, with an exponential increase in the risk of needing LTC with a rising age at the time of the first dementia diagnosis. This finding is in line with the results of other studies that analyzed risk factors for limitations in ADL and disability (Agüero-Torres et al. 1998; Boult et al. 1994; Moritz et al. 1995; Sauvaget et al. 2002).

In addition, women were shown to be more likely than men to require LTC. This result is in line with the findings of other studies which showed that women are more likely to be functionally impaired than men (Oksuzyan et al. 2008; Leveille et al. 2000, Arber & Cooper 2006). However, this could also be an effect of marital and/or cohabitation status, which we cannot control for. Women are more likely than men to be widowed and live alone (Statistisches Bundesamt 2012; 2013b), which means that they are less likely to have a potential caregiver in the household who can meet their care needs, even in the early stages of dementia. As a consequence, women might apply earlier than men for benefits from the statutory long-term care insurance scheme in order to obtain professional help.

As expected, we found that cardiovascular comorbidities, like diabetes mellitus, cerebrovascular diseases, and atrial fibrillation, were related to a higher risk of LTC. Although dementia is a leading cause of functional limitations and care need (Agüero-

Torres et al. 1998), other chronic comorbidities may also lead to a need for LTC (Boult et al. 1994). This is an inherent result, as the construction of the dependent variable was based on limitations in ADL, which are induced by chronic diseases. The presence of hypertension and ischemic heart disease did not show any significant effects. By contrast, dementia patients with hypercholesterolemia had a significantly reduced risk of LTC. This may be an effect of the treatment of hypercholesterolemia with statins. Studies have shown that the use of statins can reduce the risk of the onset of dementia, and is correlated with a reduced prevalence of dementia (Haag et al. 2009; Hajjar et al. 2002). Furthermore, the use of statins has been shown to delay the progression of cognitive impairments (Hajjar et al. 2002), and therefore to reduce the risk of LTC among patients with dementia.

The present study has some limitations. The data do not allow for meaningful distinctions between dementia subtypes, as 45% of the cases were coded as "unspecified dementia", and 27% of the cases were of the type of Alzheimer's disease which does not correspond to other epidemiological studies (Bickel 2000; Ott et al. 1995; Weyerer 2005). However, a sensitivity analysis which took only incident cases with Alzheimer's disease into account led to comparable estimates. Only care needs based on entitlement to benefits from the statutory long-term care insurance scheme were considered. However, this entitlement is dependent on the patient or the patient's family making an application for benefits, and assumes that the family members know about the existence of these benefits. In addition, a successful application for benefits is based on impairments in ADLs, but dementia patients experience limitations in ADLs rather late in the progression of their illness, even though the need for care may arise due to certain behaviors, such as a tendency to wander. Since 2008, patients have been able to obtain funds if a care need is ascertained, even with no (or not enough) limitations in ADLs. However, this information was not in the data. Because of the use of routine data, the set of explaining variables was limited to basic demographic variables and medical information that were relevant for the claims process. Therefore, it was not possible to control for other confounding factors, like life style variables.

The strength of the present study is the large number of cases available for analysis. Even after data cleaning, over 13,000 dementia patients without entitlement to benefits or services from the statutory long-term care insurance could be included in the data set. Bias effects due to attrition for reasons other than death were marginal thanks to the completeness of the data over time, and the low rate of shifts between public health insurance funds, especially at old ages. There was no selection bias by health care providers or self-selection into the study. All insured persons were included in the study, regardless of their functional and cognitive status. There was no recall bias of the medical diagnoses.

The World Alzheimer Report 2011 has emphasized the importance of early dementia diagnosis. An early diagnosis allows patients to plan for the future and make important decisions in conjunction with their relatives. Moreover, drug and non-drug therapies can be started earlier in order to preserve cognitive functions as long as possible and improve the patient's quality of life. This may result in a delay in care dependence, and thus lessen the costs associated with care provision (Alzheimer's Disease International 2011). Of the 244,000 new dementia cases in Germany each year (Ziegler and Doblhammer 2009), about 100,000 are diagnosed by a GP. Assuming the lowest possible benefit from the statutory long-term care insurance fund of 235 euros per month, a postponement of the transition into LTC of just two months would lead to a cost savings of about 47 million euros per year. This is likely the minimum amount that could be saved in the nursing care sector. Our results imply that a higher rate of involvement of specialists in the treatment of dementia

patients would not only be meaningful for the patients, who would benefit from earlier and more accurate diagnoses and treatments; but also for society, as the need for costly LTC is postponed.

References

Agüero-Torres, H.; Fratiglioni, L.; Guo, Z.; Viitanen, M.; von Strauss, E.; Winblad, B. (1998): Dementia is the major cause of functional dependence in the elderly: 3-year follow-up data from a population-based study. In: *American Journal of Public Health* 88(10), pp. 1452-1456.

Alzheimer's Disease International (2011): World Alzheimer Report 2011: The benefits of early diagnosis and intervention.

Arber, S.; Cooper, H. (2006): Gender differences in health in later life: the new paradox? In: *Social science & medicine* 48(1), pp. 61-76.

Arriaga, E. E. (1984): Measuring and explaining the change in life expectancies. In: *Demography* 21(1), pp. 83-96.

Atri, A.; Molinuevo, J. L.; Lemming, O.; Wirth, Y.; Pulte, I.; Wilkinson, D. (2013):. Memantine in patients with Alzheimer's disease receiving donepezil: new analyses of efficacy and safety for combination therapy. In: *Alzheimer's Research & Therapy* 5(1), pp. 1-11.

Barberger-Gateau, P.; Fabrigoule, C. (1997): Disability and cognitive impairment in the elderly. In: *Disability & Rehabilitation* 19(5), pp. 175-193.

Bickel, H. (2000): Demenzsyndrom und Alzheimer Krankheit: Eine Schätzung des Krankenbestandes und der jährlichen Neuerkrankungen in Deutschland. In: *Das Gesundheitswesen* 62(4), pp. 211-218.

Boult, C.; Kane, R. L.; Louis, T. A.; Boult, L.; McCaffrey, D. (1994): Chronic conditions that lead to functional limitation in the elderly. In: *Journal of Gerontology* 49(1), pp. M28-M36.

Campbell, A.; McCosh, L.; Reinken, J.; Allan, B. (1983): Dementia in old age and the need for services. In: *Age and Ageing* 12(1), pp. 11-16.

Doblhammer, G.; Schulz, A.; Steinberg, J.; Ziegler, U. (2012): Demografie der Demenz. Bern, Verlag Hans Huber, Hofgrefe AG.

Eisele, M.; van den Bussche, H.; Koller, D.; Wiese, B.; Kaduszkiewicz, H.; Maier, W.; Glaeske, G.; Steinmann, S.; Wegscheider, K.; Schön, G. (2010): Utilization Patterns of Ambulatory Medical Care before and after the Diagnosis of Dementia in Germany – Results of a Case-Control Study. In: *Dementia and Geriatric Cognitive Disorders* 29(6), pp. 475-483.

Federal Ministry of Health Germany (2013): Selected facts and figures about long-term care insurance (10/12). Retrieved April, 25, 2013, from http://www.bmg.bund.de/ministerium/english-version/long-term-care.html.

Feldman, H. H.; Pirttila, T.; Dartigues, J. F.; Everitt, B.; Van Baelen, B.; Schwalen, S.; Kavanagh, S. (2009): Treatment with galantamine and time to nursing home placement in Alzheimer's disease patients with and without cerebrovascular disease. In: *International Journal of Geriatric Psychiatry* 24(5), pp. 479-488.

Förstl, H. (2008): Antidementiva – wem nützen sie wirklich? In: *Der Internist* 49(3), pp. 353-359.

Geldmacher, D. S.; Provenzano, G.; McRae, T.; Mastey, V.; Ieni, J. R. (2003): Donepezil is associated with delayed nursing home placement in patients with Alzheimer's disease. In: *Journal of the American Geriatrics Society* 51(7), pp. 937-944.

Haag, M. D.; Hofman, A.; Koudstaal, P. J.; Stricker, B. H.; Breteler, M. M. (2009): Statins are associated with a reduced risk of Alzheimer disease regardless of lipophilicity. The Rotterdam Study. In: *Journal of Neurology, Neurosurgery & Psychiatry* 80(1), pp. 13-17.

Hajjar, I.; Schumpert, J.; Hirth, V.; Wieland, D.; Eleazer, G. P. (2002): The impact of the use of statins on the prevalence of dementia and the progression of cognitive impairment. In: *The Journals of Gerontology* Series A: Biological Sciences and Medical Sciences 57(7), pp. M414-M418.

Jakob, A.; Busse, A.; Riedel-Heller, S. G.; Pavlicek, M.; Angermeyer, M. C. (2002): Prävalenz und Inzidenz von Demenzerkrankungen in Alten- und Altenpflegeheimen im Vergleich mit Privathaushalten. In: *Zeitschrift für Gerontologie und Geriatrie* 35(5), pp. 474-481.

Jeschke, E.; Ostermann, T.; Vollmar, H. C.; Tabali, M.; Schad, F.; Matthes, H. (2011): Prescribing patterns in dementia: a multicentre observational study in a German network of CAM physicians. In: *BMC Neurology* 11(1), p. 99.

Kiencke, P.; Rychlik, R.; Grimm, C.; Daniel, D. (2010): Krankheitskosten bei Alzheimer-Demenz. In: *Medizinische Klinik* 105(5), pp. 327-333.

Klein, J. P.; Moeschberger, M. L. (2003): Survival analysis: techniques for censored and truncated data. New York, Springer.

Koch, H. J.; Uyanik, G.; Fischer-Barnicol, D. (2005): Memantine: a therapeutic approach in treating Alzheimer's and vascular dementia. In: *Current Drug Targets-CNS & Neurological Disorders* 4(5), pp. 499-506.

Kwok, C. S.; Loke, Y. K.; Hale, R.; Potter, J. F.; Myint, P. K. (2011): Atrial fibrillation and incidence of dementia. In: *Neurology* 76(10), pp. 914-922.

Leicht, H.; Heinrich, S.; Heider, D.; Bachmann, C.; Bickel, H.; van den Bussche, H.; Fuchs, A.; Luppa, M.; Maier, W.; Mösch, E.; Pentzek, M.; Rieder-Heller, S. G.; Tebarth, F.; Werle, J.; Weyerer, S.; Wiese, B.; Zimmermann, T.; König, H.-H.; for the AgeCoDe study group (2011): Net costs of dementia by disease stage. In: *Acta Psychiatrica Scandinavica* 124(5), pp. 384-395.

Leicht, H.; König, H.-H. (2012): Krankheitskosten bei Demenz aus gesellschaftlicher Perspektive. In: *Bundesgesundheitsblatt – Gesundheitsforschung – Gesundheitsschutz* 55(5), pp. 677-684.

Leveille, S. G.; Penninx, B. W.; Melzer, D.; Izmirlian, G.; Guralnik, J. M. (2000): Sex differences in the prevalence of mobility disability in old age: the dynamics of incidence, recovery, and mortality. In: *Journals of Gerontology* Series B 55(1), pp. 41-50.

Lopez, O.; Becker, J.; Wisniewski, S.; Saxton, J.; Kaufer, D.; DeKosky, S. (2002): Cholinesterase inhibitor treatment alters the natural history of Alzheimer's disease. In: *Journal of Neurology, Neurosurgery & Psychiatry* 72(3), pp. 310-314.

Lopez, O. L.; Becker, J. T.; Wahed, A. S.; Saxton, J.; Sweet, R. A.; Wolk, D. A.; Klunk, W.; DeKosky, S. T. (2009): Long-term effects of the concomitant use of memantine with cholinesterase inhibition in Alzheimer disease. In: *Journal of Neurology, Neurosurgery & Psychiatry* 80(6), pp. 600-607.

Luck, T.; Luppa, M.; Weber, S.; Matschinger, H.; Glaesmer, H.; König, H.-H.; Angermeyer, M. C.; Riedel-Heller, S. G. (2008): Time until institutionalization in incident dementia cases–Results of the Leipzig Longitudinal Study of the Aged (LEILA 75+). In: *Neuroepidemiology* 31(2), pp. 100-108.

Luppa, M.; Luck, T.; Brähler, E.; König, H.-H.; Riedel-Heller, S. G. (2008): Prediction of institutionalisation in dementia. In: *Dementia and Geriatric Cognitive Disorders* 26(1), pp. 65-78.

Mitchell, A. J.; Meader, N.; Pentzek, M. (2011): Clinical recognition of dementia and cognitive impairment in primary care: a meta-analysis of physician accuracy. In: *Acta Psychiatrica Scandinavica* 124(3), pp. 165-183.

Moritz, D. J.; Kasl, S. V.; Berkman, L. F. (1995): Cognitive functioning and the incidence of limitations in activities of daily living in an elderly community sample. In: *American Journal of Epidemiology* 141(1), pp. 41-49.

Oksuzyan, A.; Juel, K.; Vaupel, J. W.; Christensen, K. (2008): Men: good health and high mortality. Sex differences in health and aging. In: *Aging Clinical and Experimental Research* 20(2), pp. 91-102.

Ott, A.; Breteler, M. M. B.; Van Harskamp, F.; Claus, J. J.; Van der Cammen, T. J. M.; Grobbee, D. E.; Hofman, A. (1995): Prevalence of Alzheimer's disease and vascular dementia: association with education. The Rotterdam study. In: *British Medical Journal* 310(6985), pp. 970-973.

Pentzek, M.; Abholz, H. H. (2004): Das Übersehen von Demenzen in der Hausarztpraxis: Der Stand der Forschung zu möglichen Einflussfaktoren. In: Essers, M.; Gerlinger, T.; Herrmann, M.; Hinricher, L.; Lenhardt, U.; Seidler, A.; Simon, M.; Stegmüller, K. (Eds.): Jahrbuch Kritische Medizin, Demenz als Versorgungsproblem. Hamburg, Argument-Verlag. 40, pp. 22-39.

Pentzek, M.; Wollny, A.; Wiese, B.; Jessen, F.; Haller, F.; Maier, W.; Riedel-Heller, S. G.; Angermeyer, M. C.; Bickel, H.; Mösch, E. (2009): Apart from nihilism and stigma: what influences general practitioners' accuracy in identifying incident dementia? In: *American Journal of Geriatric Psychiatry* 17(11), pp. 965-975.

Quentin, W.; Riedel-Heller, S.; Luppa, M.; Rudolph, A.; König, H.-H. (2010): Cost-of-illness studies of dementia: a systematic review focusing on stage dependency of costs. In: *Acta Psychiatrica Scandinavica* 121(4), pp. 243-259.

Reisberg, B.; Doody, R.; Stöffler, A.; Schmitt, F.; Ferris, S.; Möbius, H. J. (2003): Memantine in Moderate-to-Severe Alzheimer's Disease. In: *New England Journal of Medicine* 348(14), pp. 1333-1341.

Riepe, M.; Gaudig, M. (2010): Ambulante Versorgung von Demenzpatienten? Behandlungsrealität in Deutschland. In: *Aktuelle Neurologie* 37(6), pp. 282-288.

Rocca, W. A.; Petersen, R. C.; Knopman, D. S.; Hebert, L. E.; Evans, D. A.; Hall, K. S.; Gao, S.; Unverzagt, F. W.; Langa, K. M.; Larson, E. B. (2011): Trends in the incidence and prevalence of Alzheimer's disease, dementia, and cognitive impairment in the United States. In: *Alzheimer's & Dementia* 7(1), pp. 80-93.

Rogers, S. L.; Doody, R. S.; Mohs, R. C.; Friedhoff, L. T. (1998): Donepezil improves cognition and global function in Alzheimer disease: a 15-week, double-blind, placebo-controlled study. In: *Archives of Internal Medicine* 158(9), pp. 1021-1031.

Rothgang, H.; Iwansky, S.; Müller, R.; Sauer, S.; Unger, R. (2010): Barmer GEK Pflegereport 2010, Schwerpunktthema: Demenz und Pflege. Schwäbisch-Gmünd.

Sano, M.; Wilcock, G. K.; van Baelen, B.; Kavanagh, S. (2003): The effects of galantamine treatment on caregiver time in Alzheimer's disease. In: *International Journal of Geriatric Psychiatry* 18(10), pp. 942-950.

Sauvaget, C.; Yamada, M.; Fujiwara, S.; Sasaki, H.; Mimori, Y. (2002): Dementia as a predictor of functional disability: a four-year follow-up study. In: *Gerontology* 48(4), pp. 226-233.

Schrijvers, E. M. C.; Verhaaren, B. F. J.; Koudstaal, P. J.; Hofman, A.; Ikram, M. A.; Breteler, M. M. B. (2012): Is dementia incidence declining? Trends in dementia incidence since 1990 in the Rotterdam Study. In: *Neurology* 78(19), pp. 1456-1463.

Schubert, I.; Ihle, P.; Köster, I. (2010): Interne Validierung von Diagnosen in GKV-Routinedaten: Konzeption mit Beispielen und Falldefinition. In: *Das Gesundheitswesen* 72(6), pp. 316-322.

Schulz, A.; Doblhammer, G. (2012): Aktueller und zukünftiger Krankenbestand von Demenz in Deutschland auf Basis der Routinedaten der AOK. In: Günster, C.; Klose, J.; Schmacke, N. (Eds.): Versorgungs-Report 2012: Schwerpunkt: Gesundheit im Alter. Stuttgart, Schattauer.

Smith, G.; O'Brien, P.; Ivnik, R.; Kokmen, E.; Tangalos, E. (2001): Prospective analysis of risk factors for nursing home placement of dementia patients. In: *Neurology* 57(8), pp. 1467-1473.

Statistisches Bundesamt (2010): Gesundheit: Krankheitskosten 2002, 2004, 2006 und 2008. Wiesbaden.

Statistisches Bundesamt (2012): Alleinlebede in Deutschland: Ergebnisse des Mikrozensus 2011. Wiesbaden.

Statistisches Bundesamt (2013a): Bevölkerung und Erwerbstätigkeit: Sterbetafel Deutschland 2009/11. Wiesbaden.

Statistisches Bundesamt (2013b): Bevölkerung und Erwerbstätigkeit: Bevölkerungsfortschreibung 2011. Wiesbaden.

Stoppe, G.; Haak, S.; Knoblauch, A.; Maeck, L. (2007): Diagnosis of dementia in primary care: a representative survey of family physicians and neuropsychiatrists in Germany. In: *Dementia and Geriatric Cognitive Disorders* 23(4), pp. 207-214.

Swart, E.; Ihle, P. (2005): Sekundärdatenanalyse: Aufgaben und Ziele. Routinedaten im Gesundheitswesen. In: Swart, E.; Ihle, P. (Eds.): Handbuch Sekundärdatenanalyse: Grundlagen, Methoden und Perspketiven. Bern, Verlag Hans Huber, Hogrefe AG, pp. 11-14.

van den Bussche, H.; Kaduszkiewicz, H. (2005): Verschreibungsmuster und Wirksamkeitsvermutung von Antidementiva. In: *Nervenheilkunde* 24, pp. 485-492.

van den Bussche, H.; Kaduszkiewicz, H.; Koller, D.; Eisele, M.; Steinmann, S.; Glaeske, G.; Wiese, B. (2011a): Antidementia drug prescription sources and patterns after the diagnosis of dementia in Germany: results of a claims data-based 1-year follow-up. In: *International Clinical Psychopharmacology* 26(4), pp. 225-231.

van den Bussche, H.; Wiese, B.; Koller, D.; Eisele, M.; Kaduszkiewicz, H.; Maier, W.; Glaeske, G.; Steinmann, S.; Wegscheider, K.; Schön, G. (2011b): Specialist involvement and referral patterns in ambulatory medical care for patients with dementia in Germany: results of a claims data based case-control study. In: *BMC Health Services Research* 11(1), p. 148.

Weyerer, S. (2005): Altersdemenz. Gesundheitsberichterstattung des Bundes. Berlin, Robert-Koch-Institut. Heft 28.

Ziegler, U. (2011): Dementia in Germany: Past Trends and Future Developments. Rostock, Südwestdeutscher Verlag für Hochschulschriften

Ziegler, U.; Doblhammer, G. (2009): Prevalence and Incidence of Dementia in Germany-A Study Based on Data from the Public Sick Funds in 2002. In: *Das Gesundheitswesen* 71(5), pp. 281-290.

Ziegler, U.; Doblhammer, G. (2010): Projections of the Number of People with Dementia in Germany 2002 through 2047. In: Doblhammer, G.; Scholz, R. D. (Eds.): Ageing, Care Need and Quality of Life. Wiesbaden, VS Verlag, pp. 94-111.

Health inequalities of immigrants: Patterns and determinants of health expectancies of Turkish migrants living in Germany

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Abstract

This study presents new aspects of the health expectancies of elderly Turkish migrants living in Germany relative to the health expectancies of the German host population. In this study, we pursue two objectives: first, we seek to compare the differences in the health expectancies of Germans and Turkish migrants; and, second, we seek to examine the factors which could affect functional limitations in the two groups. Our analyses are based on population data from the German Office for National Statistics and the Central Register of Foreigners, as well as individual-level data from the German Generations and Gender Survey 2005/2006. We use the measurement of health expectancy to highlight health inequalities between Germans and Turkish migrants living in Germany, and we employ the decomposition method to explore the impact of mortality and disability on differences in health expectancy. In addition, we apply a logistic regression model to detect variations in the factors that influence limitations in daily activities. We analyze this issue in separate samples for (a) Turkish migrants living in Germany and (b) Germans.

The results on health expectancy show that there are significant differences by sex and nationality in the proportion of the remaining life expectancy spent in good and in bad health. Within the Turkish migrant population, women in particular show greater advantages in life expectancy, but also greater disadvantages in health relative to women in the German population.

1 Introduction

Germany has been a transit and immigration country since the Second World War (Bade and Oltmer 2004; Hahlen 2004). The Turkish foreign population was and still is the largest of the immigrant groups (Statistisches Bundesamt 2012). The majority of the migrants from Turkey arrived as so-called guest workers who were recruited by the Federal Republic of Germany between 1961 and 1973. Some also migrated as family members, especially after 1973 (Hubert et al. 2009). Migrant workers were mostly young and healthy, as they had to undergo health checks in the recruiting countries. The policymakers who designed the recruitment program had originally expected that these migrants would return to their home countries after working in Germany for a few years. In reality, many of the migrants stayed

for decades or spent the remainder of their lives in Germany (Abraído-Lanza et al. 1999; BMFSFJ 2000; Ronellenfitsch et al. 2006; Hubert et al. 2009). Thus, older migrants today make up a growing share of the population in Germany.[1]

In light of these developments, politicians have been devoting greater attention to the aging process of guest workers, especially as many of these migrants are starting to retire (Statistisches Bundesamt 1991; BAMF 2006; Statistisches Bundesamt 2010). Increasingly, the broadening of the ethnic differentiation of older age groups has to be taken into consideration in assessments of future needs for health protection and care among the foreign resident population. Because of their language constraints and cultural characteristics, including specific attitudes they may have towards health, foreign residents may have different requirements and concerns than the German elderly population. In order to assess whether the elderly foreign resident population will indeed need more health care in the future, and whether the German health care system will have to adapt to this new group of users, it is important to gain more insight into their health status.

