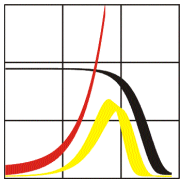

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German unification and the plasticity of mortality at older ages

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Running head: OLD-AGE SURVIVAL IN GERMANY

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Abstract

German unification can be seen as a natural experiment that allows us to study the health effects of political and economic transition. This study examined old-age survival following German unification in cohorts born in 1895, 1900, 1905 and 1910. People born in these years were in their 80s and 90s at the time of unification in 1990. Before unification, mortality in these cohorts was considerably higher in East Germany than in the West. Following unification, mortality in the East declined toward prevailing levels in the West, particularly among women. This indicates that even the very-old East Germans were able to profit from the medical, social, and economic improvements associated with unification. Study results support the view that old-age mortality is plastic and amenable to intervention, and they attest to the importance of late-life events.

Introduction

How plastic is mortality at older ages? There are two conflicting views. On the one hand, gerontological research has often been guided by the notion that there is a fixed maximum life span, that life expectancy in Germany and similar countries is close to the limit imposed by biology, and that little can be done to increase survival among the oldest old (Fries, 1980; Hayflick, 2000). On the other hand, there is the view that aging is plastic and survival can be substantially extended by innovation and intervention (Maier & Vaupel, 2003; Vaupel et al., 1998). Research over the last decade has provided a large body of evidence challenging the notion of fixed limits. Far from being fixed, mortality at older ages has fallen dramatically since 1950, and especially since 1970, in developed countries (Kannisto, 1994; Kannisto, Lauritsen, Thatcher, & Vaupel, 1994; Vaupel, 1997). Mortality improvements have been greater for females than males, and the pace of improvement has been more rapid in recent decades than it was in earlier decades.

In the present study we examined old-age survival in Germany after unification with the goal of gaining new insights into the plasticity of mortality at older ages. Recent German history offers a unique opportunity to study the effects of political, economic, and social factors on mortality. Prior to 1945 East and West Germans shared a cultural and historical background that included the political system. Between 1949 and 1989, however, Germans lived under two different political and economic systems: a socialist planned economy (the former German Democratic Republic; East Germany) versus a free-market democracy (the Federal Republic of Germany; West Germany). With German unification in 1990 the two German populations were integrated again into one political and economic system.

The populations of developed countries are characterized by sustained mortality decline (Kannisto, 1994; Oeppen & Vaupel, 2002; Tuljapurkar, Li, & Boe, 2000). From around 1975 onward, mortality decline in East Germany was slower than in West

Germany, which resulted in a mortality gap between the two German states. After German unification in 1990 and the ensuing cultural, political, and economic changes in the former East Germany, the mortality gap between East and West decreased (Fig. 1; Dinkel, 1992, 1999; Gjonca, Brockmann, & Maier, 2000; Nolte, Shkolnikov, & McKee, 2000a, 2000b; Scholz, 1996).

--- insert Figure 1 here

The gap has been closing in recent years, primarily because life expectancy in the East increased rapidly after unification (Fig. 1). Recent increases in East German life expectancy were largely determined by improvements in survival at older ages. Among East German women, more than 71 percent of the total increase in life expectancy from 1980 to 1996 came from those aged over 60, and a remarkable 31 percent came from those over 80 (Gjonca et al., 2000). A similar pattern was evident for West German women and for men, although it was somewhat less pronounced.

The present study complements earlier research on mortality in unified Germany in two respects. First, much of the research to date has investigated German mortality differentials at younger ages, and little is known about old-age survival in East and West Germany. We were interested in the plasticity of mortality in older individuals, thus we examined the mortality of persons who had already outlived the average individual of their birth cohort at the time of unification. Specifically, the present study focused on persons aged 80, 85, 90 and 95 at the time of unification. Secondly, much of the earlier research was based on life expectancy and death rates derived from period life tables, whereas our study focuses on cohort mortality, and we investigate the mortality of persons who were born in the same birth cohorts. The study was designed to address one central research question: following German unification, did cohort mortality in the East decline towards prevailing levels in the West?

Data

Data came from the Human Mortality Database (HMD, www.humanmortality.org). This database contains detailed raw data on death and population counts by age, year of birth, and calendar year for 17 countries, including East and West Germany. Derived variables such as death rates and life table parameters are also included in this database. A complete description of the methodology of the HMD is available in the methods protocol (www.humanmortality.org/Docs/MethodsProtocol.pdf) for the HMD. The approach of the HMD is guided by the conventional knowledge that age reporting in death registration is typically more reliable than in official population estimates. For this reason, official population estimates at older ages are replaced by estimates calculated from death counts, employing extinct cohort methods. Such methods eliminate some of the biases in old-age mortality estimates.

