Paper presented at
The 2002 Annual Meeting of the Population Association of America
May 9-11, 2002
Atlanta

Session 46 "Health in Eastern Europe and Former Soviet Union"

Mortality Crisis in Russia: New Health Threats

Natalia S. Gavrilova[*], Victoria G. Semyonova[**], Galina N. Evdokushkina[**]

(*) Center on Aging, NORC/University of Chicago, 1155 East 60th Street, Chicago, IL 60637

(**) Central Research Institute of Public Health and Informatics, Moscow, Russia.

Address for correspondence:
Dr. Natalia S. Gavrilova, Center on Aging
NORC/University of Chicago
1155 East 60th Street, Chicago, IL 60637
Fax: (773) 256-6313; Phone: (773) 256-6359
E-mail: nsgavril@midway.uchicago.edu

Abstract

In 1992 and 1998 Russia experienced two economic crises accompanied by subsequent mortality upsurge. Using exploratory factor analysis of age-adjusted mortality from major causes of death, this study shows that more than 95% of the total variation in mortality in Russia can be explained by 3 factors: (1) factor related to social stress, correlated with mortality from ischaemic heart disease and alcohol poisoning; (2) factor of asocial behavior, correlated to mortality from tuberculosis, drug dependence, AIDS, sexually transmitted diseases; and (3) factor related to selective mortality, correlated to mortality from some chronic diseases (diabetes, asthma). Our analysis demonstrates that diseases related to the second mortality factor will determine the future mortality changes in Russia. These diseases, more common among young adult age groups, are becoming a serious threat for population health in Russia and may affect other countries.

Introduction

In 1992 and 1998 Russia experienced two serious economic crises accompanied with drop in personal income and rapid impoverishment. In both cases, adverse economic changes were followed by mortality increase.

From 1992 to 1994 life expectancy of Russian males dropped from 63.8 to 57.7 years. Female life expectancy dropped from 74.4 years to 71.2 years. This decrease in life expectancy coincided in time with the introduction of painful economic experiments ('reforms') in Russia, leading to a rapid decrease in real wages and pensions, nearly complete loss of personal savings, and a tremendous increase in the poverty rate. The main causes of death that contributed to this mortality decline were diseases of the circulatory system, accidents, poisoning and injuries, diseases of the respiratory system. After 1995 mortality in Russia demonstrated slow but stable decrease. However, in August 1998 Russia experienced another economic crisis (crash of the banking system) resulting in mass impoverishment. Shortly after this crisis mortality started to grow again and male life expectancy dropped from 61.3 in 1998 to 58.8 years in 2000, while female life expectancy dropped from 72.6 to 71.7 years during the same period. In both cases population at working ages appeared to be the most vulnerable age group while children and the elderly were not significantly affected (Notzon et al., 1998). The losses in life expectancy during 1992-94 were more than 5 years for males and 3 years for females compared to the life expectancy in pre-crisis 1991. These decreases are beyond the peacetime experience of any industrialized country. Current life expectancy in Russia is lower than in China and even less than in some countries of Africa (see Table 1). Thus, the shock effect of "shock therapy" was achieved, but no therapy was provided.

Table 1 about here

This phenomenon received significant attention in a number of papers (Ellman, 1994; Gavrilova et al., 1997; Notzon et al., 1998; Leon et al., 1997; Leon, Shkolnikov, 1998; Shkolnikov et al., 1996a; 1996b; 1998a; Tulchinsky, Varavikova, 1997; Walberg et al., 1998), which showed that diseases of the circulatory system, injuries, and diseases of the respiratory system were the major causes of death contributing to the decrease in life expectancy in Russia after 1991.

Increase in mortality and drop in fertility resulted in substantial decline in natural increase and negative values of population growth (Heleniak, 1995). Attempts to estimate the premature death toll during the transition period resulted in figures ranging from 2.9 to 6.1 millions (Rosefielde, 2001) with average estimate about 3-3.5 millions (Rosefielde, 2001; Ivanova et al., 2002a). Steven Rosefielde (2001) provides perhaps the most objective view on the radical economic reforms conducted by Yeltsin giving account of Yeltsin's economic radicalism in historical perspective.

Our study does not intend to give a political or social evaluation of the transition period but rather to explore possible mechanisms and causes of huge mortality fluctuations during the last 20-35 years. Although mortality from many causes increased after 1992, some causes of death remained stable during the transition period (malignant neoplasms) or even demonstrated slow decline (transport accidents). Some apparently

unrelated causes of death might demonstrate similar time trajectories. In this study we tried to explore these potential similarities and interactions between causes of death using the method of exploratory factor analysis. Another purpose of this study is to analyze mortality patterns after the second economic crisis (1998), which revealed some new threatening signs of the future mortality changes.

Data and Methods

Data Sources

In this study we used three data sources on Russian mortality:

(1) Dataset of age-adjusted cause-specific death rates for years 1965-98 provided by the Centre of Demography and Human Ecology (Russian Academy of Sciences, Moscow). The advantage of this dataset is its rather long time series of age-adjusted death rates, which allowed us to conduct data analyses on a larger set of variables (causes of death).

(2) Official data on mortality provided by the Russian State Statistical Committee (Goskomstat), which include deaths by cause, sex, five-year age groups, for each single calendar year of death, together with corresponding population denominators. Population age distributions for corresponding calendar years were presented by the Goskomstat five-year age estimates adjusted for migration at the beginning of the year (Leon et al., 1997). The corresponding mid-year populations were calculated on the basis of two adjacent population age distributions. These data were obtained directly from the Goskomstat by the Central Research Public Health Institute and the Institute for Medical Information. The advantage of this dataset is its detailed information on age-sex distribution of deaths over the period of 1981-2000. Thus, this dataset allows us to analyze the most recent changes in Russian mortality. These data were collected every year over the 15-year period, so they do not contain corrections made later by the Goskomstat. They also do not contain data on suicide and homicide mortality before 1988 (year when these data became publicly available).

(3) Detailed mortality file provided by the World Health Organization (ICD-9). This file was used as a supplement to the official Goskomstat data, because it contains information on suicide and homicide mortality for years before 1988 (although it does not have this information for years 1983 and 1984).

The Goskomstat cause-of-death classification has been subjected to several changes over the last 20 years. Changes in cause-of-death classification have been made in years 1981, 1988, 1989, and 1999. The most notable changes in cause-of-death classification occurred in 1999 when a new coding system based on ICD-10 has been introduced. Although Russian coding system is claimed to be compatible with ICD-9 (1980-98) or ICD-10 classifications, there are substantial differences between the International and Russian classifications, especially for cardiovascular diseases. The latter issue makes study of cardiovascular mortality over long period particularly difficult.

Data Quality

The rapid and sharp changes in mortality experienced by Russia in the recent decades have generated some concerns about the quality of Russian vital statistics. Most of authors who worked with Russian mortality data admitted that recent mortality fluctuations in Russia are not artifactual and population estimates and death counts are accurate enough to ensure correct statistical analyses (Notzon et al., 1998; Leon et al., 1997; Bennett et al., 1998; Andreev, 1999). Wasserman and Varnik (1998) conducted a study of the reliability of statistics on violent death and suicide in the republics of the former USSR. They concluded that mortality data were reliable for Russia, Ukraine, and Belarus. The completeness of death reporting in Russia is rather high except for the North Caucasus Republics and the Republic of Tuva (Andreev, 1999). Unspecified diagnoses ("senility without mention of psychosis" or "symptoms and other unspecified conditions"), which often serve as a measure of quality for cause-of-death statistics, comprised only 4.4 per cent of all medical certificates in 1996 (Andreev, 1999). On the other hand, mortality from unspecified causes has very huge regional variation, which requires a special investigation (Semenova et al., 2002b). Also, the quality of cause-of-death coding is not always high (Notzon et al., 1998; Andreev, 1999), and the last audit of the accuracy in reporting causes of death was conducted in Russia only in 1982 (see Shkolnikov et al., 1996a). The autopsies were performed on 33.2 per cent of all deaths in 1996 (Andreev, 1999).

For external causes, the main concern is the increase in mortality from "injuries undetermined whether accidentally or purposely inflicted" (Russian code 175) or simply "undetermined injuries". This term could be used to conceal some cases of homicide and suicide in order to avoid criminal investigation (Wasserman, Varnik, 1998). Male mortality from this cause increased dramatically after 1992 reaching its maximum in 1994. We found that in Moscow, with its relatively high proportion of unregistered migrants, homeless, and refugees, the "undetermined injuries" for males exceeded any other cause of external mortality in 1994. Thus, while the population estimates and death counts are reasonably accurate, the quality of death coding is less satisfactory. This deficiency can bias the estimates of violent mortality and lead to mortality underestimation for some causes (especially for homicide and suicide deaths which may be assigned to "undetermined injuries"). To cope with this problem, we included in our analysis the whole class of external mortality, which is less influenced by misclassification bias.

Another problem of the Russian mortality statistics is the increase in the proportion of deaths with undefined (not stated) ages during the transition period. Although the contribution of such deaths is not substantial for total mortality (0.25% in 1991 and 1.19% in 1994 for males), it is much higher for mortality from violent deaths (0.73% in 1991 and 2.59% in 1994 for males). The latter fact can affect the proper estimation of demographic indicators dependent on age distribution.

Despite the problems listed above, most researchers studying mortality in Russia admit that the quality of Russian vital statistics is good enough, with nearly 94% of all deaths being medically certified (Leon et al., 1997; Notzon et al., 1998; Wasserman, Varnik,

1998; Andreev, 1999). One of the arguments supporting the acceptable quality of Russian statistics is the temporal stability of cancer mortality in 1992-95 against the background of a dramatic increase in total mortality (Leon et al., 1997). Also, the standard rules of cause-of-death coding in the whole country ensure comparability of regional cause-specific mortality statistics. The mandatory internal passport system ensures a low level of age misreporting in death certificates, although age information in census data (denominators) may be less accurate because of self-reporting bias. Nevertheless, there is every reason to believe that the quality of Russian mortality data, although not perfect, is reasonably good for conducting demographic analyses.

Statistical Analyses.

The age-adjusted cause-specific death rates for years 1965-98 were provided by the Centre of Demography and Human Ecology and are based on their calculations.