The aim of our study is twofold. First, we focus on the health expectancy (HE) of Turkish migrants. In previous research, life expectancy (LE) has most often been used as an indicator of health. But this indicator is no longer adequate, as the link between mortality and health has weakened, and many causes of morbidity do not result in death (Mathers 2002; Molla et al. 2003; Robine and Jagger 2006). Previous studies have revealed that Turkish migrants live longer than Germans (Helmert et al. 2002; Kohls 2008b; Razum et al. 2008). However, the question of whether migrants will spend these additional years of life in good or bad health remains open. To address this question, we decided to use a broader set of indicators that allow us to compare the health status of Turkish migrants and German citizens. Our study is one of the first to measure the health status of migrants by considering life expectancy in conjunction with functional impairments and activity limitations which can affect the quality of life (Riley 1990; Robine et al. 2003a; Robine et al. 2003b). Against this backdrop, our first main goal in this study is to answer the following questions: Compared to the German population, how healthy are older Turkish migrants[2] living in Germany; and, how many years and what proportion of their remaining life span do older Turkish migrants and their German counterparts live with or without disability?

Our second main objective is to identify the risk factors that influence the health of elderly Turkish migrants, and to find out whether these determinants differ between the Turkish migrant population and the German population. The scientific evidence for Germany on the impact of migration on the health status, especially at older ages, is limited and somewhat contradictory. On the one hand, the existing literature has indicated that immigrants are healthier than the native or host population. This advantage has been partly attributed to positive selection effects among immigrants (Abraído-Lanza et al. 1999;

[1] In 1991, shortly after reunification, 298,200 migrants aged 60 years and older were living in Germany. In 2011 the number of 60+-year-old migrants had risen to 1,037,875 (Statistisches Bundesamt 2012). Projections show that the proportion of the foreign population in Germany aged 60 and older will nearly double from 6.8 percent in 1998 to 13.2 percent in 2030 (Münz and Ulrich 2000; Ulrich 2001). The exact number of older people with a migration background is unknown. Only the number of those migrants and of the elderly with migration backgrounds who do not have German citizenship is known. Naturalized migrants are treated statistically as Germans.

[2] In order to create comparative analyses, Turkish migrants are defined as all persons who are not German under Article 116 paragraph 1 of the Basic Law, which means that do not have a German citizenship (see: http://www.gesetze-im-internet.de/gg/art_116.html (16.04.2013)). Thus, Turkish migrants are defined in this paper as persons who have Turkish citizenship and are registered as living in Germany. Persons with dual Turkish/German citizenship are classified as Germans in this study.

Razum et al. 2000; Razum et al. 2002; Uitenbroek and Verhoeff 2002). On the other hand, the advantage observed among immigrants appears to decline as their duration of stay increases, possibly due to factors such as having lower socio-economic status, fewer coping resources, greater barriers to accessing medical care, and migration stress (Schenk 2007; Sander 2008). In a logistic regression analysis, we will compare the health determinants of older Turkish migrants and Germans (ages 50+) considering relevant factors such as the socio-demographic and socio-economic background, as well as potential confounding factors, such as the family network, and the migration status itself.

We open the paper with an introduction of the theoretical and conceptual framework we used to generate our working hypotheses and to organize and interpret our results. This is followed by a description of the data and the methods used, as well as a discussion of the data quality issues. In section four, we present estimates of limitation-free life expectancy (LFLE), and show the results of the logistic regression models employed to detect variations in the determinants that influence health. Finally, we discuss the scope and limits of the methods and data employed.

2 Explanatory approaches concerning migrant health diversity

Until recently, international migrants have not been explicitly considered in health-related research in Germany. This lack of research on migrants may be attributed to the inadequacy of the available data on the health of this population, and to the fact that no decisive and comprehensive theory of the effect of international migration on the health status of migrants had been established in the literature (Spallek 2008). The findings on the health status of older migrants have up to now produced a contradictory picture, with some studies indicating that migrants are healthier than the majority population, and others showing the opposite. In the following, we discuss prior research which showed that migration might be positively related to health outcomes. We then present theoretical approaches that could explain the health disadvantages of the migrant population relative to the host population.

2.1 The health advantage of migrants

Contrary to expectations given the social status of migrants, studies have found that migrants have lower mortality rates than native Germans (Razum et al. 1998; Razum et al. 2000; Jasso et al. 2004; Kohls 2012a). In a comparison of previously published studies, Kohls (2008a, 2012b) observed that research has consistently shown that mortality is lower among the foreign population than among the host population in Germany. Several studies on migration populations in other countries, such as the US, Canada, the UK, and the Netherlands, have reached similar conclusions (Sharma et al. 1990; Balarajan and Raleigh 1997; Abraído-Lanza et al. 1999; Uitenbroek and Verhoeff 2002; McKay et al. 2003). Tsugane et al. (1989) found a lower general mortality rate for the Japanese migrant population in Brazil relative to the Brazilian host population and to the population in Japan.

A possible explanation for the mortality advantage is a selection process that has been called the *healthy migrant effect*. This effect is an expression of positive selection by health due to labor recruitment policies, or an expression of a lower risk of contracting certain

diseases because healthier people are more likely to migrate (McMichael 1976; McKay et al. 2003; Schenk 2007; Schenk et al. 2008; Spallek 2008; Kohls 2008a; Razum and Spallek 2012). This leads to an advantage in health among migrants relative to the native populations in their home and host countries, especially shortly after migration. But this health advantage is only temporary, and decreases over time because migrants are affected by social disadvantages and barriers to health care services (Lechner and Mielck 1998; Razum et al. 2004; Razum 2006a; Schenk 2007; Razum et al. 2008; Spallek and Razum 2008). Yet the explanatory power of the *healthy migrant effect* appears to be limited, as it cannot explain why the observed mortality of adult migrants often remains low for years or even decades (Razum 2006a).

Razum et al. (2002) developed an alternative to the *healthy migrant effect* model by introducing the idea of the *health transition*. A *health transition* occurs when a person migrates from a less developed country with high mortality in which infectious diseases are one of the main causes of death, to a developed country with low mortality in which chronic illnesses are the main causes of death (Caselli et al. 2002; Omran 2005; Razum and Spallek 2012). On the one hand, migrants may benefit from the better medical treatment and nutrition, which lead to a reduction in their risk of suffering and dying from an infectious disease. On the other hand, after migrating to a developed country, they are also subject to new (negative) risk factors (e.g., smoking and the adoption of poor nutrition habits). But due to the long latency of diseases of civilization (e.g., heart disease and lung cancer), the increase in mortality among migrants is slow. As a consequence, migrants develop a mortality advantage relative to the population of origin shortly after the move to a more developed country (Zeeb et al. 2002; Spallek and Razum 2008; Razum 2009; Razum 2012). If migration is seen as a health transition, the geographical change has an effect on health, and it often leads to advantages in mortality among migrants. This advantage exists independent of selection effects and despite the socio-economic disadvantaged position of migrants relative to the population in the destination country (Razum 2009).

Another possible reason why migrants may have a health advantage relative to the host population is that they have greater social resources, which "give people the emotional and practical resources they need" (Wilkinson and Marmot 2003; Razum and Spallek 2012). Social resources may be provided by stable family structures and supportive social networks within the wider family or the ethnic community (Razum et al. 2004; Geiger and Razum 2006). An element of social support which is often cited as being conducive to good health is family cohesion. For example, the effect of a high degree of "reciprocity" has been observed in the Turkish immigrant population (BMFSFJ 2000; Spallek and Razum 2008; Razum and Spallek 2012).[3] This resource-based explanatory approach has up to now been used as a hypothetical concept only, and it is cited in discussions mainly because of its plausibility (Schenk 2007; Razum and Spallek 2012). However, only a few studies have examined these health resources, and it is not yet clear what role social networks actually play in determining the health status of migrants (Mielck 2005).

In addition to examining possible explanations for migrant health advantages, we should note that there are concerns about the reliability of the migration statistics, as discrepancies may lead researchers to make overly positive estimates of migrant mortality. So far, mortality and morbidity among immigrants in Germany have not been fully explored, especially at older ages. This is mainly due to the fact that the immigrants living

[3] An example of reciprocity is that members of the older generation provide childcare and members of the younger generation provide care for their elderly parents if they are in need of help or care.

in Germany are relatively young (Kohls 2008b; Hubert et al. 2009; Razum and Spallek 2012). Hence, the population numbers and the absolute numbers of deaths of older migrants have been small. Moreover, the population statistics underestimate the mortality of foreigners. This is because the number of the resident foreigners counted in the statistics is higher than it should be, as not every case of out-migration is reported (Kibele et al. 2008). The under-recording of deaths among migrants results in the migrant population having a statistical mortality advantage relative to the German population.[4] For example, the official population data from 2005/2006 showed that, on average, foreign men have a six-year and foreign women a four-year LE advantage over their German counterparts (Kohls 2008b).

However, Razum and colleagues. (2012) argued that only a portion of the observed migrant mortality advantage can be attributed to the limitations of the available data, because low migrant mortality was also found in studies which were able to exclude an underestimation of migrant deaths (Abraído-Lanza et al. 1999; Razum 2006a). Hence, a partial mortality advantage may persist (Kohls 2011; Razum and Spallek 2012).

2.2 The health disadvantage of migrants

While above studies found relatively low mortality among migrants, other research has indicated that migrant health may be worse. Various studies have shown that relative to non-migrants, migrants have worse health, higher morbidity, and greater long-term care needs, especially at older ages (Elkeles and Mielck 1997; Lechner and Mielck 1998; Dietzel-Papakyriakou and Olbermann 2001; Matthäi 2004; Schopf and Naegele 2005; BMFSFJ 2005; Solé-Auró and Crimmins 2008; Razum et al.; 2008; Beauftragte der Bundesregierung für Migration, Flüchtlinge und Integration 2012; Wengler 2012). Various factors and different explanatory approaches have been proposed in the literature to explain this health gap. The most prominent approaches have focused on the specific disadvantages of migrants in terms of their social and economic resources and migration-specific and cultural characteristics (Lechner and Mielck 1998; Brucks and Wahl 2003; Schenk 2007; Schenk et al. 2008; Spallek and Razum 2008; Kohls 2008a; Razum and Spallek 2012; Wengler 2012).

Given what is known about the effects of social inequality, the social position of migrants may be expected to play a role in their health outcomes. Socio-economic status is seen as an important factor in health (Bollini and Siem. 1995; Porsch-Oezçueruemez et al. 1999). Socio-economic problems, such as occupational and economic uncertainty, dangerous working conditions, and unfavorable living conditions, can affect health (Razum et al. 2008; Spallek and Razum 2008; Hubert et al. 2009). In general, having lower socio-economic status is related to having worse health outcomes (Wilkinson and Marmot 2003). As the social status of the average migrant is lower than that of the average native-born citizen, migrants are subject to the risk factors associated with having a disadvantaged position in society (Hoffmann-Nowotny 1973; Razum et al. 2008; Wengler 2011; Wengler 2012). Findings for the German population with the same social status have indicated that members of this group are exposed to the same risk factors (Razum and Geiger 2006). However, unlike non-migrants with deprived backgrounds, migrants appear to be affected by migration-specific factors.

[4] For further detailed information on over-coverage of the migrant population and under-coverage of mortality, see the chapter on data quality.

The migration process is a biographical event which has significant implications in all areas of life, and which requires a process of reorientation. Major life changes like migration may be associated with the development of mental and physical diseases. Proponents of the migration stress hypothesis have argued that due to the loss of their socio-cultural environment in their country of origin, migrants may experience specific health problems (Schenk 2007). Among the pathogenic factors which could increase health risks are uncertainties regarding their legal and immigration status, language barriers, changes in diet, discrimination, and the loss of family networks through the process of migration (Schenk 2007; Razum et al 2008; Hubert et al. 2009; Igel et al. 2010). These sources of stress, combined with a possible failure to achieve their goals in the host country, can cause a variety of psychological and physical problems (Spallek and Razum 2007). Milewski and Doblhammer (2015 in this issue) found that the mental health status of the average elderly migrant in Germany is lower than that of the average elderly non-migrant. Sluzki (2001), who developed a stress-theory oriented five-phase model of migration, has offered a vivid description of the psychological stressors of the migration process. Each migration process starts with a preparation phase and ends with a "transgenerational impact" (Sluzki 2001). At each stage, conflicts can occur which could be considered stress factors or stressors, and which could cause psychological disorders or diseases.[5]

Culture is another important factor that may influence the health of migrants. Immigrants and natives may differ in their attitudes toward health care and in their definitions of health and illness. Insufficient knowledge of the language of the host country, as well as culture-specific interpretations of symptoms and perceptions of medical treatments, may interfere with a migrant's use of health care services. Studies have shown that migrants are less likely than non-migrants to take advantage of preventive programs, screenings, and ambulant primary care services. By contrast, migrants are more likely than non-migrants to use emergency clinics and hospitals (Borde et al. 2003; Schulte-Sasse 2003; Baune 2004).

2.3 Working hypotheses

Based on the theoretical framework outlined above, we test four working hypotheses that lead to the formulation of expectations regarding the health status of migrants, some of which are contradictory.

First, we address the question of health status differentials between Turks and Germans by estimating healthy life expectancies. We assume that Turkish migrants have lower morbidity and lower mortality than Germans, as migrant workers had to undergo health checks before migrating to Germany (healthy migrant effect), and that the two countries vary in terms of their morbidity and mortality patterns and of their health care services (health transition effect). By contrast, later immigrant cohorts, such as those who migrated due to family reunions, were not subject to health checks. On average, Turkish immigrants have

[5] Phase 1: Preparatory Stage: The prospective migrant mentally considers the upcoming migration act (positive expectations versus expectations about the risks and opportunities). Phase 2: The Act of Migration: The migrant faces various risks and burdens depending on the progression, duration, and form of migration. Phase 3: Period of Overcompensation: The migrant tends to perceive only positive images and opportunities, while possible risks are ignored. Phase 4: Period of Decompensation or Crisis: The migrant perceives risks, burdens, and separation experiences. Phase 5: Transgenerational Impact: The migrant develops individual adaptation strategies and a bicultural identity.

fewer socio-economic resources than Germans (Lechner and Mielck 1998; Schenk 2007; Schenk et al. 2008; Spallek and Razum 2008; Kohls 2008a; Razum and Spallek 2012; Wengler 2012). Hence, the healthy migrant effect and the health transition effect may level off. We therefore expect to find that, on average, Turkish migrants spend a longer period of time (more years and a higher proportion of their remaining life) in poor health than Germans.

Second, we investigate why health differentials between Turks and Germans may occur. Migration status is still associated with social and economic disadvantages in Germany. Compared to the native population, first-generation migrants[6] are more likely to have poor working conditions, frequent periods of unemployment, and inadequate or poor housing (BMFSFJ 2000; Zeman 2005; Lampert et al. 2005; Schenk 2007; Razum et al. 2008). All of these factors are detrimental to health. This is not only true for migrants; Germans who live in similar conditions are also subject to increased health risks (Schopf and Naegele 2005; BMFSFJ 2005; Mielck 2005; Razum et al. 2008; Bauer et al. 2008; Hubert et al. 2009; Brzoska et al. 2010). Hence, we assume that health differentials between Turkish migrants and Germans will decrease when we control for socio-economic factors.

In our third hypothesis, we assume that social support within the Turkish migrant population is associated with better health. Since Turks may face migration-related problems and conflicts, psychological, social, and material support may be particularly important for them. Family solidarity is central for acculturation and for well-being. Family cohesion may counteract loneliness and provide support that promotes well-being, and may therefore in a wider sense be seen as being conducive to the health of migrants (Dietzel-Papakyriakou 1993; Nauck 2001; Olbermann 2003; Steinbach 2004; Matthäi 2005; Baykara-Krumme 2007).

In our fourth hypothesis, we assume that Turkish migrants who are exposed to unfavorable migration-related factors have worse health than those who are subject to favorable migration-related factors. In general, migrants are exposed to stress arising from the migration process and the circumstances surrounding the transition, and this stress may cause a variety of psychological and physical problems. The well-being of migrants may be negatively affected if their duration of stay is undefined, their legal status is uncertain, or their language skills are insufficient. The inability to communicate may, for example, interfere with access to health care (Lechner and Mielck 1998; Razum et al. 2008; Hubert et al. 2009).

[6] Germans are all persons who, under §1 of the Nationality Act (StAG of 01.06.2012) and Article 116 of the German Constitution (GG of 11.07.2012), have German citizenship (see: http://www.gesetze-im-internet.de/gg/art_116.html (16.04.2013)). Turkish migrants are defined in this paper as persons who have Turkish citizenship and are registered as living in Germany. This means we have included both the first and second generations. First-generation Turkish migrants are defined as having been born in Turkey and migrated to Germany (Statistisches Bundesamt 2012). People who were born in Germany and have at least one parent who was born in Turkey are classified as second generation (Statistisches Bundesamt 2012). Since we only consider older migrants, we can assume that we are dealing mainly with first-generation migrants. This definition is necessary to yield equivalent results and conclusions for the different analyses.

3 Data and methods

3.1 Data

Our first analysis is based on two types of information: a) standard period life table data, from which age- and sex-specific mortality information and LE can be obtained; and b) prevalence data on health by age and sex from a cross-sectional survey for the same period as the one covered in the standard life table (Table 1) (Robine et al. 2003a; van Oyen et al. 2006; Ette et al. 2007; Jagger et al. 2007).

We used data on age-specific deaths and on the mid-year population of Germans from 2004/2005; these were provided by the Federal Statistical Office (Statistisches Bundesamt 2012). The data on Turkish foreigners are from the years 2005/2006 and were collected by the Central Register of Foreigners (AZR). This register allowed us to disaggregate the entire permanent migrant population in Germany by nationality (Central Register of Foreigners Act (AZRG) of 03.05.2013, Art. 2(1)). The AZR is based on information from around 6,000 partner authorities[7] and includes only foreign citizens who stay in Germany for more than three months and have legal residency status (AZRG Art. 2(2) §6). The data are primarily used for internal administrative purposes, such as the implementation of legislation pertaining to foreigners and asylumseekers (Elrick 2005).

The AZR has the most comprehensive stock of individual data on foreigners living in Germany. But the raw data contained in the AZR are not directly accessible for scientific purposes. Researchers are only permitted to obtain an extract[8] of the collected data in the aggregated form provided by the AZR to the Federal Statistical Office (Destatis; see Figure 1, which presents a structural overview of the data sources used for Germans and Turkish migrants in Germany). These aggregate statistics cover the foreign population in Germany at the end of each year by age, sex, citizenship, migration status, country of birth, and length of stay (AZRG Art. 2(2) §23(1)). In addition, the statistics provide information about moves in and out of Germany (AZRG Art. 2(2) §23(1)).

Prevalence data on health by age and sex for the health expectancy (HE) calculations and for the regression analysis are based on the representative German Generations and Gender Survey (GGS) (Table 1). This survey is part of the Generations and Gender Program, which is coordinated by the United Nations Economic Commission for Europe (UNECE), and is designed to serve as a tool for improving our knowledge of demographic and social developments (Ruckdeschel et al. 2006; Ette et al. 2007). In Germany, the GGS is carried out by the Federal Institute for Population Research (BiB), together with TNS Infratest (Ruckdeschel et al. 2006; Ette et al. 2007).

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7 Partner authorities are the Federal Criminal Police Office, the Foreign Office, etc. (AZRG Art. 2(2) §6) which are responsible for the accuracy and timeliness of the data provided (AZRG Art. 2(2) §8). They store information on immigration and out-migration, dates of death, information on prosecutions, and photographs (AZRG Art. 2(1) §3.

8 The Central Register of Foreigners Act (AZRG) Art. 2(2) §23 stipulates by law that the Federal Statistical Office must receive an annual extract from the AZR. The AZR registers only foreigners who stay in Germany longer than three months; there is also the option of a longer stay with a special visa (one year without being registered in the general stock of AZR) (see: http://www.bamf.de/cln_092/nn_442016/DE/Migration/AZR/azr-node.html?__nnn=true (Nov. 2009). The Central Register of Foreigners Act of 03.05.2013 (BGBl.Ip.2265), which was amended by Art. 4, §3 of the Act of 30 July 2009 (BGBl. Ip.2437).

Table 1: Mid-year population, death counts, and number of respondents by sex, age, and health status for Germans and Turkish nationals in Germany in 2005/2006

Age	Germans				Turkish migrants			
	Federal Statistical Office		GGS 2005		AZR / Federal Statistical Office[1]		GGS 2006	
	Population statistics	Death statistics	Health & well-being[2]	Population statistics	Population statistics	Death statistics	Health & well-being[2]	Population statistics
	Mid-year population 2004/2005	Death counts 2005	N[3]	% Not limited	Mid-year population 2005/2006	Death counts 2006	N[3]	% Not limited
Men								
50-54	2,592,311	15,207	357	92	26,817	99	78	90
55-59	2,112,808	18,423	363	89	35,740	106	84	89
60-64	2,250,655	30,085	388	87	53,830	319	121	84
65-69	2,390,308	48,246	428	91	45,744	705	70	86
70-74	1,596,888	52,929	256	91	21,668	637	25	76
75-79	1,176,656	64,197	252	83	5,767	418	4	75
Total	12,119,625	229,087	2,044		189,564	2284	382	
Women								
50-54	2,578,107	7,641	462	93	41,182	39	107	88
55-59	2,142,461	9,490	372	90	52,897	85	111	78
60-64	2,376,214	15,511	360	96	43,007	204	74	80
65-69	2,665,983	25,721	378	90	27,862	257	28	71
70-74	1,962,293	33,626	308	88	12,621	246	10	90
75-79	1,782,191	56,864	299	82	5,010	150	4	67
Total	13,507,248	148,853	2,179		182,577	981	334	

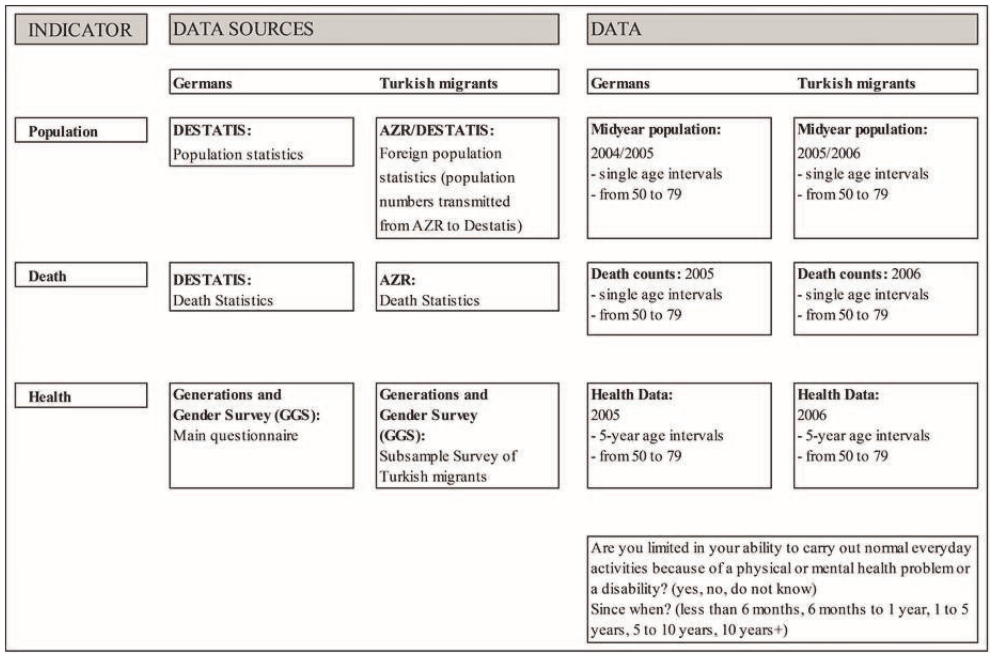
Source: Calculations based on German GGS 2005 and GGS subsample 2006; AZR 2006, Federal Statistical Office 2004, 2005, 2006; [1] population statistics from AZR are modified and provided by Federal Statistical Office; [2] GALI: health question F070300 & F070301; [3] number of respondents.

