Spatial Patterns in German Long-term Care and their Relationship with Socioeconomic Factors[1]

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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, 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.

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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, 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, Rau 2012) and within countries (Porell, Miltiades 2002).

Because of its position as one of the forerunners of population aging (Muszyńska, 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, Schneider 2011; Kroll, 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.

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, 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 problem 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, 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, Pearl 2001; Kawachi, 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, 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 & Balfour (2003). Glass & Balfour (2003) 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, Pearl 2001; Glass, Belfour 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, 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 & Balfour (2003) highlighted the role of built environment and (health care) services on health status. Diez-Roux & 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 & Schneider (2011) concluded that rurality is positively linked with ill health. Glass & Balfour (2003) attributed the positive effect of urbanity on health to the dimension of services and resources. Following Glass & 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.

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, 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, Belfour 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 here -

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.

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 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, Higgins 2008). The general formula of a random effects linear meta-regression is

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

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 $1/(\sigma_i^2 + \tau^2)$, where σ is the standard error of the estimated spatial HR and τ^2 is the between-county variance (Thompson, Sharp 1999; Harbord, Higgins 2008).

The standard errors σ of the HR are calculated based on the assumption that the DLFE are random variables (Jagger et al. 2007), and that the LE is a scalar variable.[3] 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, Higgins 2008).

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).

- Table 2 here -

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

Table 2 shows the sex-specific age profiles in the unweighted[4] 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.[5]

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[6]=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).

- Figure 1 here -

In relative terms, the proportion of years without disability (HR) was only 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 ($\beta=-0.58$, $p<0.001$), 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

[4] 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%).
[5] IQR = Interquartile range (third quartile Q_3 minus first quartile Q_1).
[6] β = Coefficient in the meta-regression

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. Table 8 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.

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[7] 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.

- Figure 2 here -

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

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

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 here -

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 here -

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 here -

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[8] and the counties in West Germany, separate region-specific regression models were additionally estimated for both regions (Table 5).

- Table 5 here -

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 wealth and the health of the population seemed to be log-linear in the

[8]Including the city of Berlin.

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 here -

- Table 7 here -

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.

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 8 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 & 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.

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Tables and Figures

Table 1: Overview of computation of county-level indicators

Group of indicator	Indicator	Year	Computation
Socioeconomic conditions and composition	Disposable income of private house-holds 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.

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)

Males

Age	Median LE (years)	Median DFLE (years)	Median HR (%)	Q_1 (HR) (%)	Q_3 (HR) (%)	Min HR (%)	Max HR (%)	N
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

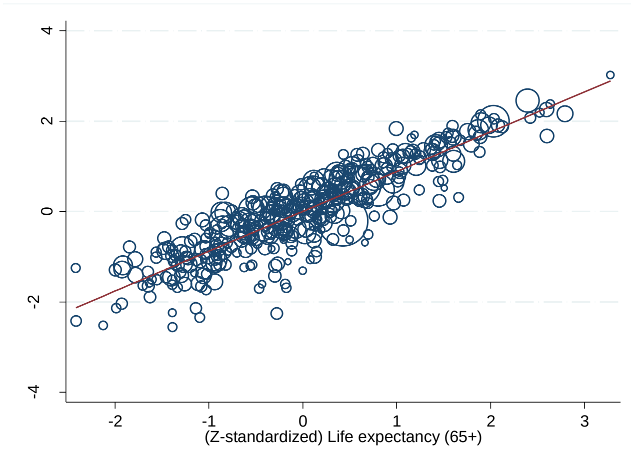
Females

Age	Median LE (years)	Median DFLE (years)	Median HR (%)	Q_1 (HR) (%)	Q_3 (HR) (%)	Min HR (%)	Max HR (%)	N
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