The age range in the HMD goes up to 110+ years. For Germany, the HMD currently includes data for all years from 1956 through 1999. For German data in the HMD, all official population estimates for age 90 and above were replaced by estimates obtained by applying the extinct cohort method (Vincent, 1951) and the survivor ratio method (Thatcher, Kannisto, & Andreev, 2002).

Results

In a first step we sought to gain a comprehensive view of excess mortality in East Germany as compared to West Germany. We calculated excess mortality for every age x and calender year t as the ratio of the age-specific annual probability of death $q(x,t)_{East}$ and $q(x,t)_{West}$. The surface presented in Figure 2 shows these ratios for single ages up to age 110 from 1956 to 1999, for both sexes combined as well as separately for women and men. The color red in this graph indicates lower mortality in West Germany; the color blue signifies lower mortality in East Germany. The scale on the right shows the ratio of

East/West mortality. For example, a ratio of 1.1 indicates that mortality in East Germany was 10% higher than in the West.

--- insert Figure 2

Figure 2 shows that East and West Germany had similar levels of mortality (ratios close to 1.0) until about 1975. The survival advantage of West Germany started in the mid-1970s and became even more pronounced in the 1980s. By the time of unification in 1990 the mortality gap had increased sharply in childhood and in some adult ages—but not at ages 80 and above. From about 1992 onwards, mortality in East and West Germany started to converge, particularly among women.

Next we examined old-age survival in four selected birth cohorts born in 1895, 1900, 1905 and 1910. Their age-specific cohort mortality $q(x,c)$ was determined using the formula of Becker and Zeuner (Flaskämper, 1962, p. 351) and was calculated as the ratio of the sum of the death counts of the triangles $D_L\ (x, t)$ and $D_U\ (x, t+1)$ at age x divided by the population at the beginning of age x. The population $P(x, t)$ at the beginning of year t is corrected using the death counts $D_L\ (x, t)$ (see Fig. 3).

--- insert Figure 3

Figure 4 shows cohort mortality for the selected birth cohorts separately for East and West Germany from 1980 to 1999. As indicated by the gray column, the Berlin Wall fell on November 9, 1989, and formal unification was completed on October 3, 1990. Before 1989, the annual probability of death was considerably higher in East Germany than in West Germany. Nonetheless, the very-old East Germans were able to profit from the improvements associated with unification and their mortality converged towards West German levels.

--- insert Figure 4

The cohort mortality for women is shown in Figure 5. It can be seen that mortality among very old East German women started to decrease after unification,

edging closer to the mortality of West German women. The pattern for women is very similar to the pattern for both sexes (Fig. 4) because more women than men survive to older ages, and consequently the female pattern increasingly determines the pattern for both sexes.

--- insert Figure 5

The cohort mortality for men is depicted in Figure 6. It appears that East and West German mortality in cohorts born in 1895 and 1900 converged after unification. However, the mortality estimates for these two cohorts are somewhat erratic, particularly in recent years, because only relatively few men survived to age 95 and above, and definite conclusions about convergence cannot be drawn for these cohorts. The mortality estimates for the younger cohorts born in 1905 and 1910 are more stable, due to the larger number of surviving men. Surprisingly, there was almost no East-West convergence in cohort mortality for male cohorts born in 1905 and 1910.

--- insert Figure 6

Discussion

We examined cohort mortality following German unification in cohorts born in 1895, 1900, 1905 and 1910. Before unification, mortality in these cohorts was considerably higher in East Germany than in the West. With the collapse of the socialist government in 1989 and German unification a year later, cohort mortality in the East declined toward prevailing levels in the West, particularly among women. This suggests that even the very-old East Germans were able to profit from medical, social, and economic improvements associated with unification. These improvements in old-age survival in East Germany are in stark contrast with the view that old age mortality is immutable. Instead, the fact that East German death rates at the oldest ages fell

considerably after German unification highlights the importance of factors operating late in life.