The age-specific mortality rates for years 1981-2000 were calculated on the basis of official statistics (numbers of deaths and corresponding population denominators). Age-standardized (age-adjusted) mortality rates were calculated using the direct method of age adjustment (Chiang, 1978). The standard population chosen was the WHO "new" European standard population (see WHO, 1992). Life expectancies for years 1999-2000 were calculated using the Keyfitz method of life table construction (Keyfitz, 1985).

Correlation analysis of male-female age-adjusted death rates was conducted using the SAS statistical package (procedure CORR).

We used an exploratory factor analysis in order to uncover the underlying structure of fluctuations in cause-specific mortality over time. We used a P-technique of factor analysis when points in time (calendar years) are used as observations. In the first method of analysis age-adjusted death rates for 19 causes of death were used as variables and studied over long period of time (1965-1998). In the second stage of data analysis 9 causes of death were used as variables and studied over shorter period of time (1981-2000). These causes of death were selected after preliminary screening of their behavior over time. Causes of death, which do not demonstrate significant changes after 1992 (like all cancers), were not included into analysis. The particular type of factor analysis we used was the principal component analysis with paramax method of rotation (FACTOR procedure in SAS statistical package).

Two Economic Crises and the Patterns of Mortality Increase

Temporal changes in life expectancy after 1991 demonstrate a three-stage pattern. In the first stage (immediately after 1992), when response to the sharp changes in life style and living standards was particularly acute, mortality rapidly increased reaching its peak in 1994. In the second stage, mortality was gradually decreasing until 1998 although it did not reach the initial pre-crisis levels. In the third stage, which is not yet finished, mortality increased again as a response to the 1998 financial crisis. Coincidence in time for both economic crises (resulted in rapid impoverishment of population) and subsequent mortality hikes gives us a reason to suggest possible causal link between these events.

Mortality from diseases of the circulatory system and violent deaths demonstrated very strong response to economic crisis, while mortality from neoplasms did not change during this period (Leon et al., 1997; Gavrilova et al., 1997; Notzon et al., 1998; Shkolnikov et al., 1996a; 1996b; 1998a; 2001). The secular stability of mortality from neoplasms could be expected from the nature of these diseases (long-term multistage process) and also indicates that the fluctuations in other causes of death are not caused by errors in population estimates (denominator problem) (Leon et al., 1997). During the first crisis, mortality from external causes of death moved from the third to the second place for males, replacing mortality from neoplasms, while for women external causes remained on the 3rd place. Mortality from violent causes started to increase rapidly in 1992 and reached its maximum values in 1994. The only exception was mortality from transport accidents, including traffic accidents, decreasing after 1992 (Russian codes 160-162, see Gavrilova et al., 2001). Population of urban areas demonstrated the highest rate of mortality increase after 1992 compared to the rural population, which by the year of economic crisis (1992) already had very high mortality at working ages (Ivanova et al., 2002b; Semenova et al., 2002a).

Cause-specific mortality changes after the second crisis (1998) were not yet well studied, so we tried to analyze these changes in more detail. The results of our study are presented in Table 2.

Table 2 about here

Data in Table 2 show that during ***the first surge of mortality*** (1992-94), the external causes of death (accidents, injuries and poisoning) played the leading role in a rapid relative increase of mortality for both sexes (Gavrilova et al., 2000). The role of alcohol-related mortality (accidental poisoning by alcohol) was particularly important for this mortality surge (increase by 215% for males and by 276% for females). The relative rate of mortality increase was the highest for external causes (increase by 74% for males and by 65% for females), infectious diseases (71% for males and 47% for females) and respiratory diseases (44% for males), exceeding the relative rate of increase for the total mortality (37% for males and 20% for females). The relative rate of mortality increase for cardiovascular diseases (33% for males and 18% for females) was high, but less than for the increase in total mortality (Table 2).

The most striking feature of ***the second mortality crisis*** (1998-2000) compared to the first one (1992-94) is a particularly rapid increase in mortality from infectious diseases (tuberculosis and sexually transmitted diseases in particular), with less rapid growth of mortality from accidents, injuries and poisoning (Table 2). Mortality from infectious diseases had the highest relative rate of growth among the large classes of diseases (increase by 29% in 2000 compared to 1998 for males, and by 17% for females). Respiratory diseases are the second most rapidly growing cause of death (21% increase for males and 8% increase for females in 1998-2000). External causes of death (accidents, injuries and poisoning) occupy the third place by the rate of relative increase (17% for males and 7% for females).

Data presented in Table 2 also demonstrate that after the first crisis suicide mortality surge was particularly high in males while homicide dynamics was similar for both sexes.

The response to the 1998 crisis was different: both suicide and homicide dynamics did not demonstrate profound gender differences. The most dramatic increase in violent mortality is observed for mortality from accidental poisoning by alcohol (see Table 2). This cause of death became more common in 1994 than homicide and traffic accidents. Mortality from alcohol poisoning also shows the most rapid decrease after 1994. Mortality from homicide follows similar temporal pattern as mortality from alcohol poisoning (Gavrilova et al., 2001). This similarity implies some relation between these two causes of death. At the same time, homicide mortality demonstrates a slower decline after 1994 compared to the mortality from alcohol poisoning which suggests an additional, non-alcohol component in this type of violent mortality. Suicide mortality has increased dramatically after 1992 and continued to be the main cause of violent death for males in Russia. After 1994, this cause of death demonstrated a slow but steady decline in mortality with another increase in 1999.

The second mortality crisis was accompanied by extremely high rate of mortality growth for causes related to asocial behavior (tuberculosis rapidly spreading among prison inmates, sexually transmitted diseases, drug dependence, AIDS). These causes of death became a real threat to the future of population health in Russia.

Hypotheses Explaining the Observed Mortality Fluctuations

Following the "shock therapy," views on the underlying causes of mortality crisis gradually evolved. Initially, researchers proposed multiple explanations for the observed mortality increase: poor lifestyle (alcoholism, smoking, low physical activity), environmental catastrophe, economic impoverishment, widening social inequality, legacy of the communist system, deterioration of the health system, and malnutrition (Feshbach, 1995; Chen et al., 1996; Cockerham, 1997; Notzon et al., 1997). Although poor life style, deteriorating health care system, and environment are important in explaining rather high baseline mortality observed in 1991, they hardly could explain the mortality hike in 1992-94.

The hypothesis that the increase in alcohol consumption is a major cause of the observed mortality upsurge in 1992-1994 has received significant attention (Ryan, 1995; Leon et al., 1997; Notzon et al., 1998; Leon, Shkolnikov, 1998; Vichnevsky, 2000). The rise in alcohol consumption undoubtedly contributed to the rapid increase in mortality from external causes of death (Nemtzov, Shkolnikov, 1999). Some authors considered increase in the alcohol consumption after the end of anti-alcohol campaign as one of the major causes of the mortality upsurge in 1992-94 (Leon et al., 1997; Notzon et al., 1998; Leon, Shkolnikov, 1998).

An extreme view on the role of alcohol in the observed mortality increase has been proposed by Zakharov (1999) and Vishnevsky (2000). According to their hypothesis, rapid increase in mortality after 1992 can be explained by selective elimination of the cohorts of alcoholics 'saved' during the Gorbachev's anti-alcohol campaign of 1985-87. This explanation, particularly seductive for Russian authorities, became now an official point of view inside Russia although it has little support among researchers outside Russia (see Cornia, Panniccia, 2000). This hypothesis proposes a selection mechanism of mortality increase, which does not agree with the 2nd mortality hike from alcohol-related

diseases. In addition to that, this hypothesis fails to explain significant increase in mortality from cardiovascular diseases after 1992. Using the latter fact, some researchers even challenged the view that alcohol might be a major factor in the Russian mortality crisis of the 1990s (Bobak, Marmot, 1999). Recently McKee et al. (2000; 2001) provided some indirect evidence that increase in cardiovascular mortality might be related to increase in alcohol consumption which is a cause of sudden cardiac death in middle-aged men. Later the same group of researchers tried to check the link between alcohol consumption and cardiovascular death directly using autopsy records on the amount of blood alcohol among the persons died from cardiovascular diseases. They did not find supporting evidence that concentration of alcohol in the blood of these persons was high enough to explain their deaths as alcohol-related (Shkolnikov et al., 2002). More interesting in this regard is a hypothesis proposed by Ogurtsov et al. (2001) that the Russian population has high prevalence of a specific mutant allele coding alcohol dehydrogenase 2 (ADH2). Carriers of this allele have high tolerance to alcohol, but increased production of toxic acetaldehyde causing accelerated tissue damage (including damage to heart muscle). As a result, individuals with this mutation may suffer from cirrhosis, cardiomyopathy and other heart diseases. This hypothesis may explain apparent failure to discriminate between alcohol-related and cardiovascular mortality in Russian males.

Despite typical view of Western researchers on the Russian health care system as extremely poor and rapidly deteriorating service (DaVanzo, Grammich, 2001), the deterioration of health care system could hardly be an important factor of mortality hike after 1992. This explanation is not supported by decline in infant mortality and stability of mortality among the children and the elderly during the transition period (age groups the most dependent on health care services) (Shkolnikov et al., 1998a). Moreover, there are some reasons to question the common view that the weaknesses in the health service are probably an important factor in explaining the generally poor levels of health in Russia by comparison with other European countries. For example, Irina Virganskaya (1991) calculated life expectancies for groups with different educational background in Moscow and found that life expectancy in the group with higher education (University degree or equivalent) is the same as in the countries of Western Europe both for males and females. Later Shkolnikov et al. (1998b) calculated mortality rates for adult persons with different educational level in Russia and again found that mortality at working ages for persons with higher education did not differ from mortality of the U.S. whites for the same period of time. These results suggest that unhealthy life-styles and behavior among Russian less-educated males and females are dominating factors of high mortality levels at working ages in Russia.

Although deterioration of health care system did not play a significant role in mortality changes during the transition period, there is one specific factor of additional mortality, which is usually overlooked by researchers. Although health care system in Russia remained free during the transition period (with increasing proportion of paid services), the cost of prescription drugs, purchased outside the hospital, skyrocketed after prices liberalization. As a result, many chronically ill individuals could not afford necessary medication and died prematurely. We tried to test this hypothesis in our study considering mortality from two chronic diseases: diabetes and asthma.

