

Length of life and the pensions of five million retired German men

Vladimir M. Shkolnikov¹, Rembrandt Scholz², Dmitri A. Jdanov¹, Michael Stegmann³, Hans-Martin von Gaudecker⁴

Background: Socioeconomic differences in old-age mortality have not been studied in Germany. This study fills in the gap, evaluating mortality and life expectancy differentials among retired German men aged 65+ in 2003. **Methods:** Mortality rates are calculated from the administrative database on all public pensions and deaths of pensioners in 2003. Relative mortality rates and life expectancies are estimated for population subgroups according to the quintiles of lifetime earnings, type of medical insurance, broad occupational group, and residence in eastern or western Germany. **Results:** Among pension income quintiles, mortality varies by 60% and life expectancy at age 65 ranges from 14.9 to 18.5 years. Quintile-specific mortality and life-expectancy values are only slightly more favorable in western compared to eastern Germany. The mortality of manual workers is by 35% greater than that of salaried employees, while the mortality of those with mandatory public health insurance is 44% greater than the mortality of those with private or voluntary public health insurance. When all four characteristics are taken into account, relative mortality in the group with the highest mortality is three times higher than at the opposite end of the distribution, and corresponding life expectancies are 12.5 and 20 years. Half of all male deaths at ages 65+ are attributable to this variation. The mortality differentials remain significant at ages 80+. **Conclusions:** Socioeconomic mortality differentials persist into old age. They are similar in both regions and their magnitude is much greater than the diminishing mortality gap between the two parts of the country.

Keywords: elderly, germany, health, mortality, social inequality

Introduction

Relative socioeconomic inequality in old-age mortality constitutes a major public health issue, given the growing size of the elderly population and the sharp rise in absolute mortality with age. The international literature in this area is marked by the persistent absence of Germany. So far, Germany has not been included in reviews of socioeconomic mortality differences in Europe.^{1–5} Unlike many other countries, German population statistics do not provide suitable data for mortality estimation by socioeconomic status. This gap is only partly compensated by survey-based estimates.^{6–10} In most surveys, the number of elderly subjects is too small for a robust estimation of mortality differentials. Furthermore, the survey data suffer from recruitment bias and the absence of people living in institutions. At present, we are not aware of any estimates of differential mortality among elderly Germans.

However, the situation has begun to change recently with the introduction of new policies enabling scientific analyses of administrative micro-data. The present study exploits this opportunity by using data of the German pension system to evaluate mortality differentials among men aged 65 and older in the year 2003. Our analyses are based on a large data set

produced in 2005 at the Würzburg Research Data Centre (*Forschungsdatenzentrum*) of the German Pension Insurance Union (*Deutsche Rentenversicherung Bund*, DRV hereafter).

The present study identifies important differences in mortality and life expectancy associated with lifetime pension earnings points, the type of health insurance, broad occupational group and residence in eastern or western Germany.

Data and Methods

We exploit a database of records on all pensions paid by the German public pension system. We are aware of only one study that made use of similar administrative data in Canada.¹¹ The DRV database includes information on several characteristics of pensioners and death records which can be linked to measure mortality differentials.

A detailed description of the German pension system is given elsewhere.^{12–14} The administration of the system is performed by a variety of statutory bodies. They are required by law to report to their umbrella association, the DRV, statistics on all pensioners including deaths as of the end of each year.

We use an extract from the DRV data based on all records of the year 2003. The records reflect an accumulation of pensionable income over the entire working life. The data do not include information about work time spent in the German Civil Service or in private entrepreneurship. The DRV data refers to a ‘population of pensions’ rather than a population of pensioners. The former is larger than the latter since a pensioner may receive more than one pension. The excess of pensions relative to individuals is very substantial for women, about 50% of whom received widows’ pensions in 2003. It is less significant for men, only 10% of whom received widowers’ pensions in that year. Furthermore, the latter are usually small in magnitude relative to regular pensions.

