Health crisis in Belarus as reflected by cause-of-death and regional mortality trends and patterns

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***Grigoriev, P.;** Shkolnikov, V. M.; Andreev, E. M.; Jasilionis, D.; Jdanov, D. A.; Meslé, F.; Vallin, J.* (2010). Mortality in Belarus, Lithuania, and Russia: divergence in recent trends and possible explanations. *European Journal of Population*, 26:3, 245-274.

Grigoriev, P. (2007) About mortality data for Belarus. Human Mortality Database (http://www.mortality.org/). University of California, Berkeley and Max Planck Institute for Demographic Research Working Paper.

ERKLÄRUNG

Ich erkläre hiermit, dass ich die vorliegende Arbeit ohne unzulässige Hilfe Dritter und ohne Benutzung anderer als der angegebenen Hilfsmittel angefertigt habe; die aus fremden Quellen direkt oder indirekt übernommenen Gedanken sind als solche kenntlich gemacht.

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CONTENTS

ABSTRACT

The increase in mortality observed in the former USSR, and, after its collapse, in the Newly Independent States, represents a trend that is unprecedented in peacetime, and it has therefore stimulated extensive research. Yet this research has mainly focused on Russia, while mortality in Belarus has received very little attention. Until now, research evidence on Belarus had been fragmented and scattered, largely because of a lack of detailed and comparable mortality data.

This thesis is the first study that provides a systematic analysis of mortality in Belarus over the last half century. Two main aspects, methodological and substantive, are dealt with here. The methodological part is the work on the reconstruction of continuous time series by causes of death. It relies on the *method of reconstruction* previously applied in similar mortality studies in the USSR, Russia, Ukraine, and the Baltic countries. A distinguishing feature of this method is that it cannot be adopted uniformly for any population; each time when it is applied the specifics of the country studied must be taken into account. The substantive part employs the analysis of the reconstructed data, data on socioeconomic indicators, recent regional mortality data, and individual data on self-perceived health. Focusing on both long-term and recent trends in health and mortality, this thesis consists of four papers. The first paper is devoted to the reconstruction and analysis of long-term mortality trends by causes of death in Belarus over the period of 1965 onwards. Using aggregate mortality data and data on socioeconomic indicators, the second paper explores the peculiarities of recent mortality trends in Belarus, relative to trends in neighboring Russia and Lithuania; and proposes possible explanations for the observed patterns. Using detailed cause-specific mortality data at the *oblast* and *rayon* levels, the third paper provides new evidence on the geographical diversity of overall and cause-specific mortality in Belarus. It also explores the potential mortality effects of the Chernobyl accident, and provides an analysis of the factors underlying regional mortality variations. Using individual-level data, the fourth paper analyzes recent trends in self-perceived

health in Belarus, and assesses factors that have been associated with perceptions of health status over the last decade.

One of the main outcomes of this study is that the harmonized cause-specific mortality series for Belarus are now freely available to the international research community. In the future, these data will serve as a foundation for in-depth mortality research in Belarus, and as a useful basis for comparative studies. The analysis of long-term mortality trends by causes demonstrates that it is reasonable to describe the epidemiologic situation in Belarus as a chronic health crisis. The inefficiency of the health care system in tackling cardiovascular diseases and the excessive alcohol consumption among Belarusians have been the main drivers of this crisis. The main distinguishing feature of the Belarusian health crisis is the gradual, rather than abrupt, increase in mortality during the early years of the transition. While in the 1990s it may have been possible to interpret this as evidence of the advantages of the 'special Belarusian path', now it is evident that this achievement was only a temporary phenomenon. It is true that Belarus, which followed the slowest transition path, experienced the lowest increase in mortality in the early 1990s. However, the initial advantage that Belarus enjoyed due to its choice of a 'preservation' model now appears to have turned into a prolongation of the adverse health trend that has its origins in the past.

Previous studies have demonstrated that alcohol consumption and the abrupt change in economic conditions are the most important factors underlying the mortality changes in Russia and the Baltic countries. The results of this study, which are based on regional mortality data, confirm the significance of these factors. They also point to the possible relevance of other factors, including culture, traditions, and the environment. For example, the finding that mortality is lower in the southwestern part of Belarus than in the eastern part of the country can likely be attributed to historical and cultural factors. The elevated mortality from diseases of the respiratory system found in the north and northwest of Belarus might be linked to the proximity to highly polluted industrial centers. Although many people believe that the Chernobyl accident has had a very significant impact on mortality trends in Belarus, the results of this study do not provide sufficient grounds to

support the assumption that the Chernobyl accident is one of the main mortality determinants.