Recently, researchers have begun to pay more attention to the role of stress as a major cause of mortality crisis (Shapiro, 1997; Shkolnikov et al., 1998b; Vlassov, 1999). Studies of regional mortality in Russia have showed that mortality increase after the economic crisis was related to the pace of economic changes, crime rate, and social inequality rather than the average level of personal income or sales of alcohol (Walberg et al., 1998). Another study of regional mortality has demonstrated a strong negative influence of high divorce rate on mortality from violent causes (Becker, Hemley, 1998). Kennedy et al. (1998) have studied the role of social capital in the regional differences in Russian mortality using a regression model, which included a set of proxy indicators of social capital. They found strong links between age-adjusted sex-specific mortality and such proxy measures of social capital as the level of distrust in local government, disinterest in politics, crime rate, and divorce rate (Kennedy et al., 1998). These studies demonstrate that psychological stress, social disadaptation, and disintegration, and loss of social capital have played a significant role in the recent mortality increase (Shkolnikov et al., 1998a; Walberg et al., 1998; Kennedy et al., 1998), while the role of such traditional economic indicators as poverty and unemployment have been far less important (Shkolnikov et al., 1998a; Walberg et al., 1998; Zoohuri et al., 1998). However, the estimates of economic indicators in Russia are not particularly accurate and reliable. Also, the divorce and crime rates may be again strongly related to increased alcohol consumption.

Population surveys demonstrated that the rapid decline in living standards did not affect mortality rates directly through mass malnutrition or starvation (Shkolnikov et al., 1998a; Zohoori et al., 1999). Moreover, children and the elderly who should be more vulnerable to malnutrition and often are the first victims of economic crisis in other countries (Palloni, Hill, 1997) were much less affected compared to adults. Increase in mortality predominantly among working ages provides some support to the stress-related hypothesis. According to this hypothesis, it is more likely that increase in mortality was one of the first manifestations of stress experienced by the population after rapid impoverishment and change in living conditions in 1992 (Shapiro, 1995; Shkolnikov et al., 1998a). Loss of traditional sources of income and personal savings forced the active part of the population to change their traditional life style. In many cases, these life style changes resulted in deviant behavior, including increased alcohol consumption, suicides, and homicides. The observed two-stage dynamics of mortality in 1991-98 (acute stage and recovery) fits the typical stress-related pattern (Braunstein, Toister, 1981). After the period of initial acute response to stress (1992-94), people adapted to the changing living conditions, found ways to make additional income, and mortality began to decline. At this moment, the available data do not provide a convincing support in favor of stress-related hypothesis over alcohol related one and vice versa. In addition to that, it seems that the selection processes also played some role in the initial mortality increase: the most vulnerable groups of the population (heavy alcohol drinkers in our case) show increased mortality during the crisis periods (Palloni, Hill, 1997). For example, mortality from acute poisoning by alcohol demonstrated a very rapid decrease after its initial hike that is more consistent with the selection of heavy drinkers rather than with their adaptation when a slower recovery would be expected (Nemtsov, Shkolnikov, 1999). We

believe that effects of alcohol and stress are very difficult to discriminate from each other (particularly for males), because increased consumption of alcohol is a typical reaction to stressful situations for Russian males.

Most researchers consider negative effects of social stress and increased alcohol consumption in response to economic crisis as major causes of the recent mortality upsurge (Shkolnikov et al., 1998a; Vishnevsky, 2000; Gavrilova et al., 2000; 2001). Based on these explanations, researchers suggest that without severe economic shocks mortality in Russia will recover and reach pre-crisis levels (Kontorovich, 2001). However, another factors of mortality increase, related to asocial behavior, may be a serious threat to population health and may become an obstacle for returning mortality in Russia to pre-crisis level.

Gender Differences in Mortality During the Transition Period

Gender is a factor that may seriously influence human behavior and hence mortality and health. Table 2 shows that after 1992 male mortality was increasing at substantially higher pace than female mortality except for mortality from external causes. Within the group of external causes female mortality from accidental poisoning by alcohol grew faster than male mortality and female mortality from homicide had the same rate of increase with time (see Table 2). After the second crisis (between 1998 and 2000) female mortality from accidental poisoning by alcohol grew at lower pace than male mortality suggesting possible selective elimination of women-alcoholics after the first mortality crisis (Table 2). Suicide was the main cause of violent mortality both for males and females before the first mortality crisis. The relative role of suicide in the first rise of violent mortality (after 1992) was higher for males compared to females. Male suicide mortality demonstrates a very rapid increase after 1992 while female mortality shows a rather small change after that time. The age-adjusted suicide mortality rate was 1.6 times higher for males and 1.2 times higher for females in 1994 compared to 1991 (see Table 2). The different dynamics of suicide mortality for males and females may be explained by taking into account a lower contribution of alcohol consumption to female suicides compared to male suicides (Wasserman et al., 1998). It was estimated that the attributable fraction of alcohol consumption for female suicides in the former USSR (27%) is approximately half that for male suicides (50%) (Wasserman et al., 1998). At the same time, it seems that alcohol is not the only explanation for the increased response in suicide mortality for males. In contrast to the mortality from alcohol poisoning, which rapidly declined after 1994, suicide mortality for males was decreasing very slowly after 1994. Additional explanation of rather weak response of female suicide to the economic crisis is care-giving function of women who often have to take care for children or old parents. These family responsibilities may protect women from committing suicide.

The age-adjusted homicide mortality rate increased two-fold by 1994 compared to 1990 for both sexes. The relative importance of homicide as a cause of violent death increased significantly for females after 1992: by 1998 homicide became as common a cause of death for females as suicide. In 1994, age-adjusted mortality from alcohol poisoning was

3.2 times higher for males and 3.8 times higher for females compared to 1991. Thus, the immediate response of mortality from alcohol poisoning to economic crisis was much the same for both sexes.

These gender-specific patterns of response to economic crisis allows us to suggest that some causes of death may have different underlying causes and mechanisms. To study this issue in more detail, we used an approach based on determination of sex-concordant causes of death applied earlier in the study of developed countries (Gavrilov, Gavrilova 1991). The main idea of this approach is to analyze the relationship between male and female mortality for particular cause. It has been found that causes of death differ strongly in the extent of relationship between male and female mortality rates. For some causes of death (stomach cancer, pneumonia, cirrhosis of liver) the values of male and female mortality rates are in a very strong agreement (correlation coefficient, $r > 0.85$) while for other causes of death (lung cancer, cancer of larynx) this agreement is very poor ($r < 0.5$). The strong agreement in male-female mortality for gender-concordant causes of death suggests that these causes of death are related to the same (presumably environmental) underlying factors. In the case of gender-discordant causes of death, mortality is determined by gender-specific (presumably behavioral) factors.

Thus, in the next step of our analysis we compared age-adjusted death rates of males and females over period of 1965-1998 using methods of correlation analysis. Data in Table 3 present correlation coefficients of age-adjusted death rates between male and female mortality for the period 1965-1998.

Table 3 about here

Analysis of mortality changes in Russia over the last 35 years demonstrated that for most causes of death male and female age-adjusted death rates were changing in a good agreement with each other (see Table 3). These results suggest that temporal changes of mortality in males and females were driven by the same underlying factors for the majority of causes of death. The only exceptions are mortality from chronic bronchitis and emphysema, suicide, gastric ulcer, syphilis and drug dependence. Low correlation between male-female mortality in the case of bronchitis may be explained by different nature of this disease in males and females (with bronchitis in males caused predominantly by smoking and bronchitis in females caused apparently by environmental pollution or other factors). We found similar low concordance between male and female mortality from lung cancer in our previous study on mortality in developed countries (Gavrilova, Gavrilov, 1991). The case of suicide mortality was already discussed earlier.

Factor Analysis of Mortality for Males and Females

Correlation analysis of age-adjusted mortality showed that mortality in Russia was changing in a concerted way for the majority of causes. Thus, we may suggest that changes in mortality were directed by underlying factors similar to both sexes. To collapse the observed age- and sex-specific changes in cause-specific mortality into

simpler pattern, we used the method of factor analysis that allows us to reduce the set of variables to a smaller number of factors.

Factors Analysis of Mortality in 1965-1998: A Broad View on Mortality Fluctuations.
In the first stage of factor analysis we used a set of age-adjusted death rates provided by the Centre of Demography and Human Ecology. This dataset contains information on mortality for a relatively long time period – from 1965 to 1998. This allowed us to include more variables (causes of death) into analysis and to find causes of death, which tend to have similar time trajectories. For our analysis we have selected 19 causes of death, which, according to our experience, demonstrated substantial changes after 1992 and had relatively clear definition (no causes including "other" diagnoses were used in the analysis). We did not include deaths from malignant neoplasms, because diseases of this category did not show rapid increase or fall after 1992 (Leon et al., 1997). The analyses were conducted for males and females separately. The results of factor analysis for males are presented in Table 4.

Table 4 about here

The first 4 principal components account for 92% of the total variation in mortality. The first factor explaining 51% of total variation is obviously related to the infectious diseases (Table 4). It is also interesting that two apparently different causes of death - myocardial infarction with hypertension and stroke with hypertension – are collapsed into one factor. The only common feature of these two causes of death is their relation to hypertension. This finding allowed us to use hypertensive disease instead of these two causes in our future analyses. These results also demonstrate that using "cerebrovascular diseases" as one general category may be misleading because it contains two different types of stroke (with and without hypertension) with different behavior and underlying causes. The reason why hypertension-related diseases are grouped with tuberculosis in one factor may be explained by strong dependence of both causes on proper medication. The 1st mortality factor had the highest score in 1965 and then gradually decreased up to 1992. After this year the declining pattern has been reversed and it started to increase again reaching by 2000 the levels observed in 1982.

The second factor (18% of total variation) is obviously related to alcohol consumption and includes such causes of death as accidental poisoning by alcohol, suicide, chronic alcoholism, homicide, undetermined injuries (concealed homicides), and gastric ulcer. This result suggests that this group of causes of death may be replaced by one cause reflecting alcohol-related mortality (we used accidental poisoning by alcohol in our further analyses as the most representative one). This factor had the lowest score during the Gorbachev's anti-alcohol campaign and reached its peak in 1994.