Is the plasticity of mortality reduced in scope with age? The age-related increase in mortality for most adult ages is well known and attests to age-related decrements in biological adaptability. Numerous cross-sectional and longitudinal studies have reported age-dependent decrements in a number of anatomical, physiological and psychological factors. As individuals grow older, their biological adaptability decreases and they are less well-adapted to survive. The age-related increase in adult mortality appears to be fairly universal. It can be observed across different countries and regions as well as across different time periods. Evolutionary accounts have been used to explain why biological adaptability decreases and the mortality risk increases with age. Most of these accounts rest on the argument that the force of natural selection weakens with increasing adult calendar age, and that there is no selection against mutations that are expressed after reproductive activity has ceased (Baltes, 1997; Hamilton, 1966; Medawar, 1952; Williams, 1957). Despite all these pervasive age-related decrements in people's capability to survive, the present study lends support to the proposal that mortality at older ages is plastic and that cultural change and innovations can affect it. Moreover, it appears that a cultural innovation as extensive as German unification can lead to both a reduction of mortality at old ages and to increasing death rates at younger ages (cf. Figure 2). For example, the sudden economic change and the availability of cars resulted in both a rise in vehicle ownership and an increase in the number of inexperienced drivers on the roads who were ill equipped to deal with the increased traffic. As a consequence, the death rates of East German car owners aged 18-24 increased sharply (Winston, Rineer, Menon, & Baker, 1999). It could be argued that German society has invested more resources after unification in combating mortality at older than at younger ages, which has led to the marked increase in survival at older ages.

Oldest-old death rates were remarkably sensitive to the cultural, political, and economic changes associated with German unification. Speculation about the specific factors responsible focuses on the health care system and individuals' economic resources (Gjonca et al., 2000). Studies on mortality from conditions amenable to medical interventions confirm that medical resource deficiencies are decisive (Velkova, Wolleswinkel-Van den Bosch, & Mackenbach, 1997). The financial weakness of the socialist health care system in East Germany could be one reason why improvements in old-age mortality were relatively slow prior to unification. After unification the West German health care system was quickly introduced in East Germany, and this could have led to immediate progress in the area of old-age mortality. An alternative argument rests on the extensive literature on socioeconomic differentials in mortality. Individual resource availability increases ones chances at having good health and, ultimately, survival. With unification the West German pension scheme was transmitted to East Germany, which made retired persons one of the groups that has benefited most from the transformation. Increased individual resources and the opportunities that came with them may have contributed to the accelerated decline in old-age death rates in East Germany.

An alternative explanation draws upon the theory of heterogeneous populations (Vaupel, Manton, & Stallard, 1979). All populations are heterogeneous. Some individuals are frailer than others, and the frail die first. As time goes by, the residual population is increasingly made up of those individuals who were always the most resilient. Consequently, those individuals alive at older ages may be fundamentally different from the rest of the individuals alive at younger ages. Some of the East-West convergence shown in Figures 4 and 5 may reflect the effects of compositional changes as the frailer individuals drop out of these cohorts. For example, in East Germany it was comparatively more difficult to survive to age 90 because of higher death rates at older ages, and only the most resilient individuals survived. In West Germany it was

comparatively easier to survive to age 90 because of lower death rates, and some of the frail individuals survived. An East-West comparison of cohort mortality at age 90 may entail a comparison of very resilient group (survivors in East Germany) with a less resilient group (survivors in West Germany), and these compositional effects may have caused some of the convergence observed after unification.

Interestingly, following unification cohort mortality converged in older women but to a much lesser degree in older men. We speculate that there are two main reasons that might explain the sex difference observed in the pattern of convergence. On the one hand, women make more use of medical services than do men (Waldron, 1995), women rely more on institutional care, and women are more likely to be admitted to a nursing home. Consequently, women might have benefited more from medical and nursing care improvements after unification. On the other hand it is true that the West German pension system rewards long working biographies. After unification the West German pension system was then transmitted to East Germany. Particularly East German women benefited because they had, on average, considerably longer working biographies than their West German counterparts. Resources and opportunities that came with increased pensions may have contributed to the increased survival among older East German women.

In sum, this study of cohort mortality suggests that even the very-old East Germans were able to profit from medical, social and economic improvements after unification. This result lends support to the proposal that mortality at older ages is plastic and amenable to intervention. Little is known yet about the relative contribution of the specific factors that affected old-age survival after unification and about the reasons why late-life mortality has converged in women but has not (yet?) in men.

Acknowledgements

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References

Baltes, P. B. (1997). On the incomplete architecture of human ontogeny – selection, optimization, and compensation as foundation of developmental theory. *American Psychologist, 52*(4), 366-380.

Dinkel, R.H. (1992). Kohortensterbetafeln für Geburtsjahrgäng ab 1900 bis 1962 in den beiden Teilen Deutschlands. *Zeitschrift für Bevölkerungswissenschaft, 18*(1), 95-116.

Dinkel, R.H. (1999). *East and West German mortality before and after reunification.* Unpublished manuscript, University of Rostock.