While most of the inferences in this study were based on the aggregated mortality data, it was also important to look at how individuals perceived their own health status. The analysis of the micro-data suggests that there has been a notable improvement in self-perceived health. This improvement is in line with the improved economic situation in the country and with the morbidity statistics, which show a marked reduction in disability rates. However, this more positive assessment of personal health does not appear to be connected with actual trends in life expectancy, which have been stagnating over the last decade. Given the prominent role of mortality from external causes, this observation does not appear to be paradoxical. Mortality from external causes mainly affects individuals of working age who are often in good health. Seemingly, improvements in individual health may contribute to some decrease in mortality, particularly at older ages, but this positive impact is offset by excessive premature mortality.

LIST OF ABBREVIATIONS

BSSR	Belarusian Soviet Socialist Republic
BMI	Body Mass Index
CVD	Cardiovascular Diseases
FSU	Former Soviet Union
EBRD	European Bank for Reconstruction and Development
EU	European Union
GDP	Gross Domestic Product
FA	Fundamental Association
HLE	Health Life Expectancy
HDI	Human Development Index
HFA-DB	Health for All Database
HMD	Human Mortality Database
ICD	International Classification of Diseases
IEHS	Income and Expenditures of the Household Survey
ILS	Index of Living Standards
IHD	Ischaemic Heart Diseases
LE	Life Expectancy
LISA	Local Indicators of Spatial Autocorrelation
OR	Odds Ratio
PPP	Purchasing Power Parity
RLMS	Russian Longitudinal Monitoring Survey
SC	Soviet Classification
SDR	Standardized Death Rate
SPH	Self-Perceived Health
TM	Transition Matrix
TB	Tuberculosis
TC	Transition Coefficient
UNDP	United Nations Development Program
USSR	Union of Soviet Socialist Republics
WHO	World Health Organization
WIID2	World income Inequality Database
WWII	World War Two

LIST OF ORIGINAL PUBLICATIONS

Paper I

Grigoriev P. (2012). Health Crisis and Mortality Trends by Causes of Death in Belarus (1965-2008). *Population: English Edition*, 67:1, 7-38.

Paper II

Grigoriev, P., Shkolnikov, V., Andreev, E., Jasilionis, D., Jdanov, D, Meslé, F. and Vallin, J. (2010). Mortality in Belarus, Lithuania, and Russia: Divergence in recent trends and possible explanations. *European Journal of Population,* 26: 245-274.

Contributors: PG proposed the initial hypotheses, assembled and analyzed the data, and wrote the paper. VS proposed the initial hypotheses and provided expert knowledge on Russian mortality. EA developed the program for the life expectancy decomposition. DJ provided expert knowledge on Lithuanian mortality. DMJ provided expert knowledge on issues related to the quality of mortality data. FM provided expert knowledge on the analysis of mortality by causes of death and revised the paper. JV provided expert knowledge on mortality in the FSU, proposed the analyses, and revised the final draft of the paper. All of the authors commented on the paper.

Paper III

Grigoriev, P., Doblhammer G., Shkolnikov, V. Trends, patterns and determinants of regional mortality in Belarus, 1990-2007. *Population Studies,* iFirst Article, 1-22

Contributors: PG proposed the initial hypotheses, assembled and analyzed the data, and wrote the paper. GD provided a critical discussion of the results and helped to revise the paper. VS provided expert knowledge on mortality determinants, proposed analyses, and revised the final draft of the paper. All of the authors commented on the paper.

Paper IV

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Contributors: PG conceived the study, performed the statistical analysis, and wrote the paper. OG assembled and arranged the IEHS data, contributed to statistical analysis, and provided expert knowledge on the design and structure of the IEHS.