¹Max Planck Institute for Demographic Research, Rostock, Germany

²Rostock Center for the Study of Demographic Change, Rostock, Germany

³German Pension Insurance Federal Union, Scientific Data Centre, Würzburg, Germany

⁴Free University Amsterdam, Department of Economics, The Netherlands

Correspondence: Vladimir M. Shkolnikov, Laboratory for Demographic Data, Max Planck Institute for Demographic Research, Konrad-Zuse-Str., 118057 Rostock, Germany, tel: +493812081147, fax: +493812081447, e-mail: shkolnikov@demogr.mpg.de

Considering this difficulty and the low female labour-market participation rates in the cohorts under scrutiny, the present study focuses solely on *men and their own pensions*. To achieve higher data integrity, we also exclude men of non-German citizenship, those with a migration background, those living in a foreign country, and those covered by foreign health insurance. The remaining data set consists of 5.1 million men, constituting 90% of the total male population of Germany aged 65+. In 2003, 256 000 of them died.

Our data consists of deaths and population exposure time, split by the following sociodemographic variables:

- (i) *Age* in 5-year intervals: 65–69, 70–74, . . . , 95–99, 100+.
- (ii) *Region* based on the current place of residence in either eastern or western Germany.
- (iii) *Earnings points* reflecting individual work career earnings. For each year spent working, the amount of earnings points is obtained by dividing individual pensionable earnings by average pensionable earnings. For example, if in a given year an individual earns an amount that is 50% higher (lower) than the mean earnings for this year, his accrual would be 1.5 (0.5) earnings points. Pension payments are based on the sum of earnings points accumulated over an entire working lifetime. Pensionable earnings are earnings of up to a threshold value. In 2003 for example, this was 61 200 Euro per year in western Germany and 51 000 Euro in eastern Germany. If somebody's individual income is higher than the maximum amount, the excess does not produce a contribution to the earnings points. Accordingly, the maximum number of annual earnings points that could be gained in West Germany was 2.15, given the average gross annual salary of 28 938 Euro for that year.¹⁵ Non-working time periods related to unemployment, advanced education, or other reasons¹⁶ generally produce lower earnings points' contributions. Corresponding regulations have been changing over time. By current rules, the first year of unemployment produces annual contribution corresponding to 80% of the last salary. For the second and subsequent years, annual contribution is about 0.17 points. A year of schooling after age 16 (no more than three years in total) adds 0.75 points. In 2003, one point corresponded to 23 Euro in eastern Germany and 26 Euro in western Germany. Systematic under-registration of lifetime earnings stems from the fact that certain types of income (civil servants' salaries, income from self-employment, etc.) are not taken into account by the earnings points' measure, thus giving rise to two problems: a selection problem if persons never had pensionable earnings and another problem if they were covered by the system merely during parts of their working life. In our data, measurement error in earnings will bias mortality of people with very low registered income downwards. This is something we cannot address fully. Hence, our results on mortality differences by income are conservative ones.
- (iv) *Health insurance* refers to the type of medical insurance and has two categories: mandatory public insurance (henceforth called 'mandatory') and voluntary public or private insurance (henceforth called 'voluntary'). Dependent employees in Germany are covered by mandatory public funds up to an earnings threshold that was 41 400 Euro per year in 2003. Individuals with higher earnings, the self-employed, and civil servants have the option of self-insurance, voluntary insurance within the public system or insurance with a private company. Hence the voluntary health insurance variable in our data is primarily a marker of unobserved earnings. These could either stem from self-employment, civil servants' salaries, or earnings above the threshold. If the observed variable was private insurance status, health

selection problems and differential access to treatment would impact much stronger upon the analysis.

- (v) *Occupational group* refers to three very broad categories originating from the traditional sectors of the German pension insurance system. These are (manual) workers, salaried employees, and miners. The groups are not strictly hierarchical, unlike conventional socio-occupational categories in other countries.^{17,18} The group of salaried employees predominantly consists of individuals in non-manual labour—but it also includes a small part of manual workers who receive salaries. Miners are those working in the mining industry, but not necessarily in mines.

