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**Comments at the Ceremony for the IUSSP-Dogan Award for Comparative Research in Demography.**

# Towards the understanding of mortality divergences and reversals.

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## Acknowledgements

I am sincerely grateful to the IUSSP Council and the Mattei Dogan Foundation for honoring me with the IUSSP-Mattei Dogan Award for Comparative Research in Demography.

Comparative and multidisciplinary research is only possible with extensive collaboration with colleagues. I think that today's honor largely reflects my good fortune in working with many outstanding and open-minded colleagues at the Max Planck Institute for Demographic Research in Rostock, my current place of work, and my former work place, the Center of Demography and Human Ecology in Moscow. Today I am happy to express my gratitude and appreciation to people with whom I have had especially close scientific collaboration during the last ten years. These are France Meslé and Jacques Vallin from INED in Paris, Dave Leon, Martin McKee, and Ellen Nolte from LSHTM in London, Anatoly Vishnevski and Evgueni Andreev from CDHE in Moscow, Sudhir Anand from the St. Catherine's College in Oxford, Mark Field from the Davis Center for Russian and Eurasian Studies at Harvard, William Pridemore from the University of Indiana, Tapani Valkonen from the University of Heslsinki, Oystein Kravdal from the University of Oslo, John Wilmoth and Dana Glei from the University of California at Berkeley, Jan Sundin and Sam Willner from the Department for Health and Society at the Linkoeping University, Maria Shkolnikova from the Center for Cardiac Arrhythmias in Moscow and Maxine Weinstein from Georgetown University in Washington. I am very grateful also to my present and former Max Planck colleagues James Vaupel and Jan Hoem, Dimiter Philipov, Dmitri Jdanov, Domantas Jasilionis, Rene Houle, Alexander Begun, Rembrandt Scholz, Christoph Buehler, Martin Spielauer, Kirill Andreev, Sigrid Gellers-Barkmann, Marketa Peccholdova, Eva Kibele, and Edelgard Katke. It is a good opportunity also to express my appreciation to colleagues from the IUSSP Committee on Emerging Health Threats: France Meslé, Michel Caraël, Ian Timæus, Tapani Valkonen, Mari Bhat, and Eliwo Akoto Mondiale, with whom I have been working jointly since the Committee was set-up in 2000.

This Award comes at a moment when demographic studies are tightly connected with other disciplines such as public health and epidemiology, medicine and biology, sociology and anthropology. As many other demographers, I am involved in several multidisciplinary studies and today's Award will certainly encourage me and other scholars to reinforce efforts in the area of comparative and multidisciplinary research.

## Scientific Presentation

I would like to share with you a few broad-brush comments on mortality divergences and reversals in the modern world.

Declining mortality has been a routine expectation in most of the world, apart from wartime interruptions. Many mortality forecasts envisage global convergence to low mortality over decades to come and indeed mortality continues to decline in most regions of the world (Tuljapurkar et al., 2000, Wilson, 2001, Vallin and Meslé, 2005). Mortality reversals refer to exceptions to this mainstream and long-run trend – situations in which the decline ceases or even reverses.

In the 1960s-80s, the expectation of rapid inter-national mortality convergence prevailed. It arose from systematic analyses of mortality trends in industrialized countries over the 20th century that became available in the 1970s (Omran, 1971, Preston, 1976). In the 1970s-80s the UN Population Division projected a 2.5 year gain in life expectancy at birth every five calendar years for countries with a life expectancy below 62 years, after which the gain would decrease to about 2 years (United Nations, 1981, United Nations, 1986). In reality, however, during the last two decades of the 20th century 42 countries have experienced mortality reversals (MacMichael et al., 2004, Caselli et al., 2002, Vallin and Meslé, 2005). These countries are mostly situated in sub-Saharan Africa or in Eastern Europe. But mortality increases have also taken place in other countries such as North Korea, Haiti, Fiji, the Bahamas, and Iraq.