I. INTRODUCTION

1.1. Research background and research questions

Research background

The unfavorable mortality trends in the former USSR (FSU) have been studied very extensively. Previous research suggests that three factors are mainly responsible for the rapid mortality increase in the 1990s: increased alcohol consumption, psychosocial stress associated with the socioeconomic crisis, and the deterioration of the health care system (Cornia and Paniccià, 2000; Shkolnikov et al., 2004; Brainerd and Cutler, 2005). It has also been suggested that the acute health crisis emerged as a second phase of a long-standing health crisis that had been observed in the USSR since the mid-1960s (Eberstadt, 1981; Feshbach, 1984; McKee, 2006). Since that time, adverse trends in overall mortality have been mainly driven by high mortality from external causes of death at working ages, as well as high and gradually increasing mortality from cardiovascular diseases (Shkolnikov et al., 1996). These adverse trends were interrupted only briefly as a result of the anti-alcohol campaign launched by the Soviet government in 1985 (Shkolnikov and Nemtsov, 1997).

Mortality trends in Belarus have been studied to a much lesser extent than trends in the other FSU countries. The existing data and research evidence are fragmented and scattered for two main reasons. First, there has been a generally misleading tendency to treat all of the countries of the former USSR as one homogeneous unit of analysis, even though these countries have never been the same, even during the Soviet era. Following this logic, one could assume that the directions of mortality trends and the determinants driving these trends in Belarus were more or less the same as those in, for example, Russia, which has been studied extensively. Thus, it may be assumed that evidence obtained from Russia can be directly applied to the Belarusian case. Although this could be true to some extent, it is necessary to support this assumption with scientific evidence. Furthermore, the detailed mortality analysis might reveal some unexpected

developments specific to Belarus only. The second and the most important reason why mortality trends in Belarus have so far been underexplored is the lack of detailed long-term mortality data by causes of death. Data of this kind data are considered to be very informative and reliable resources for investigating the components and determinants of observed health changes.

Research questions

Apart from the need to fill in the knowledge gap on mortality trends in Belarus, there are several other reasons why Belarus is an interesting case to study. One of them is the very sharp contrast between the country's past and recent mortality trends. In the past, the life expectancy of Belarusians looked very favorable, not only compared to that of the other Soviet republics and communist countries, but also relative to life expectancy in Western countries (Figure 1).

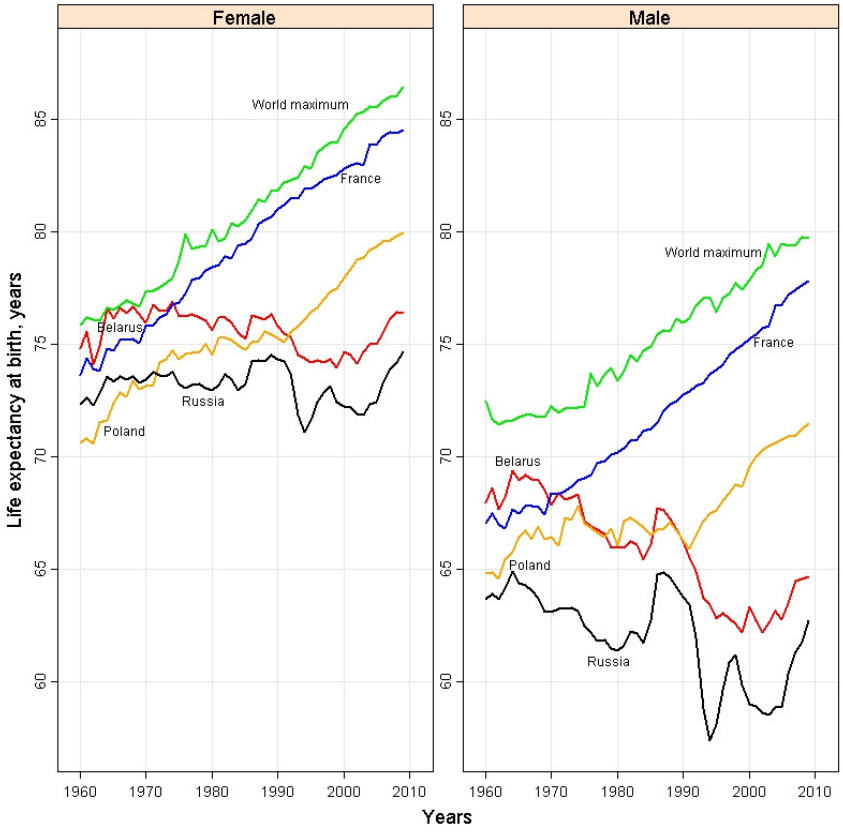

Figure 1. Life expectancy in Belarus, France, Poland, Russia and world record life expectancy by sex, 1960-2009