Non-parametric as well as parametric methods are applied when conducting the mortality analyses. On the non-parametric side, we compute the empirical life expectancies and age-standardized mortality ratios (SMRs) independently for every sociodemographic category. In doing so, we use conventional techniques for the computation of life tables and of SMRs.²⁰ Parametric analyses are performed by means of Poisson regression. It returns expected mortality rate ratios (MRRs), which are less subject to random fluctuations than are multivariate empirical SMRs. The MRRs reveal the mortality profile across all population groups. The analyses are conducted using Stata 8.2 and MS Excel.

Results

Mortality effects of sociodemographic characteristics

Table 1 displays population sizes and mortality measures for the total male DRV population and its categories. In the DRV data, life expectancy at age 65 is 16.5 years. In population statistics, the equivalent value for the entire national population is 16.5 years (16.6 and 16.1 years for the west and the east of Germany, respectively).²¹ Because of the large number of observations, the confidence intervals for many life expectancy and mortality estimates are very narrow and not repeated in the text.

According to the DRV data, most of the observed category-specific SMRs deviate from one (reference value) in the expected direction (table 1). Mortality is slightly higher (by 2%) in eastern Germany than it is in western Germany. Mandatory health insurance is associated with a 43% mortality excess compared to voluntary insurance. Mortality excesses of 36% and 41% are characteristic of manual workers and miners respectively, as compared to salaried employees. The differences in relative mortality associated with health insurance and occupation correspond to 2- to 3-year differences in life expectancy. It stands at 15.3 years for miners and 17.9 years for salaried employees, and at 16.2 years and 19.1 years for mandatory and voluntary health insurance holders, respectively.

The relationship of mortality with earnings points is J-shaped rather than being monotonous. Mortality increases from the first to the second quintile and then decreases from the second to the fifth quintile. We will investigate this unusual shape in more detail below. The maximal SMRs in the second quintile are about 1.6. Life expectancy at age 65 varies between 14.9 years in the second quintile and 18.5 years in the fifth quintile.

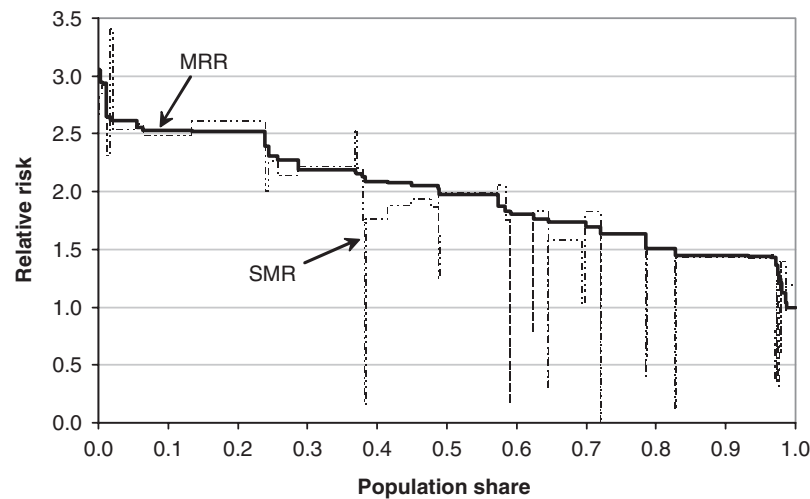
Table 1 demonstrates generally small differences between regression-based MRRs and empirical SMRs. Regression models 1 and 2 estimate the mortality effects of variables, controlling for age only and for age and all other variables, respectively. A comparison of the two models shows that the mortality effects of single variables are not substantially modified after adjustment for other variables.