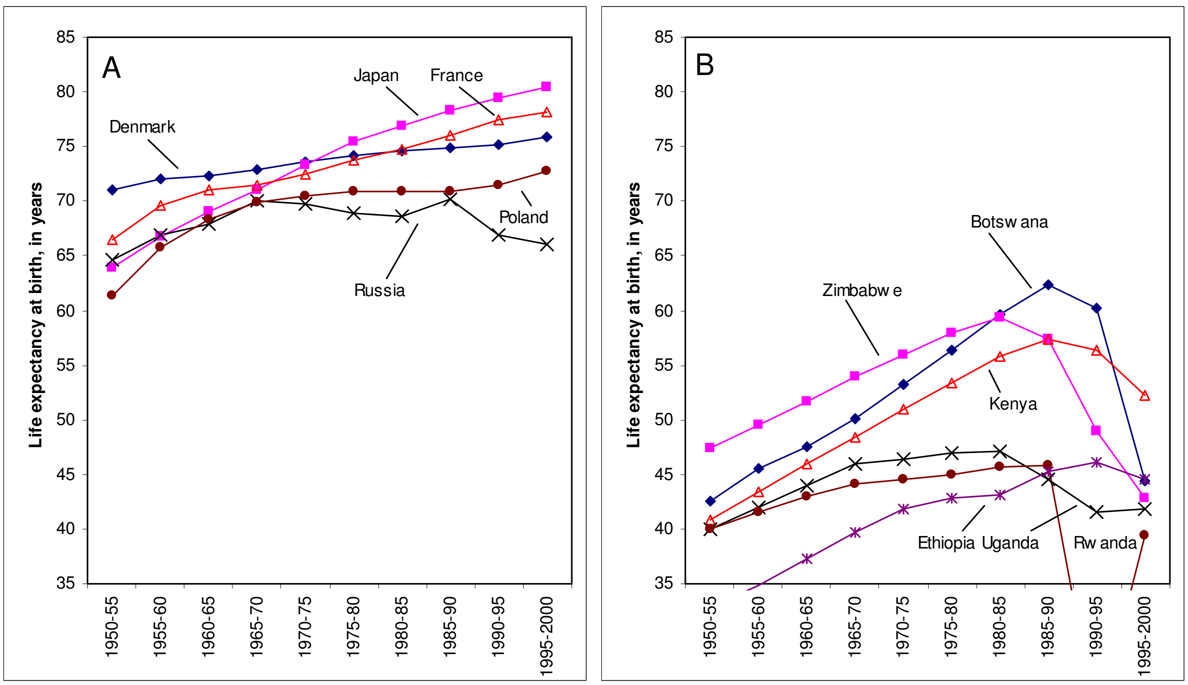


**Figure 1. Life expectancy at birth in two groups of countries, 1950-55 to 1995-2000.**
After Caselli et al., 2002

The left panel of Figure 1 shows an unexpected slowdown in life expectancy increase in Denmark, long-term stagnation in Poland, and significant deterioration in Russia contrasting with a continuous and steep increase in Japan and France. The right panel shows striking set backs in countries of sub-Saharan Africa that were hit hard by the HIV/AIDS epidemics and increases in malaria and TB. Many of these countries also faced economic hardships, political conflicts, and collective and inter-individual violence over the 1980s-90s.