Source: Human Mortality Database

In 1964, Belarus even had the world's highest female life expectancy (76.6 years). It should be acknowledged that the value of life expectancy at birth at that time is likely to have been overestimated due to several problems related to the quality of death registration (Grigoriev, 2008). However, there are reasons to believe that the degree of this overestimation was not large. The calculations show that, in the 1960s and 1970s, life expectancy adjusted for under-registration of infant deaths (the most significant data quality problem) would be approximately 0.3 years lower than the official estimates and estimates provided by the HMD. Today, however, female life expectancy is still at the same level as it was five decades ago, and male life expectancy is actually four years lower than it was at that time. The current disadvantage of Belarus in relation to the world leaders in longevity is striking: 10 and 15 years for female and male life expectancy, respectively (HMD, 2011). These adverse dynamics lead us to characterize the epidemiological situation in Belarus over the last half-century as a health crisis. The main research question of this thesis is as follows: "*What are the components, driving forces, and peculiarities of the Belarusian health crisis*?" In order to answer this question, it is first necessary to collect detailed mortality data and harmonize them in such way that the periodic changes in classifications of causes of death are accounted for. Subsequently, the obtained cause-specific mortality trends are to be interpreted. All of these issues are dealt with in Paper I.

Another interesting feature of Belarusian mortality (explored in detail in Paper II) is related to more recent mortality trends. Unlike in Russia and most of the other FSU countries, life expectancy trends in Belarus did not exhibit large fluctuations in the early 1990s. Instead, they had been continuously falling at a slower pace since the late 1980s. This observation coincides with the fact that Belarus, unlike the other FSU countries, has largely maintained the Soviet-like socioeconomic system (World Bank, 2008). It is particularly interesting to look at how mortality trends respond to the specifics of the political and socioeconomic developments of Belarus after the dissolution of the USSR. Thus, the second research question of this study can be formulated as follows: *"Has the policy of gradual transition chosen by Belarusian authorities been proven to be more appropriate than the*

rapid transition to a market economy in terms of population health?" This kind of question continues to provoke debate among researchers and policy makers (Stuckler et al., 2009; Earle and Gehlbach, 2010; Gerry at al. 2010). The evidence from Belarus is also likely to be valuable for comparative studies of the effects of different policies on health that are experienced across the European region.

Apart from the two broad research questions mentioned above, this study seeks to answer two other, more specific questions. The third research question can be formulated as follows: *"What are the main factors associated with mortality change in Belarus? Do existing explanations, such as alcohol and economic conditions, also explain the mortality variations in Belarus? What are the roles of other factors, including the impact of the Chernobyl accident, and how important are these factors?"* Paper III addresses this multi-part question. It uses recent regional mortality data by causes of death and data on socioeconomic indicators to assess statistically the directions and strength of associations.

Finally, the fourth research question can be formulated as follows: *"How do individuals assess their own health? What are the trends in self-perceived health? What are the factors associated with better health status?"* Paper IV seeks to answer this multi-part question. It mainly relies on the micro-data from five cross-sectional surveys conducted in Belarus over the last decade.

1.2. Country background

Geographical location and administrative division

Belarus, officially the Republic of Belarus, is a country located in Eastern Europe. During the Soviet era it was known as the Byelorussian Soviet Socialist Republic (BSSR), or Byelorussia. Belarus borders Poland to the west, Lithuania and Latvia to the northwest, Russia to the north and the east, and Ukraine to the southeast (Figure 2). The country occupies an area of 207,600 km^2, and by territory it the 13th-largest of all the European countries (Belstat, 2011).

Figure 2. Geographical location of Belarus

Source: own design
Note: 1) base map (countries): www.diva-gis.org; base map (marine): www.naturalearthdata.com/
2) re-projected and mapped in ArcGIS 9.3

Administratively, Belarus is divided into six regions (oblasts) named after their administrative centers: Brest, Vitebsk, Gomel, Grodno, Minsk, and Mogilev.