In contrast to the 2nd factor, the meaning of the 3rd factor of mortality is not entirely clear. It is obviously related to the mortality from atherosclerosis (cause of death more common for older ages) and may reflect some patterns of old-age mortality. Strong correlation of mortality from transport accidents with the same factor is not completely clear. The temporal pattern of mortality from transport accidents is puzzling, because this is a rare example of cause of death, which declined after 1992. There is no agreement among the specialists on the true causes of this unusual behavior, taking into

account increase of automobiles on the roads during the transition period. This factor had the highest level in 1970 and then was gradually decreasing reaching its minimum in 2000. This dynamics may reflect both changes in coding of cardiovascular diseases and real improvement in mortality from heart diseases at older ages. Because of uncertainties with interpretation, we decided to exclude the causes related to the 3rd factor from our further analyses.

The 4th factor has the highest loadings for such causes of death as asthma, chronic bronchitis and emphysema, diabetes, myocardial infarction and stroke without hypertension, and homicide. The common feature of these causes of death (except for homicide) is chronic nature of diseases leading to these deaths. Thus, persons suffering from chronic diseases may be vulnerable to deprivation of medicine necessary for proper disease treatment. Such situations could arise either with low supply of prescription drugs (in 1989-1991) or high prices for prescription drugs after 1992 making them unaffordable for low income people. Partial inclusion of homicide mortality into this factor may reflect the fact that chronically ill (or older) persons may become homicide victims more often than younger healthy ones. We used two diseases from this group (diabetes and asthma) for our further analyses.

The factor analysis of mortality for females is presented in Table 5.

Table 5 about here

Two factors of female mortality (Factor 1 related to tuberculosis and Factor 2 related to atherosclerosis) are virtually the same as for male mortality. In contrast to male mortality, all other causes of death (except for chronic bronchitis) were combined in one factor. These results show that alcohol-related mortality and mortality from chronic diseases have similar temporal pattern in the case of females suggesting stronger selection component for alcohol-related mortality in women.

Factors Analysis of Mortality in 1981-2000: More Focused Study.

In the second stage of our analysis we used more narrow time window (1981-2000) focused on more recent changes in Russian mortality. This step of data analysis was applied to more detailed data on mortality obtained from Goskomstat. Based on our previous analyses, we could select fewer variables representing causes of death with similar behavior in time. Also, in this case we could use data on mortality from a number of diseases, which were not available in our first dataset, containing data for non-grouped causes of death. We have selected the following causes of death for factor analysis: (1) Ischaemic heart disease as an important cause of death at middle and old ages; (2) Accidental poisoning by alcohol as an indicator of alcohol-related deaths; (3) Accidents, injuries and poisoning as a broad category of external mortality (less subjected to possible flaws in cause of death registration when homicides are registered as undetermined injuries, etc.); (4) Tuberculosis as the main cause among the infectious diseases category; (5) Drug dependence syndrome as possible indicator of asocial behavior; (6) Hypertensive disease as a combined indicator for all hypertension-related diseases, which have similar behavior in time as shown in our previous analysis; (7) Diabetes as chronic disease, which requires continuous medication; (8) Asthma as

another example of diseases, which require medication. Age-adjusted death rates from these 8 causes of death were analyzed using exploratory factor analysis. We also conducted sensitivity analyses replacing one cause of death with another (for example, mortality from drug dependence by mortality from syphilis or AIDS) to test the similarity in time trajectories for different causes of death.

The results of factor analysis for males are presented in Table 6. The first three principal components account for 97 percent of the variation in mortality. For further analysis we have retained 3 factors with eigenvalues greater than 1. The first factor explaining 64% of mortality variation has strong correlation with mortality from tuberculosis, syphilis and drug dependence and may be interpreted as a factor of 'asocial behavior' (as a proxy name). In Russia most persons are infected by tuberculosis in jails, so it is not surprising that mortality from this cause has increased with the increasing of crime rate. High correlation (factor loading) of hypertension mortality with this factor is puzzling. This observation is not a statistical artifact because similar results are obtained on another data sample (see Tables 4-5) covering longer time period (1965-1998) and with another hypertension-related causes of death (myocardial infarction with hypertension and stroke with hypertension). Perhaps this observation requires a special study to explain the causes of the observed similarity in time trajectories. The first factor has the highest rate of growth over time, which is the most disturbing phenomenon.

In the case of males, the second factor explaining 19% of total variation in mortality has high correlations with ischaemic heart disease and alcohol-related deaths and hence may be interpreted as a stress-related factor. The values of this factor increase after each economic crisis confirming the interpretation of this factor as a stress-related one.

The third factor explaining 13% of mortality variation has strong correlations with mortality from diabetes and asthma. Although these two chronic diseases have different etiology and methods of treatment, both require continuous medication. The access to pharmaceutical drugs was severely deprived after each economic crisis because of high prices, which might result in mortality increase of chronically ill individuals. Thus, the third factor may be interpreted as a factor of selective mortality. This factor was increasing in 1987-1994, reaching its peak in 1994 and declining afterwards. Because of selective elimination of chronically ill individuals in 1992-1994 the score for this factor did not increase after the second mortality crisis of 1998. These data allow us to test the hypothesis of selective mortality among chronic alcoholics. If the selection hypothesis is correct we could expect higher factor loadings of alcohol-related mortality for the 3rd factor. In the case of accidental poisoning by alcohol the observed correlation with the 3rd factor of selective mortality is moderately high (0.55) suggesting that selection may account for 25-27% of alcohol-related mortality. This suggests that selection did not play the major role in the mortality increase from alcohol-related causes of death during the transition period and that social stress was more important in explaining the observed mortality hike in 1992-1994.

In addition to the analysis of factor loadings and scores, it would be interesting to study the relation of each factor to the total mortality. The second (stress-related) factor has the highest correlation with total mortality supporting the hypothesis of social stress as a primary explanation for the recent mortality fluctuations. This is also a factor of mortality for middle-aged men because this factor has the highest correlation with mortality at ages 40-44. The first factor has the lowest correlation with age-adjusted total

mortality (0.65), but the highest correlation (0.92) with mortality in the young adult age group (20-24). In fact this factor determines mortality patterns among the youth. Rapid growth of this factor with time is the most worrisome. Taking into account that this is a dominating factor of mortality at younger ages, the prospects of future mortality trends in Russia do not look particularly encouraging. The third factor has the highest correlation (0.70) with total mortality at ages 60-64 years. Keeping in mind that retirement age for males in Russia is 60 years, this factor may also be considered as a factor of post-retirement mortality.

Variations of female mortality over time (Table 7) also are explained by 3 factors with similar interpretation. The only difference is a specific behavior of mortality from ischaemic heart disease suggesting possible differences in etiology of this disease among males and females (involvement of alcohol-related causes in the mortality of males). These differences may also be a result of coding misclassification (over-diagnostic of cardiac deaths among older females).

Table 7 about here

The dynamics of score estimates for factors 1-3 is similar to that of males (Table 7) suggesting consistency in the factor interpretation.

Conclusion

In this paper we tried to analyze changes in Russian mortality using age-adjusted death rates for various causes of death. Our study revealed at least 4 possible mechanisms of mortality changes over time: (1) stress-related factor having the highest correlation with mortality at middle ages; (2) factor of 'asocial behavior' having the highest correlation with mortality at younger age (20-24); (3) factor of selective mortality; (4) factor related to atherosclerosis with suggested effect on mortality at older ages (hypothesis which we could not test in our study because of data limitations).

Thus, mortality changes in Russia are conditioned by superposition of these mortality factors, which in turn provide us some clues for the future mortality dynamics. It appears that the future changes of mortality in Russia will be determined by the most rapidly growing factor – the factor of 'asocial behavior'. As a result, mortality of young adults will continue to grow. In fact, total mortality of young adults in 2000 was already higher than mortality observed in 1994 (the year of the lowest life expectancy) and this trend will apparently persist. However, the most recent news from Russia that tuberculosis morbidity has been reversed, give us some point for optimism. It is expected that mortality at middle age will decline over some period until negative effects of the second factor (factor of 'asocial behavior') will reverse this tendency. Mortality at older ages will apparently continue its slow decline started in 2000.

Acknowledgments: This study was supported in part by the grant 98-52206 from the MacArthur Foundation and the Center on Aging (NORC/University of Chicago) grant # P30 AG-12857-06 from the National Institute on Aging.

References

Andreev E. (1999). The dynamics of mortality in the Russian Federation. In: *Health and Mortality. Issues of Global Concern*. United Nations: New York, 262-283.

Bennett, N.G., Bloom, D.E., Ivanov S.F. (1998). Demographic implications of the Russian mortality crisis. *World Development,* 26: 1921-1937.

Brainerd, E. (1998). Market reform and mortality in transition economies. *World Development,* 26: 2013-2027.

Brainerd, E. (2001). Economic reform and mortality in the Former Soviet Union: a study of the suicide epidemic in the 1990s. *IZA Discussion Paper No. 243*. Bonn, Germany.

Chen, L.C., Wittgenstein, F., McKeon, E. (1996). The upsurge of mortality in Russia: causes and policy implications. *Population and Development Review*, 22: 517-30.

Chenet, L., McKee, M., Leon, D., Shkolnikov, Vassin, S. (1998). Alcohol and cardiovascular mortality in Moscow; new evidence of a causal association. *J. Epidemiol Community Health*, 52: 772-774.

Chiang Ch. (1978). *Life Table and Mortality Analysis*. Geneva: WHO.

Cockerham, W.C. (1997). The social determinants of the decline of life expectancy in Russia and Eastern Europe: a lifestyle explanation. *Journal of Health and Social Behavior*, 38: 117-30.

Commission on Women, Family, and Demography at the President of Russian Federation (1997). *Report on Mortality*. Moscow.

Cornia G.A., Pannicia R. (2000). *The Mortality Crisis in Transitional Economies.* Oxford Univ. Press.

DaVanzo J., Grammich C. (2001) Dire Demographics: Population Trends in the Russian Federation. RAND, MR-1273-WFHF/DLPF/RF.

EBRD [European Bank for Reconstruction and Development] (1997). *Transition Report*. London.

Ellman, M. (1994). The increase in death and disease under 'katastroika'. *Cambridge Journal of Economics,* 18: 329-355.

Feshbach, M. (1995). *Environmental and Health Atlas of Russia*. Moscow: "PAIMS".

Gavrilov L.A., Gavrilova N.S. (1991) *The Biology of Life Span: A Quantitative Approach,* NY: Harwood Academic Publisher.