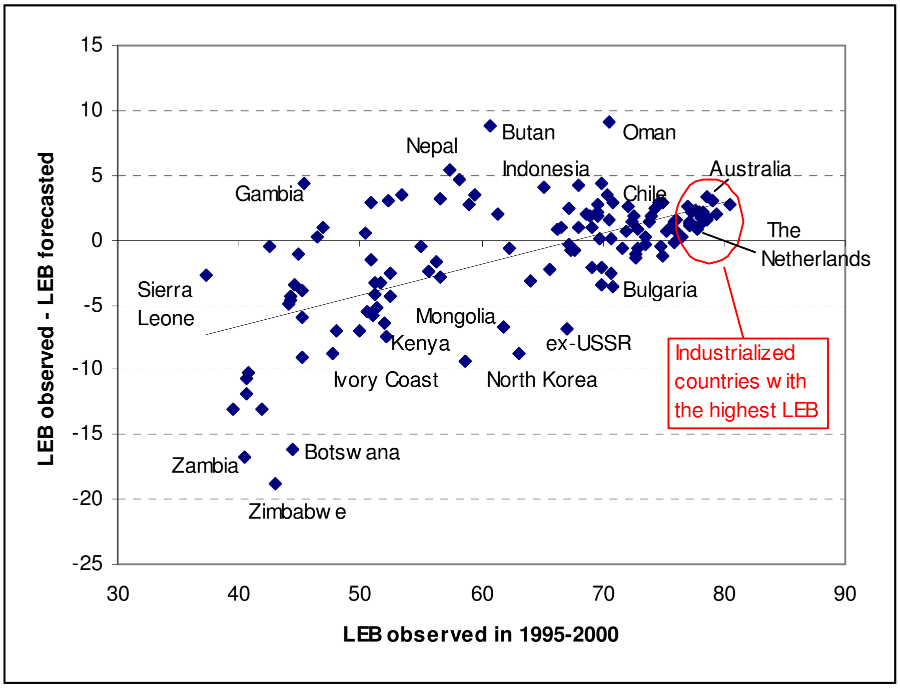


**Figure 2. Difference between the observed and predicted (in 1984) values of life expectancy at birth by country in 1995-2000.**

Although inter-country differences in life expectancy have been very much reduced since the 1950s, this trend slowed down or even reversed by the end of the twentieth century (Moser et al., 2004). The reason for that becomes clear from Figure 2. Figure 2 depicts how reality differs from the expected future mortality predicted 20 years ago. The graph plots present estimates of life expectancy at birth against the difference between these estimates and the life expectancy values predicted by the UN Population Division in 1984. Many countries with high life expectancy have made significant further progress, whereas many high- or middle-mortality countries have lost or gained much less than expected. In several sub-Saharan Africa countries present life expectancy estimates are more than 10 years lower than the values predicted in 1984. In China and India the present life expectancy estimates for 1995-2000 are slightly lower than the predicted values.

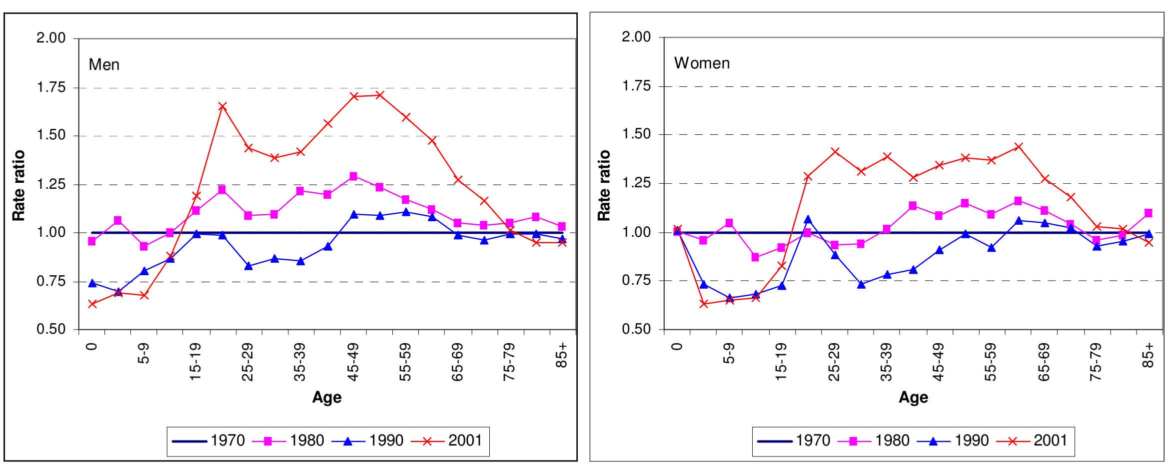


**Figure 3a. Proportional changes in age-specific death rates in Russia from 1970 to 2001 with reference level of 1970 taken as one.**