The mortality differences between sociodemographic categories persist into much more advanced ages. Life expectancy at age 80 increases from 6.9 to 8.1 years when moving from the

Table 1 Life expectancy at age 65 and relative mortality rates at ages 65+ according to residence, type of health insurance, professional group, and pension earnings points quintile

	Population, × 1000	Empirical measures		Regression-based measures	
		Life expectancy at age 65, in years	SMR	MRR, Model 1	MRR, Model 2
Total	5100	16.46 (16.43,16.49)	–	–	–
Region					
Western	4036	16.49 (16.46,16.52)	1 (reference)	1 (reference)	1 (reference)
Easternt	1064	16.36 (16.30,16.43)	1.018 (1.005,1.023)	1.032 (1.022,1.042)	1.032 (1.022,1.043)
Health insurance					
Voluntary	666	19.13 (19.01,19.25)	1 (reference)	1 (reference)	1 (reference)
Mandatory	4434	16.16 (16.13,16.19)	1.439 (1.420,1.458)	1.324 (1.305,1.342)	1.402 (1.380,1.424)
Occupational group					
Manual workers	2694	15.58 (15.54,15.62)	1.359 (1.352,1.366)	1.355 (1.343,1.366)	1.222 (1.211,1.233)
Salaried employees	2091	17.94 (17.90,17.99)	1 (reference)	1 (reference)	1 (reference)
Miners	315	15.29 (15.17,15.40)	1.405 (1.385,1.426)	1.491 (1.467,1.454)	1.427 (1.404,1.450)
Quintiles of the earnings points' distribution					
1	914	16.27 (16.20,16.34)	1.316 (1.304,1.327)	1.322 (1.305,1.339)	1.382 (1.363,1.402)
2	1076	14.93 (14.87,14.99)	1.591 (1.579,1.605)	1.553 (1.534,1.572)	1.423 (1.404,1.404)
3	994	15.88 (15.81,15.95)	1.421 (1.408,1.435)	1.382 (1.363,1.400)	1.245 (1.228,1.263)
4	1068	16.88 (16.82,16.94)	1.240 (1.230,1.250)	1.223 (1.208,1.239)	1.127 (1.112,1.141)
5	1048	18.52 (18.45,18.59)	1 (reference)	1 (reference)	1 (reference)

SMR denotes empirical age-standardized mortality ratio, MRR denotes regression-based mortality rate ratio. 95% confidence limits are given in parentheses. In Model 1, mortality rate ratios are controlled for age. In Model 2, they are controlled for age and other explanatory variables.

**Figure 1** Regression-based and empirical mortality rate ratios across all combinations of residence, type of health insurance, occupational group, and earnings points' quintile

second to the fifth earnings point quintile. Life expectancies at age 80 of those with mandatory and voluntary health insurances are 7.3 and 9 years, respectively. Life expectancy for salaried employees, manual workers and miners is 8, 7 and 6.9 years, respectively. At ages 80+, the MRRs are: 1.27 for the second earnings points' quintile compared to the fifth quintile, 1.25 for mandatory compared to voluntary health insurance, and 1.2 for manual workers compared to salaried employees.

Multidimensional mortality variation

We have used the mutually adjusted estimates from table 1 (model 2) to estimate the relative mortality for each combination of region, insurance status, occupational group, and fifths of earnings points. Figure 1 shows these estimates in the form of population mortality risk profile. This visualization can be regarded as a series of 'inequality steps' because of its shape. The y axis presents the relative mortality as expressed by the model MRRs and the empirical SMRs calculated for combinations of the four sociodemographic variables. The

population shares of the combinations are given on the x axis. The combinations are sorted in descending order of MRRs, something we discuss first before turning to discrepancies between them and SMRs.

In figure 1 we have chosen to express mortality in each group relative to the group with the lowest mortality risk i.e. western salaried employees with voluntary health insurance from the highest quintile of earnings points. Life expectancy at age 65 in this group is 20 (19.7, 20.4) years. The other numbers can be computed from table 1. For example, for eastern manual workers with mandatory health insurance from the fourth earnings points' quintile:

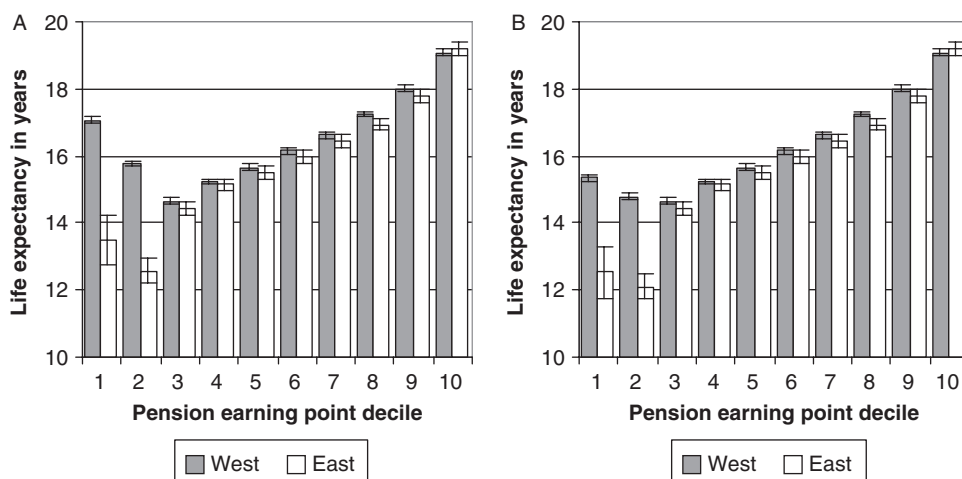
$$\begin{aligned} \text{MRR} &= \exp[\ln(1.032) + \ln(1.402) + \ln(1.222) + \ln(1.127)] \\ &= 1.993. \end{aligned}$$

The maximal MRRs of about 3 are observed among eastern and western miners with mandatory health insurance from the two lowest earnings point quintiles. Life expectancy at age 65 in these groups varies between 12.5 and 13 years.

Table 2 Mortality rate ratios at ages 65+ for the earnings points-occupational group, earnings points, type of health insurance, and earnings points-region combinations

	Earnings point quintiles				
	1	2	3	4	5
Occupational groups					
Manual workers	1.53(1.51,1.56)	1.77(1.75,1.80)	1.53(1.51,1.56)	1.38(1.36,1.40)	1.28(1.25,1.31)
Salaried employees	1.19(1.16,1.21)	1.33(1.31,1.36)	1.29(1.26,1.32)	1.17(1.15,1.19)	1 (reference)
Miners	3.35(3.14,3.56)	2.13(2.06,2.21)	1.78(1.73,1.84)	1.57(1.52,1.61)	1.37(1.32,1.41)
Health insurance					
Voluntary	1.21(1.16,1.27)	1.12(1.06,1.19)	1.04(0.96,1.13)	1.13(1.05,1.22)	1 (reference)
Mandatory	1.79(1.71,1.87)	1.85(1.77,1.94)	1.62(1.55,1.70)	1.43(1.36,1.49)	1.17(1.12,1.22)
Region					
East	2.82(2.69,2.94)	1.64(1.60,1.67)	1.41(1.38,1.44)	1.26(1.23,1.28)	1.02(0.99,1.04)
West	1.29(1.28,1.31)	1.54(1.52,1.56)	1.38(1.36,1.40)	1.22(1.20,1.24)	1 (reference)

Calculated from Poisson regressions connecting the relative mortality with quintile-occupation, quintile-health insurance, and quintile-region combinations.

**Figure 2** Life expectancy at age 65 and population shares of eastern and western Germany by the earning point deciles

Another way of measuring the amount of diversity in figure 1 is through population-attributable risk calculation, which takes into account relative risks and population weights of the fractions. It suggests that the number of deaths would be 50% lower if mortality in all population fractions corresponded to that in the best group.

The MRR estimates of the four-dimensional risk in Figure 1 are based on the additive risks with no interaction effects among the explanatory variables. The closeness of MRRs and empirical SMRs suggests that this additive model is a reasonable approximation for almost all population subgroups. The most salient differences in figure 1 are due to random fluctuations in very small population fractions (which become evident from the fact that these appear essentially as vertical lines). Some statistically significant deviations are seen for combinations that include the lowest quintile of earnings points and voluntary health insurance. We investigate these in more detail now.