Flaskämper, P. (1962). *Bevölkerungsstatistik.* Hamburg, Germany: Verlag Richard Meiner.

Fries, J. F. (1980). Aging, natural death, and the compression of morbidity. *New England Journal of Medicine, 303,* 130-135.

Gjonça, A., Brockmann, H., & Maier, H. (2000). Old-age mortality in Germany prior to and after reunification [On-line]. *Demographic Research, 3*(1), 5,861 words. Available: http://www.demographic-research.org/volumes/vol3/1/ [2000, July 12].

Hamilton, W. D. (1966). The moulding of senescence by natural selection. *Journal of Theoretical Biology, 12,* 12-45.

Hayflick, L. (2000). The future of aging. *Nature, 408,* 267-269.

Kannisto, V. (1994). *Development of oldest-old mortality 1950-1990.* Odense, Denmark: Odense University Press. Electronic edition: http://www.demogr.mpg.de/Papers/Books/Monograph1/OldestOld.htm.

Kannisto, V., Lauritsen, J., Thatcher, A. R., & Vaupel, J. W. (1994). Reductions in mortality at advanced ages: several decades of evidence from 27 countries. *Population and Development Review, 20,* 793-810.

Maier, H., & Vaupel, J. W. (2003). Age differences in cultural efficiency: secular trends in longevity. In U. M. Staudinger, U. Lindenberger (Eds.), *Understanding human development: dialogues with lifespan psychology* (pp.59-78). Boston, MA: Kluwer Academic Publishers.

Medawar, P. B. (1952). *An unsolved problem of biology.* Oxford: Oxford University Press.

Nolte, E., Shkolnikov, V., & McKee, M. (2000a). Changing mortality patterns in East and West Germany and Poland. I: Long-term trends (1960-1997). *Journal of Epidemiology and Community Health, 54,* 890-898.

Nolte, E., Shkolnikov, V., & McKee, M. (2000b). Changing mortality patterns in East and West Germany and Poland. II: Short-term trends during transition and in the 1990s. *Journal of Epidemiology and Community Health, 54,* 899-906.

Oeppen, J., & Vaupel, J. W. (2002). Broken limits to life expectancy. *Science, 296,* 1029-1031.

Scholz, R. (1996). Analyse und Prognose der Mortalitätsentwicklung in den alten und neuen Bundesländern - Ergebnisse des Ost/West-Vergleiches der Kohortensterblichkeit. In R. Dinkel, C. Höhn & R. Scholz (Eds), *Sterblichkeitsentwicklung - unter besonderer Berücksichtigung des Kohortenansatzes* (pp. 89-102). München, Germany: R. Oldenbourg Verlag.

Thatcher, R., Kannisto, V., & Andreev, K. (2002). The survivor ratio method for estimating numbers at high ages. *Demographic Research, 6*(1), 4,843 words. Available: http://www.demographic-research.org/volumes/vol6/1/ [2002, January 4].

Tuljapurkar, S., Li, N., & Boe, C. (2000). A universal pattern of mortality decline in the G7 countries. *Nature, 405,* 789-792.

Vaupel, J. W. (1997). The remarkable improvements in survival at older ages. Philosophical Transactions of the Royal Society of London - Series B: *Biological Sciences, 352,* 1799-1804.

Vaupel, J. W., Carey, J. R., Christensen, K., Johnson, T. E., Yashin, A. I., Holm, N. V., Iachine, I. A., Kannisto, V., Khazaeli, A. A., Liedo, P., Longo, V. D., Zeng, Y, Manton, K. G., & Curtsinger, J. W. (1998). Biodemographic trajectories of longevity. *Science, 280,* 855-860.

Vaupel, J. W., Manton, K. G., & Stallard, E. (1979). The impact of heterogeneity in individual frailty on the dynamics of mortality. *Demography, 16,* 439-454.

Velkova, A., Wolleswinkel-Van den Bosch, J., & Mackenbach, J. (1997). The East-West life expectancy gap: differences in mortality from conditions amenable to medical intervention. *International Journal of Epidemiology, 26,* 75-84.

Vincent, P. (1951). La mortalité des veillards. *Population, 6,* 181-204.

Waldron, I. (1995). Contributions of changing gender differences in behavior and social roles to changing gender differences in mortality. In D. Sabo & D. F. Gordon, (Eds.), *Men's health and illness: gender, power, and the body* (pp. 22-45). Thousand Oaks, CA:

Williams, G. C. (1957). Pleiotrophy, natural selection, and the evolution of senescence. *Evolution, 11,* 398-411.