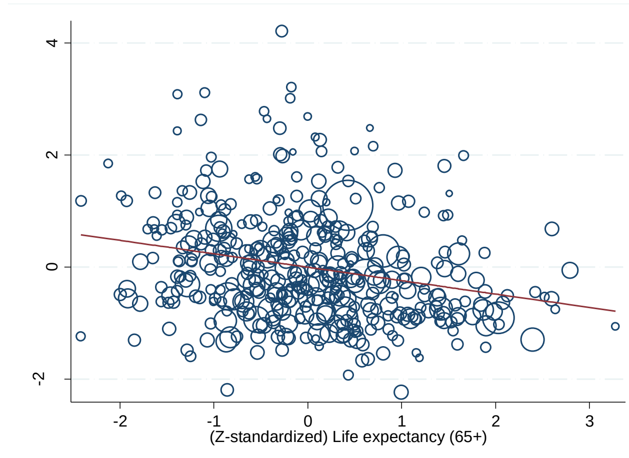
Figure 1: Life expectancy at age 65+ compared with disability-free life expectancy (65+), life years with disability (65+), age-standardized prevalence rate (65+) and health ratio (65+) for German counties in 2009 (z-standardized values, (larger) size of the single marker/circle indicates the (higher)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

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



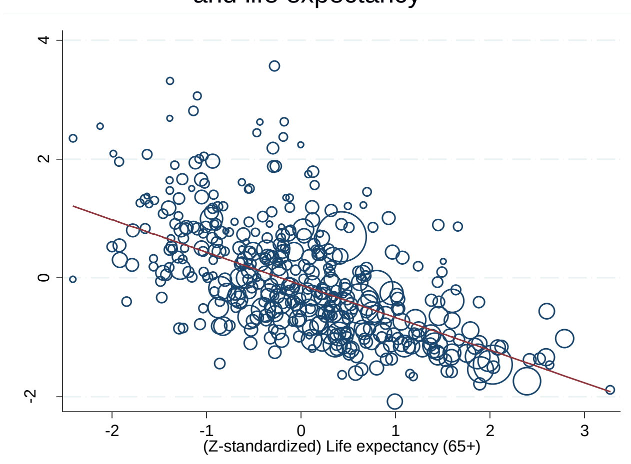
β=0.88 (p<0.001)
West: β=0.89 (p<0.001)
East: β=0.77 (p<0.001)

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)

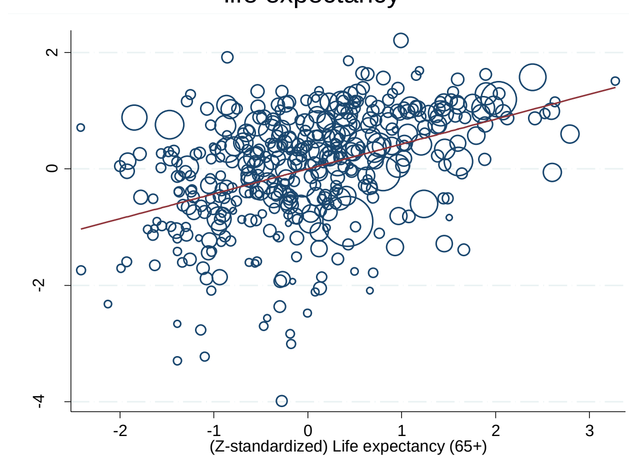
Figure 1c: Age-standardized prevalence rate* and life expectancy



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)