Note: Age groups 70-74 and 75-79 are grouped together in the regression analysis.

The GGS is designed as a panel survey, but it is used here as a cross-sectional survey. Two kinds of surveys are available for Germany. The first is the main survey, which includes "all persons of the residential population in Germany who were linguistically able to follow the interview, regardless of their nationality". The second is a survey (designed as a subsample) of Turkish migrants living in Germany (Ruckdeschel et al. 2006; Ette et al. 2007). We used the first wave of the GGS main questionnaire for Germany, which was conducted in 2005 and included 10,017 respondents aged 18 to 79. In addition, we used the first wave of the GGS subsample of Turkish migrants in Germany, which was conducted in 2006 and included 4,000 respondents of Turkish nationality aged 18 to 79 (Ruckdeschel

et al. 2006; Ette et al. 2007).[9] For our analyses, we selected only respondents aged 50 to 79 who were living in Germany. The sample sizes were reduced from 10,017 to 4,223 for the Germans and from 4,400 to 716 for the Turkish migrants. The questions in the subsample correspond to the German GGS main questionnaire in terms of their structure and contents, but the migrants were asked some additional questions about their language habits and intention to stay in Germany. To minimize communication problems and sampling bias toward better-integrated Turkish citizens, a Turkish-language translation tool was used.[10]

Figure 1: A schematic framework of the data sources used at the national level for Germans and Turkish migrants in Germany



Source: own chart.

3.2 Data quality

The quality of an analysis of health expectancies obviously depends on the quality of the data provided. For a calculation of the HE of the German and Turkish population in Germany, we have data on 1) the population stock, 2) mortality, and 3) morbidity. The quality of the population and health data on Germans can be seen as rather good, as the data

9 The survey excludes individuals living in institutions.

10 An internal differentiation of the different generations of Turkish migrants was not possible using the official data of the Federal Statistical Office. Only the GGS data would have permitted a differentiation. However, due to the analytical method used, we had to choose this definition to yield equivalent results and conclusions for the different analyses.

have been thoroughly examined (Haug 2005). In contrast, the quality of the existing data sources on foreign populations is not satisfactory. First, there are limitations due to problems within the administrative processes. The data collection for the AZR registry is decentralized. Various governmental authorities report to the AZR and provide information on resident foreigners. Each of these authorities has its own methods of data acquisition and definitions of the populations studied. Thus, the comparability of the various sources that contribute to the AZR is limited. The resulting distortions can lead to an overestimation or an underestimation of the number of residents of specific nationalities in the overall AZR/foreign statistics (Elrick 2005; Opfermann et al. 2006).

Further errors occur in the stock data because of a lack of updating and double registration due to the ambiguous spelling of names, and because of the failure to register or de-register, or to report changes in address. The largest element of uncertainty is caused by the failure of some migrants to de-register when leaving the country. While migrants are obliged to report their in- and out-migration to the authorities, in practice the de-registration may be missed because migrants are unaware of the reporting guidelines or because they are late in reporting the move to the registration authorities (Opfermann et al. 2006; Kohls 2008a; Statistisches Bundesamt 2010). This leads to the under-reporting of moves abroad. The overestimation of the population stock therefore increases with age and with the time interval to the last census (Scholz and Jdanov 2006).

A second major problem is related to the statistics on cases of death among foreign residents. These statistics are distorted since they do not include all cases of death that occur while foreign residents of Germany are abroad (Currle 2006; Kibele et al. 2008; Kohls 2008b). Deaths abroad are more likely to be recorded in the AZR statistics than in the official statistics. This means that the death counts in the AZR have a high degree of validity. However, a selective under-coverage of registered deaths is still to be expected in the AZR, since it cannot be assumed that all deaths abroad are reported to the official authorities (Kibele et al. 2008; Kohls 2008b). The result is a selective underestimation of the number of deaths, primarily in the elderly migrant population. Mortality rates calculated on this basis include a systematic error, which leads to a downward bias. This might be one of the reasons why migrants in Germany have a lower mortality rate than the German population (Kohls 2008a; Kohls 2008b).

Despite these drawbacks, the AZR is the most solid data source on foreigners in Germany that is currently available. Kohls (2008a) showed that the error factor in the mortality rates of foreigners based on AZR data is lower than that of other available data sources. The AZR is assumed to be more accurate than other sources for two main reasons: 1) a large number of authorities are required to transfer information on migrants, which leads to a high density of information; and 2) the AZR data were cleaned up[11] between 2000 and 2004. In this cleanup process, the total stock of the AZR was matched with the data of regional immigration offices and adjusted for discordant cases (Opfermann et al. 2006). Following this cleanup, Turkish migrants showed low overall correction values (Opfermann et al. 2006). Therefore, in terms of data on age-specific mortality rates, we assume that the AZR produces fairly valid data.

[11] The highest percentage of incorrect cases was found in the upper age range, in which the greatest number of deaths occur and the stock numbers are low (Opfermann et al. 2006). At the same time, the Turks had low correction values overall; an increasing adjustment takes place only in the highest age groups (Opfermann et al. 2006).

3.3 Methods

In answering the first research question of whether elderly people spend their remaining years of life in good or in poor health, we have chosen to use the concept of health expectancy (HE). This approach combines information on mortality and morbidity to determine the average number of years lived in a given health status (Robine and Ritchie 1991; Robine et al. 1999; Mathers 2002; Robine 2002; Molla et al. 2003; Robine et al. 2003b; Robine et al. 2003a; Robine and Jagger 2006). Our calculations are based on the method devised by Sullivan (1971), and follow the calculation guide from the European Health Expectancy Monitoring Unit (Jagger et al. 2007). The methods used are the classic life table calculation combined with age-specific period prevalence data on limitations (Sullivan 1971; Molla et al. 2003; Jagger et al. 2007).[12] Limitations are defined by the Global Activity Limitations Indicator (GALI) (Robine et al. 2003a; Jagger et al. 2011). The HE analyses divide the age-specific person-years lived into limitation-free life expectancy (LFLE) and life expectancy with limitation (LEL) (Molla et al. 2003; Jagger et al. 2007).[13]

We analyzed the HE of persons in the age range 50 to 79 years. We chose 50 as the starting age because disabilities begin to appear more frequently at this age (BMFSFJ 2000; Hurrelmann and Kolip 2002; Günster et al. 2012). Because the survey did not include any data on people older than age 79, we calculated partial life expectancies (Arriaga 1984).

To decompose the differences in HE, we applied the decomposition method of Nusselder and Looman (2004). This allowed us to separate out the contributions of different age groups and different types of effect (e.g., mortality or morbidity) to variations in (partial) HE. We first decomposed the gap in HE between the Turkish migrant population and the German population by age. We then split each age component according to differences in mortality and health effects (Andreev et al. 2002; Nusselder and Looman 2004; Nusselder et al. 2005).

In the second analytical step, we used multivariate regression analyses, applying two different models (Hosmer and Lemeshow 2000). First, we investigated whether there were differences in health between the German and Turkish migrant populations, and, if so, why. Second, we generated separate models for the two populations to determine whether the factors that determine health status vary across the two populations. Here we focused on the same age range as the one used in our HE calculations. We controlled for socio-demographic and economic variables, living standards, coping resources, and migration-specific variables.

3.4 Limitations of health

The dependent variable in our analyses is whether individuals have limitations in their daily activities (GALI). As the GGS questionnaire did not include the exact question posed in the GALI,[14] we had to combine the two health questions that were worded in the same way in

12 Based on Chiang (1984), abridged life tables with five-year age groups were used in our calculations.

13 The limitations calculated illustrate the current state of morbidity in the target groups, adjusted for age and mortality, and independent of the size of populations. The method calculates the expected years of life spent with or without limitations or from a certain age, given that the mortality and morbidity rates in the observed period remain constant (Jagger et al. 2007).

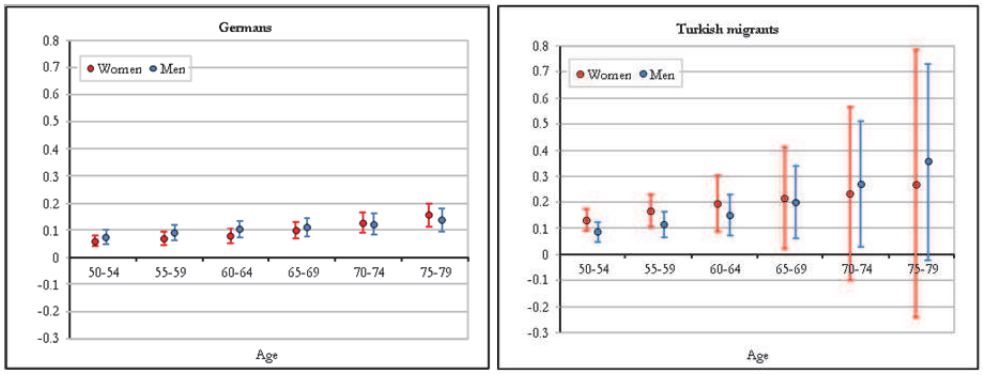
14 GALI is self-reported. Individuals were asked, "For the past six months at least, to what extent have you been limited because of a health problem in activities people usually do?" There are three possible responses: not limited, moderately limited, or severely limited.

both surveys: "Are you limited in your ability to carry out normal everyday activities because of a physical or mental health problem or a disability?" and "Since when?" The possible response categories for the question on limitations were "yes", "no", "do not know", "no answer"; while the response categories for the duration of limitations were "less than 6 months", "6 months to 1 year", "1 year to 5 years", "5 years to 10 years", "more than 10 years". Respondents who reported having limitations for more than six months were classified as "limited". Hence, those who reported having no limitations or limitations for less than 6 months were classified as "not limited".

For the second set of multivariate regression analyses, we applied "limitations" as a dependent variable derived from the GALI concept (with the question and the generation of the variable as described above), relying on the GGS. For our analyses, we recoded the answer into a dichotomous variable [1 - "limited"; 0 - "not limited"].

The comparison of age-specific prevalence of limitations for the two populations indicated that, among the respondents aged 50 and above, the Turkish migrants were less healthy than the Germans (Figure 2).

Figure 2: Age-specific prevalence and 95% confidence intervals of limitations for Germans and Turkish migrants in Germany 2005/2006 by sex



Source: Calculations based on German GGS 2005 and GGS subsample 2006.

3.5 Determinants of health limitations

We explored the determinants of limitations using two sets of characteristics which relied on socio-economic and migration-related characteristics. The socio-demographic variables included nationality, age, sex, education, and partnership status.

Nationality distinguished between Germans and Turkish migrants. Germans were defined as persons who, under § 1 of the Nationality Act (StAG of 01.06.2012) and Article 116 of the German Constitution (GG of 11.07.2012), have German citizenship. Turkish migrants were defined as persons who held Turkish citizenship and were registered as living in Germany. Individuals with dual Turkish/German citizenship were classified as Germans in this study. This means that the sample included both first- and second-generation Turks. As we only considered older migrants, most of the individuals in our Turkish sample were first-generation migrants. The citizenship approach was used to yield

equivalent results and conclusions for the two analyses which are based on different data sources. Age was classified in five-year age groups from age 50 onwards. The *education* variable was generated based on the GGS items on the highest school degree and the highest training qualification. After we merged these two variables, the individual values represented categories defined by the International Standard Classification of Education (ISCED) (United Nations Educational, Scientific and Cultural Organization (UNESCO); Institute for Statistics (UIS) 2012), and were "low", "middle", and "high". Due to the small number of highly educated Turkish migrants, we combined the medium and high education groups. Individuals who had, for example, completed lower secondary school or secondary general school, had no vocational education or qualifications, or had completed a semi-skilled training course, were placed in the low education group. Individuals with a general qualification for university entrance, a university degree, a master's degree, or a doctoral degree were placed in the middle and high education group.

We also took partnership status into account as a determinant that affects health. *Partnership status* was not explicitly available as a variable in the GGS. The operationalization of this variable could only be achieved by using the current partnership and the partnership history. For the present analysis, the variable "partnership status" had the categories "not married" and "married".[15]

The second set of variables consists of stressors which could be relevant for the health outcomes of the migrant population in particular, but which may also affect the health of the German population. As we noted in the theoretical section, migration involves both stressful life events and ongoing daily burdens. Thus, migration-specific issues, such as the challenges that come with having to adapt to new living conditions and to adjust to the loss of the country of origin, are often seen as sources of increased vulnerability for migrants. In order to capture the dimensions of migration-related stress, we employed the phase model of Sluzki (2001). This model focuses on the psychological phases of migration, which are, in turn, directly reflected in physical health. Because of the limitations of the GGS, we had to greatly simplify and shorten the empirical implementation of the model. In the GGS, the issue of health is not a priority. Moreover, only a prospective longitudinal study which considers all phases of the Sluzki model as they change over time could provide the necessary indicators. The survey design and data quality of the GGS are not suitable for such an approach. Therefore, in order to identify potential indicators, we considered the different phases of the Sluzki model, which served as a foundation for identifying influencing factors on health combined with theoretical indicators based on the migration stress theory.

As a proxy indicator of the subjective level of general life satisfaction, *subjective financial well-being* was included in the analysis using the values "with major difficulty", "with minor difficulty", "good/very good", and "missing". The quality of the *living situation* was operationalized by means of the level of satisfaction with the housing situation expressed in the values "unsatisfied", "more or less satisfied", or "satisfied" with one's residence. In this case as well, the level of satisfaction was only a subjective proxy variable for the quality.

[15] The value "married" includes, in addition to married people, individuals who were unmarried but were living with a partner. Accordingly, the value "not married" included all persons who currently did not have a partner and persons who were part of a couple but did not live with their partner.

As a potential counterweight to these migration-related stressors, we also considered the migrants' resources. We tested the availability of social support and the respondents' *formal networks* by examining their self-reported attendance at religious events. The level of attendance at religious events was measured with the values "several times a week", "several times a month", "several times a year", and "rarely/never". The emotional support provided by the family was operationalized by the variable of family support network. To identify respondents with low to no emotional and social support, we used the indicator of *emotional loneliness* based on the "loneliness scale" developed by De Jong-Gierveld and Kamphuis (De Jong-Gierveld and Kamphuis 1985; De Jong-Gierveld and van Tilburg 2006). Using the loneliness scale, the strength of the intergenerational family relationship was operationalized by the feeling that familial or friendship relationships were missing or inadequate, and also by the feeling that intimacy and deep familiarity were lacking in existing relationships (ibid.). The GGS includes all variables for the six-item short scale, which has the values "yes", "more or less", and "no".

The variable *intention* to stay is an indicator of migration-specific burdens, with the response categories "yes" and "no". The influence of the *duration of stay* in Germany on health was shown using two categories: "less than 20 years" and "more than 20 years". We chose these rather broad categories because, as our study focuses on older people, the number of respondents who had been living in Germany for less than 20 years was too small for a further division into five-year categories. Respondents with missing values were retained in a separate "missing" category.[16] To examine language-related barriers to accessing health care services in Germany, the self-assessed indicator of the *ability to speak German*, expressed as "good" or "rather bad", was applied.

4 Results

4.1 Health expectancy

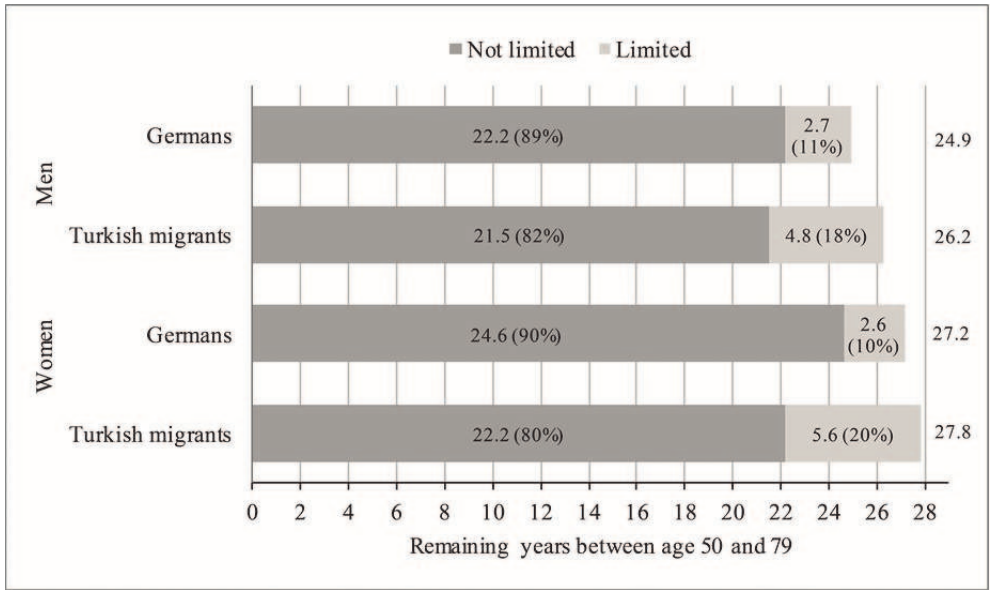
4.1.1 Expected years with and without limitation for Germans and Turkish migrants by sex and age

The HE analysis for the years 2005/2006 showed that the Turkish migrant population had spent more years of their remaining LE with limitations than the German population. This result applied to both men and women.

In 2005/2006, the remaining LE at age 50 was 24.9 years for German men and 26.2 years for Turkish men (Figure 3). At age 50, German men could expect to live 22.2 years (89 percent) of their remaining life without limitations, and 2.7 years (11 percent) with limitations. At the same age, Turkish men could expect to spend 21.5 years (82 percent) without limitations, and 4.8 years (18 percent) with limitations. For women at age 50, the remaining LE was 27.2 years for the German population and 27.8 years for the Turkish migrant population. However, at age 50 Turkish women were expected to spend more years (5.6 years; 20 percent) of their remaining LE with limitations than German women (2.6 years; 10 percent).

[16] This is also the case for the variables "*duration of stay*" and "*subjective financial well-being*".

Figure 3: Expected years of life between ages 50 and 79 with and without limitations for Germans and Turkish migrants in Germany in 2005/2006



Source: Calculations based on German GGS 2005 and GGS subsample 2006, AZR 2006, Federal Statistical Office 2004, 2005, 2006.

4.1.2 Decomposition of HE between different nationalities

The decomposition of HE by nationality from age 50 to age 79 underlined the results of the HE analyses by quantifying the number of years that the different mortality and morbidity regimes of the two populations contributed to the differences in HE (Table 2).

In 2005/2006, the remaining LE of Turkish migrant men was 1.3 years higher than that of German men, while their limitation-free life expectancy (LFLE) was 0.8 years lower. The lower LFLE among Turkish men was the net effect of 1.1 additional years due to lower mortality, and the loss of 1.9 years due to higher prevalence of limitations in health. Thus, the advantages in LE observed among Turkish men in the given year were diminished by their poor state of health. In terms of life expectancy with limitations (LEL), Turkish men had a disadvantage relative to their German counterparts of 2.1 years. A small share of this difference was caused by lower mortality (0.2 years), but the greater share was attributable to more years spent with limitations (1.9 years).

The LE of Turkish migrant women was 0.6 years higher than that of German women, but their LFLE was 2.4 years lower. The lower LFLE among Turkish women consisted of a gain of 0.5 years due to lower mortality and a loss of 2.9 years due to higher prevalence of limitations. The LEL of Turkish women was 3.0 years higher than that of German women, which was the result of lower mortality (0.1 years) and more years spent with limitations (2.9 years).

Table 2: Decomposition of HE between ages 50 and 79 due to differences in mortality and in limitations for Germans and Turkish migrants in Germany

	Men			Women		
	Remaining LE (in years)	Limitation-free LE (LFLE) (in years)	LE with limitation (LEL) (in years)	Remaining LE (in years)	Limitation-free LE (LFLE) (in years)	LE with limitation (LEL) (in years)
Germans	24.9	22.2	2.7	27.2	24.6	2.6
Turkish migrants	26.2	21.5	4.8	27.8	22.2	5.6
Differences (Turkish migrants - Germans)	1.3	-0.8	2.1	0.6	-2.4	3.0
Due to mortality	1.3	1.1	0.2	0.6	0.5	0.1
Due to limitation		-1.9	1.9		-2.9	2.9

Source: Calculations based on German GGS 2005 and GGS subsample 2006, AZR 2006, Federal Statistical Office 2004, 2005, 2006.

4.2 Determinants of limitations in health

4.2.1 Descriptive results

The Germans in the dataset were, on average, 10 years older than the Turkish migrants. Most of the respondents in both populations (90 percent of the Germans and 84 percent of the Turkish migrants) reported having no limitations. However, a greater share of the Turkish migrants reported having limitations (Table 3).

When we looked at the distribution of the covariates, we found statistically significant differences between the Turkish migrants and the Germans. While the sex distribution among the German population was nearly equal, the proportion of men was higher among the Turkish migrant population. The older Turkish migrants reported having lower educational and income levels than their German counterparts. Just 24 percent of the Turkish migrants had completed (upper) secondary education, compared with 84 percent of the Germans. However, 80 percent of the Turkish migrants were married (or lived in cohabitation), compared with 66 percent of the Germans.

Table 3: Descriptive statistics for Germans and Turkish migrants in Germany

	Nationality				p-value
	Germans		Turkish migrants		
	N	%	N	%	
GALI (functional limitations)					
Yes	438	10	115	16	<0.001
No/under 6 months	3,785	90	601	84	
Sex					
Women	2,179	52	334	46	0.014
Men	2,044	48	382	54	
Age groups					
50-54	819	19	185	26	
55-59	735	17	295	27	
60-64	748	18	195	27	<0.001
65-69	806	19	98	14	
70+	1,115	26	43	6	
Partnership status					
Married	2,789	66	572	80	<0.001
Not married	1,434	34	144	20	
Education					
Low	658	16	544	76	<0.001
Middle/high	3,565	84	172	24	
Living situation					
Unsatisfied	92	2	56	8	
More or less satisfied	466	11	147	21	<0.001
Satisfied	3,665	87	513	72	
Subjective financial well-being					
With major difficulty	379	9	207	29	
With minor difficulty	2,173	51	402	56	<0.001
Good/very good	1,656	39	89	12	
Missing	15	0	18	2	
6-item loneliness scale					
Yes	111	3	253	7	
More or less	3,906	92	628	88	<0.001
No	206	5	35	5	
Attending religious events					
Several times a week	92	2	127	18	
Several times a month	714	17	248	35	<0.001
Several times a year	1,179	28	121	17	
Rarely/never	1,338	53	220	30	
Intention to stay					
Yes	-	-	468	65	
No	-	-	110	15	<0.001
Missing	-	-	138	19	

	Nationality				p-value
	Germans		Turkish migrants		
	N	%	N	%	
Ability to speak German					
Good	-	-	264	37	<0.001
Rather bad	-	-	452	63	
Duration of stay					
<= 20 years	-	-	57	8	
> 20years	-	-	647	88	<0.001
Missing	-	-	32	4	
N	4,223		716		

Source: Calculations based on German GGS 2005 and GGS subsample 2006.