In many mortality reversal cases, mortality increases are greater among working-age adults than in traditionally vulnerable groups of children and the elderly. In Russia and other countries of the former USSR and Eastern Europe, unfavorable trends in life expectancy at birth were determined by increasing death rates among men and, to a lesser extent, among women, between the ages of 20 to 65 (Shkolnikov et al., 1996, Chen et al., 1996, Meslé et al., 2003). Figure 3a reflects a continuous elevation of the Russian mortality at working ages over the 1970s-90s with only one short-term interruption associated with M.Gorbatchev's anti-alcohol campaign in the second half of the 1980s. The increase in adult-age mortality, mainly caused by external and circulatory causes (Meslé et al., 2003), has significantly aggravated after the disintegration of the Soviet Union, the beginning of painful economic reforms, and termination of all anti-alcoholic measures in 1991-92. In total, the rise of adult-age mortality between 1970 and 2001 led to decreases in life expectancy at birth from 63 to 59 years for men and from 74 to 72 for women. During this time, the life expectancy gap between Russia and most industrialized countries has increased from 3 to 17 years for men and from 1 to 8 years for women.

Studies of the Russian health crisis in the 1990s suggest its connection with alcohol abuse and psychosocial stress (Shapiro, 1995, Shkolnikov and Meslé, 1996, Chen et al., 1996, Leon et al., 1997, Shkolnikov, Cornia et al., 1998, Walberg et al., 1998, Siegrist, 2000, Bobak et al., 2000, Shkolnikov, Andreev et al., 2004). Observed patterns of mortality by age and sex together with evidence on causes of death, regional and social-group mortality, stress and social cohesion suggest that mortality reversal in Russia and especially its acute stage in the 1990s represent not only medical but also *socio-psychological phenomenon*.

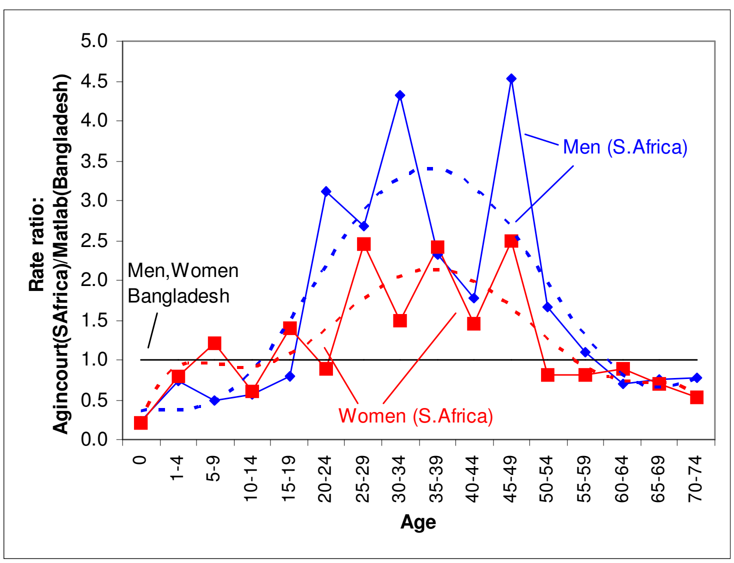


**Figure 3b. Proportional difference between age-specific death rates in Agincourt (South Africa) in 1995-98 and in Matlab (Bangladesh) in 1998.**
**Both for men and women the Matlab death rates are taken as a reference level = 1.**

For sub-Saharan Africa, similar data are rarely available. It is difficult to obtain even very basic data on mortality age curves in order to inspect shapes of excess mortality. Existing fragmentary evidence suggests that mortality reversals in the region have been largely driven by increases in adult-age mortality. Figure 3b was built with mortality data provided by INDEPTH network of demographic surveillance sites (Population and Health, 2002). It shows proportional differences between age-specific death rates in two rural regions: Agincourt in South Africa and Matlab in

Bangladesh. Figure 3b reveals a higher toll of excess mortality at adult ages in the South African site compared to the Asian site. The latter, however, experienced higher infant mortality and *lower* overall life expectancy at birth.