Oblasts are further divided into 118 districts (rayons). There are 112 cities and towns, 93 smaller townships, and 23,467 villages. Minsk, the capital of Belarus with a population of 1.8 million, has the status of an independent administrative unit (Belstat, 2011).

As of January 1, 2011 the officially estimated population of Belarus was 9,481,100. From 1991, the population declined by 708,000, which is comparable to the population size of two regional centers, such as Vitebsk and Mogilev. According to the 2009 population census, the ethnic composition of the Belarusian population was as follows: 83.2 percent were Belarusians, 8.3 percent were Russians, 3.1 percent were Poles, 1.7 percent were Ukrainians, and 3.2 percent were from other ethnic groups (Belstat, 2011).

History

Historically, the lands that today make up Belarus belonged to several states, and Belarus only recently became an independent state, in 1991. In medieval times, between the 9th and 12th centuries, a large part of the territory of modern Belarus belonged to the Principality of Polotsk (*Polotskoe Knyzhestvo*). In the 13th and 14th centuries, the Belarusian territories became parts of the Grand Duchy of Lithuania; and in the 16th century, the territories belonged to the Commonwealth of the Kingdom of Poland and the Grand Duchy of Lithuania (*Rzeczpospolita*). As a result of the three subsequent partitions of the Rzeczpospolita the Belarusian lands were annexed by the Russian empire at the end of the 18th century. The territory of Belarus was divided into the Minsk, Vitebsk, Mogilev, and Grodno 'gubernias'. Thus, for centuries, the population of Belarus was exposed to both Polish and Russian cultural influences. After the Revolution of 1917 in Russia, Belarus entered the most dramatic period in its history. In 1917, the Soviet power was proclaimed. In 1918, while under German occupation, the Belarusian People's Republic was created. The new state did not exist for long, as in 1919, Belarus became one of the founding members of the Soviet Union, and was renamed the Byelorussian Soviet Socialistic Republic (BSSR). Later, following the war between Poland and Soviet Russia, the territory of Belarus was split into two parts. In 1921,

according to the terms of the Riga Treaty, the western part of Belarus (106,000 km^2 with a population of four million people) was incorporated into Poland. In 1939, these lands became a part of the BSSR as a result of Soviet invasion in Poland in September 1939. This was the final shift in the borders of modern Belarus (Zelinski and Pinchuk, 2003).

Throughout its history, Belarus has experienced many wars, and this turmoil has had a devastating impact on Belarusian ethnicity, customs, and traditions. During the 20^{th} century alone, Belarus suffered through three revolutions and three wars. A special place in Belarusian history belongs to the Great Patriotic War (1941-1945). For three years, Belarus was occupied by the Nazis, and the majority of the population was involved in the partisan and underground movements. In World War II, Belarus experienced the greatest loss of life among all of the republics of the former USSR. The war led to the deaths of more than three million Belarusians (one-third of the population), including 860,000 Jews exterminated by the Nazis. In recognition of the enormous sacrifices of the Belarusian people during the war, the BSSR was declared a funding state by the United Nations (UNDP, 1996).

Socioeconomic development

For more than 70 years, the Belarusian industrially oriented economy was an integral part of the national economic complex of the USSR, specializing in machine building and chemical and petro-chemical production. The industrial sector of Belarus relied heavily on imports of energy, raw materials, and supplies from the other Soviet republics. The Belarusian industrial sector was developed to produce primarily capital goods needed by the entire USSR. In addition, as was typical for the all-Union economic system, the Belarusian economy was highly militarized, with military production accounting for 40 percent of domestic output. As a result, there was a substantial shortage of consumer goods and services (UNDP, 1996). Furthermore, little attention was paid to the development of resource-efficient technologies, and thus the competitiveness of Belarusian products was low relative to world standards. Despite the shortcomings of its economic system, Belarus was one of the most economically developed parts of

the former USSR. In 1990, all governmental expenditures were covered by the surplus of incomes over expenditures of 2.3% of GDP. The consumer price index in 1990 constituted just 103.9%. In 1991 and 1992, Belarus ranked 40th among 174 countries by its HDI (UNDP, 2000). Under Soviet rule, the Belarusian economic output increased more than a hundredfold, making the formerly agrarian country an industrial state (UNDP, 1996).