Winston, F. K., Rineer, C., Menon, R., & Baker, S. P. (1999). The carnage wrought by major economic change: ecological study of traffic-related mortality and the reunification of Germany. *British Medical Journal, 318,* 1647-1649.

Figure Captions

Figure 1. Life expectancy at birth in Germany, separately for women and men. Source: Human Mortality Database, http://www.humanmortality.org/.

Figure 2. East/West ratio of age-specific annual probability of death from 1956 to 1999. Source: compiled by authors from the Human Mortality Database, http://www.humanmortality.org/.

Figure 3. Lexis diagram of cohort mortality calculation.

Figure 4. Cohort mortality in cohorts born in 1895, 1900, 1905 and 1910, separately for East and West Germany, plotted on a logarithmic scale. Source: compiled by authors from the Human Mortality Database, http://www.humanmortality.org/.

Figure 5. Cohort mortality in women born in 1895, 1900, 1905 and 1910, separately for East and West Germany, plotted on a logarithmic scale. Source: compiled by authors from the Human Mortality Database, http://www.humanmortality.org/.

Figure 6. Cohort mortality in men born in 1895, 1900, 1905 and 1910, separately for East and West Germany, plotted on a logarithmic scale. Source: compiled by authors from the Human Mortality Database, http://www.humanmortality.org/.

Figure 1
Life expectancy at birth in East and West Germany, separately for women and men.
Source: Human Mortality Database, **http://www.humanmortality.org/**.