Note: p-value is based on a chi-square test between nationality and the independent variables.

Relative to Germans, Turkish migrants reported being less satisfied with their housing and their financial well-being, and they were more likely to have reported feeling lonely.

Finally, the findings indicated that 65 percent of Turkish migrants intended to stay in Germany. A majority of the respondents who had been living in Germany for a long time (88 percent of them had been in Germany longer than 20 years) rated their ability to speak German as rather limited (63 percent).

Given that these risk factors influence health, the higher prevalence of potential risk factors among the Turkish migrants suggests that they would have been in worse health. In the following, we examine the extent to which the compositional differences explain the health patterns.

4.2.2 Multivariate regression analyses

First, we present a basic regression model for all respondents, including the variables nationality, age, and sex (Model 1A, Table 4). In Model 1B we also controlled for different life circumstances. Second, we present the effects of the covariates on the risk of having limitations among Germans and Turkish migrants in separate models (Models 2A and 2B in Table 5). A direct comparison was not possible across the models, but this allowed us to investigate whether the determinants differed between the two groups. The findings are presented as odds ratios (OR) of having limitations.

The regression analysis showed significant differences in the OR of having limitations by nationality (Table 4). With an OR of 1.87 ($p<0.001$), the odds of having limitations was almost twice as high among Turkish migrants as it was among Germans (Model 1A). ORs increased with age and were twice as high at age 70 (and older) than they were in the reference category (ages 50-54). We did not find any significant effect for sex. The results persisted when we controlled for the different socio-demographic indicators and variables of the living situation (Model 1B).

In Models 2A and 2B, we found in both populations that, with increasing age, respondents were more likely to have reported having limitations. As in the first model, sex had no significant effect on the occurrence of limitations.

Table 4: Odds ratios of limitations for Germans and Turkish migrants in Germany

	Model 1A			Model 1B		
	OR	p-value	95% CI	OR	p-value	95% CI
Nationality						
German (Ref.)	1			1		
Turkish migrants	1.87	<0.001	1.505 – 2.379	1.52	0.006	1.125 – 2.039
Age groups						
50-45 (Ref.)	1			1		
55-59	1.47	0.011	1.093 – 2.007	1.49	0.012	1.089 – 2.025
60-64	1.34	0.039	1.017 – 1.878	1.49	0.014	1.083 – 2.038
65-69	1.43	0.024	1.049 – 1.963	1.66	0.002	1.200 – 2.288
70+	2.15	<0.001	1.625 – 2.876	2.53	<0.001	1.872 – 3.430
Sex						
Women (Ref.)	1			1		
Men	1.02	0.722	0.864 – 1.234	1.06	0.518	0.880 – 1.288
N	4,939			4,939		
chi2	48.92	<0.001		168.62	<0.001	
Pseudo r2 (McFadden)	0.01			0.05		

Source: Calculations based on German GGS 2005 and GGS subsample 2006, authors' own calculations. In Model 1B, we included covariates on partnership status, education, living situation, subjective financial well-being, and the 6-item loneliness scale.

Partnership status was important for Turkish migrants. Those who were not married had significantly higher odds (OR=1.83; p=0.017) of reporting having limitations than married respondents. For the German population, the partnership status had no significant effect.

Education had a statistically significant effect for Turkish migrants only. Unexpectedly, migrants with medium or high levels of education were significantly more likely (OR=1.94; p=0.011) to have reported having limitations than those with lower levels of education.

Table 5: Odds ratios of limitations for Germans and Turkish migrants in Germany, presented separately

	Germans (Model 2A)			Turkish migrants (Model 2B)		
	OR	p-value	95% CI	OR	p-value	95% CI
Age groups						
50-45 (Ref.)	1			1		
55-59	1.46	0.040	1.018 – 2.095	1.53	0.191	0.810 – 2.884
60-64	1.37	0.096	0.945 – 1.988	1.83	0.065	0.963 – 3.481
65-69	1.52	0.023	1.061 – 2.190	2.31	0.030	1.083 – 4.939
70+	2.42	<0.001	1.734 – 3.378	2.90	0.027	1.129 – 7.447
Sex						
Women (Ref.)	1			1		
Men	1.21	0.084	0.975 – 1.492	0.64	0.067	0.397– 1.032
Partnership status						
Married (Ref.)	1			1		
Not married	1.05	0.680	0.840 – 1.306	1.83	0.017	1.116 – 2.996
Education						
Low (Ref.)	1			1		
Middle /high	0.78	0.066	0.596 – 1.017	1.94	0.011	1.161 – 3.247
Living situation						
Unsatisfied (Ref.)	1			1		
More or less satisfied	1.13	0.702	0.596 – 2.157	0.39	0.015	0.185 – 0.836
Satisfied	0.89	0.704	0.488 – 1.623	0.36	0.003	0.185 – 0.715
Subjective financial Well-being						
With major difficulties (Ref.)	1			1		
With minor difficulties	0.42	<0.001	0.309 – 0.561	0.47	0.002	0.293 – 0.764
Good/very good	0.33	<0.001	0.238 – 0.458	0.42	0.033	0.191 – 0.932
Missing	0.19	0.118	0.024 – 1.517	0.50	0.412	0.098 – 2.594
6-item loneliness scale						
More or less (Ref.)	1			1		
Yes	1.71	0.040	1.025 – 2.861	2.12	0.033	1.062 – 4.231
No	1.06	0.790	0.680 – 1.658	1.75	0.250	0.674 – 4.550
Attending religious events						
Several times a week (Ref.)	1			1		
Several times a month	1.82	0.179	0.760 – 4.353	0.92	0.821	0.466 – 1.831
Several times a year	1.45	0.403	0.608 – 3.443	1.12	0.776	0.521 – 2.392
Rarely/never	2.32	0.053	0.991 – 5.420	1.63	0.149	0.840 – 3.149

	Germans (Model 2A)			Turkish migrants (Model 2B)		
	OR	p-value	95% CI	OR	p-value	95% CI
Intention to stay						
Yes (Ref.)	-	-	-	1		
No	-	-	-	0.96	0.894	0.518 – 1.775
Missing	-	-	-	0.95	0.862	0.538 – 1.680
Ability to speak German						
Good (Ref.)	-	-	-	1		
Rather bad	-	-	-	1.66	0.042	1.017 – 2.712
Duration of stay						
<=20 years (Ref.)	-	-	-	1		
> 20 - 30 years	-	-	-	2.52	0.049	1.005 – 6.326
Missing	-	-	-	1.70	0.499	0.364 – 7.967
N	4,223			716		
chi2	114.20	<0.001		72.73	<0.001	
Pseudo r2 (McFadden)	0.12			0.04		

Source: Calculations based on German GGS 2005 and GGS subsample 2006.

The second set of variables referred to constant and everyday stress, a relevant health factor for both the migrant and the German population. Turkish migrants who stated that they were satisfied with their living conditions had significantly lower odds (OR=0.36; p=0.003) of having limitations than those who said that they were not satisfied with their living environment. For the variable financial well-being, we found a similar picture. Higher levels of subjective financial satisfaction were positively related to health in both models 2A and 2B. Among Turkish migrants who reported having no financial problems, we found lower odds (OR=0.42; p=0.033) of having limitations than among those who reported having major difficulties. Germans who reported having high levels of financial well-being also showed significantly lower odds (OR=0.33; p<0.001) of having limitations than those with major problems.

For the role of social resources on health, we used the variables attendance at religious events and loneliness as proxies. Attendance at religious events had no consistent effect on health limitations. An association between church attendance and health limitations was identified for the German sample only. People who were not or were rarely involved in religious activities were more likely (OR=2.32; p=0.053) to have been affected by limitations than those who were deeply involved; however, this effect was weakly statistically significant. No significant effect was found among Turkish migrants.

Feeling lonely was associated with health limitations. Turkish migrants who said they felt less involved in a social/family network reported having significantly more (OR=2.12; p=0.033) limitations than those who reported feeling a little bit lonely. For Germans, we also found a significant effect (OR=1.71; p=0.040). We should note, however, that for these two variables causality may have worked in both directions: the respondents who reported having limitations in health may have been less likely to attend religious services, and they may have been feeling more lonely as a result of their disability than people who reported having no health constraints.

In Model 2B, we further controlled for a set of covariates which are directly related to migration. We found significant effects for the variables of the ability to speak German and the period of residency in Germany. The reported risk of limitations was higher when language skills were rather basic (OR=1.66; p=0.042). The effect of the duration of stay was significant, even when age was simultaneously controlled for. We found that Turkish migrants who had lived in Germany for more than 20 years were significantly more likely (OR=2.52; p=0.049) to have reported having limitations than those who had spent fewer years in the country.

5 Discussion and conclusion

Our study addressed two questions concerning the health of elderly migrants in Germany: First, what is the health status of aging migrants? Second, which factors determine the health status of migrants as they age in an environment that was initially foreign to them?

For our first hypothesis on the health differentials between migrants and Germans, we found that Turkish migrants spent more years of their remaining life expectancy with limitations than Germans. Turkish women had nearly the same life expectancy as German women, but greater disadvantages in health. Turkish men had, on average, a longer life expectancy than German men, but more years with limitations.

Among the different population groups analyzed here, why were older Turkish women found to have the greatest health disadvantages? A possible explanation for this finding is that the men who came to Germany as migrant workers represented a selective group in terms of health because they had to pass an entry examination to attain a work permit for Germany; i.e., only healthy applicants were accepted. Many women joined their husbands later as family migrants, and did not need a health examination. Another explanation may be related to gendered attitudes toward health and coping strategies. Previous research has shown that, in addition to familial strains and occupational strains such as unemployment, conflicts may occur which can be attributed to living in a foreign culture (BMFSFJ 2000, BMFSFJ 2005; Zeman 2005; Schenk 2007; Razum et al. 2008; Schenk et al. 2008; Wengler 2011). Studies have indicated that, among migrant women in Germany, satisfaction with health tends to deteriorate at an above-average rate with increasing age and duration of stay. Researchers have found, for example, that migrant women have the highest overall level of dissatisfaction with their state of health (Razum et al. 2008), and that their mental health status is lower than average (Milewski and Doblhammer 2015 in this issue). Women in this group also have above-average rates of illness starting at age 40, with psychological illnesses making up the highest proportion of causes for working days lost due to sickness (Razum et al. 2008).

We had also assumed that these differences may be attributable to socio-economic differentials in the composition of the respective groups. However, the regression analysis that took into account the characteristics of the Turkish migrants and the Germans could only partially explain the differences in their states of health. A significant health disadvantage among Turkish migrants remained. The disadvantages in health observed among both male and female migrants may not be produced by migration itself, but rather by the reasons for and the circumstances surrounding the migration process, as well as by their living and working conditions in Germany (Lechner and Mielck 1998; Kohls 2008a; Razum et al. 2008). In order to test the influence of these factors on older Turkish migrants'

states of health, and to answer our second question regarding which factors determine the migrant health status, we included in our analyses information on the life circumstances of migrants, such as financial well-being, as well as indicators that reflect the migration and integration process. These included feelings of loneliness, the intention to stay in Germany, and the ability to interact with others in German. We found that some factors have the same effects on the health status of Turkish migrants and Germans. For instance, we showed for both populations that limitations increase with age. Having access to coping resources like family networks or financial security reduced limitations in both samples.

By contrast, education did not have the expected effect on the health of Turkish migrants. Contrary to the findings of other authors (Wilkinson and Marmot 2003, Razum et al. 2008; Hubert et al. 2009), our analysis showed that highly educated Turkish migrants were more likely to have reported having limitations.[17] It is difficult to interpret these results. One hypothesis is that the perception of aging is influenced by culture and education. It is possible that the less educated Turkish migrants did not report their limitations, or saw their limitations as part of the process of aging. By contrast, migrants with higher levels of education might have been more conscious of their limitations, or were more likely to view changes in their health as negative.

Moreover, the indicators attendance at religious events and loneliness did not provide a clear answer concerning our third hypothesis about social support. For Turkish migrants, we found no statistically significant relationship between attendance at religious events and limitations in health. These results were contrary to our assumption that social resources, which could be acquired by attendance at religious events and include emotional and instrumental support, reduce limitations in health and help to prevent mental or physical illnesses. One explanation for this could be an endogeneity problem, as people who already have limitations are less likely to participate in religious events.

While we did not find any effect of religious attendance, our analyses showed that the Turkish migrants who felt less involved in a family network and who felt lonely were more likely to have reported having limitations. This is in line with the literature that has shown that family networks represent a relevant resource for migrants, helping them cope more effectively with migration-specific stress (such as acculturation) (BMFSJ 2005; Hubert et al. 2009). Migrant family networks also tend to be bigger than those of the Germans: migrants are more likely to live in large households and have large numbers of children, and are more likely to be married (BMFSJ 2000; BMFSJ 2005; Hubert et al. 2009). More generally, a study by Carnein and Baykara-Krumme (2013) on Turkish migrants showed that strong familial solidarity is an important resource for the exchange of support and transfers among family members, especially at older ages.

The duration of stay and language ability were important determinants of health among the Turkish migrants. As we discussed above, we found that the health of the migrants was affected by the conditions in the country of destination, both short-term (e.g., language barriers, leaving family and friends in their home country) and long-term (e.g., identifying with a different culture, experiencing discrimination, not achieving migration goals). We included the duration of stay in Germany in this study in order to evaluate to what extent the health of Turkish migrants living in Germany varied based on their length of stay. As we had anticipated in our fourth hypothesis, the migration-specific indicators were shown to have affected the Turkish migrants' health. The likelihood of having limitations was higher among

[17] Wengler (2011) found the same effect between high education and lower levels of self-perceived health among first-generation migrants. However, she does not further discuss this finding.

those migrants who had stayed in the country longer. Various factors could explain this finding, including aspects of the country of origin and the host country, selection processes, and socio-demographic factors. The models of Schenk (2007), Kohls (2008), and Spallek and Razum (2008) have shown that these factors strongly affect the state of health based on the duration of stay. This means that the Turkish migrant population had an initial health advantage relative to the German population due to different selection processes of immigration (e.g., the healthy migrant effect). However, this effect would have diminished or disappeared over time and with the duration of stay (Lechner and Mielck 1998; Razum et al. 2004; Razum 2006a; Schenk 2007; Razum et al. 2008; Spallek and Razum 2008). More precisely, this means that various forms of stress may affect migrants and lead to long-term socio-economic disadvantages, such as working conditions that endanger health, occupational strains, poor living conditions, and downward social mobility. As the duration of a migrant's stay increases, these health risks also rise (Richter and Hurrelmann 2006; Kohls 2011). Additional factors that may negatively affect health include the ongoing and acute level of (psychological) strain that comes from migration-related socio-economic insecurity, uncertainty regarding residence status, lack of financial resources, and separation from family members. We suggest that our results are attributable in part to the negative life circumstances of migrants and to the membership in a minority group. Migrants who had been living in Germany for a longer period of time had been exposed to these risk factors for more years than those who immigrated later, and were therefore more likely to have been in poor health.

In addition, we found that the ability to speak German reduced the prevalence of limitations. In our sample, almost 40 percent of the survey respondents indicated that they spoke German very well or well. Conversely, this means that almost 60 percent of the Turkish migrants had rather poor German language skills. This finding demonstrates the importance of formulating health policies that are aligned with the needs of migrants. For example, inadequate language skills among migrants may lead to communication problems between doctors and patients, and to reduced access to preventive measures and appropriate therapies. This finding suggests that health care professionals should make special efforts to reach out to the Turkish migrant population. Migrant women in particular may be reluctant to make use of public health and medical care services in Germany because of their comparatively low levels of education and lack of proficiency in German, and because their cultural traditions discourage them from learning about bodily functions and medical issues (BMFSFJ 2000; Razum et al. 2008). Research has shown that Turkish migrant women are more likely than their German counterparts to be prescribed inappropriate medications because of their poor German language skills (Razum et al. 2008, Kotwal 2010).

Migrants with an insufficient knowledge of German may also often find it difficult to integrate into German society. A lack of language skills and of education may be associated with a number of problems, including having a lower income, having poor career prospects, being unemployed, and having a low degree of social integration. As we noted in the discussion of the duration of stay, these problems can in turn lead to psychological and social difficulties which could negatively affect health (Hubert 2009). Insufficient German language skills and the resulting lack of connections with and low degree of integration into German culture may exacerbate health risks. However, knowledge of a language is always closely connected to education, which suggests that a lack of language skills could also be the result of inadequate education. Despite this obvious relationship, in this study we used language skills as an independent migration-related determinant of health to show that migrants are even more disadvantaged than Germans with the same socio-economic status.

When studying Turkish migrant health, we have to be aware that the results may be affected by a wide range of limiting factors. As a number of scholars have pointed out, the quality of data in the area of migration and the statistics on foreigners in Germany remain unsatisfactory and need to be improved (Haug 2005; Kohls 2012b). Thus, the results presented here may be biased because the data validity is limited. First, registered deaths are underrepresented, especially for those who die abroad and at older ages. Second, the numbers of migrants reported in the population registers is higher than the number of foreign residents who actually live in Germany.[18] The latter effect is caused by a frequent failure among migrants to de-register when they leave Germany (Kibele et al. 2008; Kohls 2008). This could affect our results, because we are likely to underestimate the measured values on mortality (Razum et al. 2004; Kibele et al. 2008).

Given these data problems, future studies should use the new data from the German census of 2011 as soon as the data on migration are available to researchers. As the census is a 10 percent sample of the German population, the uncertainties about the migrant population registered are reduced. These data will allow us to test whether the advantages in LE of Turkish migrants are still present after the over-coverage has been corrected.

Furthermore, the results of our analyses might have been influenced by a selection bias in the GGS sampling procedure. With regard to information on morbidity among Germans and Turkish migrants, there is a high degree of uncertainty about prevalence rates in the Turkish migrant population, as the response rates among migrants to the survey's question about activity limitations were low, especially at older ages (Table 1). This might lead to an underestimation or an overestimation of the proportion of people with disabilities, and therefore to an underestimation or an overestimation of the health status in our HE analysis.

This problem could be related in part to the fact that the GGS is a household survey which contains observed prevalence rates and excludes people living in institutions. We can assume that people in institutions are in poor health and suffer from increasingly severe limitations in daily activities. The absence of the institutionalized population from the survey sample might lead to an underestimation of the proportion of people with disabilities and an overestimation of health status. If the people in institutions were taken into account, the results for the German population might change to show higher illness levels. But the status of the Turkish migrant population would be expected to remain constant, because Turkish migrants have traditionally not taken advantage of institutional care to the extent that Germans have (Matthäi 2004). Further research is required to estimate this bias.

The relatively low number of older Turkish respondents in the survey might also be explained by the young age structure of the Turkish migrant population in Germany. The people who answered the health question in the survey were mostly younger, and were not yet prone to develop most age-related health conditions.

Finally, the significance of the answers to the health questions in the GGS may be limited because of differences in the cultural perceptions of health. A general problem in health studies that investigate foreign and native populations are variations in the understanding and description of illness (Razum et al. 2004; Spallek and Razum 2008). Cultural norms may influence perceptions of good and bad health. For example, older Turkish migrants may rate their health status more favorably than their German counterparts because they consider their limitations to be a natural part of the aging process, and do not view them as significant changes in health. However, this hypothesis could be

[18] The limitation of the migration statistics described here applies to one possible source of distortion only. For a broad overview of further data shortcomings, see chapter 4 in this article.

neither proven nor disproven in this study, and needs to be investigated further in the future. It is also possible that migrants in poor health will choose to return to their home country in order to receive better medical care in a familiar environment country (Kohls 2011). A number of studies suggest, however, that only a small share of the migrant population actually return to their home countries, especially at older ages (Haug 2001; Schimany et al. 2012). We can assume that in the future a large proportion of migrants will remain in Germany, mainly for family reasons. If family caregivers also live in the host country, a return in response to health problems is unlikely (Dietzel-Papakyriakou 1993; Kohls 2011). Additional factors which argue against a migrant returning to the home country while old and ill are the possible loss of the residence status and the fact that the health system in a less developed country is unlikely to provide better medical services than the system in the more developed host country (Sander 2007; Głodny et al. 2011; Schimany et al. 2012). Migrants may refrain from remigration in order to take advantage of better medical services in the host country (Sander 2007; Głodny et al. 2011; Schimany et al. 2012). If this is the case, however, shuttle migration of pensioners due to bilocal orientations and relationships may increase in the future.

This study has another inherent limitation related to the Sullivan method used here. Both, the calculation of LE with and without limitation and the decomposition analyses were based on the Sullivan method. In general, the method reflects the current health of a population adjusted for mortality and independent of age structure. This means that it applies age-specific health prevalence rates instead of incidence rates. Incidence rates are necessary to provide the number of person-years lived in a health state at a particular age and time. These can be calculated by longitudinal measures to provide the transition rates between health states.

A more sophisticated increment-decrement life table measure (multi-state life tables) would be based on the transition rates in and out of the different states up to the point of death. Such a measure would provide an appropriate solution, as it could display undistorted short-term and long-term changes in active LE. However, in order to perform HE calculations using a multi-state life table, we would need representative longitudinal data with mortality follow-up data and a large sample size. These data are, however, extremely rare, and are not available in our datasets. Therefore, in our study the Sullivan method was chosen because it allowed us to use more readily available data: i.e., the age-specific prevalence of the health state and the total person-years lived at a particular age. Robine and Mathers (1993) have shown that the Sullivan method and multi-state methods produce similar results, provided all of the transition rates are smooth and regular over time. We therefore assumed that our results were appropriate for a comparison of the health status of Turkish migrants and the German population.

One last observation on possible limitations is related to the regression analyses. As the main focus of the GGS is on family relations and not on health, some potentially relevant information was missing in the dataset (e.g., health-related behaviors like smoking, physical activity, or the utilization of health care services). Some of our hypotheses therefore had to be evaluated with the help of proxy variables (e.g., loneliness and attending religious events as a proxy for a social network), which reduced the validity of the results.

Despite these limitations, the study does exhibit strengths which indicate the quality of our results. One strength of this study is that we used a range of migration-related data sources, which when combined improve the robustness of our results on the health of the Turkish migrant population relative to the health of the German population. To our

knowledge, no prior study has attempted a comparison of health status calculations between the migrant and non-migrant populations in Germany using the HE method. The datasources chosen for this study – i.e., the population statistics and the register stock data – are full censuses of the foreign and the native German populations, and therefore provide a direct basis for comparison. The AZR data in particular can be regarded as the most valid data source for migration statistics, due to the recent improvements to the AZR data.