Gavrilova N.S., Evdokushkina G.N., Ermakov, S.P., Gavrilov L.A. (1997). An analysis of the health and mortality data for the provinces of Russia. In: *International Population Conference. Beijing, 1997*. Liege: IUSSP, vol.3, 1245-1257.

Gavrilova, N.S., Semyonova, V.G., Evdokushkina G.N., Gavrilov, L.A. (2000). The response of violent mortality to economic crisis in Russia. *Population Research and Policy Review*, 19: 397-419.

Gilinski, J., Roumiantseva, G. (1998). Suicides in Russia. *Population & Society*, N.25. [in Russian].

Goskomstat. (1993). Social and economic status of Russian Federation in January-March, 1993. Economic Review No.4. Moscow: Goskomstat. [in Russian].

Heleniak T. (1999). Out-migration and depopulation of the Russian North during the 1990s. *Post-Soviet Geography and Economics*, 36: 446-458.

Heleniak T. (1999). Economic transition and demographic change in Russia, 1989-1995. *Post-Soviet Geography and Economics*, 40: 155-205.

Ivanova A.E., Semenova V.G., Gavrilova N.S., Evdokushkina G.N., Gavrilov L.A., Demchenko T.A. (2002a). Mortality patterns of Russian population in the 1990s and the potential of mortality decline: dynamics and prognosis. *Disease Prevention and Health Promotion*, (in press).

Ivanova A.E., Semenova V.G., Gavrilova N.S., Evdokushkina G.N., Gavrilov L.A., Devyachinskaya M.N. (2002b). Age patterns of mortality in Russian urban and rural population in the 90s years of the 20th century. *Disease Prevention and Health Promotion*, (in press).

Kennedy, B.P. & Kawachi, I. (1998). The role of social capital in the Russian mortality crisis. *World Development* 26: 2029-2043.

Keyfitz, N. (1985). *Applied mathematical demography.* Springer Texts in Statistics, 2nd ed. Springer-Verlag: New York/Berlin

Klugman, J., Braithwaite, J. (1998). Poverty in Russia during the transition: an overview. *The World Bank Research Observer*, 13: 37-58.

Leon, D.A., Shkolnikov, V.M. (1998). Social stress and the mortality crisis. *JAMA*, 279, 790-791.

Leon, D.A., Chenet, L., Shkolnikov, V.M., Zakharov, S., Shapiro, J., Rakhmanova, G., Vassin, S., McKee, M. (1997). Huge variation in Russian mortality rates 1984-94: artefact, alcohol, or what? *Lancet*, 350, 383-388.

Makinen, I.H. (2000). Eastern European transition and suicide mortality. *Social Science & Medicine*, 51: 1405-1420.

Martynov, A.S., Artykhov, V.V., Vinogradov, V.G. (1998). *Environment and Health of Russia.* Web-Atlas. Moscow Public Scientific Foundation. Available: http://www.sci.aha.ru/ATL/ (In Russian).

McKee, M., Shkolnikov, V., Leon, D.A. (2000). Alcohol is implicated in the fluctuations in cardiovascular disease in Russia since the 1980s. Ann. Epidemiology, 11: 1-6.

McKee M., Shkolnikov V. (2001). Understanding the toll of premature death among men in eastern Europe. British Medical Journal, 323: 1051-1055.

Mroz, T., Mancini, D., Popkin, B. (1999). Monitoring economic conditions in the Russian Federation: The Russia Longitudinal Monitoring Survey 1992-98. *Report submitted to the U. S. Agency for International Development*. Carolina Population Center, University of North Carolina at Chapel Hill, North Carolina.

Nemtsov, A.V. (2000). Estimates of total alcohol consumption in Russia, 1980-1994. *Drug and Alcohol Dependence*, 58: 133-142.

Nemtsov, A.V., Shkolnikov, V.M. (1999). Losses due to alcohol mortality in Russia in 80th-90th. News of Science and Technology, Medicine series, "Alcohol Disease" issue. Moscow: VINITI, p.1-15. (In Russian).

Notzon, F.C., Komarov, Yu.M., Ermakov, S.P., Sempos, Ch.T., Marks, J.S., Sempos, E.V., (1998). Causes of declining life expectancy in Russia. *JAMA*, 279: 793-800.

Ogurtsov P.P., Nuzny V.P., Garmash I.V., Moiseev V.S. (2001). Mortality in Russia, *Lancet*, 358: 669-670.

Palloni, A. & Hill, K. (1997). The effects of economic changes on mortality by age and cause: Latin America, 1950-90, pp.75-128, in G.Tapinos, A.Mason, and J.Bravo

(eds.), *Demographic Responses to Economic Adjustment in Latin America*. Oxford: Clarendon Press.

Rosefielde S. (2001). Premature deaths: Russia's radical economic transition in Soviet perspective. *Europe-Asia Studies*, 53: 1159-1176.

Ryan, M. (1995). Alcoholism and rising mortality in the Russian Federation. *British Medical Journal*, 310: 646-8.

Semenova V.G., Gavrilova N.S., Varavikova Ye.A., Gavrilov L.A., Yevdokushkina G.N. (2000a). Rise in violent death rates in Russia as a consequence of the economic crisis. *Disease Prevention and Health Promotion*, 4: 3-10.

Semenova V.G., Varavikova Ye.A., Gavrilova N.S., Evdokushkina G.N., Gavrilov L.A. (2000b). Evolution of female mortality due to injuries and intoxications in some regions of Russia in the period of economic reforms. *Disease Prevention and Health Promotion*, 3: 29-31.

Semenova V.G., Ivanova A.E., Gavrilova N.S., Evdokushkina G.N., Gavrilov L.A., Devyachinskaya M.N. (2002). Medico-demographic conditions in urban and rural areas – similarity and differences. *Disease Prevention and Health Promotion,* (in press).

Semenova V.G., Ivanova A.E., Gavrilova N.S., Evdokushkina G.N., Gavrilov L.A. (2002). Regional variation of mortality as an indicator of health decline in Russian population. *Disease Prevention and Health Promotion,* (in press).

Shapiro, J. (1997). The hypothesis of stress as a leading explanatory variable. In: *International Population Conference/Congrès International de la Population: Beijing, 1997*. Volume 2. 1997. 529-53 pp. International Union for the Scientific Study of Population [IUSSP]: Liège, Belgium.

Shkolnikov, V., Meslé, F., Vallin, J., (1996a). Health crisis in Russia. I. Recent trends in life expectancy and causes of death from 1970 to 1993. *Population: An English Selection*, 8: 123-154.

Shkolnikov, V., Meslé, F., Vallin, J. (1996b). Health crisis in Russia. II. Changes in causes of death: a comparison with France and England and Wales (1970 to 1993). *Population: An English Selection*, 8: 155-190.

Shkolnikov, V.M., Cornia, G.A., Leon, D.A., Meslé, F. (1998a). Causes of the Russian mortality crisis: evidence and interpretations. *World Development* 26: 1995-2011.

Shkolnikov V.M., Leon D., Adamets S., Andreev E., Deev A. (1998b). Educational level and adult mortality in Russia: an analysis of routine data 1979 to 1994. *Soc. Sci. Med.*, 47: 357-369.

Shkolnikov, V.M., McKee M., Leon D.A. (2001). Changes in life expectancy in Russia in the mid-1990s. *Lancet* 357: 917-921.

Shkolnikov, V.M., McKee M., Chervyakov V.V., Kyrianov N.A. (2002). Is the link between alcohol and cardiovascular death among young Russian men attributable to misclassification of acute alcohol intoxication? Evidence from the city of Izhevsk. *J. Epidemiol. Community Health*, 56: 171-174.

Tulchinsky, T.H., Varavikova, E.A. (1996). Addressing the epidemiologic transition in the former Soviet Union: strategies for health system and public health reform in Russia. *Am.J.Public Health*, 86: 313-20.

Varnik, A., Wasserman, D., Dankowicz, M., Eklund, G. (1998). Age-specific suicide rates in the Slavic and Baltic regions of the former USSR during perestroika, in comparison with 22 European countries. *Acta Psychiatr. Scand. Suppl.*, 394: 20-25.

Vishnevsky, A.G. (1998). *Population of Russia in 1998. Annual Demographic Report*. Center of Demography and Human Ecology: Moscow. [In Russian].

Vishnevsky, A.G. (2000). Mortality hike in 90s: fact or artifact. *Population & Society*, No.45. [in Russian].

Vital and Health Statistics, (1995). *Vital and Health Statistics: Russian Federation and United States, Selected Years 1980-93*. Ser.5, No.9, NCHS, Hyattsville.

Vlassov, V. (1999). The role of alcohol and social stress in Russia's mortality rate. *JAMA*, 281: 321-322.

Walberg, P., McKee, M., Shkolnikov, V., Chenet, L., Leon, D.A. (1998). Economic change, crime, and mortality crisis in Russia. *British Medical Journal*, 317: 312-318.

Wasserman, D., Varnik, A. (1998). Reliability of statistics on violent death and suicide in the former USSR, 1970-1990. *Acta Psychiatr. Scand. Suppl.*, 394: 34-41.

Wasserman, D., Varnik, A., Eklund, G. (1998). Female suicides and alcohol consumption during perestroika in the former USSR. *Acta Psychiatr. Scand. Suppl.*, 394: 26-33.

WHO [World Health Organization] (1977-1978). *Manual of the international statistical classification of diseases, injuries, and causes of death : based on the recommendations of the Ninth Revision Conference, 1975, and adopted by the Twenty-ninth World Health Assembly*. Geneva: World Health Organization.

WHO [World Health Organization] (1992a). *ICD-10 : international statistical classification of diseases and related health problems*. Geneva: World Health Organization.

WHO [World Health Organization] (1992b). World Health Statistics Yearbook 1992. Geneva: World Health Organization.

Zakharov S. (1999). Cohort analysis of the Russia's population mortality: Long- and short-term effects of generations' inequality in the face of death. *Studies on Russian Economic Development*, 10(2): 199-211.

Zohoori, N., Mroz, T.A., Popkin, B., Glinskaya, E., Lokshin, M., Mancini, D., Kozyreva, P., Kosolapov, M., Swafford, M. (1998). Monitoring the economic transition in the Russian Federation and its implications for the demographic crisis - the Russian Longitudinal Monitoring Survey. *World Development*, 26: 1977-1993.