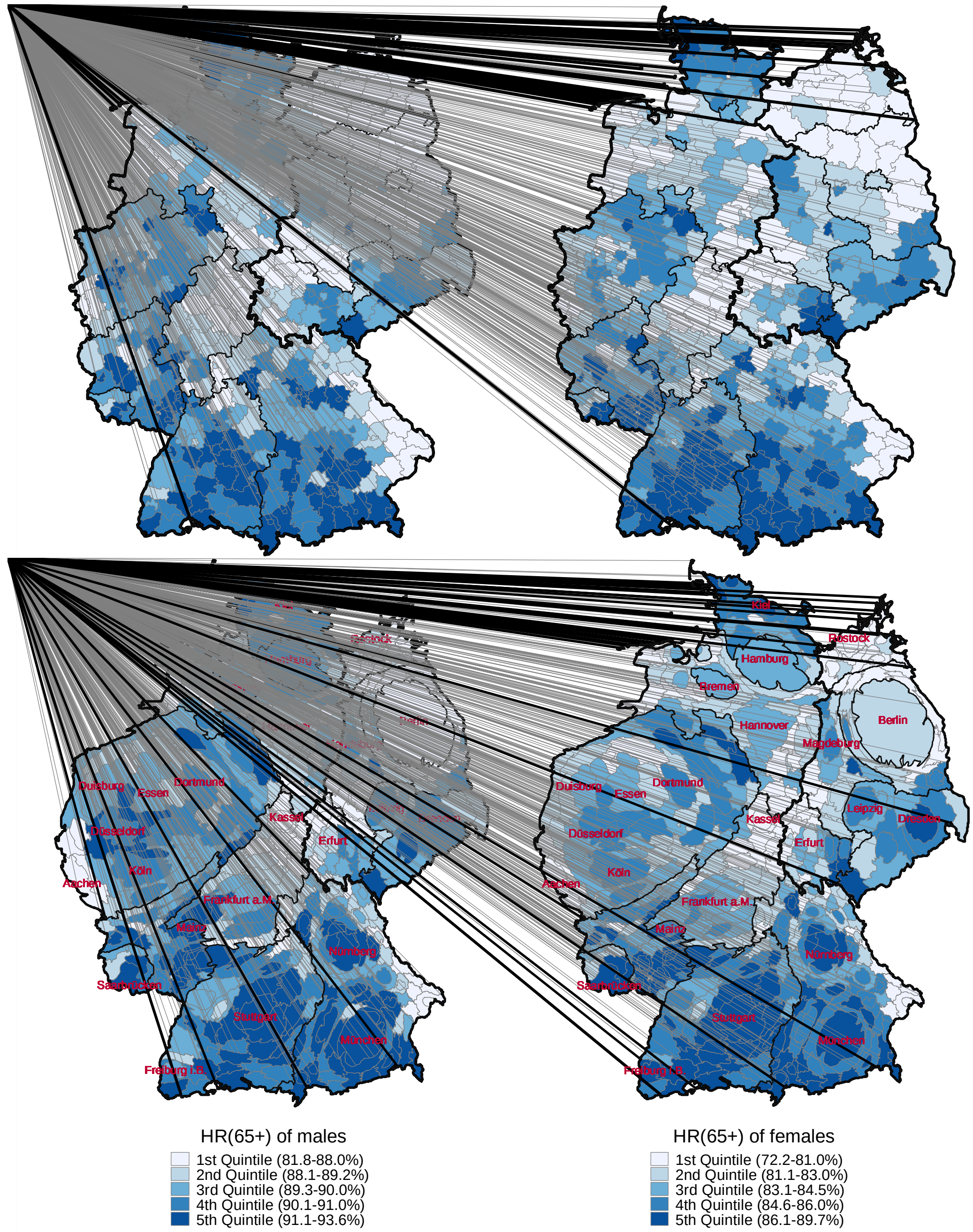
Figure 1d: Health ratio and life expectancy