A further strength of this study is that we did not focus on migrants in general. Migrants living in Germany are socio-economically and culturally diverse, with a wide range of migration experiences. Health analyses which focus on foreigners in general may not be able to reflect the underlying diversity of factors and their influence on the health status of different migrant groups. We therefore chose to focus on a single migrant group consisting of people with Turkish citizenship who live in Germany. This enabled us to reduce bias resulting from the heterogeneity of different migrant populations.

Additionally, this study conducted an inter-population comparison in a single country. Previously, the measurement of HE was considered mostly within the framework of cross-country comparisons. Comparing Turkish migrants and the German population within one country makes it possible to research the variance within that country and the factors which explain these variances, particularly the migrant-specific influences on health.

All in all, our findings clearly showed that the Turkish migrant population was less healthy than the German population, and that they were affected by migration-related risk factors (e.g., language skills). When we look at the results of our study in a wider societal context, several key health-related and quality-of-life issues arise for the elderly in both the German and the Turkish migrant populations. The increasing proportion of older migrants in Germany and the accompanying trend towards a multi-cultural society make the question of whether there are differences in health between the various cultural sub-populations highly relevant. This also leads us to ask how the health care system is dealing with the specific needs and problems of the various sub-groups. These questions are obviously important, both for improving our understanding of changes in the state of health of a given population, and for formulating public policies regarding the provision of services.

There are three reasons to assume that migrants in Germany will need even more health care in the future than is the case today: 1) Relatively few migrants in Germany have reached older ages. In the coming years, however, the number of elderly migrants will increase and their care needs will also grow. 2) The migrant populations, like the German host population, face an increasing risk of multi-morbidity as they age. The aging of these populations is therefore expected to result in an increasing demand for nursing and care (BMFSFJ 2000). 3) Migrants are subject to particular risk factors, such as insufficient language skills, which make them more likely to have limitations. These migrant-specific risk factors may also increase their likelihood of developing multi-morbidity. Future research should focus more on these aspects of migration and health, and analyze how the social security system can adequately meet the specific needs of this migrant group. The languages used in care institutions and differing cultural and religious customs regarding health and palliative care are only a few of the challenges that must be addressed in a multi-cultural and multi-religious society.

6 References

Abraído-Lanza, A. F.; Dohrenwend, B. P.; Ng-Mak, D. S.; Turner, J. B. (1999): The Latino mortality paradox: a test of the "salmon bias" and healthy migrant hypotheses. In: *American Journal of Public Health* 89 (10), pp. 1543-48.

Andreev, E. M.; Shkolnikov, V. M.; Begun, A. Z. (2002): Algorithm for decomposition of differences between aggregate demographic measures and its application to life expectancies, healthy life expectancies, parity-progression ratios and total fertility rates. In: *Demographic Research* 7 (14), pp. 498-522.

Arriaga, E. E. (1984): Measuring and explaining the change in life expectancies. In: *Demography* 21 (1), pp. 83-96.

Bade K. J.; Oltmer, J. (2004): Normalfall Migration. Deutschland im 20. und frühen 21. Jahrhundert. Zeitbilder. Vol. 15. Bonn: Bundeszentrale für politische Bildung.

Balarajan, R.; Raleigh, V. S. (1997): Patterns of mortality among Bangladeshis in England and Wales. In: *Ethnicity and Health* 2 (1-2), pp. 5-12.

Bauer, U.; Bittlingmayer U. H.; Richter M. (Eds.) (2008): Health Inequalities. Determinanten und Mechanismen gesundheitlicher Ungleichheit. Wiesbaden: VS Verlag.

Baune, B. T. (2004): Psychische Gesundheit unter transkulturellen Gesichtspunkten. Besonderheiten der psychotherapeutischen und psychiatrischen Versorgungssituation von Migranten. In: Krämer, A.; Prüfer-Krämer, L. (Eds.): Gesundheit von Migranten – Internationale Bestandsaufnahme und Perspektiven. Weinheim/München: Juventa Verlag, pp. 123-141.

Baykara-Krumme, H. (2007): Gar nicht so anders: Eine vergleichende Analyse der Generationenbeziehungen bei Migranten und Einheimischen in der zweiten Lebenshälfte. Discussions Paper Nr. SP IV 2007-604, Berlin: Wissenschaftszentrum.

Beauftragte der Bundesregierung für Migration, Flüchtlinge und Integration (2012): 9. Bericht der Beauftragen der Bundesregierung für Migration, Flüchtlinge und Integration über die Lage der Ausländerinnen und Ausländer in Deutschland. Berlin.

BMFSFJ (Bundesministerium für Familie, Senioren, Frauen und Jugend) (2000): Sechster Familienbericht: Familien ausländischer Herkunft in Deutschland: Leistungen - Belastungen - Herausforderungen Berlin.

BMFSFJ (Bundesministerium für Familie, Senioren, Frauen und Jugend) (2005): Fünfter Bericht zur Lage der älteren Generation in der Bundesrepublik Deutschland. Potenziale des Alters in Wirtschaft und Gesellschaft. Der Beitrag älterer Menschen zum Zusammenhalt der Generationen. Bericht der Sachverständigenkommission. Berlin.

Bollini, P.; Siem, H. (1995): No real progress towards equity: Health of migrants and ethnic minorities on the eve of the year 2000. In: *Social Science & Medicine* 41 (6), pp. 819-828.

Borde, T.; Braun, T.; David, M. (2003): Unterschiede in der Inanspruchnahme klinischer Notfallambulanzen durch deutsche Patienten/innen und Migranten/innen. Problembeschreibung, Ursachenanalyse, Lösungsansätze. Final Report. Berlin: Bundesministerium für Bildung und Forschung und Spitzenverbände der Krankenkassen.

Brucks, U.; Wahl, W. B. (2003): Über-, Unter-, Fehlversorgung? Bedarfslücken und Strukturprobleme in der ambulanten Gesundheitsversorgung für Migrantinnen und Migranten. In: Borde, T.; David, M. (Eds.): Gut versorgt? Migrantinnen und Migranten im Gesundheits- und Sozialwesen. Frankfurt am Main: Mabuse-Verlag, pp. 15-33.

Brzoska, P.; Reiss, K.; Razum, O. (2010): Arbeit, Migration und Gesundheit. In: Badura, B.; Schröder, H.; Klose, J.; Macco, K. (Eds.): Fehlzeiten-Report 2010: Vielfalt managen: Gesundheit fördern - Potenziale nutzen. Berlin: Springer, pp. 129-139.

Carnein, M.; Baykara-Krumme, H. (2013): Einstellungen zur familialen Solidarität im Alter: Eine vergleichende Analyse mit türkischen Migranten und Deutschen. In: *Zeitschrift für Familienforschung* 25 (1), pp. 29-53.

Caselli, G.; Mesle, F.; Vallin, J. (2002): Epidemiologic transition theory exceptions. In: *Journal of Population Sciences* 9, pp. 9-51.

Central Register of Foreigners Act of 03.05.2013 Retrieved May 5th 2013, available online at http://www.gesetze-im-internet.de/azrg/BJNR226500994.html#BJNR226500994BJNG000300000.

Chiang, A. C. (1984): Fundamental methods of mathematical economics. 3rd ed. New York: McGraw-Hill.

Currle, E. (2006): Die Verbesserung der Migrationsstatistik durch den Austausch von Bevölkerungsdaten am Beispiel der skandinavischen Länder. Expertise des Europäischen Forums für Migrationsstudien (efms). Bamberg: Bundesamt für Migration und Flüchtlinge.

De Jong-Gierveld, J.; Kamphuis, F. (1985): The development of a Rasch-type loneliness scale. In: *Applied Psychological Measurement* 9 (3), pp. 289-299.

De Jong-Gierveld, J.; van Tilburg, T. (2006): A 6-item scale for overall, emotional, and social loneliness: Confirmatory tests on survey data. In: *Research on Aging* 28 (5), pp. 582-598.

Dietzel-Papakyriakou, M. (1993): Altern in der Migration. Die Arbeitsmigranten vor dem Dilemma: zurückkehren oder bleiben? Stuttgart: Ferdinand Enke Verlag.

Dietzel-Papakyriakou, M.; Olbermann, E. (2001): Gesundheitliche Lage und Versorgung alter Arbeitsmigranten in Deutschland. In: Marschalck, P.; Wiedl, K. H. (Eds.): Migration und Krankheit. Schriften des Instituts für Migrationsforschung und interkulturelle Studien (IMIS),Vol. 10. Osnabrück: V&R unipress GmbH, pp. 283-313.

Elkeles, T.; Mielck, A. (1997): Entwicklung eines Modells zur Erklärung gesundheitlicher Ungleichheit. In: *Gesundheitswesen* 59 (3), pp. 137-143.

Elrick, J. (2005): Foreigners, immigrants and persons with a 'migration background'. What kind of official data are needed in Germany? In: *Sozialwissenschaftlicher Fachinformationsdienst* soFid Migration und ethnische Minderheiten, Vol. 2, pp. 7-15.

Ette, A.; Hullen, G.; Leven, I.; Ruckdeschel, K. (2007): Generations and Gender Survey. Dokumentation der Befragung von türkischen Migranten in Deutschland, Vol. 121b. Wiesbaden: Bundesinstitut für Bevölkerungsforschung.

Geiger, I.; Razum, O. (2006): Migration: Herausforderungen für die Gesundheitswissenschaften. In: Hurrelmann, K.; Laaser, U.; Razum, O. (Eds.): Handbuch Gesundheitswissenschaften, 4. ed. Weinheim und München: Juventa, pp. 719-746.

German Constitution 11.07.2012: Retrieved May 10th 2013, available online at http://www.gesetze-im-internet.de/gg/BJNR000010949.html.

Günster C.; Klose J.; Schmacke N. (2012): Versorgungsreport 2012: Schwerpunkt: Gesundheit im Alter. Stuttgart: Schattauer.

Hahlen, J. (2004): Bevölkerungsentwicklung Deutschlands bis 2050. Statistisches Bundesamt.

Haug, S. (2001): Bleiben oder Zurückkehren? Zur Messung, Erklärung und Prognose der Rückkehr von Immigranten in Deutschland. In: *Zeitschrift für Bevölkerungswissenschaft* 26 (2), pp. 231-270.

Haug, S. (2005): Die Datenlage im Bereich der Migrations- und Integrationsforschung. Working Paper 1/2005. Nürnberg: Bundesamt für Migration und Flüchtlinge, available online at http://www.bamf.de/SharedDocs/Anlagen/DE/Publikationen/WorkingPapers/wp01-datenlage.html.

Helmert, U.; Voges, W.; Sommer, T. (2002): Soziale Einflussfaktoren für die Mortalität von männlichen Krankenversicherten in den Jahren 1989 bis 2000. In: *Gesundheitswesen* (64), pp. 3-10.

Hoffmann-Nowotny, H. J. (1973): Soziologie des Fremdarbeiterproblems. Eine theoretische und empirische Analyse am Beispiel der Schweiz. Stuttgart: Enke.

Hosmer, D. W.; Lemeshow, S. (2000): Applied logistic regression, 2nd ed. New York: Wiley.

Hubert, S.; Althammer, J.; Korucu-Rieger, C. (2009): Soziodemographische Merkmale und psychophysisches Befinden älterer türkischer Migrantinnen und Migranten in Deutschland. Schriftenreihe des Bundesinstitutes für Bevölkerungsforschung, Vol. 39. Berlin: Pro Business.

Hurrelmann K.; Kolip P. (Eds.) (2002): Geschlecht, Gesundheit und Krankheit. Männer und Frauen im Vergleich. Bern: Verlag Hans.

Igel, U.; Brähler, E.; Grande, G. (2010): Der Einfluss von Diskriminierungserfahrungen auf die Gesundheit von MigrantInnen. In: *Psychiatrische Praxis* 37 (4), pp. 183-190.

Jagger, C.; van Oyen, H.; Cox, B; and team (2007): Health Expectancy Calculation by the Sullivan Method: A Practical Guide. In: *EHEMU Technical Report*, available online at http://www.eurohex.eu/pdf/Sullivan_guide_final_jun2007.pdf.

Jagger, C.; Weston, C.; Cambois, E.; van Oyen, H.; Nusselder, W.; Doblhammer, G.; Rychtarikova, J.; Robine, J.-M.; EHLEIS team (2011): Inequalities in health expectancies at older ages in the European Union: findings from the Survey of Health and Retirement in Europe (SHARE). In: *Journal of Epidemiology & Community Health* 65 (11), pp. 1030-5.

Jasso, G.; Massey, D. S.; Rosenzweig, M. R.; Smith, J. P. (2004): Immigrant health: Selectivity and acculturation. In: Anderson, N. B.; Bulatao, R. A.; Cohen, B. (Eds.): Critical perspectives on racial and ethnic differences in health in late life. Washington DC: National Academy Press, pp. 227-266.

Kibele, E.; Scholz, R.; Shkolnikov, V. M. (2008): Low migrant mortality in Germany for men aged 65 and older: Fact or artifact? In: *European Journal of Epidemiology* 23 (6), pp. 389-393.

Kohls, M. (2008a): Healthy-Migrant-Effect, Erfassungsfehler und andere Schwierigkeiten bei der Analyse der Mortalität von Migranten. Eine Bestandsaufnahme. Working Paper Vol. 15. Nürnberg: Bundesamt für Migration und Flüchtlinge.

Kohls, M. (2008b): Leben Migranten wirklich länger? Eine empirische Analyse der Mortalität von Migranten in Deutschland. Working Paper, Vol. 16. Nürnberg: Bundesamt für Migration und Flüchtlinge.

Kohls, M. (2011): Morbidität und Mortalität von Migranten in Deutschland. Forschungsbericht 9. Nürnberg: Bundesamt für Migration und Flüchtlinge.

Kohls, M. (2012a): Leben ältere Migranten länger? Eine Analyse von Sterberisiken älterer Migrantinnen und Migranten in Deutschland. In: Baykara-Krumme, H.; Motel-Klingebiel, A.; Schimany. P. (Eds.): Viele Welten des Alterns. Ältere Migranten im alternden Deutschland. Wiesbaden: Springer VS, pp. 201-223.

Kohls, M. (2012b): Demographie von Migranten in Deutschland. Challenges in Public Health 63. Frankfurt am Main: Peter Lang.

Kotwal, A. A. (2010): Physical and psychological health of first and second generation Turkish immigrants in Germany. In: *American Journal of Human Biology* 22 (4), pp. 538-545.

Lampert, T.; Saß, A.; Häfelinger, M.; Ziese, T. (2005): Armut, soziale Ungleichheit und Gesundheit. Expertise des Robert-Koch-Instituts zum 2. Armuts- und Reichtumsbericht der Bundesregierung. Beitrage zur Gesundheitsberichterstattung des Bundes. Berlin: Robert Koch-Institut.

Lechner, I.; Mielck, A. (1998): Die Verkleinerung des Healthy-Migrant-Effects: Entwicklung der Morbidität von ausländischen und deutschen Befragten im sozioökonomischen Panel 1984-1992. In: *Das Gesundheitswesen* 60 (12), pp. 715-720.

Mathers, C. D. (2002): Health Expectancies: An Overview and Critical Appraisal. In: Murray, C. J. L., Salomon, J. A., Mathers, C. D.; Lopez, A. D. (Eds.): Summary measures of population health. concepts, ethics, measurement and applications. Geneva: World Health Organization, pp. 177-204.

Matthäi, I. (2004): Lebenssituation der älteren alleinstehenden Migrantinnen. Berlin: Bundesministerium für Familie, Senioren, Frauen und Jugend.

Matthäi, I. (2005). Die vergessenen Frauen aus der Zuwanderergeneration. Zur Lebenssituation von alleinstehenden Migrantinnen im Alter. Wiesbaden: VS Verlag für Sozialwissenschaften.

McKay, L.; Macintyre, S.; Ellaway, A. (2003): Migration and Health: A review of the international literature. Glasgow: Medical Research Council.

McMichael, A. J. (1976): Standardized mortality ratios and the "healthy worker effect": Scratching beneath the surface. In: *Journal of Occupational Medicine* 18 (3), pp. 165-168.

Mielck, A. (2005): Soziale Ungleichheit und Gesundheit. Einführung in die aktuelle Diskussion. Bern: Verlag Hans Huber.

Molla, M. T.; Madans, J. H.; Wagener, D. K.; Crimmins, E. M. (2003): Summary measures of population health: Report of findings on methodological and data issues. National Center for Health Statistics, Hyattsville, Maryland.

Münz, R.; Ulrich, R. (2000): Migration und zukünftige Bevölkerungsentwicklung in Deutschland. In: Bade, K. J.; Münz, R. (Eds.): Migrationsreport 2000 Fakten – Analysen – Perspektiven. Bonn: Bundeszentrale für politische Bildung, pp. 23-57.

Nationality Act (StAG) of 01.06.2012: Retrieved May 10th 2013, available online at http://www.gesetze-im-internet.de/rustag/BJNR005830913.html.

Nauck, B. (2001). Solidarpotenziale von Migrantenfamilien. Bonn: Friedrich-Ebert-Stiftung (Expertise).

Nusselder, W. J.; Looman, C. W. N. (2004): Decomposition of differences in health expectancy by cause. In: *Demography* 41 (2), pp. 316-329.

Nusselder, W. J.; Looman, C. W. N.; Mackenbach, J. P.; Huisman, M.; van Oyen, H.; Deboosere, P.; Gadeyne, S.; Kunst, A. E. (2005): The contribution of specific diseases to educational disparities in disability-free life expectancy. In: *American Journal of Public Health* 95 (11), pp. 2035-2041.

Olbermann, E. (2003): Soziale Netzwerke, Alter und Migration. Theoretische und empirischen Exploration zur sozialen Unterstützung älterer Migranten. Dissertation. Dortmund: Technische Universität Dortmund.

Omran, A. R. (2005): The epidemiological transition: A theory of the epidemiology of population change. In: *The Milbank Quarterly* 83 (4), pp. 731-757.

Opfermann, H.; Grobecker, C.; Krack-Roberg, E. (2006): Auswirkung der Bereinigung des Ausländerzentralregisters auf die amtliche Ausländerstatistik. Wiesbaden: Statistisches Bundesamt.

Porsch-Oezçueruemez, M.; Bilgin, Y.; Wollny, M.; Gediz, A.; Arat, A.; Karatay, E.; Akinci, A.; Sinterhauf, K.; Koch, H.; Siegfried, I.; von Georgi, R.; Brenner, G.; Kloer, H. U. (1999): Prevalence of risk factors of coronary heart disease in Turks living in Germany: In: *The Giessen Study*. Atherosclerosis 144 (1), pp. 185-198.

Razum, O. (2006a): Commentary: of salmon and time travellers – musing on the mystery of migrant mortality. In: *International Journal of Epidemiology* 35 (4), pp. 919-21.

Razum, O. (2009): Migration, Mortalität und der Healthy-migrant-Effekt. In: Richter, M.; Hurrelmann, K. (Eds.): Gesundheitliche Ungleichheit. Grundlagen, Probleme, Perspektiven. 2nd ed. Wiesbaden: VS Verlag für Sozialwissenschaften, pp. 257-282.

Razum, O.; Geiger, I.; Zeeb, H.; Ronellenfitsch, U. (2004): Gesundheitsversorgung von Migranten. In: *Deutsches Ärzteblatt* 101 (43), pp. A2882-A2887.

Razum, O.; Geiger, I. (2006): Migranten. In: Schwartz, F. W.; Badura, B.; Busse, R.; Leidl, R.; Raspe, H.; Siegrist, J.; Walter. U. (Eds.): Das Public Health Buch. Gesundheit und Gesundheitswesen. München / Jena: Urban & Fischer, pp. 686-694.

Razum, O.; Meesmann, U.; Bredehorst, M.; Brzoska, P.; Dercks, T.; Glodny, S.; Zeeb, H.; Schenk, L.; Salman, R.; Menkhaus, B.; Ulrich, R.; Saß, A.; Neuhauser, H.; Brucks, U.; Ziese, T. (2008): Migration und Gesundheit: Schwerpunktbericht der Gesundheitsberichterstattung des Bundes. Berlin: Robert-Koch-Institut.

Razum, O.; Rohrmann, S. (2002): Der Healthy-migrant-Effekt: Bedeutung von Auswahlprozessen bei der Migration und Late-entry-Bias. In: *Das Gesundheitswesen* 64 (2), pp. 82-88.

Razum, O.; Spallek, J. (2012): Erklärungsmodelle zum Zusammenhang zwischen Migration und Gesundheit im Alter. In: Baykara-Krumme, H.; Motel-Klingelbiel, A.; Schimany, P.; (Eds.): Viele Welten des Alterns: Ältere Migranten im alternden Deutschland. Wiesbaden: Springer VS Verlag, pp. 161-180.

Razum, O.; Twardella, D. (2002): Time travel with Oliver Twist – towards an explanation for a paradoxically low mortality among recent immigrants. In: *Tropical Medicine & International Health* 7 (1), pp. 4-10.

Razum, O.; Zeeb, H.; Akgün, H. S.; Yilmaz, S. (1998): Low overall mortality of Turkish residents in Germany persists and extends into a second generation: merely a healthy migrant effect? In: *Tropical Medicine & International Health* 3 (4), pp. 297-303.

Razum, O.; Zeeb, H.; Rohrmann, S. (2000): The 'healthy migrant effect' – not merely a fallacy of inaccurate denominator figures. In: *International Journal of Epidemiology* 29 (1), pp. 191-192.

Richter, M.; Hurrelmann, K. (2006): Gesundheitliche Ungleichheit. Grundlagen, Probleme, Perspektiven. Wiesbaden: VS Verlag für Sozialwissenschaften.

Riley, J. C. (1990): The risk of being sick: Morbidity trends in four countries. In: *Population and Development Review* 16 (3), pp. 403-432.

Robine, J.-M.; Ritchie, K. (1991): Healthy life expectancy: evaluation of global indicators of change in population health. In: *British Medical Journal* 302 (6774), pp. 457-460.

Robine, J.-M.; Romieu, I.; Cambois, E. (1999): Health expectancy indicators. Bulletin of the World Health Organization. In: *Health Organization* 77 (2), pp. 181-185.

Robine, J.-M. (2002): A new health expectancy classification system. In: Murray, C. J. L.; Salomon, J. A.; Mathers, C. D.; Lopez, A. D. (Eds.): Summary measures of population health: Concepts, ethics, measurement and applications. Geneva: World Health Organization, pp. 205-211.

Robine, J.-M.; Jagger, C.; Euro-REVES Group (2003a): Creating a coherent set of indicators to monitor health across Europe. The Euro-REVES 2 project. In: *European Journal of Public Health* 13 (3), pp. 6-14.

Robine, J.-M.; Jagger, C.; Mathers, C. D.; Crimmins, E. M.; Suzman, R. M. (2003b): Determining health expectancies. Chichester: Wiley.

Robine, J.-M.; Jagger, C. (2006): Lengthening of Life and the Population Health Status. In: Caselli, G.; Vallin, J.; Wunsch, G. (Eds.): Demography: analysis and synthesis: a treatise in population studies, Vol 3. Burlington/San Diego/London: Academic Press, pp. 285-303.