Zohoori, N., Henderson, L., Gleiter, K., Popkin, B. (1999). Monitoring health conditions in the Russian Federation: The Russia Longitudinal Monitoring Survey 1992-98. *Report submitted to the U. S. Agency for International Development*. Carolina Population Center, University of North Carolina at Chapel Hill, North Carolina.

Table 1. Life Expectancy at Birth in Russia and Other Countries

Country	Year	Life expectancy at birth	
		Males	Females
Russia	1991	63.5	74.3
	1992	62.0	73.8
	1993	58.9	71.9
	1994	**57.6**	**71.2**
	1995	58.3	71.7
	1996	59.8	72.5
	1997	60.8	72.9
	1998	61.3	72.6
	1999	59.9	72.4
	2000	58.8	71.7
India	1994-1997	62.4	63.4
China	1994-1997	69.0	73.0
Tunisia	1994-1997	69.5	73.3
United States	1997	73.6	79.4

Source: Russian official statistics (Goskomstat); World Health Organization; National Center of Health Statistics.

Table 2. Age-adjusted mortality rates (per 100,000 population) for various causes of death in pre- and post-crisis years in Russia.

Males

Cause of death	1991 (1)	1994 (2)	(2)/(1)	1998 (3)	2000 (4)	(4)/(3)
All causes	1629.8	2224.4	1.37	1787.8	2012.4	1.13
Classes of Diseases						
Diseases of the circulatory system	815.1	1084.7	1.33	885.8	1001.5	1.13
Accidents, injuries, poison.	243.9	423.5	**1.74**	309.9	361.8	1.17
Diseases of the respiratory system	104.5	150.6	1.44	101.8	123.3	1.21
Infectious diseases	20.8	35.5	1.71	33.5	43.2	**1.29**
Selected Diseases:						
Suicide	47.7	76.9	1.61	62.9	69.7	1.11
Homicide	25.1	52.8	2.10	36.0	44.0	1.22
Accidental poisoning by alcohol	19.4	61.2	3.15	28.7	40.4	1.41
Tuberculosis	16.1	28.2	1.75	28.5	37.0	1.30

Females

Cause of death	1991 (1)	1994 (2)	(2)/(1)	1998 (3)	2000 (4)	(4)/(3)
All causes	1278.6	1539.9	1.20	1365.3	1441.2	1.05
Classes of Diseases:						
Diseases of the circulatory system	861.3	1015.9	1.18	901.5	959.0	1.06
Accidents, injuries, poison.	62.5	103.3	**1.65**	79.5	88.0	1.07
Diseases of the respiratory system	47.5	53.3	1.12	37.7	40.7	1.08
Infectious diseases	5.5	8.1	1.47	6.9	8.4	**1.17**
Selected Diseases						
Suicide	11.2	13.6	1.21	11.6	11.6	1.09
Homicide	6.9	14.5	2.10	10.8	13.2	1.17
Accidental poisoning by alcohol	4.2	15.8	3.76	7.1	10.3	1.18
Tuberculosis	2.1	3.1	1.48	3.6	4.7	1.16

Table 3.
Correlation between male and female age-adjusted death rates.

Cause of death	Correlation coefficient
Pulmonary tuberculosis (9)	0.963
Syphilis (37)	*0.819*
Diabetes (68)	0.997
Chronic Alcoholism (75)	0.960
Drug dependence (76)	*0.846*
Myocardial Infarction with hypertension (90)	0.986
Myocardial Inf. without hypertension (91)	0.966
Atherosclerosis with hypertension (92)	0.953
Atherosclerosis without hypertension (93)	0.986
Stroke with hypertension (98)	0.985
Stroke without hypertension (99)	0.990
Chronic bronchitis, emphysema (108)	*0.275*
Asthma (109)	0.928
Peptic ulcer (115)	*0.811*
Transport accidents (162)	0.912
Accidental poisoning by alcohol (163)	0.969
Suicide (173)	*0.746*
Homicide (174)	0.986
Injury undetermined (175)	0.998

Table 4.
Factor analysis of male mortality in Russia, 1965-1998.

Eigenvalues (top 10) of the Correlation Matrix: Total = 19 Average = 1

Factor	Eigenvalue	Difference	Proportion	Cumulative proportion
1	9.629557	6.218326	0.5068	0.5068
2	3.411231	0.196509	0.1795	0.6864
3	3.214722	1.934536	0.1692	0.8556
4	1.280186	0.857911	0.0674	0.9229
5	0.422275	0.126970	0.0222	0.9452
6	0.295305	0.041773	0.0155	0.9607
7	0.253532	0.097188	0.0133	0.9740
8	0.156344	0.036884	0.0082	0.9823
9	0.119461	0.051105	0.0063	0.9886
10	0.068356	0.009002	0.0036	0.9922

Factor structure after rotation (correlations)

Cause of death	Factor1	Factor2	Factor3	Factor4
Pulmonary tuberculosis (9)	**0.94596**	-0.09171	0.04029	-0.30205
Syphilis (37)	**0.94553**	-0.27328	0.19286	-0.42616
Myocardial Infarction with hypert. (90)	**0.92194**	-0.48319	0.41163	-0.34628
Stroke with hypertension (98)	**0.91945**	-0.21548	0.56733	-0.51160
Diabetes (68)	-0.73137	0.64754	-0.68097	**0.79814**
Myocardial Inf. without hypert (91)	-0.89322	0.14856	-0.18268	0.65799
Stroke without hypertension (99)	-0.91422	0.46662	-0.18216	0.60694
Suicide (173)	-0.12062	**0.90720**	0.01682	0.10856
Accidental poisoning by alcohol (163)	-0.19532	**0.94586**	0.01846	0.23295
Chronic Alcoholism (75)	-0.12435	**0.89083**	-0.31256	0.42079
Homicide (174)	-0.57270	**0.85851**	-0.58892	0.68027
Peptic ulcer (115)	-0.60037	0.75814	-0.29878	0.52840
Injuries undetermined (175)	-0.54238	**0.81198**	-0.70710	0.68562
Atherosclerosis with hypertension (92)	0.22719	-0.07416	**0.93795**	-0.19563
Atherosclerosis without hypertension (93)	0.26852	-0.17031	**0.96131**	-0.52524
Transport accidents (162)	0.61412	-0.18502	**0.82337**	-0.60299
Drug dependence (76)	0.29147	0.14342	-0.72551	0.00769
Chronic bronchitis, emphysema (108)	-0.38503	0.29825	-0.23542	**0.94548**
Asthma (109)	-0.49628	0.51646	-0.58838	**0.90554**

Table 4 (continued).
Factor analysis of male mortality in Russia, 1965-1998.

Factor score estimates

YEAR	Factor1	Factor2	Factor3	Factor4
1965	**1.85876**	-0.90272	-1.25857	-1.17030
1966	1.70500	-0.97947	-0.42525	-0.78066
1967	1.75451	-0.83018	-0.07483	-0.26506
1968	1.54980	-0.75131	0.23908	-0.24744
1969	1.69169	-0.47956	0.53709	0.06590
1970	1.49024	-0.21893	**1.06869**	0.42454
1971	1.21070	-0.19090	0.91811	-0.09758
1972	1.02188	-0.35344	0.85302	-0.32110
1973	0.73145	-0.34116	0.79179	-0.24823
1974	0.43952	-0.29733	0.78637	-0.78857
1975	0.28010	-0.06379	0.93262	-0.89318
1976	0.31420	0.04587	0.89831	-1.01883
1977	0.05680	0.06368	0.81529	-1.12583
1978	-0.06039	0.11381	0.72042	***-1.34334***
1979	-0.08455	0.23300	0.77793	-1.02521
1980	0.00156	0.39766	1.05099	-0.73454
1981	-0.15405	0.40563	0.71540	-0.92380
1982	-0.44306	0.23567	0.51834	-0.99026
1983	-0.49161	0.22881	0.50570	-0.89053
1984	-0.62941	0.35960	0.71530	-0.37600
1985	-0.67713	-0.26996	0.53965	0.14832
1986	-0.85467	-1.32900	0.03961	-0.11007
1987	-0.98142	***-1.38425***	0.02447	0.30074
1988	-1.04545	-1.36078	-0.30619	0.56181
1989	-1.02256	-1.09733	-0.47658	0.89263
1990	-1.15535	-0.90352	-0.50514	1.37713
1991	-1.17718	-0.78481	-0.65137	1.17708
1992	***-1.26325***	0.46109	-0.79112	1.38236
1993	-1.13004	1.86879	-0.21589	2.33251
1994	-0.92787	**2.76345**	-0.19833	**2.66328**
1995	-0.66200	2.41104	-1.64900	1.06447
1996	-0.43371	1.47767	-1.97540	0.61154
1997	-0.46435	0.84740	-2.26618	0.40935
1998	-0.44819	0.62528	***-2.65432***	-0.06113

Note: maximum values of each factor are shown in bold; minimal values of each factor are shown in bold italics.

Table 5.
Factor analysis of female mortality in Russia (1965-1998).

Eigenvalues (top 10) of the Correlation Matrix: Total = 19 Average = 1

Factor	Eigenvalue	Difference	Proportion	Cumulative proportion
1	10.02902	6.090422	0.5278	0.5278
2	3.938593	1.714989	0.2073	0.7351
3	2.223603	1.095022	0.1170	0.8522
4	1.128581	0.453544	0.0594	0.9116
5	0.675038	0.437375	0.0355	0.9471
6	0.237663	0.025478	0.0125	0.9596
7	0.212185	0.047652	0.0112	0.9708
8	0.164534	0.060917	0.0087	0.9794
9	0.103617	0.016362	0.0055	0.9849
10	0.087255	0.010165	0.0046	0.9895

Factor structure after rotation (correlations)

Cause of death	Factor1	Factor2	Factor3	Factor4
Pulmonary tuberculosis (9)	**0.96476**	0.05957	-0.37097	0.09981
Syphilis (37)	**0.86954**	-0.10938	-0.31709	0.04905
Stroke with hypertension (98)	**0.87155**	0.49450	-0.38803	0.34691
Myocardial Infarction with hypertension (90)	**0.89270**	0.17206	-0.58097	0.44575
Drug dependence (76)	*0.50745*	-0.30831	-0.15391	-0.51975
Asthma (109)	-0.74470	-0.62367	*0.55135*	0.03002
Peptic ulcer (115)	-0.80253	-0.61204	*0.53802*	-0.01176
Stroke without hypertension (99	-0.93169	-0.30547	0.49469	-0.05353
Myocardial Inf. without hypertension (91)	-0.87371	-0.46400	0.28503	-0.05495
Atherosclerosis without hypertension (93)	0.29066	**0.95699**	-0.34756	0.30466
Transport accidents (162)	0.36190	**0.91155**	-0.36991	0.21393
Atherosclerosis with hypertension (92)	-0.00818	**0.85158**	-0.16499	*0.50441*
Suicide (173)	-0.35772	*0.60584*	*0.55088*	-0.04132
Diabetes (68)	-0.71699	-0.76141	*0.68216*	-0.12692
Chronic Alcoholism (75)	-0.05712	-0.38136	**0.84249**	-0.12189
Accidental poisoning by alcohol (163)	-0.50626	-0.02776	**0.96185**	-0.13571
Homicide (174)	-0.64997	-0.48196	**0.92818**	-0.19348
Injury undetermined (175)	-0.58335	-0.72082	**0.82319**	-0.23135
Chronic bronchitis, emphysema (108)	0.44452	0.42474	-0.35973	**0.87342**

Table 5 (continued).
Factor analysis of female mortality in Russia (1965-1998).