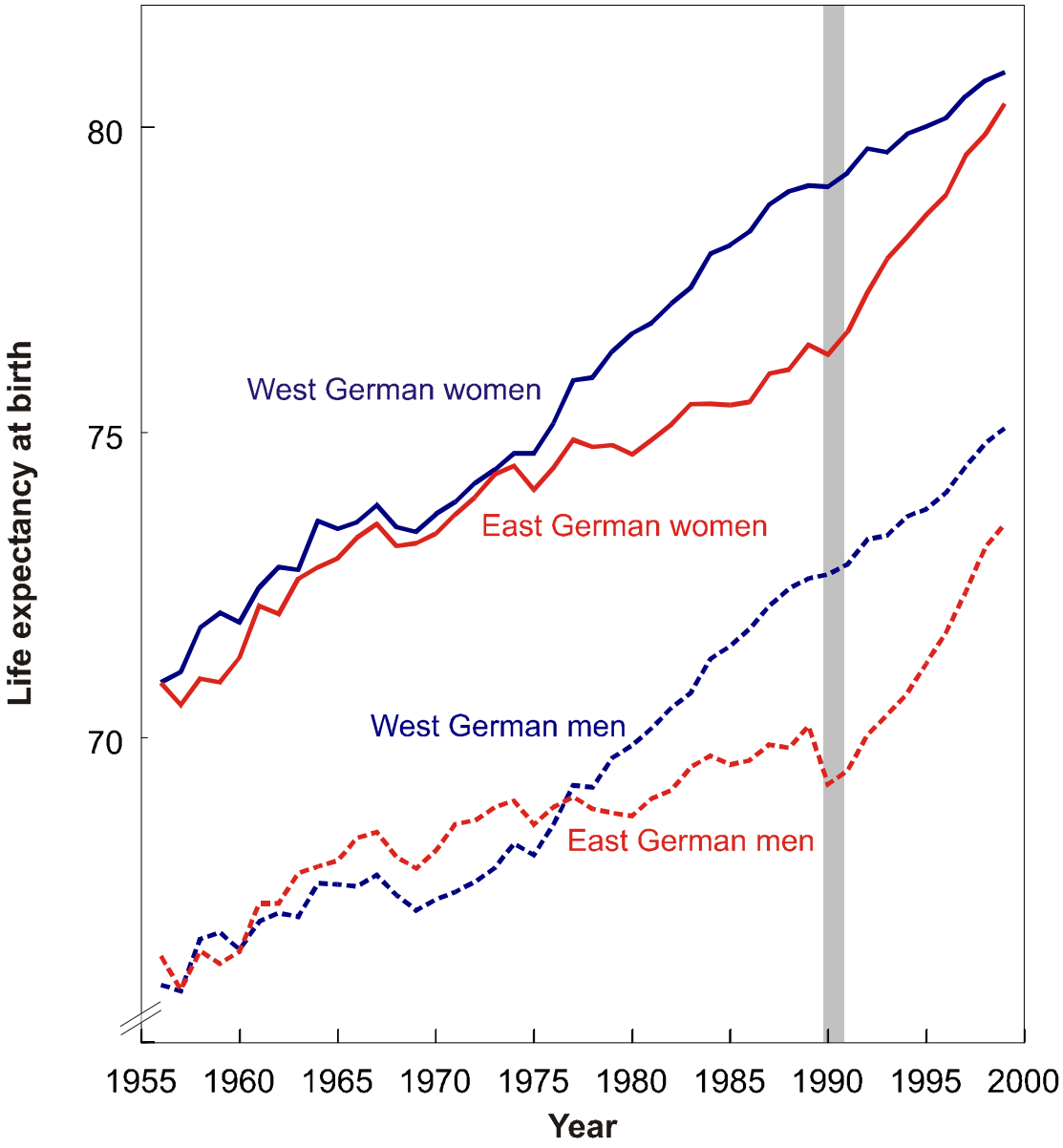

Figure 2
East/West ratio of age-specific annual probability of death from 1956 to 1999.
Source: compiled by authors from the Human Mortality Database, http://www.humanmortality.org/.

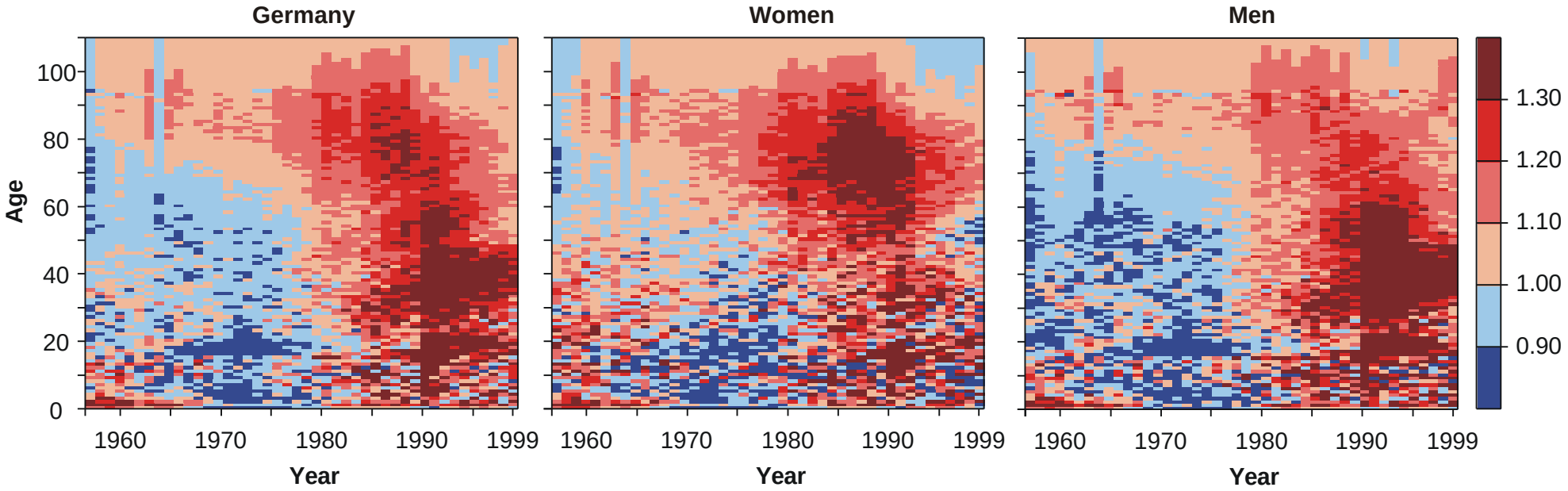

Figure 3
Lexis diagram of cohort mortality calculation.