Ronellenfitsch, U.; Kyobutungi C.; Becher H.; Razum O. (2006): All-cause and cardiovascular mortality among ethnic German immigrants from the Former Soviet Union: a cohort study. In: *BMC Public Health* 6 (16), pp. 1-12.

Ruckdeschel, K.; Ette, A.; Hullen, G.; Leven, I. (2006): Generations and Gender Survey. Dokumentation der ersten Welle der Hauptbefragung in Deutschland. Materialien zur Bevölkerungswissenschaft 121a. Wiesbaden: Bundesinstitut für Bevölkerungsforschung.

Sander, M. (2007): Return Migration and the "healthy immigrant effect". SOEP papers on Multidisciplinary Panel Data Research Vol. 60. Berlin: DIW.

Sander, M. (2008): Changes in immigrants' body mass index with their duration of residence in Germany. In: *SOEP papers on Multidisciplinary Panel Data Research*. Vol. 122. Berlin: DIW.

Schenk, L. (2007): Migration und Gesundheit – Entwicklung eines Erklärungs- und Analysemodells für epidemiologische Studien. In: *International Journal of Public Health* 52 (2), pp. 87-96.

Schenk, L.; Ellert, U.; Neuhauser, H. (2008): Migration und gesundheitliche Ungleichheit. In: *Public Health Forum* 16 (59), pp. 18.e1-18.e3.

Schimany, P.; Rühl, S.; Kohls, M. (2012): Ältere Migrantinnen und Migranten. Entwicklung, Lebenslagen, Perspektiven. Forschungsbericht 18. Nürnberg: Bundesamt für Migration und Flüchtlinge.

Scholz, R. D.; Jdanov, D. A. (2006): Nutzung der Daten des Forschungsdatenzentrums der Rentenversicherung zur wissenschaftlichen Mortalitätsanalyse: Verfahren zur Korrektur der Bevölkerungsbestände der amtlichen Statistik im hohen Alter in Deutschland. In: *Deutsche Rentenversicherung Bund*. Vol. 55, pp. 200-211.

Schopf, C.; Naegele, G. (2005): Alter und Migration. In: *Zeitschrift für Gerontologie und Geriatrie* 38 (6), pp. 384-395.

Schulte-Sasse, H. (2003): Was bedeutet Migration für die Gesundheit? In: Beauftragte der Bundesregierung für Migration, Flüchtlinge und Integration (Eds.): Gesunde Integration. Dokumentation der Fachtagung am 20. und 21. Februar 2003. Berlin/Bonn: Bonner Universitäts-Buchdruckerei, pp. 14-21.

Sharma, R. D.; Michalowski, M.; Verma, R. B. P. (1990): Mortality differentials among immigrant populations in Canada. In: *International Migration* 28 (4), pp. 443-450.

Sluzki C. E. (2001): Psychologische Phasen der Migration und ihre Auswirkungen. In: Hegemann, T.; Salman R. (Eds.): Transkulturelle Psychiatrie. Konzepte für die Arbeit mit Menschen aus anderen Kulturen. Bonn: Psychiatrie Verlag, pp. 101-115.

Solé-Auró, A.; Crimmins, E. M: (2008): Health of immigrants in European countries. In: International Migration Review 42 (4), pp. 861-876.

Spallek, J.; Razum O. (2007): Gesundheit von Migranten: Defizite im Bereich der Prävention. In: *Medizinische Klinik* 102 (6), pp. 451-456.

Spallek, J.; Razum, O. (2008): Erklärungsmodelle für die gesundheitliche Situation von Migrantinnen und Migranten. In: Bauer, U.; Bittlingmayer, U. H.; Richter, M. (Eds.): Health inequalities: Determinanten und Mechanismen gesundheitlicher Ungleichheit. Wiesbaden: VS Verlag, pp. 271-288.

Statistisches Bundesamt (1991): Bevölkerung und Erwerbstätigkeit: Ausländer. Fachserie 1 Reihe 2. Wiesbaden: Statistisches Bundesamt.

Statistisches Bundesamt (2010): Bevölkerung und Erwerbstätigkeit: Ausländische Bevölkerung. Ergebnisse des Ausländerzentralregisters. Fachserie 1 Reihe 2. Wiesbaden: Statistisches Bundesamt.

Statistisches Bundesamt (2012): Bevölkerung und Erwerbstätigkeit: Ausländische Bevölkerung. Ergebnisse des Ausländerzentralregisters. Fachserie 1 Reihe 2. Wiesbaden: Statistisches Bundesamt.

Steinbach, A. (2004): Solidarpotenziale in Migrantenfamilien. In: Krüger-Potratz, M. (Ed.): Familien in der Einwanderungsgesellschaft. Beiträge der Akademie für Migration und Integration. Vol. 8. Göttingen: V&R unipress, pp. 39-48.

Sullivan, D. F. (1971): A single index of mortality and morbidity. In: *HSMHA Health Reports* 86 (49), pp. 347-354.

Tsugane, S.; Gotlieb, S. L.; Laurenti, R.; Souza, J; Watanabe, S. (1989): Mortality and cause of death among first-generation Japanese in Sao Paulo, Brasil. In: *International Journal of Epidemiology* 18 (3), pp. 647-651.

Uitenbroek, D. G.; Verhoeff, A. P. (2002): Life expectancy and mortality differences between migrant groups living in Amsterdam, The Netherlands. In: *Social Science and Medicine* 54 (9), pp. 1379-1388.

Ulrich, R. E. (2001): Die zukünftige Bevölkerungsstruktur Deutschlands nach Staatsangehörigkeit, Geburtsort und ethnischer Herkunft: Modellrechnung bis 2050. Erstellt im Auftrag der Unabhängigen Kommission "Zuwanderung". Berlin/Windhoek.

United Nations Educational, Scientific and Cultural Organisation (UNESCO); Institute for Statistics (UIS) 2012: Retrieved from 10th Mai 2013, available online at http://www.uis.unesco.org/EDUCATION/Pages/international-standard-classification-of-education.aspx.

van Oyen, H.; van der Heyden, J.; Perenboom, R.; Jagger, C. (2006): Monitoring population disability: evaluation of a new Global Activity Limitation Indicator. In: *Sozial- und Präventivmedizin/Social and Preventive Medicine* 51 (3), pp. 153-161.

Wengler, A. (2011): The health status of first- and second-generation Turkish immigrants in Germany. In: *International Journal of Public Health* 56 (5), pp. 493-501.

Wengler, A. (2012): Ungleiche Gesundheit. Zur Situation türkischer Migranten in Deutschland. Frankfurt/New York: Campus Verlag.

Wilkinson, R. G.; Marmot, M. (2003): Social determinants of health. The solid facts. 2nd ed. Copenhagen: World health Organization.

Zeeb, H.; Razum, O.; Blettner, M.; Stegmaier, C. (2002): Transition in cancer patterns among Turks residing in Germany. In: *European Journal of Cancer* 38 (5), pp. 705-711.

Zeman, P. (2005): Ältere Migranten in Deutschland. Befunde zur soziodemographischen, sozioökonomischen und psychosozialen Lage sowie zielgruppenbezogene Fragen der Politik- und Praxisfeldentwicklung. Expertise im Auftrag des Bundesamtes für Flüchtlinge und Migration. Berlin: Deutsches Zentrum für Altersfragen.

Mental health among immigrants: Is there a disadvantage in later life?

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Abstract

This study analyzes the mental health of immigrants living in Germany relative to the mental health of the non-migrant German population. We focus on health in the second half of life by following women and men born between 1922 and 1950 throughout the years 2002 to 2010. Using data from the German Socio-Economic Panel Study, we apply linear regression techniques to examine mental health. Health was included in the questionnaire as SF12, a set of questions that address both physical and psychological dimensions. Our sample contains 28,967 observations in total, which were gathered in five survey waves from 7,220 respondents, around 15% of whom were immigrants. The immigrants in the sample come from a wide range of countries, including former migrant worker countries such as Turkey. Some of the immigrants are ethnic Germans from eastern Europe, while others were asylum seekers. Overall, the analysis shows that immigrants rate their mental health as being significantly lower than that of non-migrants. These results therefore provide evidence for the immigrant disadvantage hypothesis. These differences can be explained in part by differences in the socio-economic composition of the groupings. Moreover, our study finds variation between the immigrant groups, as the analysis shows that asylum seekers as well as immigrants from Turkey and from southern and southeastern European countries have lower mental health than non-migrants and ethnic Germans.

1 Introduction

The growing share of immigrants who live in Germany, and especially the increasing number of immigrants who are reaching older ages, enable us to study the long-term effects of international migration on individuals' life courses. While social science researchers have become increasingly interested in studying the milestones in the life course – leaving the parental home, union and family formation, and other aspects of family dynamics – the effects of migration on health in general and at older ages in particular have, until recently, not been explicitly considered in health-related research for Germany. This dearth of research was largely attributable to the scarcity and inadequacy of the available data on immigrant health (Spallek and Razum 2008; Kohls 2012).

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The findings regarding the health status of international migrants in general have produced a contradictory picture, as studies that have compared immigrants to the majority population have generated both favorable and unfavorable results. These studies looked at both younger and older migrants. When lower morbidity is observed among immigrants, the healthy migrant effect may play a role: i.e., as the individuals who are selected into migration tend to be healthy, their health seems to be better than that of the average population at destination. Moreover, return migration seems to be more common among migrants who are ill (salmon bias hypothesis). While the relative health advantage of immigrants appears to be attributable to various selection mechanisms, it may also be explained by the health transition hypothesis (Razum and Twardella 2002), which posits that the migrants' respective countries of origin differ in their morbidity and mortality patterns from those in the country of destination, and that migrants may therefore cumulate the respective advantages from both countries. By contrast, the socio-economic position of international migrants is on average lower than that of non-migrants at the destination. This structural disadvantage, in combination with an adaptation to the lifestyle at the destination, may lead to a steady erosion of the initial health advantage, and may turn into a long-term disadvantage.

While these hypotheses have increasingly been tested in international studies on somatic health, the framework has also been applied to mental health, albeit to a lesser extent. Previous research has focused on the processes of migration and acculturation and their short-term impact on mental health, as well as on mental health among adolescents of the second migrant generation. Mental health among elderly migrants in Germany has not yet been studied. Our paper extends previous research by examining the mental health of international migrants in the second half of life. Elderly migrants may experience a cumulative disadvantage, which can in turn contribute to an elevated degree of psychological vulnerability: according to the compositional hypothesis, the socio-economic gap between the social groups in a given society may become even greater at older ages, when people are retired and collecting pensions (Tucci and Yildiz 2012). The healthy migrant effect may wear off with the length of time spent in the destination country and with age, and may even turn into an immigrant disadvantage. Meanwhile, somatic diseases may become more frequent and more serious with rising age, and could affect mental health as well.

Our research question is twofold. First we ask whether international migrants and non-migrants differ in their self-evaluations of mental health. Second, if there are differences, we ask why they appear. We take into account the origins of the immigrants, various socio-demographic and economic factors, and a number of other health indicators. The focus of our analysis is on the second half of life.

We investigate mental health among elderly immigrants and non-migrants living in Germany, a country which has, until recently, been one of the leading destinations for immigrants coming to western Europe. There are three major immigrant groups in Germany: migrant workers from Mediterranean countries, ethnic Germans from eastern Europe, and refugees and asylum seekers. Whereas the German-born population is declining due to persistent low fertility, the share of the population who have an immigrant background has been rising continuously. Today, about 20% of the 82 million inhabitants of Germany either migrated themselves, or were born to one or two parents born abroad (Swiazny and Milewski 2012).

2 Background

2.1 Theoretical considerations and previous research

The previous literature has clearly shown that international migration affects each domain in life, including those that become important in the later stages of a person's life course. While immigrants may benefit from new opportunities in the destination country, previous studies have focused mainly on the perception that migration is one of the most demanding events in life, and that it may disrupt the life course (disruption hypothesis) (Bhugra 2004; Carta et al. 2005). While many changes can occur when a person undertakes an international move, seven categories of losses have been identified: namely, the loss of family networks, social networks, language, culture, homeland, social status, and ethnic group contact. Because of these losses, migration may be viewed as a process of grief. If migrants have difficulties in expressing grief or in coping with their losses, psychological problems may be the consequence, especially in cases in which migration was not voluntary (Kuo 1976; EC 2004).

Other authors have compared a person's performance before, during, and after migration to behavior under stress (Bhugra 2004), with losses and mourning for those losses playing central roles. According to Sluzki (1979), five stages of migration and related psychological reactions can be identified. First, there is a stage in which the individual prepares mentally for the upcoming migration act. This phase has ups and downs, which may take the form of euphoria, overload, or dismay. In the second stage, the individual migrates, and faces various risks and burdens depending on the progression, the duration, and the form of the migration process. The third stage, which generally lasts about six months after migration, is often characterized by apparent calm. In this stage, individuals may overcompensate, concentrating only on positive images and opportunities, while discounting possible risks. The fourth stage, which may last several years, tends to be a period of decompensation or crisis. During this stage, the migrant becomes increasingly aware of the risks, burdens, and separation experiences he or she faces. "Some families manage to mourn what has been left behind and integrate it constructively into a blend of old and new rules, models, and habits that constitute their new reality. For them, the positive side of the experience outweighs the disruptive nature of the stress, and they emerge from the process – some three years after migration – with new individual and collective strengths" (Sluzki 1979: 5). Migrants who are less able to cope with the losses may experience high levels of intrafamilial conflict. In the fifth phase, the transgenerational impact of migration becomes apparent. This phase is characterized by the development of individual adaptation strategies and of a bicultural identity. If the first generation in migrant families has avoided intercultural and interfamilial confrontations, conflicts may occur between the first- and the second-generation members, as members of the younger generation adapt to the values of the host society while their parents continue to adhere to the values of the home country (Sluzki 1979).

The gradual adaptation to a new context can be divided into three domains of acculturation: socio-cultural, economic, and psychological (Berry 1997). Psychological adaptation is "a set of internal psychological outcomes including a clear sense of personal and cultural identity, good mental health, and the achievement of personal satisfaction in the new cultural context," and socio-cultural adaptation is "a set of external psychological

outcomes that link individuals to their new context, including their ability to deal with daily problems, particularly in the areas of family life, work and school" (Berry 1997: 14). If, however, individuals experience a mismatch between their expectations and reality, or if conflicts occur, acculturative stress may be the consequence. This stress may increase the greater the cultural distance is between the societies of origin and of destination and the higher the need for greater culture learning is (Berry 1997: 23).

Cultural distance refers mainly to the dimensions of language, religion, and values. While knowledge of the language of the host country enhances an immigrant's ability to integrate and communicate with members of the host society, having shared values and beliefs also seem to be crucial components of social and family life. According to Inglehart (1997), there are two basic types of societies. Societies of the first type tend to be dominated by rather traditional family values, including strong intergenerational ties and the clear division of labor between men and women. In societies of the second type, religion tends to be viewed as less important, there is more support for gender equality, and individual wellbeing is more highly regarded than collective interests. This categorization is in line with Reher's (1998) typology of family systems in Europe, in which he distinguishes between countries, often located in the Mediterranean region, in which a tradition of stem families dominates and in which great value is placed on familism; and the northern countries, which are less likely to have these characteristics.

The short-term disruptive effects of migration and the persisting socio-cultural conflicts that result from contrasts between the country of origin and the country destination may contribute to long-term health disadvantages among migrants. In addition, the socio-economic position of immigrants is, on average, lower than that of the non-migrants in the destination country (Massey 1981). Since socio-economic disadvantages are correlated with health inequalities, immigrants may have worse mental health than non-migrants (immigrant disadvantage hypothesis; Kirkcaldy et al. 2006).

Good mental health appears to be both a prerequisite for coping with migration and acculturation, as well as the outcome when migration and incorporation into the new society have taken place. Therefore, selection effects must be taken into account as well. Two main outcomes of these selection mechanisms are possible. First, the mental health of migrants may appear to be worse because of social selection: i.e., selection into migration (Binder and Simoes 1980). While migration and incorporation processes are mediated and depend to a large extent on socio-economic factors, they also affect mental health. Several authors have assumed that migrants tend to have lower socio-economic status in their home countries, and that this initial disadvantage is the reason why their mental health is worse than that of non-migrants in the destination country. Testing the hypothesis of selection into migration, Binder and Simoes (1980) compared emigrants from Portugal in Switzerland to stayers in Portugal, but found no evidence to support this hypothesis.

By contrast, the second set of selection mechanisms would predict the opposite effect: immigrants may have, at least initially, better mental health than non-migrants (healthy migrant effect; Wu and Schimmele 2005). The individuals who choose to undertake an international move must be healthy and able to migrate. However, studies of various health indicators have shown that a number of other factors can affect health over the long term, including socio-economic status (Bollini and Siem 1995; Porsch-Oezcueruemez et al. 1999; Wilkinson and Marmot 2003; Ronellenfitsch and Razum 2004), occupational and economic uncertainty, dangerous working conditions, and unfavorable living conditions (Razum et al. 2008; Spallek and Razum 2008; Hubert et al. 2009). On average, migrants have lower

social status than native-born citizens, and are therefore subject to the risk factors associated with having a disadvantaged position in society (Hoffmann-Nowotny 1973; Razum et al. 2008; Shen and Takeuchi 2001; Wengler 2011). These health disadvantages may cumulate and lead to worse health over time among immigrants; i.e., to an erosion or even disappearance of the healthy migrant effect. Bollini and Siem (1995) called this the exhausted migrant effect. As somatic morbidity increases with the length of stay, it can be assumed that an immigrant's mental health may have been good initially, but that it becomes worse the longer the immigrant lives in the new country (Carballo and Nerukar 2001; Wu and Schimmele 2005; Kotwal 2010).

Previous research has investigated the various dimensions of mental health and wellbeing of international migrants. Clinical studies have focused on severe psychological disorders, including schizophrenia, anxiety, depression, and suicide (Bhugra and Jones 2001; Carta et al. 2005). Meanwhile, social science researchers have investigated life satisfaction and wellbeing, overall mental health, and depression (Carballo and Nerukar 2001; Kirkcaldy 2005). The results of these studies have, however, been inconsistent. In line with the findings on mortality and various aspects of physical health and disability, immigrants have been found to have better mental health than the non-migrants in a few studies (e.g., Vietnamese refugees in Australia have been shown to have lower rates of depression (Steel et al. 2005)), and to have worse mental health in the majority of studies. A number of clinical studies have found higher rates of mental disorders among immigrants: e.g., Hemsi (1967), Cochrane (1977), Rwegellera (1977), McGovern and Cope (1987), Harrison et al. (1997), and Cochrane and Bal (1989). Immigrant disadvantages in life satisfaction and physical symptoms related to stress have also been reported (Kirkcaldy et al. 2005 for Germany). The mental health of immigrants has been shown to decrease as the duration of stay increases; this finding supports the hypothesis of the healthy migrant effect (Wu and Schimmele 2005; Kotwal 2010 for Germany).

These studies also found differences among immigrants by country of origin. Higher rates of psychiatric disorders have been also observed in the initial period after migration: e.g., for Greeks in Cyprus (Mavreas and Bebbington 1990) and for Chinese in New Zealand (Abbott et al. 1999). The experience of discrimination leads to a worsening of psychological wellbeing (Liebkind and Jasinskaja-Lahti 2000) and mental health (Igel et al. 2010 for Germany). Intra-group differences have also been traced back to acculturation. Vega et al. (1987) found for Mexican immigrant women in the U.S., and Cheung (1995) found for Cambodian refugees in New Zealand that the highest rates of psychiatric morbidity were among those immigrants who seemed to be the least acculturated (see also: David et al. (2002); Mewes et al. (2010) for Germany).

Research on adolescents, mainly descendants of first-generation immigrants, has suggested that immigration not only has a short-term impact on mental health; but that it can even affect the next generation. Life satisfaction has been found to be lower among immigrant adolescents in Norway (Sam 1998), and higher levels of depression have been measured among immigrant children in Norway (Fandrem et al. 2009). Moreover, less acculturated immigrant children in England were shown to have worse mental health (Bhui et al. 2005). Comparing the first and second immigrant generations in England, McGovern and Cope (1987) found that, compared to the non-migrant population, the rates of schizophrenia and psychosis were higher in the second generation, but about the same in the first generation. These findings appear to support the hypothesis of cumulative disadvantages. For Germany, Kotwal (2010) found that immigrants of the second Turkish

generation rated their mental health lower than non-migrants. This may be an indicator of intragenerational conflicts that do not appear until years after immigration, as the acculturation process of immigrant families may continue with the second generation. If this is the case, first-generation immigrants may also report worse mental health in their later years of life.

2.2 Working hypotheses

In our paper, we focus on the mental health of elderly immigrants relative to that of non-migrants in Germany. We derive our working hypotheses from the theoretical framework and the previous empirical framework as follows:

H1) *Immigrant disadvantage hypothesis*: We assume that elderly immigrants in Germany rate their mental health lower than non-migrants because international migration is a stressful process which may affect mental health throughout the whole life course, and that the healthy migrant effect may level off as the length of stay increases (Sluzki 1979; Berry 1997).

H2) *Socio-economic composition hypothesis*: The socio-demographic composition of the immigrant group differs from that of non-migrants, and the immigrants' economic situation is on average worse. Since these factors are predictors of mental health, we assume that the differences in mental health between immigrants and non-migrants – assuming they exist – will decrease or vanish when we control for socio-demographic and economic indicators (Kotwal 2010).

H3) *Hypothesis of somatic health*: On one hand, immigrants have advantages in somatic health compared to non-migrants (Abraído-Lanza et al. 1999; Razum et al. 2000; Razum and Twardella 2002). On the other hand, immigrants have certain disadvantages, especially with increasing length of stay: e.g., lower health expectancies, lower rates of health care utilization, and higher rates of risk factors like adiposity (Schenk 2007; Sander 2008; Carnein et al. 2015 in this issue). If the differences in mental health levels between immigrants and non-migrants are caused by these health factors, these differences may decline or disappear when we control for other health factors.

H4) *Hypothesis of within-group variation*: We expect to find that mental health varies between immigrants by group of origin. The greater the cultural distance between the country of origin and Germany, the more demanding the process of acculturation is likely to be, and the greater the likelihood that the immigrant will experience conflicts and discrimination (David et al. 2002; Mewes et al. 2010). Moreover, differences between the immigrant groups in terms of socio-economic structure, as well as differences in their reasons for migration and types of legal status, may contribute to within-group variation in mental health. Ethnic Germans, for example, have the right to apply for German citizenship upon arrival, whereas asylum seekers may endure several years of uncertainty about whether they will be permitted to stay (Münz 1997). Moreover, the circumstances of migration itself may affect mental health throughout the life course, such as experiences of war and persecution among the asylum seekers.

3 Methods

3.1 Data

We used data from the German Socio-Economic Panel (SOEP). This is a panel study which started in 1984 as a random sample representative of private households in West Germany. One of the samples, the so-called "guest worker" sample, consists of immigrants who came to Germany to work. Most of these immigrants are from Mediterranean countries, especially Turkey, Greece, former Yugoslavia, Italy, and Spain. A sample of eastern Germans was added in 1990, and a sample of new immigrant groups was added in 1994/95 (Wagner et al. 2007). Five subsamples have also been added to account for panel attrition and to oversample people with higher incomes. In 2010, the total number of interviewed persons was 19,127 (TNS Infratest 2010).