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

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



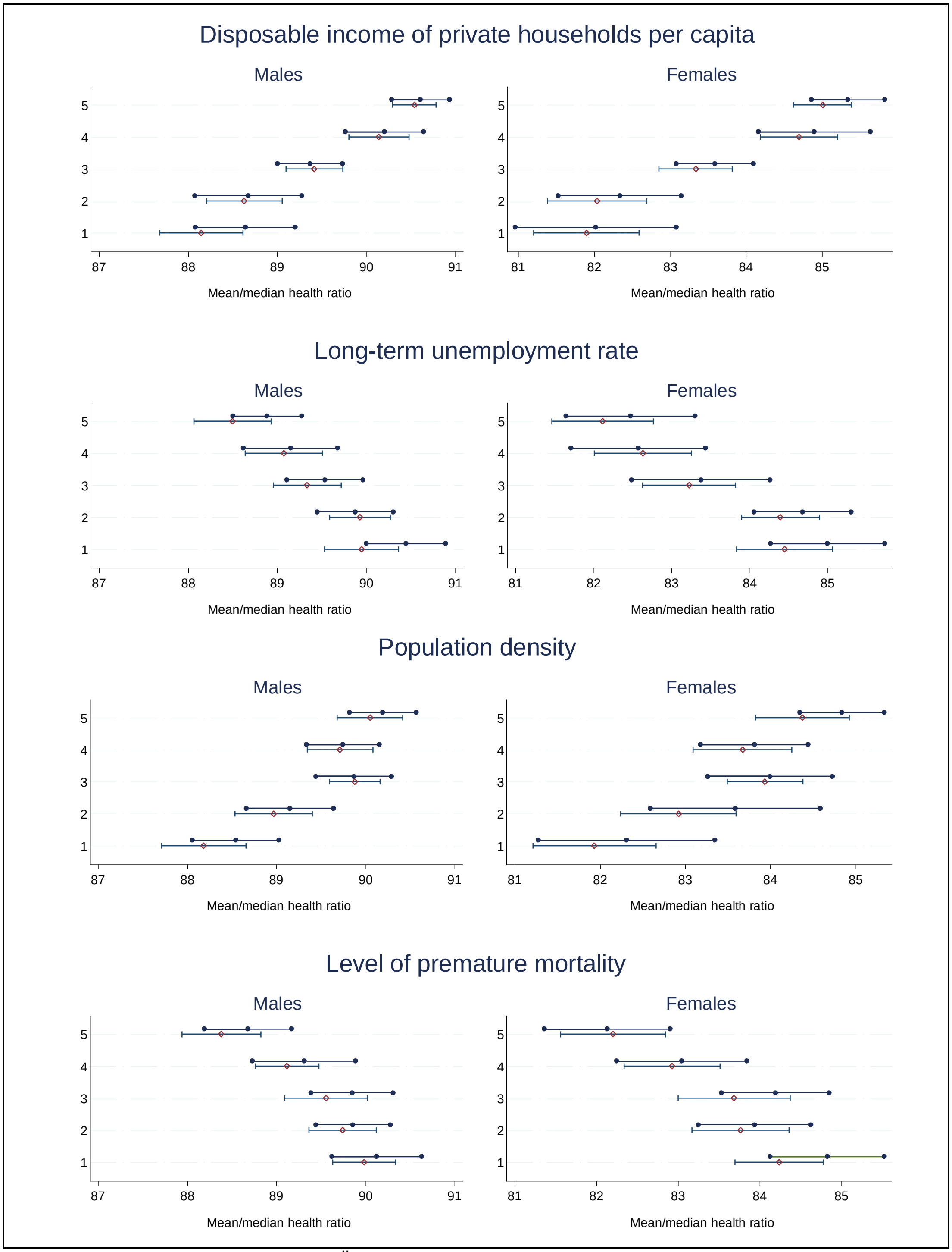
Source: Statistische Ämter des Bundes und der Länder; SLTC Census 2009;
author‘s calculations and plotting. Base map: Bundesamt für Kartographie und Geodäsie

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

Covariates	Mean (SD)	Median	Minimum	Maximum	N
Disposable income of private households per capita (in 1,000 euros)	18,59 (2.39)	18,44	13,90	31,02	412
Long-term unemployment rate (in persons per 10.000)	19,75 (16.71)	16,37	1,62	236,92	412
Population density (in inhabitants per km²)	519,55 (672.80)	198,64	37,59	4.282,21	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

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

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

Covariates		Males (65+) Coefficient	95% CI	*p-value*	Females (65+) 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)	***1^{st} - lowest***	**Ref**			**Ref**		
	2^{nd}	0,10	(-0,44 - 0,64)	*0,722*	-0,62	(-1,45 - 0,20)	*0,139*
	3^{rd}	0,71	(0,09 - 1,32)	*0,024*	0,33	(-0,61 - 1,27)	*0,488*
	4^{th}	1,07	(0,41 - 1,73)	*0,002*	1,20	(0,19 - 2,21)	*0,020*
	5^{th} - highest	1,27	(0,61 - 1,93)	*<0.001*	1,28	(0,28 - 2,29)	*0,013*
Long-term unemployment rate (quintiles)	***1^{st} - lowest***	**Ref**			**Ref**		
	2^{nd}	-0,29	(-0,81 - 0,23)	*0,278*	-0,38	(-1,17 - 0,41)	*0,349*
	3^{rd}	-0,81	(-1,34 - -0,28)	*0,003*	-1,47	(-2,28 - -0,67)	*<0.001*
	4^{th}	-0,68	(-1,25 - -0,10)	*0,021*	-1,65	(-2,52 - -0,78)	*<0.001*
	5^{th} - highest	-1,08	(-1,75 - -0,41)	*0,002*	-2,24	(-3,26 - -1,22)	*<0.001*
Population density (quintiles)	***1^{st} - lowest***	**Ref**			**Ref**		
	2^{nd}	0,36	(-0,15 - 0,87)	*0,167*	0,37	(-0,40 - 1,15)	*0,345*
	3^{rd}	0,78	(0,22 - 1,34)	*0,007*	0,66	(-0,19 - 1,51)	*0,129*
	4^{th}	0,96	(0,40 - 1,51)	*<0.001*	1,04	(0,19 - 1,89)	*0,016*
	5^{th} - highest	1,53	(0,95 - 2,11)	*<0.001*	2,19	(1,31 - 3,08)	*<0.001*
Level of premature mortality (quintiles)	***1^{st} - lowest***	**Ref**			**Ref**		
	2^{nd}	-0,19	(-0,69 - 0,31)	*0,461*	-0,38	(-1,14 - 0,39)	*0,331*
	3^{rd}	0,09	(-0,42 - 0,60)	*0,726*	0,28	(-0,50 - 1,06)	*0,479*
	4^{th}	-0,31	(-0,82 - 0,20)	*0,231*	-0,46	(-1,24 - 0,31)	*0,242*
	5^{th} - 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