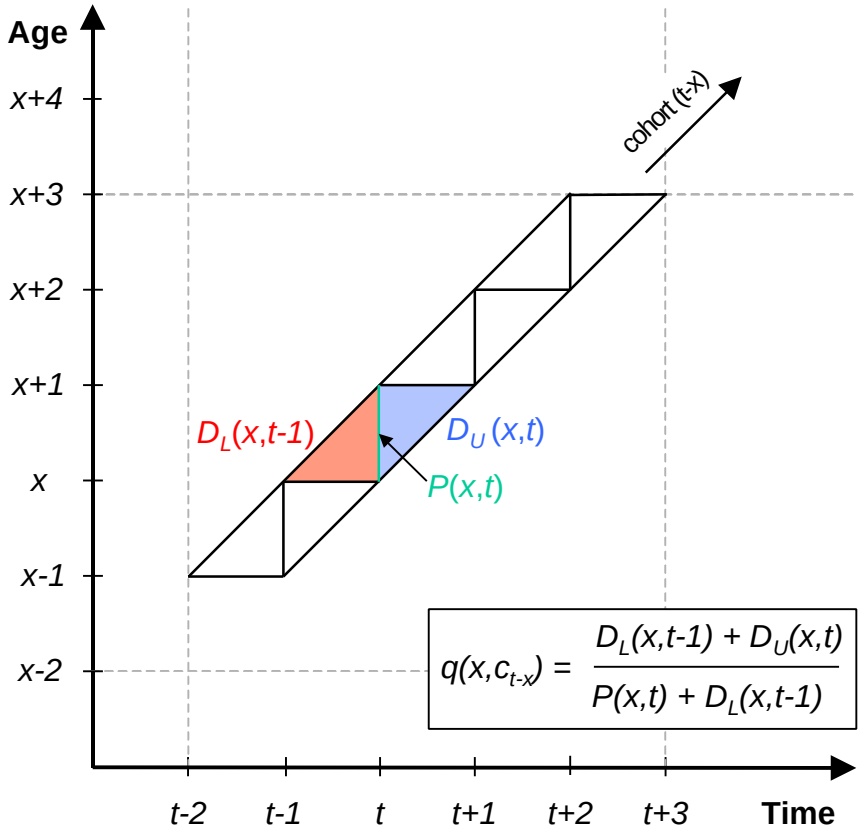

Figure 4
Cohort mortality in cohorts born in 1895, 1900, 1905 and 1910, separately for East and West Germany, plotted on a logarithmic scale.
Source: compiled by authors from the Human Mortality Database, http://www.humanmortality.org/.