The relatively inefficient economic system showed the first signs of stagnation in the middle of the 1980s. Recognizing the approaching crisis, the Soviet government launched *perestroika* as an attempt to stabilize the situation. Yet these reforms failed to reanimate the declining economy, and in practice became a catalyst for further deterioration (UNDP, 1996). The collapse of the Soviet Union in 1991 led to a deep economic crisis, which was characterized by macroeconomic instability, an abrupt decrease in production, hyperinflation, unemployment, and a drastic decline in living standards. At this point, each of the newly independent states had to develop its own strategy for resolving these economic difficulties. Unlike the neighboring Baltic States and Russia, which chose to transition rapidly to a market economy, Belarus followed a different path. In an attempt to insulate its population from painful reforms, Belarusian authorities opted for a 'mild' transition. This policy preserved the main features of the old-fashioned planned economy, the paternalism, and the methods of administrative control that were characteristic of Soviet rule. In practice, this meant the protection of jobs and wages, the retention of strong state control over most of the production resources, and the maintenance of large social expenditures and subsides (World Bank, 2008). According to the European Bank of Reconstruction and Development, Belarus remains one of the slowest-reforming countries among all of the transition economies (World Bank, 2005).

Initially, adopting a gradual approach towards market reforms enabled Belarus to mitigate to some extent the negative effects of the crisis, such as the decline in production and living standards. Remarkably, in contrast to the other, better-performing transition economies, the economy of Belarus stabilized around the mid-1990s and started growing steadily thereafter, despite the lack of sound and

consistent macroeconomic policies or advanced structural and institutional reforms (World Bank, 2005). This is why the Belarusian economic system was—until very recently—referred to as a 'puzzle' or the 'Belarusian economic miracle'. There is, however, a simple economic explanation for the country's success: Belarus had access to discounted Russian gas and oil, and enjoyed significant advantages on the Russian market (World Bank, 2005). These two major factors allowed the Belarus economy to function for years, despite the lack of reforms and its relative inefficiency. Because of the country's heavy dependence on Russia, its slow progress in terms of structural reforms, and especially its unfavorable business environment; the Belarusian economy very fragile and vulnerable, and doubts have been raised about Belarus' future socioeconomic sustainability.

Chernobyl legacy

The Chernobyl accident, which occurred in April 1986, has had devastating consequences for Belarus. About 70 percent of the total radioactive fallout fell on the country. The radioactive contamination affected one-fifth of Belarus' agricultural land and about one-third of its forests. More than 130,000 people were resettled, which required huge expenditures on housing, medicine, and other needs. Yet many people, particularly the elderly, have refused to move to 'clean' areas. As of January 1, 1994, more than 40,000 people still lived in areas where the level of contamination exceeded 15 Cu/km^2, and there were about 1,850,000 people living in the entire contaminated zone (UNDP, 1996). As of January 1, 2004, the population of the contaminated areas constituted around 1.5 million, or 15 percent of the total population (UNDP, 2005). The Gomel and Mogilev oblasts are the two regions of Belarus that were most affected: 20 out of 21 districts of the Gomel oblast and 14 out of 21 districts of the Mogilev oblast are contaminated. These areas also continue to experience above-average rates of out-migration, natural population decrease, unemployment, and poverty. In addition, the population age structure is distorted, particularly in rural areas. The most common problem is poor access to social services, particularly in smaller settlements (UNDP, 2005).

The extent of the impact of the Chernobyl accident has been a highly controversial issue. Many people believe that Chernobyl has indeed had a dramatic effect on the health status of the population. Some researchers have asserted that more than 200,000 people died due to radiation in Belarus, Russia, and Ukraine during the 15 years after the accident (Yablokov et al., 2007). However, this assessment appears to be highly exaggerated, as it tends to attribute diverse health outcomes to the impact of radiation (Chernobyl Forum, 2006). A dramatic increase in thyroid cancer among children is considered to be the main health effect of Chernobyl that has been confirmed scientifically. To date, there is no convincing evidence linking the increase in solid cancers or leukemia to the radiological impact of Chernobyl. It has been acknowledged that "it is impossible to assess reliably, with any precision, numbers of fatal cancers caused by radiation exposure due to the Chernobyl accident – or indeed the impact of the stress and anxiety induced by the accident and the response to it" (Chernobyl Forum, 2006).