Factor score estimates

YEAR	Factor1	Factor2	Factor3	Factor4
1965	**2.36858**	-0.82604	-0.97739	***-2.55561***
1966	1.87264	-0.47057	-0.87414	-0.49754
1967	1.68360	-0.29526	-0.85781	0.73339
1968	1.75717	-0.21980	-0.72332	1.12980
1969	1.47348	0.12741	-0.50658	1.23236
1970	1.18859	0.53541	-0.55297	**2.04544**
1971	0.99841	0.52689	-0.57019	1.20427
1972	0.89186	0.61275	-0.62130	1.18438
1973	0.66841	0.50988	-0.55855	1.18519
1974	0.57712	0.88436	-0.32981	0.04101
1975	0.17114	1.16578	-0.19987	0.13243
1976	0.26216	1.23900	-0.06393	-0.0069
1977	-0.06784	1.20357	-0.04934	-0.55677
1978	-0.17250	1.20897	0.13074	-0.84855
1979	-0.19300	1.20389	0.20000	-0.74191
1980	-0.32167	**1.21995**	0.42616	-0.39142
1981	-0.26455	1.13398	0.26900	-0.58497
1982	-0.35775	0.79292	0.20232	-0.84753
1983	-0.58445	0.85403	0.23399	-0.83299
1984	-0.6186	1.09620	0.47145	-0.23828
1985	-0.55206	0.45085	-0.05413	0.42720
1986	-0.5101	0.16257	-1.05733	-0.10555
1987	-0.62825	-0.26601	***-1.13149***	0.14843
1988	-0.7742	-0.41907	-0.97547	0.25932
1989	-0.87587	-0.76202	-0.86996	0.32867
1990	-1.02420	-0.98532	-0.65864	0.55171
1991	-1.05472	-1.10529	-0.67371	0.22774
1992	-1.31215	-1.18463	0.16200	0.47771
1993	***-1.35714***	-0.87652	1.86798	1.07043
1994	-1.18333	-0.84928	**2.98639**	1.12725
1995	-0.73348	-1.37919	2.68648	-0.81589
1996	-0.34745	-1.70681	1.49425	-1.31668
1997	-0.39126	-1.79099	0.7875	-1.38396
1998	-0.58858	***-1.79161***	0.38765	-1.78217

Note: maximum values of each factor are shown in bold; minimal values of each factor are shown in bold italics.

Table 6. Factor analysis of male mortality in Russia, 1981-2000.

Eigenvalues (top 5) of the Correlation Matrix: Total = 9 Average = 1

Factor	Eigenvalue	Difference	Proportion	Cumulative proportion
1	5.108866	3.578671	0.6386	0.6386
2	1.530195	0.384048	0.1913	0.8299
3	1.146148	1.058489	0.1433	0.9732
4	0.087659	0.029572	0.0110	0.9841
5	0.058087	0.007786	0.0073	0.9914

Factor structure after rotation (correlations)

Variable	Factor 1 (64%)	Factor 2 (19%)	Factor 3 (14%)
Drug dependence (76)	**0.96182**	0.26131	0.23722
Hypertensive disease	**0.95664**	0.60725	0.38874
Tuberculosis	**0.95375**	0.63003	0.41815
Ischaemic heart disease	0.40480	**0.97035**	0.29622
Accidental poisoning by alcohol (163)	0.44674	**0.98742**	0.54692
All external causes	0.65703	**0.90323**	0.72267
Asthma (109)	0.15976	0.39398	**0.97426**
Diabetes (68)	0.56397	0.46551	**0.96197**
Correlation with total mortality, r	0.65	0.92	0.70
Age group with the highest correlation	20-24 (0.92)	40-44 (0.93)	60-64 (0.76)

Factor score estimates

Year	Age-adjusted death rate	Factor1	Factor2	Factor3
1981	1754.00	-0.42784	0.38914	-1.14288
1982	1686.30	-0.54768	0.03712	-1.09737
1983	1714.25	-0.58510	0.17042	-1.16011
1984	1769.47	-0.55277	0.35127	-0.96497
1985	1694.29	-0.67582	-0.14690	-1.00722
1986	***1416.36***	-0.90186	-1.23809	***-1.36456***
1987	1418.33	-0.90499	***-1.33815***	-1.16348
1989	1576.02	***-0.94416***	-1.29151	0.01316
1990	1619.94	-0.72937	-1.11667	0.19545
1991	1633.25	-0.73158	-1.13417	0.50699
1992	1738.09	-0.55573	-0.49963	0.96214
1993	2060.90	-0.08037	1.38904	1.23887
1994	**2224.42**	0.26756	**2.28885**	**1.62264**
1995	2096.23	0.45021	1.28271	1.40531
1996	1940.99	0.71448	0.42401	0.91591
1997	1837.99	0.72491	-0.19977	0.7674
1998	1787.79	0.95495	-0.44837	0.41156
1999	1927.57	2.11192	0.33973	0.00717
2000	2012.43	**2.41324**	0.74096	-0.14601

Note: maximum values of each factor are shown in bold; minimal values of each factor are shown in bold italics.

Table 7. Factor analysis of female mortality in Russia, 1981-2000.

Eigenvalues (top 5) of the Correlation Matrix: Total = 9 Average = 1

Factor	Eigenvalue	Difference	Proportion	Cumulative proportion
1	4.409362	2.438964	0.5512	0.5512
2	1.970397	0.568239	0.2463	0.7975
3	1.402158	1.290465	0.1753	0.9727
4	0.111693	0.065142	0.0140	0.9867
5	0.046552	0.014041	0.0058	0.9925

Factor structure after rotation (correlations)

Variable	Factor 1 (55%)	Factor 2 (25%)	Factor 3 (18%)
Drug dependence (76)	**0.97015**	0.22608	0.32535
Tuberculosis	**0.91674**	0.45456	-0.10683
Hypertensive disease	**0.89775**	0.50815	0.40105
Accidental poisoning by alcohol (163)	0.36103	**0.97304**	0.0927
All external causes	0.51893	**0.94185**	0.41159
Diabetes (68)	0.39543	0.60991	**0.88319**
Asthma (109)	-0.20806	0.56494	**0.79922**
Ischaemic heart disease	-0.26558	0.09106	-0.90426
Correlation with total mortality, r	0.52	0.93	0.44
Age group with the highest correlation	20-24 (0.81)	45-49 (0.96)	65-69 (0.51)

Factor score estimates

Year	Age-adjusted death rate	Factor 1	Factor 2	Factor 3
1981	1303.32	-0.02610	0.00310	***-1.66412***
1982	1239.36	-0.26235	-0.40558	-1.23206
1983	1266.47	-0.44804	-0.20091	-1.31411
1984	1324.38	-0.58157	0.11950	-1.49345
1985	1314.43	-0.71439	-0.14745	-1.26092
1986	1180.58	-0.58918	-1.44552	-0.78951
1987	***1175.76***	-0.56790	***-1.57519***	-0.57461
1989	1260.28	***-0.98168***	-0.96608	0.52681
1990	1286.52	-0.88965	-0.77219	0.79656
1991	1278.62	-0.76120	-0.8174	1.16194
1992	1310.18	-0.64685	-0.21049	**1.23279**
1993	1470.35	-0.40647	1.47478	0.55691
1994	**1539.92**	-0.23663	**2.40753**	0.51871
1995	1477.42	0.19899	1.53495	0.86003
1996	1418.37	0.49955	0.64468	0.81963
1997	1395.49	0.57378	0.12935	0.87562
1998	1365.32	1.09535	-0.25450	0.74810
1999	1432.89	2.08525	0.18549	0.32354
2000	1441.23	**2.65911**	0.29593	-0.09186

Note: maximum values of each factor are shown in bold; minimal values of each factor are shown in bold italics.