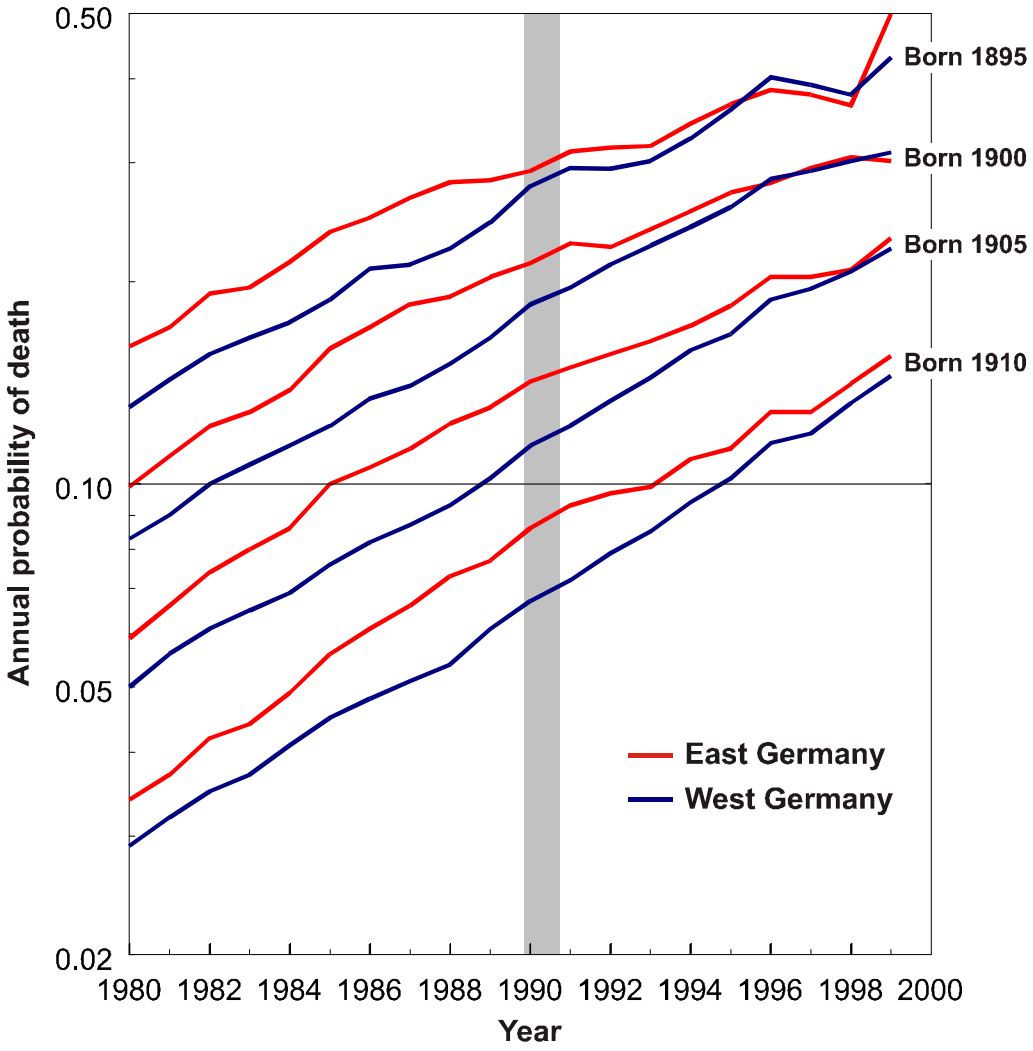

Figure 5
Cohort mortality in women born in 1895, 1900, 1905 and 1910, separately for East and West Germany, plotted on a logarithmic scale.
Source: compiled by authors from the Human Mortality Database, http://www.humanmortality.org/.

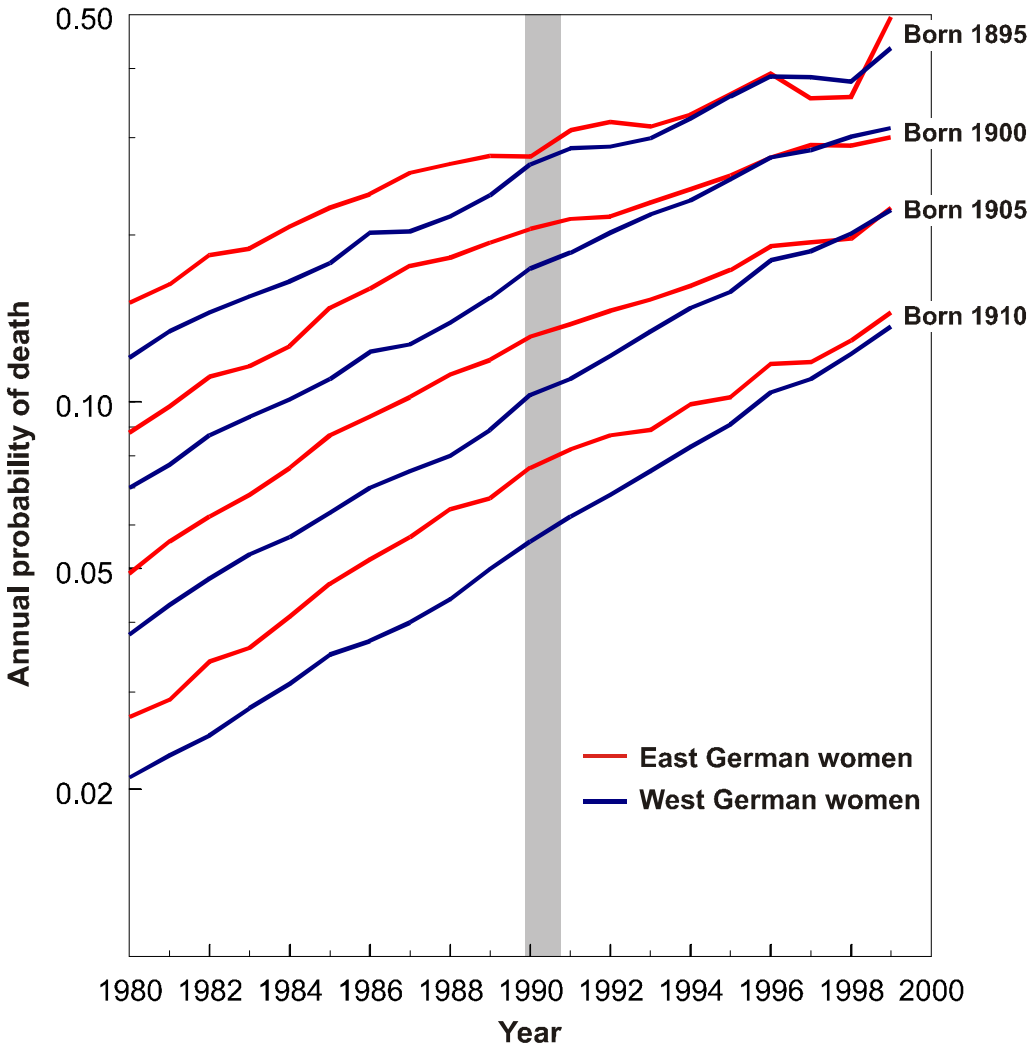

Figure 6
Cohort mortality in men born in 1895, 1900, 1905 and 1910, separately for East and West Germany, plotted on a logarithmic scale.
Source: compiled by authors from the Human Mortality Database, http://www.humanmortality.org/.