**Table 1. Probabilities of early death in childhood and adulthood by sex and broad age group in Russia, Agincourt (South Africa), and Matlab (Bangladesh).**

| Age interval | Russia, 2001 | Agincourt, 1995-98 | Matlab, 1998 |
|---|---|---|---|
| Men | | | |
| 0-14 | 0.03 | 0.04 | 0.10 |
| 15-49 | 0.26 | 0.20 | 0.08 |
| 15-64 | 0.56 | 0.40 | 0.31 |
| Women | | | |
| 0-14 | 0.02 | 0.04 | 0.11 |
| 15-49 | 0.08 | 0.11 | 0.06 |
| 15-64 | 0.23 | 0.22 | 0.20 |

Table 1 expresses in quantitative terms the contrast between traditional high infant mortality pattern in Matlab and high adult mortality patterns in Russia and Agincourt.

Both Russia and South Africa experience excess adult-age mortality for men. In both cases there is a growing prevalence of adverse “male” behaviors such as alcohol and drug abuse, crime and violence, which are causing a large part of excess adult-age mortality. At the same time, the two countries are characterized by quite different epidemiological profiles with a much higher share of cardiovascular disease and cancers in Russia, and a much higher share of HIV/AIDS and TB in South Africa. Importantly, there are considerable similarities in general societal conditions during periods of health crises (Sundin, 2004). Both countries face drastic political and economic changes strongly affecting large population groups and weakening former safety nets. In both countries, economic transitions cause growing income inequalities and psychosocial stress. An increasing participation in international markets causes difficulties for domestic industries, motivates their re-structuring and leads to growing unemployment (Chopra and Sanders, 2004, Sundin, 2004). Coping with these challenges is difficult, especially for less educated and professionally qualified groups of population.

Similar patterns of excess mortality can be found at sub-national level in low-mortality countries. It was shown, for example, that level of mortality of people with secondary education in Russia is comparable to mortality of people with the lowest education in the West (Shkolnikov, Deev et al., 2004). Excess mortality of disadvantaged social groups tends to be the highest among middle-aged people rather than children or the elderly (Antonovski, 1967) similar to what is depicted in previous Figures 3a and 3b. There is also close similarity between the cause-of-death patterns of excess mortality in disadvantaged social groups and the equivalent patterns of excess mortality in the east of Europe (Leon, 2001). This similarity suggests an existence of common mechanisms being effective in population minorities in the West and in population majorities in the East.

In most industrialized countries the general progress is beneficial for all population groups (Valkonen et al., 1993, Valkonen, 2001, Kunst et al., 2004) and an absolute worsening of mortality of disadvantaged groups can rarely be seen. A decrease in life expectancy of African-Americans in the second half of the 1980s is such an example (Kochanek et al., 1994, Shkolnikov et al., 2001). It was found to be induced by mortality from AIDS, homicide and a few other causes. It also coincided with the introduction of more market-oriented policies and some weakening of social protection for the poor in the 1980s (Whitehead and Diderechsen, 1997). Noteworthy, life expectancy of the total US population continued to rise over the 1980s in spite of the deterioration experienced by African-Americans who constitute 12-percent of the population. The adverse trend in African-Americans could be identified and analyzed with the help of data on mortality by race, which are produced annually by the US statistical system. It is not clear, however, whether race is the best or the only variable to highlight such trend.