Table 2 displays MRRs for interactions of pension income with the other three variables. These are based on three Poisson regressions, in which right-hand variables have values running across all quintile-occupation, quintile-health insurance, and quintile-region combinations, respectively. In every occupational group, relative mortality increases from the second to the fifth quintile. In every quintile, mortality is lower for salaried employees than it is for manual workers and miners. A very small group of miners with the lowest earnings points displays very high excess mortality. Accounting for population weights of the quintile-occupation combinations, the shape of

mortality risk is still close to the pattern based on the additive model. This is not the case for the quintile-health insurance combinations. Among those with voluntary health insurance, the mortality differential among the earnings points' quintiles is almost flat and non-monotonous. We attribute this profile to high earnings outside the public pension system (see the data section above). Their effect is important in terms of population shares for the lowest quintile, where 63% of men fall into the voluntary health insurance category. In all other quintiles, the share of voluntary health insurance varies between 4% and 12%. In the lowest quintile, persons with voluntary health insurance are likely to be those who have been in self-employment or the civil service. Hence, the counter-intuitive J-shaped relationship between mortality and earnings points that is evident from tables 1 and 2 can be attributed to unobserved incomes. This finding agrees with the above-cited study¹¹ on mortality and career earnings in Canada, which also revealed a high prevalence of wealthy people with additional sources of income (other than pensionable earnings) in the lower end of the public pensions' distribution.

In the 1990s, there was a rapid mortality convergence between the two parts of Germany.²² As a result, figure 2 shows a close East-West similarity of life expectancy profiles as well as a mild advantage of western Germany in 80% of the population, i.e. quintiles 2–5. In the lowest quintile, mortality in eastern Germany is very high compared to the western region. In this quintile, western residents constitute an overwhelming majority of 97%. In the higher quintiles, their share is much lower and varies between 71% and 79%. In the

remaining quintiles, the mortality advantage of the west is much smaller.

In western Germany, life expectancy increases from 14.9(14.8, 15.0) to 18.5(18.4, 18.6) years between quintiles 2 and 5, while in eastern Germany it varies from 12.8(12.4, 13.2) to 18.5(18.3, 18.7) years between quintiles 1 and 5 (panel A in figure 2). If people with voluntary health insurance (as argued above, many of them will have relatively important incomes unobserved in our data) are excluded from the first quintile, the J-shape pattern in the west diminishes, but does not disappear (panel B in figure 2).

In eastern Germany, earnings unobserved in the DRV data are very small. This is because before 1990, everyone was insured under the state GDR system. Correspondingly, this region does not exhibit a J-shaped pattern and can be considered as a model of relationship between lifetime earnings as reflected by public pensions and mortality. We assume that we would observe a similar pattern in western Germany if we could effectively exclude all individuals with considerable unobserved earnings.

Discussion

There have been almost no published analyses of mortality by socio-economic position in Germany based on large-scale population data. This study is a step into new territory and can serve as a test regarding new data opportunities in Germany.

The general difficulties of measuring the socioeconomic position of the elderly are well known.²³ There are also specific problems in the DRV data. First, the occupational categories are very broad. Second, the public pension earnings points neither capture the working time of self-employed and civil servants nor do they vary with income above an upper threshold of annual incomes. The unobserved earnings are only partly and indirectly indicated by voluntary medical insurance. Nevertheless, the DRV data set is highly informative. It covers a great majority of retired German men and provides a good measure for the acquisition of resources over entire work careers. This measure has a strong validity in light of the life course approach to health inequalities.²⁴

Our results convincingly show that in Germany the socio-economic mortality gradient continues far into old age. This agrees with the findings for other Western European countries.^{4,25} Among the earnings points' quintiles, the maximal relative risk is 1.6 as referred to the highest quintile. The SMRs for manual workers and miners are close to 1.4 compared to those for salaried employees. An analysis of the multivariate mortality variation reveals three-fold relative mortality differences and corresponding 6–7-year differences in life expectancy between the most advanced and the most disadvantaged population fractions. In the former, life expectancy at age 65 is close to 20 years (which is higher than the equivalent estimate for the general population of Japan), whereas in the latter it equals 12.5 years (which is comparable to life expectancies in Eastern European nations).²¹ About half of all male deaths at ages 65+ are attributable to mortality excess in disadvantaged groups. Socioeconomic mortality differentials are much greater than the remaining East-West mortality gap.