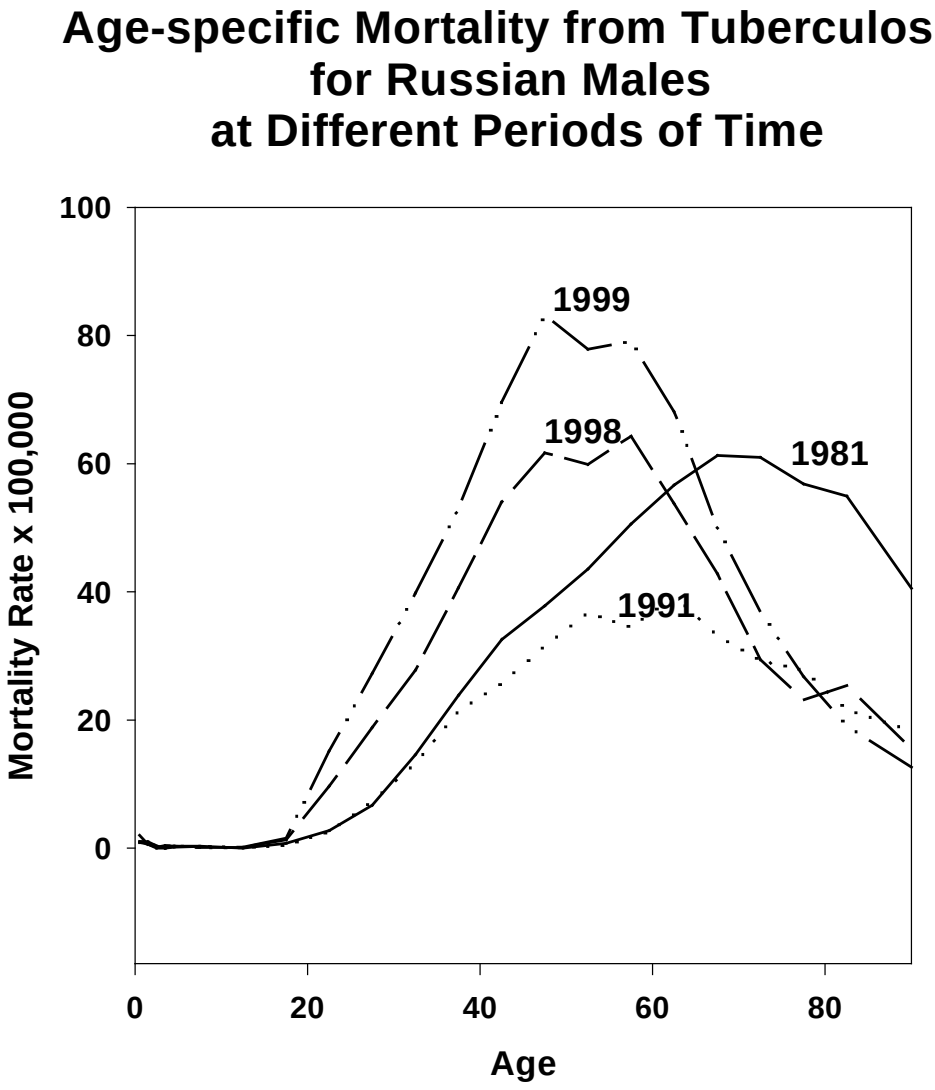
Age-specific Mortality from Tuberculosis
for Russian Males
at Different Periods of Time
Mortality Rate x 100,000
100
80
60
40
20
0
0
20
40
60
80
Age
1999
1998
1981
1991

Figure 1

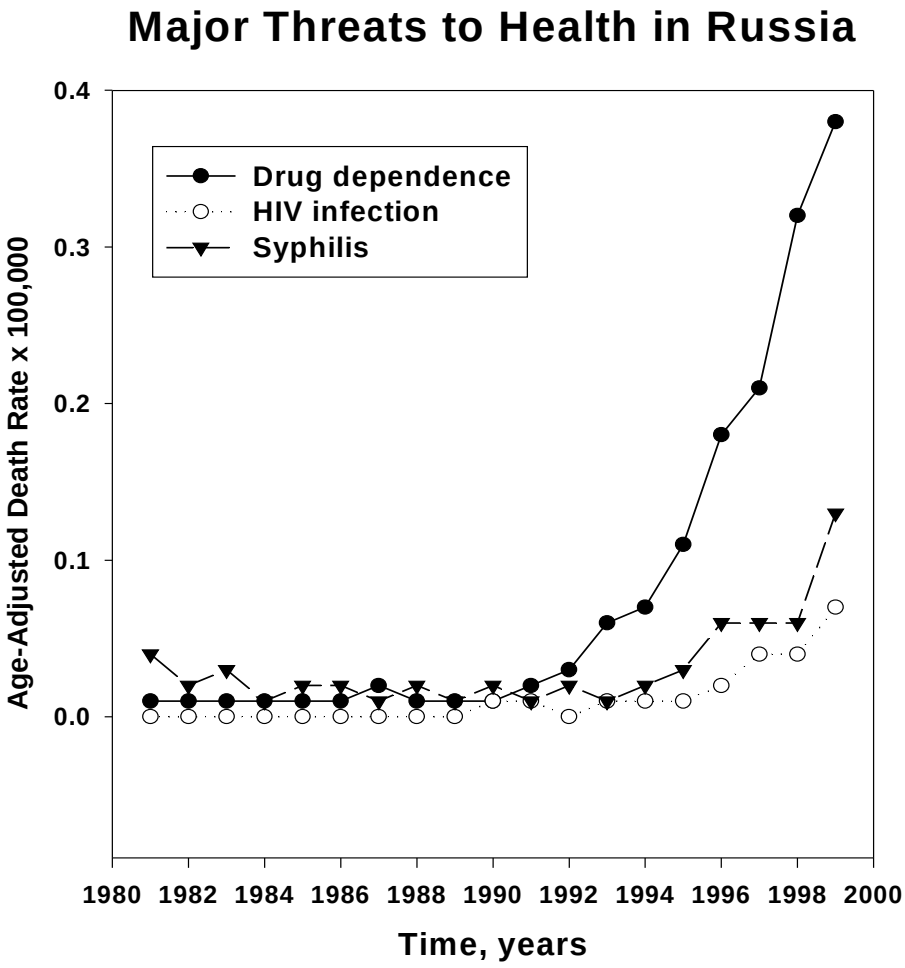
Major Threats to Health in Russia
Drug dependence
HIV infection
Syphilis
Age-Adjusted Death Rate x 100,000
0.4
0.3
0.2
0.1
0.0
1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000
Time, years

Figure 2

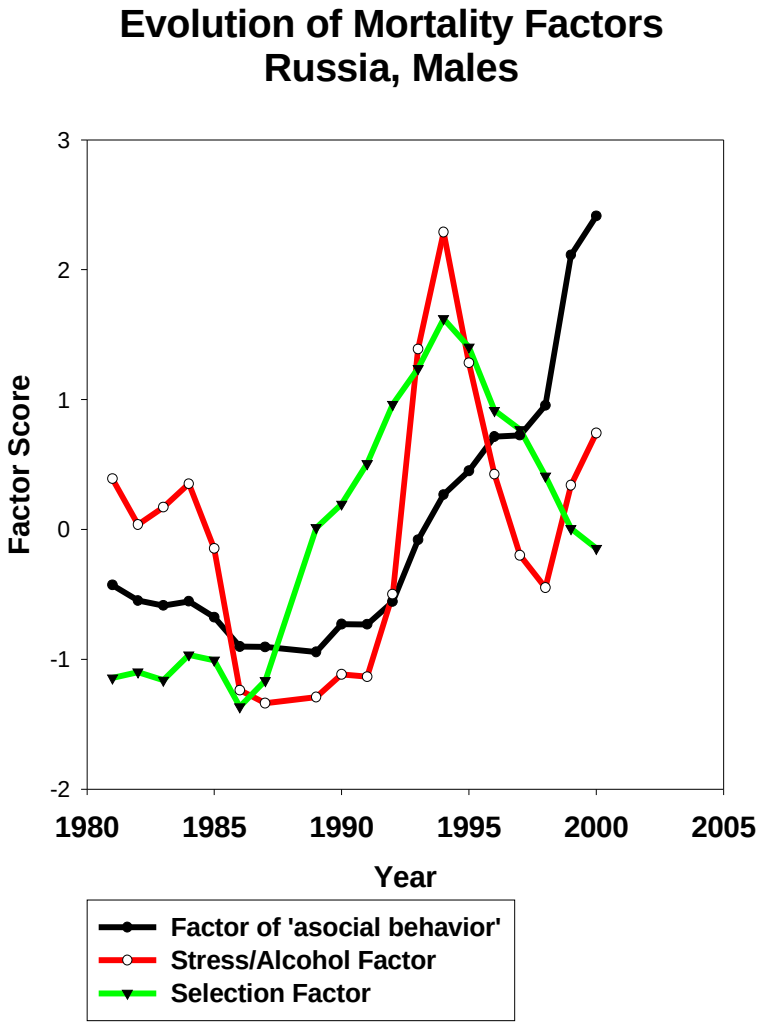
Evolution of Mortality Factors
Russia, Males
Factor Score
3
2
1
0
-1
-2
1980
1985
1990
1995
2000
2005
Year
Factor of 'asocial behavior'
Stress/Alcohol Factor
Selection Factor

Figure 3

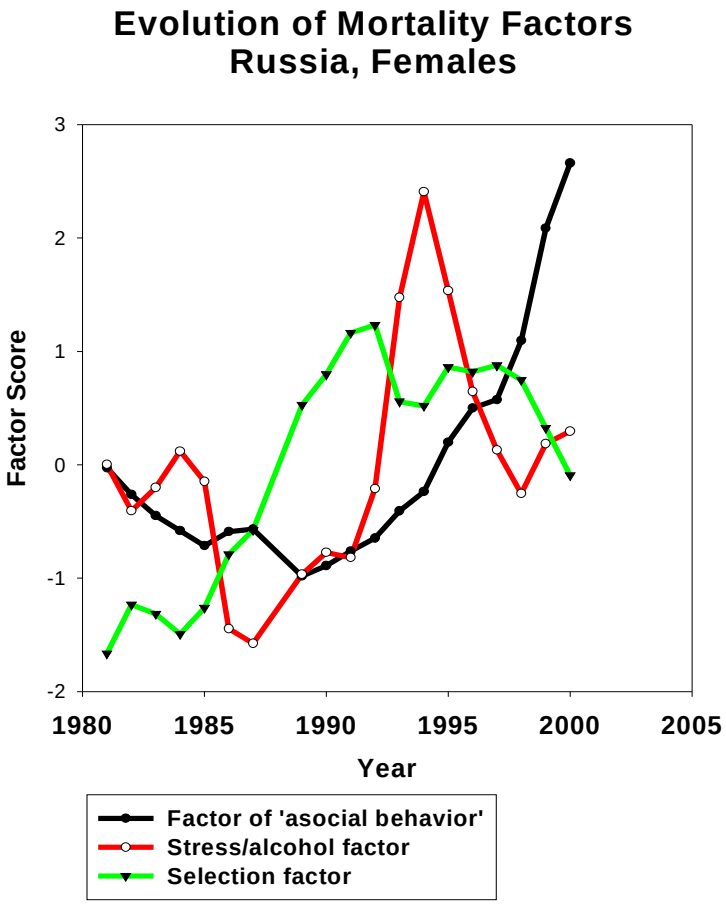
Evolution of Mortality Factors
Russia, Females
Factor Score
3
2
1
0
-1
-2
1980
1985
1990
1995
2000
2005
Year
Factor of 'asocial behavior'
Stress/alcohol factor
Selection factor

Figure 4