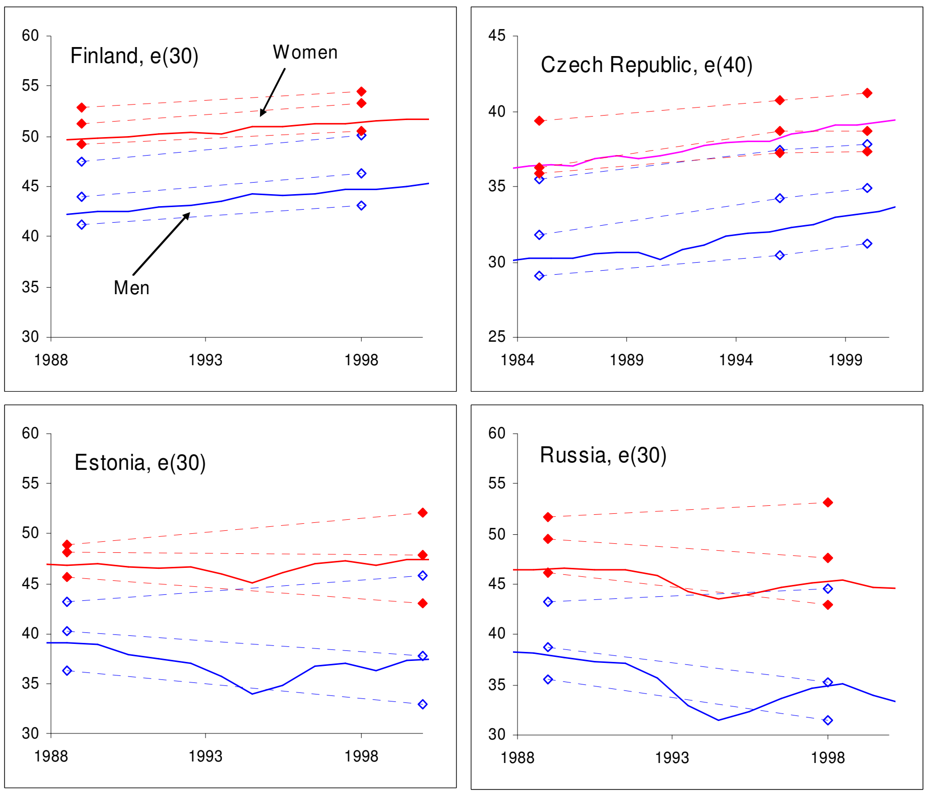


**Figure 4. Annual trends in life expectancy at age 30 (40 for the Czech Republic) of the total population and inter-census changes in life expectancy for three educational groups since the late 1980s: Finland, the Czech Republic, Estonia, Russia.**
**Blue lines are for men and red lines are for women.**
Source: Shkolnikov, Andreev et al., 2005

Until recently, there was very little information available about changes in social differentials of mortality in countries, where it has been increasing. It was also puzzling how in the 1970s-80s economic growth and improving educational level (human capital) in Eastern Europe coincided with unfavorable mortality trends. For the communist period, increases in male mortality in Hungary and Bulgaria were almost entirely concentrated among manual workers (Carlson, 1989, Carlson and Tsvetarsky, 1992). Some new results have also become available for the transition period in the 1990s. For the Czech Republic, educational differences in mortality increased only moderately between 1980 and 1995-99 (Blazek and Dzurova, 2000, Rychtarikova, 2004). However, a significant widening of the educational gap in mortality rates in Hungary between 1989 and 1999 was detected (Klinger, 2001). Finally, an enormous widening of the educational differences in life expectancy between 1988-89 and 1999-2000 was found in Estonia (Leinsalu et al., 2003).

Figure 4 (Shkolnikov, Andreev et al., 2005) compares changes in life expectancy at age 30 (40 for the Czech Republic) between the late 1980s and the late 1990s in the Czech Republic, Estonia, and

Russia with Finland. We take the latter as a comparison country representing a Western mortality pattern. The figure reveals a clear contrast between Finland and the Czech Republic on one side, where the inter-group inequalities have increased moderately, and Russia and Estonia on the other side, where inequalities have increased greatly. In Estonia, life expectancy of all men at age 30 decreased by about one year between 1989 and 2000. Simultaneously, it significantly increased by 2.5 years in the high-education group and decreased by 3.4 years in the low-education group. As a result, difference between male life expectancies at age 30 in the two educational groups increased from 7 to 13 years. In Russia between 1989 and 1998, the total male population lost 2.5 years of life expectancy at age 30. At the same time, men with high education gained about one year of life expectancy, while men with low education lost four years. These changes led to a dramatic increase in the gap from 7 to 14 years. Further analyses (not shown here) suggest that most life expectancy improvements among people with high education were caused by decreasing death rates at ages above 60, while most of the deterioration among people with low education was caused by mortality at working ages. In general, Figure 4 suggests emergence of winners and losers both in Estonia and Russia, but also a general mortality advantage of Estonia as compared to Russia.