For a large population majority, mortality indicators are slightly more favourable in western than in eastern Germany in every earning points quintile. This result agrees with survey data.^{1,26,27} In the lowest earning points quintile, the western advantage is greater. This is largely a statistical artefact since in western Germany many men with the lowest public pensions have additional incomes unobserved in the DRV data. These incomes are by far less significant in the east of Germany. The mortality advantage of being in a private or voluntarily public

health insurance is an interesting finding. It deserves further investigation. Probably, substantial parts of it can be attributed to differences in economic wealth behind the two types of health insurance. In general, the German medical care system is considered to be a classic example of a health care system with mandatory coverage that offers nearly universal access to quality care.¹ During the last decade, it has faced growing difficulties, which led to a series of reforms to the system, some of which are continuing to date. Future studies will show how these changes will affect equity in health care provision and utilization.

This study provides the first population-based evidence on the magnitude of sociodemographic mortality differences among retired Germans. Monitoring these differences and the analysis of their causes is a matter of priority.

Acknowledgements

We are grateful to David Leon, Mark Montgomery, and two anonymous reviewers for their helpful comments on the manuscript. We thank Susan Backer and Sigrid Gellers-Barkmann for valuable language editing. The work is part of the Vanguard project by the Max Planck Institute for Demographic Research.

Key points

- This study provides new population-based evidence on socioeconomic differences in old-age mortality in Germany by estimating the relationships between mortality and life career earnings, occupational group, type of health insurance, and region of residence for five million men aged 65+.
- Among pension income quintiles, mortality and life expectancy at age 65 varies greatly. Quintile-specific mortality and life-expectancy values are only slightly more favorable in western Germany than they are in eastern Germany.
- The mortality of manual workers is substantially higher than the mortality of salaried employees. By the same token, mortality among those with mandatory public health insurance is substantially higher than that among those with private or voluntary public health insurance. The latter finding deserves further investigation.
- All these mortality differentials remain significant at ages 80+.
- Socioeconomic mortality differentials among elderly Germans constitute a greater public health problem compared to the diminishing East-West health divide. Their causes should be monitored and addressed by policies as a matter of priority.

References

- 1 Mackenbach JP, Kunst AE, Cavelaars AEJM, et al. Socioeconomic inequalities and mortality in western Europe. *Lancet* 1997;349:1655–59.
- 2 Valkonen T. Trends in differential mortality in European countries. In: Vallin J, Meslé F, editors. *Trends in mortality and differential mortality*. Strasbourg: Council of Europe Publishing, 2001: 185–322.
- 3 Mackenbach JP, Bos V, Andersen O, et al. Widening socioeconomic inequalities in mortality in six Western European countries. *Int J Epidemiol* 2005;32:830–37.
- 4 Huisman M, Kunst AE, Andersen O, et al. Socioeconomic inequalities in mortality among elderly people in 11 European populations. *J Epidemiol Community Health* 2004;58:468–75.