The questions related to the general physical and health condition of the SOEP respondents were revised in 2002. Since then, the so-called SF-12v2 has been included in the questionnaire in a two-year interval. These 12 items are a subset of the SF-36v2™, and measure eight domains of health. Using these eight scale variables, two superordinate scale variables were constructed and are provided by the SOEP: namely, physical health (PCS) and mental health (MCS)[1], each with a range of zero to 100, with higher values indicating better health. The mean value for the whole German sample was standardized to 50, with a standard deviation of 10 (Andersen et al. 2007). We used each wave of the SOEP that contains information on mental health: i.e., the waves of 2002, 2004, 2006, 2008, and 2010. Our sample includes all of the respondents for whom valid information was available on mental health status, as well as on sex, age, and immigrant background. The dependent variable in our analysis is mental health, which was used as a metric variable.

We used the SOEP subsamples of western Germans, foreigners in western Germany, eastern Germans, new immigrants from 1984 to 1993, as well as the refreshments from 1993 and 2000. Since the focus of our analysis is on the second half of life, we followed the birth cohorts of 1922 to 1950 throughout the survey waves 2002, 2004, 2006, 2008, and 2010. Hence, the respondents were aged 52 to 88 in the respective waves. In total, 7,720 respondents were included in our sample, for whom 28,967 observations were available. Based on our panel design, each respondent would in theory have been observed exactly five times. However due to non-response or panel attrition, we had an unbalanced panel; about 12% of the respondents were included in one survey year, 13% in two years, 12% in three years, 17% in four years, and around 47% in all five survey years (see Table 1). The observations were almost equally distributed over the five calendar years (see Table 2).

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1 The questions referring to mental health are as follows: "How often did the following occur within the last four weeks:
- that you felt run-down and melancholy?
- that you felt relaxed and well-balanced?
- that due to mental health or emotional problems you achieved less than you wanted to at work or in everyday tasks?
- that due to mental health or emotional problems you carried out your work or everyday tasks less thoroughly than usual?" (Wagner et al. 2007).

Tab. 1: Overview about the panel structure of the sample

Number of observations per person	Number of persons	Persons (%)	Number of observations
1	894	11.6	894
2	962	12.5	1,924
3	928	12.0	2,784
4	1,315	17.0	5,260
5	3,621	46.9	18,105
Total	*7,720*	*100*	*28,967*

Source: Calculations based on SOEP 1984-2010.

Note: Survey years 2002, 2004, 2006, 2008, and 2010.

3.2 Variables

Table 2 provides a descriptive overview on the sample. A first group of covariates captured the socio-demographic characteristics of the respondents. The immigrant background of each of the respondents was constructed using information on his or her country of birth and nationality(ies), and the type of the subsample to which he or she belonged, such as those made up of immigrants (Milewski 2007; Scheller 2011). If any of these variables indicated a foreign place of birth or a foreign nationality in either year, the person was defined as having an immigrant background in this study. In our sample, 15% of the respondents were immigrants (n=623), and 85% were non-migrant Germans (n=6,597) (Germans living abroad were not included in our study). This corresponds quite closely to the respective proportions in the population of Germany, as the share of people who have an immigrant background is under 20% in the older age groups due to the relatively young age structure of the immigrant populations (Swiazny and Milewski 2012). Among the immigrants, five groups were distinguished in our sample: immigrants from Turkey and from former guest worker recruitment countries in southern and southeastern European countries, i.e., mainly former Yugoslavia, Greece, Italy, and Spain; ethnic Germans from eastern European countries; persons who came initially as asylum seekers from various countries; and immigrants who came from other countries belonging to the European Union. The cases in the last category, labeled "other," were very heterogeneous, but further distinctions between them were not possible due to the large number of origin countries. We excluded the few observations in which the duration of stay of the immigrants was less than five years in order to exclude the immediate effects of the move on subsequent health reports (Sluzki 1979).

The control variables used were mainly those that were shown in the previous literature to have a significant impact on the health differentials between migrants and non-migrants, as well as on mental health, and whose effects were largely consistent over time and across regions (Table 2 indicates the number of observations and the respective percentages).

Tab. 2: Descriptive overview of the sample

Variables	Total observations	%	Immigrant observations	%	Non-migrant observations	%
Total	*28,967*	*100*	*3,874*	13.4	25,093	86.6
Socio-demographic measures						
Country/group of origin						
Germany			na		25,093	100.0
Turkey			561	14.5		
Italy, Spain, Greece, former Yugoslavia			1130	29.2		
Ethnic German/Eastern Europe			871	22.5		
Asylum seeker			128	3.3		
Other EU countries			123	3.2		
Other			1061	27.4		
Sex						
Male	13,879	47.9	1,875	48.4	12,004	47.8
Female	15,088	52.1	1,999	51.6	13,089	52.2
Age (years) (t-v)***						
52 to 59	5524.0	19.1	914.0	23.6	4610.0	18.4
60 to 64	6,473	22.3	961	24.8	5,512	22.0
65 to 69	6,632	22.9	814	21.0	5,818	23.2
70 to 74	5,104	17.6	532	13.7	4,572	18.2
75 to 80	3,895	13.4	477	12.3	3,418	13.6
81 to 88	1,339	4.6	176	4.5	1,163	4.6
Calendar year***						
2002	7,254	25.0	1,047	27.0	6,207	24.7
2004	6,552	22.6	930	24.0	5,622	22.4
2006	5,800	20.0	776	20.0	5,024	20.0
2008	5,093	17.6	639	16.5	4,454	17.7
2010	4,268	14.7	482	12.4	3,786	15.1
School education***						
No degree or compulsory/ other (Hauptschule)	18,706	64.6	3,262	84.2	15,444	61.5
Lower secondary (Realschule)	5,803	20.0	286	7.4	5,517	22.0
Upper secondary (Abitur)	4,425	15.3	315	8.1	4,110	16.4
mv	33	0.1	11	0.3	22	0.1

Variables	Total observations	%	Immigrant observations	%	Non-migrant observations	%
Marital status (t-v)***						
Not married	1,055	3.6	129	3.3	926	3.7
Married (living together)	20,833	71.9	2,926	75.5	17,907	71.4
Divorced/married (living separately)	2,466	8.5	306	7.9	2,160	8.6
Widowed	4,582	15.8	483	12.5	4,099	16.3
mv (incl. partner living abroad)	31	0.1	30	0.8	1	0.0
Ever unemployed (t-v)***						
No	21,960	75.8	2,557	66.0	19,403	77.3
Yes	7,007	24.2	1,317	34.0	5,690	22.7
Public transfers (t-v)***						
No	21,578	74.5	2,459	63.5	19,119	76.2
Yes	7,389	25.5	1,415	36.5	5,974	23.8
Region of residence (t-v)***						
Western federal states	20,687	71.4	3,546	91.5	17,141	68.3
Berlin	1,066	3.7	86	2.2	980	3.9
Eastern federal states	7,214	24.9	242	6.2	6,972	27.8
Health status						
Feeling lonely (t-v)***						
No	27,779	95.9	3,675	94.9	24,104	96.1
Yes	1,188	4.1	199	5.1	989	3.9
Chronic disease (t-v)***						
No	26,403	91.1	3,594	92.8	22,809	90.9
Yes	2,564	8.9	280	7.2	2,284	9.1
Disability(t-v)°						
No	22,285	76.9	3,024	78.1	19,261	76.8
Yes	6,682	23.1	850	21.9	5,832	23.2
Dependent variable	mean		mean		mean	
Mental health scale***	50.87		49.84		51.03	
N	*7,220*		*623*		*6,597*	

Source: Calculations based on SOEP 1984-2010. mv=missing values, na=not applicable, t-v=time-varying covariate.

Note: *** p < .001, ** p < .01, * p < .05, ° p < .1 = bivariate association between migrant status and variable significant (chi2-test; for mcs t-test).

The sex distribution was almost even in our sample: 48% of the observations were on men and 52% were on women. Women may be expected to report worse mental health than men (Abbott et al. 1999; Bhugra 2004; Mewes et al. 2010). The ages of the respondents ranged from 52 to 88 years. The age structure of the immigrant respondents was slightly younger

than that of the non-migrant respondents. We assume that mental health declines with increasing age (Abbott et al. 1999; Kotwal 2010; Mewes et al. 2010).

Educational level was measured using three categories (time-constant): about two-thirds of the respondents left school without a degree or obtained a primary degree ("*Hauptschule*"), about 20% completed lower secondary education ("*Realschule*"), and 15% finished upper secondary school with a certificate ("*Abitur*"). Since the share of respondents who obtained an upper secondary degree was less than a fifth in total and was considerably smaller among the immigrants (below 10%), we considered having some secondary education to be sufficient to qualify for the third category (the results are rather close to the numbers released by the Federal Statistical Office for 2008: i.e., about 11% of foreigners (including all nationalities and all age groups) had completed secondary education (SVR 2010)). We expect to find that individuals with high levels of education have lower levels of mental health than individuals who have only compulsory educational qualifications (Vega et al. 1987; Hurh and Kim 1990; Abbott et al. 1999).

The marital status of the respondents was used as a time-varying variable. The majority of observations captured years in which the respondents were married and were living with a spouse (72%). The respondents were widowed in around 16% of the observations, and were divorced or separated in about 9% of the observations. We assume that mental health is lower for widowed and divorced/separated people than it is for married people (Vega et al. 1987; Hurh and Kim 1990).

We used two indicators to take into account the respondents' financial situation. Since many of the respondents in our sample were retired, we did not use current laborforce participation. We did, however, include information on a respondent's employment history by using a time-varying dummy variable which captured whether the respondent was ever unemployed before the respective survey wave. In about 24% of the observations in the sample, the respondent had been unemployed at some point in his or her work history. We assume that people who experienced unemployment may have also had lower levels of mental health later in life (Hurh and Kim 1990; Abbott et al. 1999; Ronellenfitsch and Razum 2004; Assion 2005; Kirkcaldy et al. 2006). The public transfer variable, which often fluctuated by calendar year, indicated whether any person in the household received public transfers, such as housing subsidy or social assistance. This variable is a proxy for social status and income. Public transfers were reported for about 26% of the observations. We assume that welfare dependency is associated with a lower level of mental health (as Ronellenfitsch and Razum 2004 showed for health satisfaction).

A second set of variables captured the respondents' health. In about 4% of our observations, respondents reported feeling lonely. Loneliness is assumed to be associated with a lower level of mental health (Kuo 1976; Neto 1995; Zilber and Lerner 1996; Kotwal 2010). Two indicators for physical health were used. A dummy variable indicated disability (activity limitations in daily life), which was reported in about 23% of the observations. Another dummy variable was captured if the respondents had any chronic disease, which was reported in about 9% of observations. Both factors are assumed to decrease mental health (Shen and Takeuchi 2001).

Finally, the calendar year and the region of residence were used as control variables. The majority of respondents lived in the western part of Germany. About 71% of the observations were in western Germany, 4% were in Berlin, and 25% were in eastern Germany. Each of these independent variables included in the final analysis were shown to have a significant impact on mental health in the bivariate analyses (see Table 2).

Additional determinants of immigrant health – such as duration of stay, language proficiency, or the experience of discrimination (Igel et al. 2010) – were not included in our final analysis, since they apply to immigrants only. In an exploratory analysis, we also used homeownership and income as additional time-varying covariates. We expected to find that mental health increases with income (Vega et al. 1987; Kirkcaldy et al. 2006). Since income correlated with the other economic indicators, and the other indicators had more predictive power, we dropped income from the final analysis. We also used the information on religious affiliation and the importance of religion in life to capture the cultural background of the respondent. We expected to find that mental health is lower among people with no religious affiliation (about one-fifth in our sample) than among people who belong to a Christian church or to another denomination (Gold 1992; Zilber and Lerner 1996; Strawbridge et al. 2001; Yeung and Chan 2007). Unfortunately, the variable on religiosity had a large share of missing values. As neither indicator for religion showed a significant impact on the dependent variable, these indicators were left out. Moreover, we used smoking habits and alcohol consumption as further indicators for health-related behavior that may have an impact on mental health. These variables did not, however, add to the explanations of the differences between immigrants and migrants or improve the model fit.

3.3 Modeling strategy

In the multivariate analysis (Table 3), we ran linear random effects regression models for the mental health scale using a panel regression set-up based on five survey years. The metric dependent variable was mental health, which was close to a normal distribution. The model estimated the mean effects of the covariates on mental health over the five survey years. The random effects model accounted for within-person correlation as well as between-persons variation, which was our primary focus. The model also allowed us to include time-constant covariates such as the immigrant origin, which was our main variable of interest (Cameron and Trivedi 2009, Kohler and Kreuter 2012).

The model can be described as follows:

$$Y_{it}=bX_{it} + a + u_{it} + e_{it}$$

Y_{it} denotes mental health, X_{it} are the observed time-dependent and time-invariant covariates, a is the estimated constant and b are the estimated parameters. The term u_{it} captures the errors between persons across time, and e_{it} captures the errors within persons. The variation between individuals is assumed to be random and not correlated with the dependent variable.

The modeling process was done stepwise, with the coefficients for immigrant groups controlled for sex and age estimated first (Model 1). In Model 2 we added education and the experience of past unemployment, as well as further socio-demographic variables referring to the current living situation, such as marital status and public transfers. The variables unemployment and public transfers are correlated with education; i.e., people with higher levels of education are less likely to have been unemployed or to have received public transfers. Nevertheless, the inclusion of each of these three variables improved the model fit. The calendar year and the region of residence served as further controls. Model 3 included the health variables disability, chronic disease, and loneliness.

Tab. 3: Determinants of mental health (unstandardized b-coefficients)

	Model 1				Model 2				Model 3			
	b	lower ci	upper ci	p	b	lower ci	upper ci	p	b	lower ci	upper ci	p
Country/group of origin (ref.: Germany)												
Turkey	-2.67	-4.06	-1.29	<0.001	-1.91	-4.07	-0.24	<0.082	-2.10	-4.15	-0.04	<0.045
Italy, Spain, Greece, former Yugoslavia	-1.65	-2.57	-0.73	<0.001	-1.03	-2.07	0.01	0.051	-1.04	-2.05	-0.02	0.045
Ethnic German/ Eastern Europe	-0.37	-1.32	0.59	0.452	-0.10	-1.06	0.86	0.839	-0.21	-1.12	0.70	0.644
Asylum seeker	-3.70	-6.98	-0.42	0.027	-3.34	-6.49	-0.18	0.038	-3.31	-6.29	-0.32	0.030
Other EU countries	0.40	-2.98	3.78	0.871	-0.10	-3.47	3.27	0.953	-0.01	-3.25	3.22	0.993
Other	0.18	-0.74	1.11	0.695	0.19	-0.74	1.12	0.692	0.16	-0.75	1.0	0.735
Sex (ref.: male)												
Female	-1.99	-2.37	-1.61	<0.001	-1.74	-2.14	-1.35	<0.001	-2.00	-2.38	-1.62	<0.001
Age (years) (ref.: 52 to 59)												
60 to 64	1.14	0.81	1.46	<0.001	1.08	0.74	1.42	<0.001	1.21	0.87	1.55	<0.001
65 to 69	1.65	1.27	2.04	<0.001	1.44	1.01	1.87	<0.001	1.53	1.10	1.95	<0.001
70 to 74	0.85	0.42	1.29	<0.001	0.68	0.18	1.19	0.008	0.79	0.30	1.29	0.002
75 to 80	-0.14	-0.65	-1.46	0.586	-0.25	-0.85	0.34	0.403	-0.04	-0.62	0.54	0.889
81 to 88	-2.21	-2.96	-1.46	<0.001	-2.12	-2.97	-1.28	<0.001	-1.62	-2.45	-0.80	<0.001
Education (ref.: no degree/compulsory/other)												
Lower secondary					1.04	0.55	1.53	<0.001	0.89	0.42	1.37	<0.001
Upper secondary					0.90	0.34	1.46	0.002	0.62	0.08	1.17	0.025
mv					2.61	-1.38	6.61	0.200	2.01	-2.00	6.01	0.326
Ever unemployed (ref.: no)												
Yes					-0.94	-1.38	-0.493	<0.001	-0.92	-1.35	-0.49	<0.001
Calendar year (ref.: 2002)												
2004					0.56	0.26	0.87	<0.001	0.59	0.29	0.90	<0.001
2006					0.34	0.004	0.68	0.047	0.43	0.09	0.76	0.013
2008					0.59	0.23	0.96	0.001	1.47	1.11	1.84	<0.001
2010					0.12	0.23	0.54	0.553	0.74	0.26	1.21	0.002
Region of residence (ref.: Western federal states)												
Berlin					-0.35	-1.34	0.64	0.491	-0.22	-1.20	0.76	0.659
Eastern federal states					-1.76	-2.27	-1.26	<0.001	-1.98	-2.47	-1.49	<0.001
Marital status (ref.: married, living together)												
Not married					-0.76	-1.81	0.29	0.155	-0.56	-1.56	0.43	0.267
Divorced/ married, living separately					-1.41	-2.10	-0.72	<0.001	-1.18	-1.84	-0.51	0.001
Widowed					-1.44	-2.00	-0.89	<0.001	-1.17	-1.70	-0.63	<0.001
mv (incl. partner living abroad)					-6.34	-11.12	-1.56	0.009	-6.14	-10.76	-1.51	0.009

	Model 1				Model 2				Model 3			
	b	lower ci	upper ci	p	b	lower ci	upper ci	p	b	lower ci	upper ci	p
Religious affiliation (ref.: Catholic)												
Protestant					0.39	-0.09	0.87	0.115	0.34	-0.13	0.81	0.155
Greek/other Christian					0.31	-1.04	1.66	0.652	0.13	-1.18	1.44	0.844
Other religion					0.31	-1.48	2.09	0.736	0.21	-1.50	1.91	0.814
No affiliation					1.13	0.52	1.75	<0.001	1.16	0.56	1.75	<0.001
mv					-0.85	-1.99	0.30	0.149	-0.91	-2.05	0.22	0.115
Public transfers (ref.: no)												
Yes					-1.55	-1.88	-1.23	<0.001	-1.44	-1.76	-1.13	<0.001
Home owner (ref.: no)												
Yes					0.43	0.03	0.83	0.033	0.43	0.03	0.82	0.034
Feeling lonely (ref.: no)												
Yes									-3.47	-4.07	-2.88	<0.001
Chronic disease (ref.: no)												
Yes									-0.85	-1.35	-0.35	0.001
Disability (ref.: no)												
Yes									-3.16	-1.35	-2.76	<0.001
Time to death (ref.: no)												
Yes												
Constant	51.05			<0.001	51.32	50.72	51.92	<0.001	52.09	51.509	52.678	<0.001
R^2 *within persons*	0.008				0.012				0.016			
R^2 *between persons*	0.020				0.048				0.107			
R^2 *overall*	0.018				0.038				0.076			

Source: Calculations based on SOEP 1984-2010. N=7,720; mv=missing values.

Note: Controlled for within-person correlation.

4 Results

On average, the immigrants rated their mental health lower than the non-migrants (Table 2). Since one hypothesis is that compositional differences can explain health differentials, we begin the results section by describing the compositional differences between the non-migrants and the immigrants (Table 2). The immigrants were slightly younger than the non-migrants, and the majority of them lived in the western part of Germany. In line with the previous literature (e.g., SVR 2010), our bivariate tests showed there were significant differences between the immigrants and the non-migrants in terms of their socio-demographic characteristics: the immigrants had less education and lower incomes, they were more likely to receive public transfers, and they were more likely to have had frequent episodes of unemployment. Concerning the health variables, the immigrants were more likely to report feeling lonely, but fewer of them reported having a chronic disease or being disabled.

4.1 Mental health by origin

The mental health of migrants was significantly lower than that of the non-migrants, and there was considerable heterogeneity among the immigrants according to their country of origin. Controlled for sex and age, the mental health score was about 2.7 units lower among the Turks than it was among the non-migrants (Model 1 in Table 3). In addition, the migrants from southern and southeastern Europe, and the asylum seekers, rated their mental health as being significantly lower than that of the non-migrants. The differences between the other origin groups and the non-migrants were not significant.

These significant health disadvantages among the immigrant groupings from Turkey and from southern and southeastern Europe, and among the asylum seekers, persisted when socio-demographic variables, economic indicators, and the controls for region and calendar period were taken into account (Model 2 in Table 3). The size of the coefficients decreased, however. After controlling for these variables, the results showed that, on average, the Turks rated their mental health 2.0 units lower than the non-migrants. The reduction in health differentials was mainly caused by the variables of education, unemployment, and public transfers. This indicates that the below-average levels of human capital among the immigrants can partly explain the health differentials between the immigrants and the non-migrants.

Model 3 in Table 3 added the health variables, which contributed little to our efforts to find an explanation for the variation between the immigrant origin groups. The mental health disadvantages of the Turks, the southern and southeastern Europeans, and the asylum seekers remained significant. The coefficients varied slightly between Models 2 and 3. This was attributable to the immigrants' advantages in the variables of chronic disease and disability.

We also tested whether the immigrant groups varied in their mental health rating by using the group from Turkey as a reference category. The results showed that the mental health of immigrants from southern and southeastern Europe and of asylum seekers did not differ significantly from the mental health of the Turks. Ethnic Germans, however, had significantly better mental health than the Turks when controlling for sex and age only. Their health advantage was fully explained by the socio-demographic variables (results not shown).

4.2 The effect of control variables

The effects of the control variables were largely as expected, which is an indicator of the robustness of our analyses. We report these effects, but do not discuss them in detail. Concerning the socio-economic indicators, the mental health scores were found to be lower among respondents who had a low level of education or no school certificate, who had experienced spells of unemployment, and who had received public transfers.

The indicators of physical health and health behavior were strongly correlated with mental health. The respondents who were suffering from chronic diseases or disabilities that affected their ability to perform everyday activities had lower mental health scores. Feeling lonely was also associated with worse mental health.

The mental health scores decreased with age, and were lower among women than among men. The ratings were also lower among the respondents who were separated, divorced, or widowed than they were among the respondents who were married. The effect of the calendar

year was inconsistent. While mental health was slightly higher in the years after 2002, the first year included in our study, the trend was not consistent. Mental health appears to have been lower among people living in eastern Germany, which is not related to immigrant disadvantages, since only a few of the immigrants in our sample lived in eastern Germany.

4.3 Sensitivity analyses

We performed a series of sensitivity analyses (results not shown): we ran a logistic regression analysis on the mental health scale, classifying the lowest 20% of respondents on the mental health scale as having poor mental health. We restricted the analysis to respondents aged 60 to 80, but included people who had stayed in Germany for less than five years. In order to test the impact of having only one observation for a respondent (and thus no within-person variability), we estimated all of the models using only data on those respondents who had been observed two or more times. We did this because the mean of the mental health value was significantly lower among the respondents who participated only once during the observation period than it was among the respondents who were observed two to five times (48.0 vs. 51.0). The results did not change, however.