**Table 2. Contributions of changes in mortality in the three educational groups (M-effects) and of changes in the population educational structure (P-effect) to the change in total life expectancy.**

| | Total change | M-effects | | | P-effect |
|---|---|---|---|---|---|
| | | High education | Middle education | Low education | |
| MEN | | | | | |
| Finland, e(30), 1988/89-1998/99 | 2.58 | 0.20 | 0.52 | 1.38 | 0.48 |
| Czech Republic, e(40), 1984/85-1999/2000 | 2.52 | 0.17 | 0.49 | 1.58 | 0.28 |
| Estonia, e(30), 1988/89-1999/2000 | -1.29 | 0.18 | -1.09 | -1.35 | 0.96 |
| Russia, e(30), 1988/89-1998 | -2.46 | -0.01 | -1.54 | -1.70 | 0.79 |
| WOMEN | | | | | |
| Finland, e(30), 1988/89-1998/99 | 1.97 | 0.09 | 0.30 | 1.26 | 0.31 |
| Czech Republic, e(40), 1984/85-1999/2000 | 1.79 | 0.04 | 0.36 | 1.26 | 0.13 |
| Estonia, e(30), 1988/89-1999/2000 | 0.40 | 0.17 | -0.25 | -0.21 | 0.70 |
| Russia, e(30), 1988/89-1998 | -1.43 | 0.05 | -0.54 | -1.60 | 0.65 |

Source: Shkolnikov, Andreev et al., 2005.

In all countries the educational level of the population has been improving with time. In Estonia and Russia, for example, the share of people with higher education has increased from 13 to 17 percent, while the share of people with little education has dropped from 50 to 35 percent between the late 1980s and the late 1990s. Table 2 shows decomposition of temporal changes in life expectancy of the total population according to the group-specific mortality changes (M-effects) and to the educational composition of population (P-effect) by using a general decomposition algorithm (Andreev et al., 2002). It appears that both in Finland and the Czech Republic the decreasing mortality of people with low education produces the greatest contribution to the change in the overall life expectancy. In Estonia positive contributions are produced only by lowering mortality of people with high education. In Russia a small positive contribution is produced by lowering mortality of women with high education. One could wonder why the M-effect produced by mortality changes among the highly educated Russian men is negative. This is because death rates in this group have increased, to a certain extent, at younger ages where the proportion of highly educated people is greater than at older ages where death rates have decreased.

Interestingly, both in Estonia and Russia the greatest positive contributions to the life expectancy change are produced by the compositional improvement. This positive effect is an echo of the past since the most important educational transition took place in the Soviet Union in the early 1960s when university admissions significantly went up and secondary school education became a predominant practice (Gerber and Hout, 1995). Birth cohorts most affected by this transition were at ages 45 to 60 in the late 1990s.