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

Covariates		West Germany Coefficient	95% CI	*p-value*	East Germany 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	***1 st - lowest***	**Ref**			**Ref**		
private households	***2 nd***	-0,05	(-0,73 - 0,62)	*0,874*	1,73	(-0,03 - 3,48)	*0,053*
per capita	***3 rd***	0,81	(0,11 - 1,50)	*0,023*	3,09	(1,32 - 4,86)	*<0.001*
(quintiles)	***4 th***	1,57	(0,83 - 2,31)	*<0.001*	2,96	(1,13 - 4,78)	*0,002*
	5 th - highest	1,57	(0,83 - 2,31)	*<0.001*	1,40	(-0,45 - 3,25)	*0,137*
Long-term unemployment	***1 st - lowest***	**Ref**			**Ref**		
rate	***2 nd***	-0,09	(-0,77 - 0,59)	*0,790*	0,37	(-1,25 - 2,00)	*0,648*
(quintiles)	***3 rd***	-0,68	(-1,37 - 0,02)	*0,057*	-0,17	(-1,80 - 1,45)	*0,832*
	4 th	-0,90	(-1,61 - -0,19)	*0,014*	-0,61	(-2,28 - 1,06)	*0,470*
	5 th - highest	-1,45	(-2,28 - -0,61)	*<0.001*	0,31	(-1,39 - 2,02)	*0,714*
Population density	***1 st - lowest***	**Ref**			**Ref**		
(quintiles)	***2 nd***	0,06	(-0,63 - 0,75)	*0,865*	1,29	(-0,52 - 3,11)	*0,159*
	3 rd	0,12	(-0,62 - 0,86)	*0,747*	1,36	(-0,27 - 2,99)	*0,101*
	4 th	0,56	(-0,19 - 1,30)	*0,143*	3,03	(1,18 - 4,88)	*0,002*
	5 th - highest	1,48	(0,68 - 2,29)	*<0.001*	1,50	(-0,26 - 3,26)	*0,093*
Level of premature	***1 st - lowest***	**Ref**			**Ref**		
mortality	***2 nd***	-0,31	(-0,97 - 0,36)	*0,366*	-0,93	(-2,58 - 0,72)	*0,264*
(quintiles)	***3 rd***	0,24	(-0,43 - 0,92)	*0,479*	-0,87	(-2,49 - 0,76)	*0,292*
	4 th	-0,10	(-0,78 - 0,58)	*0,774*	-1,14	(-2,78 - 0,50)	*0,170*
	5 th - 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

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**
Model 0	3.64		8.24			
Model I	2.84	*-28%*	6.59	*-25%*	21.78%	19.96%
Model II	2.85	*0%*	6.50	*-1%*	21.61%	21.10%
Model III	2.65	*-8%*	6.11	*-6%*	27.08%	25.81%
Model 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
Model 0	4.60		7.50			
Model I	3.71	*-24%*	5.73	*-31%*	19.38%	23.59%
Model II	3.71	*0%*	5.97	*4%*	19.33%	20.36%
Model III	3.54	*-5%*	5.43	*-10%*	23.09%	27.61%
Model 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

Table 8: 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 (left) and the highest HR (right) 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