Proximity to death is another variable that influences the different domains of health (Gill et al. 2010). About 13% of the respondents in our study sample died during the observation period. The share was lower among the immigrants (9.4%) than it was among the non-migrants (12.8%). The share was particularly low among the Turks (5.6%) and high among the ethnic Germans (10%); although even for the latter group the share was below that of the non-migrants. The exception was the origin group of the asylum seekers, around 23% of whom died in the observation period. Including this information in our model did not change the mental health differential between the immigrant groups (results not shown). For the 894 respondents with only one observation in our study sample, we checked whether the missing answers were related to death. This was, however, found to have been the case for only around 30% of these respondents, and their deaths occurred between one and seven years after the respective survey interview.

In addition, we ran the models separately for each survey year, as well as for the immigrants only. Overall, the sizes of the effects varied only slightly, and the significance levels of the coefficients remained relatively stable. The overall pattern estimated for the immigrant groups relative to the non-migrants was robust. We also ran a fixed effects regression model. The advantage of this kind of model is that the time-varying covariates do not have to be independent. The time-invariant characteristics, such as an individual's immigration status, were, however, dropped due to the model specification. The results from the time-varying covariates were essentially identical to those reported here.

5 Discussion

Our paper investigated mental health among elderly people with and without an immigrant background living in Germany, one of the main destination countries for international migrants in Europe. We used rich data from the German Socio-Economic Panel, which is the largest longitudinal survey in Germany that collects information on the life histories of

both German-born and immigrant populations. We studied immigrant women and men born from 1922 to 1950 over five survey waves from 2002 to 2010, and compared their self-assessments of their mental health to those of non-migrants.

Our results supported the immigrant disadvantage hypothesis (H1). We found that elderly immigrants in Germany had significantly lower mental health scores than non-migrants, independent of a series of control variables. This finding suggests that the healthy migrant effect, as described in the literature, either levels off at older ages, or does not apply to mental health.

The mental health status was shown to vary by country and/or group of origin, which lends support to the hypothesis of within-group variation among immigrants (H4): the immigrants from Turkey and from southern and southeastern Europe, as well as the asylum seekers, rated their mental health lower than the non-migrants and the migrants from other European or industrialized countries. This finding can be traced back to two factors. First, previous studies showed that the greater the cultural distance between the respective countries of origin and Germany, the more demanding the process of acculturation is. In terms of religious affiliation, language proximity, and family norms, the cultural gap is largest between Turks and Germans. Studies on immigrants in Germany have shown that the likelihood of experiencing discrimination increases with cultural distance, and there is ample evidence of a strong relationship between discrimination and poor mental health (David et al. 2002; Igel et al. 2010; Mewes et al. 2010). Second, the legal status of immigrants affects their mental health: the persons who came to Germany as asylum seekers, who may have been forced to flee from dangerous conditions, and who likely endured several years of uncertainty about whether they would be able to stay in Germany, had especially low mental health ratings. By contrast, the ethnic Germans, who were granted German citizenship upon arrival, had mental health scores that were slightly (but not significantly) lower than those of the non-migrants, but higher than those of the other immigrant groups.

The existence of significant variation in the health status of immigrant groups is, however, only one important finding. The other main finding is that the socio-economic composition of the different groups contributes to the mental health differences. Our study provided partial evidence for the hypothesis of socio-economic composition (H2). The socio-demographic composition and the economic situations of the immigrant groups differed significantly from those of the non-migrants; i.e., compared to the non-migrants, the immigrants were more likely to have had low educational levels, periods of unemployment, and periods when they relied on welfare benefits. Controlling for these and other factors decreased the differences in the mental health ratings of the immigrants and the non-migrants. We should note, however, that differences remained.

Our findings lead us to ask what role immigrant selection may play in mental health. In our analysis, we could not test the hypothesis of selection into migration by comparing international migrants to the populations in their respective countries of origin. We were also unable to examine the short-term impact of migration, since our analysis focused on the second half of life, and we included only those immigrants who had stayed in Germany for at least five years. We think that selection into migration is less important for an analysis of the mental health of the elderly than the selective out-migration of those in good mental health. According to the salmon bias hypothesis, which has mainly been proposed in reference to somatic health and disability, the main reason the health status of immigrants appears to be better than that of non-migrants is because elderly people who are ill tend to

migrate back to their country of origin (Abraído-Lanza et al. 1999; Kohls 2012). Recent studies on somatic health suggest that this assumption may be incorrect, or may no longer hold (Schenk 2007; Sander 2008). This could be the case because the quality of health care is better in Germany than in some of the countries of origin, or because older people want to stay close to younger family members. If, for example, an immigrant's children and grandchildren live in Germany, a return migration may interfere with his or her intragenerational ties in Germany (Baykara-Krumme 2013). Moreover, there may be only few relatives left in the country of origin who would be able to take care of an elderly return migrant.

Particularly for mental health, we believe that the salmon bias hypothesis does not hold. First, it should be noted that the elderly immigrants rated their mental health worse than the non-migrants. If the salmon bias hypothesis applied, we should have observed better mental health among the immigrants. Second, we think that return migration is especially demanding in terms of mental health. Even if a migrant is moving back to his or her region of origin, the transition still requires a full process of international migration, including preparation for the move, the physical act of moving, and a process of re-integration in the home region, which has probably changed in the intervening years. Mental health, as it was measured in the SOEP by using the SF12 questionnaire, centers on symptoms of depression and personal activity. We argue that international migration – even when it is return migration – demands high levels of energy, risk-taking, and initiative. We would therefore expect that the individuals who rated their mental health more highly would have emigrated at higher rates. Thus, mental health would have on average been lower among those immigrants who stayed in Germany throughout the second half of life. This assumption was supported by our findings, and appears to contradict the salmon bias hypothesis.

On the other hand, we acknowledge that international migrants may be a selected group – not for being at greater risk of mental disorders (as Binder and Simoes 1980 asserted), but for being less satisfied with life. If we regard international migration as a strategy for solving problems (Pries 2010), then migrants may be expected to express relatively low levels of life satisfaction. Kirkcaldy et al. (2005), for example, found that the life satisfaction levels of Russian immigrants in Germany were lower than those of non-migrants. If personal aspirations cannot be fully realized in the destination country, life satisfaction may continue to be lower, and mental health may be negatively affected as well.

Finally, we come back to our last working hypothesis regarding somatic health (H3). We had expected the immigrants in our sample to report lower levels of somatic health than the non-migrants, as was shown by other authors (Schenk 2007; Sander 2008). While the bivariate statistics indeed indicated that the immigrants were less likely than the non-migrants to report having a disability or a chronic disease (perhaps because their age structure is younger), these variables did not explain the differentials in mental health between the respondents based on whether they had an immigration background. This indicates that mental health is less a consequence of somatic health, and is more influenced by other risk factors. Socio-economic factors, along with the circumstances of migration and the societal climate, are important determinants of mental health, and contribute to the health differentials among the elderly.

Our study shows that while immigrants do not necessarily have worse mental health than non-migrants, the groups of immigrants who face particularly challenging acculturation processes are at especially high risk of having poor mental health in old age. Public health

policies should focus not only on the somatic health of immigrants, but also on ways to improve their mental health. The need for good mental health will become even more acute in an aging society in which elderly migrants will have to cope with changing family structures and changing family norms.

References

Abbott, M. W.; Wong, S.; Williams, M.; Au, M.; Young, W. (1999): Chinese migrants' mental health and adjustment to life in New Zealand. In: *Australian and New Zealand Journal of Psychiatry* 33(1), pp. 13-21. [DOI: 10.1046/j.1440-1614.1999.00519.x]

Abraído-Lanza, A. F.; Dohrenwend, B. P.; Ng-Mak, D. S.; Turner, J. B. (1999): The Latino mortality paradox. A test of the "salmon bias" and healthy migrant hypotheses. In: *American Journal of Public Health* 89(10), pp. 1543-1548.

Andersen, H. H.; Mühlbacher, A.; Nübling, M.; Schupp, J.; Wagner, G. G. (2007): Computation of standard values for physical and mental health scale scores using the SOEP version of SF-12v2. In: *Schmollers Jahrbuch* 127(1), pp. 171-182.

Assion, H.-J.(Ed.) (2005): Migration und seelische Gesundheit. Heidelberg: Springer Medizin.

Baykara-Krumme, H. (2013): Generationenbeziehungen im Alter: Türkische Familien in der Türkei und in Westeuropa. In: *Zeitschrift für Familienforschung* 25(1), pp. 9-28.

Berry, J. W. (1997): Immigration, acculturation, and adaptation. In: *Applied Psychology*: An International Review 46(1), pp. 5-68.

Bhugra, D. (2004): Migration and mental health. In: *Acta Psychiatrica Scandinavica* 109(4), pp. 243-258.

Bhugra, D.; Jones, P. (2001): Migration and mental illness. In: *Advances in Psychiatric Treatment* 7(3), pp. 216-223.

Bhui, K.; Stansfeld, S.; Head, J.; Haines, M.; Hillier, S.; Taylor, S.; Viner, R.; Booy, R. (2005): Cultural identity, acculturation, and mental health among adolescents in east London's multiethnic community. In: *Journal of Epidemiology and Community Health* 59(4), pp. 296-302.

Binder, J.; Simoes, M. (1980): Psychische Beschwerden bei ausländischen Arbeitern. Eine Untersuchung bei portugiesischen Arbeitsemigranten. In: *Zeitschrift für Soziologie* 9(3), pp. 262-274.

Bollini, P.; Siem, H. (1995): No real progress towards equity: health of migrants and ethnic minorities on the eve of the year 2000. In: *Social Science & Medicine* 41(6), pp. 819-828.

Cameron, A. C.; Trivedi, P. K. (2009): Microeconometrics using Stata. Texas: Stata Press.

Carballo, M.; Nerukar, A. (2001): Migration, refugees, and health risks. In: *Emerging Infectious Diseases* 7(3), pp. 556-560.

Carnein, M.; Milewski, N.; Doblhammer, G.; Nusselder, W. J. (2015). Health inequalities of immigrants: Patterns and determinants of health expectancies of Turkish migrants living in Germany. In: Doblhammer, G. (Ed.): Health among the elderly in Germany: New evidence on disease, disability and care need. Series on Population Studies by the Federal Institute for Population Research, Vol. 46, Opladen, Berlin, Toronto: Barbara Budrich, pp. 157-190.

Carta, M. G.; Bernal, M.; Hardoy, M. C.; Haro-Abad, J. M.; the "Report on the Mental Health in Europe" working group (2005): Migration and mental health in Europe (the state of the mental health in Europe working group: appendix I). In: *Clinical Practice and Epidemiology in Mental Health* 1(13. [DOI: 10.1186/1745-0179-1-13]

Cheung, P. (1995): Acculturation and psychiatric morbidity among Cambodian refugees in New Zealand. In: *International Journal of Social Psychiatry* 41(2), pp. 108-119.

Cochrane, R. (1977): Mental illness in immigrants to England and Wales: An analysis of mental hospital admissions, 1971. In: *Social Psychiatry* 12(1), pp. 25-35.

Cochrane, R.; Bal, S. S. (1989): Mental hospital admission rates of immigrants in England. A comparison of 1971 and 1981. In: *Social Psychiatry and Psychiatric Epidemiology* 24(1), pp. 2-11.

David, M.; Borde, T.; Kentenich, H. (2002): Die psychische Belastung von Migrantinnen im Vergleich zu einheimischen Frauen – der Einfluss von Ethnizität, Migrationsstatus und Akkulturationsgrad. In: *Geburtshilfe und Frauenheilkunde* 62, Suppl. 1, pp. 37-44. [DOI: 10.1055/s-2002-29095]

EC – European Commission/Health Consumer Protection Directorate-General (2004): The state of mental health in the European Union. Brussels: European Communities.

Fandrem, H.; Sam, D. L.; Roland, E. (2009): Depressive symptoms among native and immigrant adolescents in Norway. The role of gender and urbanization. In: *Social Indicators Research* 92(1), pp. 91-109.

Gill, T. M.; Gahbauer, E. A.; Han, L.; Allore, H. G. (2010): Trajectories of disability in the last year of life. In: *New England Journal of Medicine 362*(13), pp. 1173-1180.

Gold, S. J. (1992): Cross-cultural medicine a decade later. Mental health and illness in Vietnamese Refugees. In: *The Western Journal of Medicine* 157(3), pp. 290-294.

Harrison, G.; Glazebrook, C.; Brewin, J.; Cantwell, R.; Dalkin, T.; Fox, R.; Jones, P.; Medley, I. (1997): Increased incidence of psychotic disorders in migrants from the Caribbean to the United Kingdom. In: *Psychological Medicine* 27(4), pp. 799-806.

Hemsi, L. K. (1967): Psychiatric morbidity among West Indian immigrants. A study of first admissions in London. In: *Social Psychiatry* 2(3), pp. 95-100.

Hoffmann-Nowotny, H. J. (1973): Soziologie des Fremdarbeiterproblems. Eine theoretische und empirische Analyse am Beispiel der Schweiz. Stuttgart: Enke.

Hubert, S.; Althammer, J.; Korucu-Rieger, C. (2009): Soziodemographische Merkmale und psychophysisches Befinden älterer türkischer Migrantinnen und Migranten in Deutschland – Eine Untersuchung auf Basis der Haupt- und Zusatzbefragung des Generations and Gender Survey der ersten Welle. Schriftenreihe des Bundesinstitutes für Bevölkerungsforschung, Vol. 39. Berlin: Pro Business.

Hurh, W. M.; Kim, K. C. (1990): Correlates of Korean immigrants' mental health. In: *The Journal of Nervous and Mental Disease* 178(11), pp. 703-711.

Igel, U.; Brähler, E.; Grande, G. (2010): Der Einfluss von Diskriminierungserfahrungen auf die Gesundheit von MigrantInnen. In: *Psychiatrische Praxis* 37, pp. 183-190. [DOI: http://dx.doi.org/10.1055/s-0029-1223508]

Inglehart, R. (1997): Modernization and postmodernization. Cultural, economic, and political change in 43 societies. Princeton, NJ: Princeton University Press.

Kirkcaldy, B. D.; Siefen, R. G.; Wittig, U.; Schüller, A.; Brähler, E.; Merbach, M. (2005): Health and emigration. Subjective evaluation of health status and physical symptoms in Russian-speaking migrants. In: *Stress and Health* 21(5), pp. 295-309. [DOI: 10.1002/smi.1068]

Kirkcaldy, B. D.; Wittig, U.; Furnham, A.; Merbach, M.; Siefen, R.G. (2006): Migration und Gesundheit. Psychosoziale Determinanten. In: *Bundesgesundheitsblatt – Gesundheitsforschung – Gesundheitsschutz* 49(9), pp. 873-883. [DOI: 10.1007/s00103-006-0021-9]

Kohler, U., Kreuter, F. (2012): Datenanalyse mit Stata. Allgemeine Konzepte der Datenanalyse und ihre praktische Anwendung. 4th ed. München: Oldenbourg.

Kohls, M. (2012): Demographie von Migranten in Deutschland. In: *Challenges in Public Health* 63 [Dissertation]. Frankfurt am Main: Peter Lang.

Kotwal, A. A. (2010): Physical and psychological health of first and second generation Turkish immigrants in Germany. In: *American Journal of Human Biology* 22(4), pp. 538-545. [DOI: 10.1002/ajhb.21044]

Kuo, W. (1976): Theories of migration and mental health. An empirical testing on Chinese-Americans. In: *Social Science & Medicine* 10(6), pp. 297-306.

Liebkind, K.; Jasinskaja-Lahti, I. (2000): The influence of experiences of discrimination on psychological stress. A comparison of seven immigrant groups. In: *Journal of Community & Applied Social Psychology* 10(1), pp. 1-16.

Massey, D. S. (1981): Dimensions of the new immigration to the United States and the prospects for assimilation. In: *Annual Review of Sociology* 7, pp. 57-85.

Mavreas, V.; Bebbington, P. (1990): Acculturation and psychiatric disorder. A study of Greek Cypriot immigrants. In: *Psychological Medicine* 20(4), pp. 941-951.

McGovern, D.; Cope, R. V. (1987): First psychiatric admission rates of first and second generation Afro Carribeans. In: *Social Psychiatry* 22(3), pp. 139-149.

Mewes, R.; Rief, W.; Martin, A.; Glaesmer, H.; Brähler, E. (2010): Somatoforme Symptome, Angst und Depression bei Migranten aus der Türkei, aus Osteuropa und aus der ehemaligen Sowjetunion. In: *Zeitschrift für Psychiatrie, Psychologie und Psychotherapie* 58(3), pp. 165-171.

Milewski, N. (2007): First child of immigrant workers and their descendants in West Germany. Interrelation of events, disruption, or adaptation? In: *Demographic Research* 17(29), pp. 859-896.

Münz, R. (1997): Phasen und Formen der europäischen Migration. In: Angenendt, S. (Ed.): Migration und Flucht. Aufgaben und Strategien für Deutschland, Europa und die internationale Gemeinschaft. Bonn: Bundeszentrale für politische Bildung, pp. 34-47.

Neto, F. (1995): Predictors of satisfaction with life among second generation migrants. In: *Social Indicators Research* 35(1), pp. 93-116.

Porsch-Oezçueruemez, M.; Bilgin, Y.; Wollny, M.; Gediz, A.; Arat, A.; Karatay, E.; Akinci, A.; Sinterhauf, K.; Koch, H.; Siegfried, I.; von Georgi, R.; Brenner, G.; Kloer, H. U. (1999): Prevalence of risk factors of coronary heart disease in Turks living in Germany: The Giessen Study. In: *Atherosclerosis* 144(1), pp. 185-198.

Pries, L. (2010): Internationale Migration. 3rd. ed. Bielefeld: transcript.

Razum, O.; Twardella, D. (2002): Time travel with Oliver Twist. Towards an explanation for a paradoxically low mortality among recent immigrants. In: *Tropical Medicine & International Health* 7(1), pp. 4-9.

Razum, O.; Zeeb, H.; Rohrmann, S. (2000): The 'healthy migrant effect'. Not merely a fallacy of inaccurate denominator figures. In: *International Journal of Epidemiology* 29(1), pp. 191-192.

Razum, O.; Zeeb, H.; Meesmann, U.; Schenk, L.; Bredehorst, M.; Brzoska, P.; Dercks, T.; Glodny, S.; Menkhaus, B.; Ramazan, S.; Saß, A.-C.; Ulrich, R. (u. M. v. Neuhauser, H.; Brucks, U.) (2008): Migration und Gesundheit. Schwerpunktberichterstattung des Bundes. Berlin: Robert-Koch-Institut.

Reher, D. (1998): Family ties in western Europe. Persistent contrasts. In: *Population and Development Review* 24(2), pp. 203-234.

Ronellenfitsch, U.; Razum, O. (2004): Deteriorating health satisfaction among immigrants from Eastern Europe to Germany. In: *International Journal for Equity in Health* 3,4.

Rwegellera, G. G. C. (1977): Psychiatric morbidity among West Africans and West Indians living in London. In: *Psychological Medicine* 7(2), pp. 317-329.

Sam, D. L. (1998): Predicting life satisfaction among adolescents from immigrant families in Norway. In: *Ethnicity & Health* 3(1-2), pp. 5-18.

Sander, M. (2008): Changes in immigrants' body mass index with their duration of residence in Germany. In: *SOEPpapers on Multidisciplinary Panel Data Research*, 122.

Scheller, F. (2011): Bestimmung der Herkunftsnationen von Teilnehmern des Sozioökonomischen Panels (SOEP) mit Migrationshintergrund. In: *SOEPpapers* 407: 1-17.

Schenk, L. (2007): Migration und Gesundheit – Entwicklung eines Erklärungs- und Analysemodells für epidemiologische Studien. In: *International Journal of Public Health* 52(2), pp. 87-96.

Shen, B.-J.; Takeuchi, D. T. (2001): A structural model of acculturation and mental health status among Chinese Americans. In: *American Journal of Community Psychology* 29(3), pp. 387-418.

Sluzki, C. E. (1979): Migration and family conflict. In: *Family Process* 18(4), pp. 379-390.

Spallek, J.; Razum, O. (2008): Erklärungsmodelle für die gesundheitliche Situation von Migrantinnen und Migranten. In: Bauer, U.; Bittlingmayer, U. H.; Richter, M. (Eds.): Health inequalities: Determinanten und Mechanismen gesundheitlicher Ungleichheit. Wiesbaden: VS, pp. 271-288.

Steel, Z.; Silove, D.; Chey, T.; Bauman, A.; Phan, T.; Phan, T. (2005): Mental disorders, disability and health service amongst Vietnamese refugees and the host Australian population. In: *Acta Psychiatrica Scandinavia* 111(4), pp. 300-309.

Strawbridge, W. J.; Shema, S. J.; Cohen, R. D.; Kaplan, G. A. (2001): Religious attendance increases survival by improving and maintaining good health behaviour, mental health, and social relationship. In: *Annals of Behavioral Medicine* 23(1), pp. 68-74

SVR – Sachverständigenrat deutscher Stiftungen für Migration und Integration (2010): Einwanderungsgesellschaft 2010. Jahresgutachten 2010 mit Integrationsbarometer. Essen.

Swiazny, F.; Milewski, N. (2012): Internationalisierung der Migration und demographischer Wandel. Eine Einführung. In: Köppen, B.; Gans, P.; Milewski, N.; Swiazny, F. (Eds.): Internationalisierung. Die unterschätzte Komponente des demographischen Wandels in Deutschland. Schriftenreihe der DGD, Vol. 5. Norderstedt: BoD, pp. 11-41.

TNS Infratest Sozialforschung (Ed.) (2010): SOEP 2010. Methodenbericht zum Befragungsjahr 2010 (Welle 27) des Sozio-oekonomischen Panels. München.

Tucci, I.; Yildiz, S. (2012): Das Alterseinkommen von Migrantinnen und Migranten: Zur Erklärungskraft von Bildungs- und Erwerbsbiografien. In: Baykara-Krumme, H.; Motel-Klingebiel, A.; Schimany, P. (Eds.): Viele Welten des Alterns. Ältere Migranten im alternden Deutschland. Wiesbaden: Springer/VS, pp. 101-126.

Vega, W. V.; Kolody, B.; Valle, J. R. (1987): Migration and mental health. An empirical test of depression risk factors among immigrant Mexican women. In: *International Migration Review* 21(3, Special Issue: Migration and Health), pp. 512-530.

Wagner, G.; Frick, J.; Schupp, J. (2007): The German Socio-Economic Panel study (SOEP). Scope, evolution and enhancements. In: *Schmollers Jahrbuch* 127(1), pp. 139-169.

Wengler, A. (2011): The health status of first- and second-generation Turkish immigrants in Germany. In: *International Journal of Public Health* 56(5), pp. 493-501.

Wilkinson, R. G.; Marmot, M. (2003): Social determinants of health: The solid facts (2nd ed.) Copenhagen: World Health Organization.

Wu, Z.; Schimmele, C. M. (2005): The healthy migrant effect on depression. Variation over time? In: *Canadian Studies in Population* 32(2), pp. 271-295.

Yeung, W. J.; Chan Y. (2007): The positive effects of religiousness on mental health in physically vulnerable populations. A review on recent empirical studies and related theories. In: *International Journal of Psychosocial Rehabilitation* 11(2), pp. 37-52.

Zilber, N.; Lerner, Y. (1996): Psychological distress among recent immigrants from the former Soviet Union to Israel, I. Correlates of level of distress. In: *Psychological Medicine* 26(3), pp. 493-501.

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