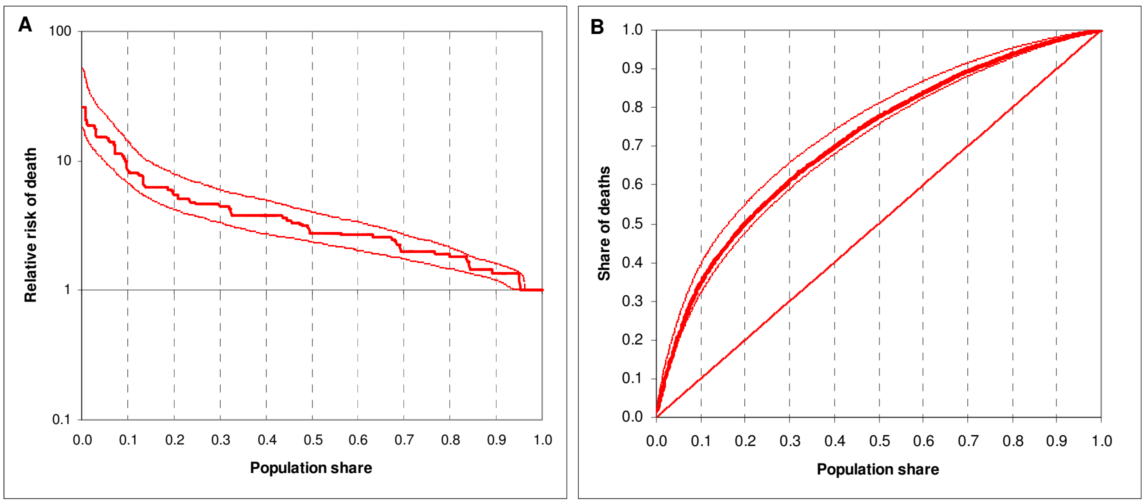


**Figure 5. Distribution of the risk of all-cause mortality among Russian men aged 25 to 54 based on a case-control study from the city of Izhevsk.**
**A: Risk of death profile across population.**
**B: Concentration (Lorenz) curve expressing the share in deaths as a function of population share.**

The mortality analysis by social group outlines only very major contours of the mortality structure within national populations. They can be determined in more detail by using survey information on other important risk factors (Murray et al., 2003). Figure 5 is based on the interim data of a case-control mortality study of men aged 25 to 54 in Izhevsk, a Russian city in the Ural region with about six hundred thousand inhabitants. The data include various information about one thousand deceased men (cases) and one thousand living men (controls). Risk assessment is based on logistic regression of a case-control variable on age, educational level, marital status, wealth, smoking, frequency of drinking, and indicator of problem drinking. The left panel in Figure 5 shows a distribution of risk of death in the male population under study. For the upper quartile, the mean relative risk of death is about 15, while for the lowest quartile this value is about 1.5. Only about four percent of men have a relative risk equal to 1, which corresponds to all risk variables being at their "safest" levels. The Lorenz curve in the right panel shows a very high inequality in the face of death. Indeed, only 20 percent of men produce half of all deaths, while the concentration ratio (Gini coefficient) is as high as 0.45.

For the whole population (or an "average" man), low education, smoking and poverty are the three most important risk factors. However, in the highest risk quartile, problem drinking is the most important factor with the population-attributable fraction constituting about 20 percent of excess deaths. Life expectancy in the highest-risk quartile of men is 46 years. Its exclusion from the male population would result in a moderate rise of life expectancy from 59 to 63 years. Especially dangerous combinations of alcohol abuse with low education and poverty, typical for the highest risk men, can not be found among the majority of men.

Knowledge of biological mechanisms is essential for understanding and prediction of mortality. However, surprisingly little is known about biological mechanisms underlying the large health discrepancies. Only modest fractions of the mortality divide in Europe and between social classes within national populations can be attributed to conventional risk factors such as smoking, alcohol consumption, blood pressure, total and HDL cholesterol. They are usually between 25 and 35 percent for cardiovascular and all-cause mortality (Feldman et al., 1989, Marmot et al., 1998, Bartley et al., 2000, Deev and Shkolnikov, 2000, Ginter, 1995, Kristenson and Kucinskiene, 2002, Averina et al., 2003). Although individual-level studies found significant associations between psychosocial stress and health indicators (Kopp et al., 2002, Bobak et al., 1998, Carlson and Vägerö, 1998, Bobak et al., 2000, Pikhart et al., 2001, Pikhart et al., 2004, Kristenson and Kucinskiene, 2002), much more research is needed for unraveling biological mechanisms underlying these correlations.

This presentation stressed the importance of diverging mortality trends and mortality reversals. Mortality experiences of the last decades, first of all, demonstrate great perspectives for further increase in human longevity. But they also suggest that certain combinations of epidemiological patterns, economic and psychological conditions, cultural and behavioral patterns can cause mortality slow downs or even reversals. The significance of the diverging mortality trends calls for an intensification of data collection and research. Certainly, no model can replace real data. Much more empirical knowledge is needed to monitor and analyze adverse health developments in sub-Saharan Africa and other regions of the world. Studies should try to capture a range of situations within national populations paying special attention to vulnerable and high-risk groups. Empirical research would contribute to the creation of a theoretical framework connecting health with social change. It in turn would help to understand why significant socio-economic transitions do or do not lead to mortality reversals in different societies, what are the conditions leading to modern health crises, how far the mortality divergence can go and how the health progress can be restored.

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