- 5 Mackenbach JP. Health Inequalities: Europe in Profile. Report of the project "Tackling Health Inequalities: Governing for Health", The European Commission, 2006.
- 6 Geyer S, Peter R. Occupational status and all cause mortality. A study with health insurance data from Nordrhein-Westfalen, Germany. *Eur J Public Health* 1999;9:114–18.
- 7 Reil-Held A. Einkommen und Sterblichkeit in Deutschland: Leben Reiche länger? Institut für Volkswirtschaftslehre und Statistik, Universität Mannheim, Beiträge zur angewandten Wirtschaftsforschung Nr. 580-00, 2000.
- 8 Helmert U. Subjektive Einschätzung der Gesundheit und Mortalitätsentwicklung. *Gesundheitswesen* 2003;65:47–54.
- 9 Frijters P, Haisken-DeNew J, Shields MA. Socioeconomic Status, Health Shocks, Life Satisfaction and Mortality: Evidence from an Increasing Mixed Proportional Hazard Model. The Australian National University, Centre for Economic Policy Research, Discussion Paper No 496, 2005.
- 10 Deutscher Bundestag. Gutachten 2005 des Sachverständigenrates zur Begutachtung der Entwicklung im Gesundheitswesen. *Koordination und Qualität im Gesundheitswesen* 2005; Drucksache 15/5670.
- 11 Wolfson M, Rowe G, Gentleman JF, et al. Career earnings and death: a longitudinal analysis of older Canadian men. *J Gerontol Soc Sci* 1993;48:S167–S179.
- 12 Börsch-Supan A, Wilke CB. The German pension system: How it was, how it will be. NBER Working Paper No 10525, 2004.
- 13 VDR. *Statistik Rentenbestand am 31. Dezember 2003*. Verband Deutscher Rentenversicherungsträger (VDR), Frankfurt am Main, Germany 2004.
- 14 Lühning R. Entwicklungen des Leistungsrechts der gesetzlichen Rentenversicherung in der Bundesrepublik Deutschland seit der großen Rentenreform von 1957 (1957–2004), Logos Verlag Berlin, 2006.
- 15 Himmelreicher RK, Frommert D. Gibt es Hinweise auf zunehmende Ungleichheit der Alterseinkünfte und zunehmende Altersarmut? Der Einfluss von Erwerbs- und Familienbiografien auf die Rentenhöhe in Deutschland. *Vierteljahreshefte zur Wirtschaftsforschung* 2006;75(1):108–130.
- 16 von Gaudecker HM, Scholz RD. Differential mortality by life time earning in Germany. *Demographic Research* 2007; 17(4): 83–108. Available at www.demographic-research.org.
- 17 Drever F, Whitehead M, eds. Health inequalities. *Decennial Supplement*. London: The Stationary Office, 1997.
- 18 Valkonen T, Martelin T, Rimpelä A, et al. Socioeconomic mortality differences in Finland 1981–90. Helsinki: Statistics Finland, 1993.
- 19 Bundesministerium des Innern. Dritter Versorgungsbericht der Bundesregierung. Berlin, 25 May 2005.
- 20 Chiang CL. *The Life Table and its Applications*. Malabar, Florida: Krieger Pub. Co., 1984.
- 21 Human Mortality Database, 2006. Available at www.humanmortality.de or www.mortality.org.
- 22 Nolte E, Shkolnikov VM, McKee M. Changing mortality patterns in East and West Germany and Poland. II: Short-term trends during transition and in the 1990s. *J Epidemiol Community Health* 2000;54:899–906.
- 23 Grundy E, Holt G. The socioeconomic status of older adults: How should we measure it in studies of health inequalities? *J Epidemiol Community Health* 2001;55:895–904.
- 24 Davey Smith G, Gunell D, Ben Shlomo Y. Life-course approaches to socio-economic differentials in cause-specific mortality. In: Leon D.A, Walt G, editors. *Poverty, Inequality, and Health*. Oxford University Press, 2001: 88–124.
- 25 Chandola T, Ferrie J, Sacker A, et al. Social inequalities in self reported health in early old age: Follow-up of prospective cohort study. *BMJ* 2007;334(7601): 2007;990–6.
- 26 Mielk A, Cavelaars A, Helmert U, et al. Comparison of health inequalities between East and West Germany. *Eur J Public Health* 2000;10:262–67.
- 27 Nolte E, McKee M. Changing health inequalities in East and West Germany since unification. *Soc Sci Med* 2004;58:119–26.

Received 20 April 2007, accepted 3 October 2007