Health care

The health care system currently functioning in Belarus inherited the main features of the Soviet health care system. It is an easily accessible and extensive system that continues to provide basic care to the entire population. The system has a hierarchical and centralized structure, with the Ministry of Health acting as its main body, and regional health departments being responsible for the organization and funding of primary and secondary care services in the regions. Health services are not subject to privatization. The health care system is primarily funded through general taxation, except for some out-of-pocket payments. Up to now, public health insurance has not been introduced in Belarus (WHO, 2009).

The main advantage of the Belarusian health care system is that it is committed to providing free and equal access to health services to everyone. Furthermore, the medical personnel are thoroughly trained in a particular, treatment-oriented, specialty-based approach to health. Additionally, the system relies on extensive health infrastructure and equipment. Still, for a number of reasons the system's overall performance has remained poor and inefficient. First, health care delivery is

unbalanced: there are too many hospitals, beds, and physicians (secondary care); while there are too few general practitioners (primary care). The shortage of physicians and nurses in primary care facilities is especially pronounced in rural areas. Second, the allocation of financial resources within the health subsectors is inefficient. Third, primary care is weak and inefficient, and, a result, many medical conditions flow through it and are treated in hospitals at higher cost. Finally, the clinical protocols and treatment methods used are not fully consistent with the international standards of the most effective approaches to medical care and disease prevention (World Bank, 2002).

The shortcomings of the inherited Semashko health care system are recognized by Belarus policy makers. There is a commitment to improving its effectiveness by introducing gradual reforms. Since 2000, health care reforms in Belarus have been focused on strengthening primary and preventive care. Yet so far there have been no significant achievements in this area, as the health care reforms have not been fundamental enough. Furthermore, the reforms have been implemented in pilot areas, rather than nationwide (WHO, 2009). As was the case in the Soviet era, primary health care is still mainly provided through territorial networks of polyclinics, and Western models of primary care are uncommon in Belarus (World Bank, 2002). Nevertheless, some steps in this direction have been made with the introduction of a primary care model with general practitioners. This initiative has been partially implemented, and in rural areas only. To date, general practices in rural areas do not hold a gate-keeping position, and funding has not yet been shifted in favor of primary care (WHO, 2009). Despite some achievements, such as reductions in infant and maternal mortality, the health care reforms in Belarus have not shown much success in tackling non-communicable diseases. More fundamental changes are needed to improve the quality and efficiency of services (Richardson et al. ,2008).

1.3. Prior research

Mortality trends in the former USSR and the post-Soviet countries have attracted the attention of many researchers. Yet so far, these studies have mainly been focused on Russia, and, to a lesser extent, on the Baltic States; meanwhile, very little is known about mortality trends and patterns in Belarus. It therefore seems reasonable to review evidence from other countries that are close to Belarus in terms of their historical, cultural, political, and socioeconomic backgrounds. This section is organized as follows. First, I will review studies devoted to the analysis of health and mortality in the USSR. Here, the review is organized in chronological order to illustrate the emergence, development, and accumulation of ideas over time. Then, I will summarize the most significant studies on health and mortality in the FSU during the post-Soviet period. Because of the huge number of studies that refer to this period, the review is organized by changes in causes of mortality. Subsequently, I will discuss the relatively scarce and scattered evidence on Belarus. Finally, I will summarize all of the scientific evidence available to date, and close the section with critical reflections on the existing literature.

1.3.1. The Soviet mortality phenomenon and the first phase of the health crisis

Mortality trends in the USSR have long been of interest to both Soviet and Western scholars. In the context of the Cold War, the interest in Soviet demographic developments was based not only on scientific, but also on ideological grounds. The USSR made an unprecedented and highly appealing commitment to its people to provide universal and free health security (Field, 1995). During the two decades after World War II, Soviet medicine was remarkably successful in reducing mortality. As a result of the widespread implementation of preventive and curative care control over infectious diseases, life expectancy in the USSR was increasing rapidly, and was catching up to rates in the Western world. However, the success and effectiveness of the Soviet system soon became less certain.

Dutton (1979) was one of the first Western scholars to document the unfavorable mortality trends in the USSR. Among the most important trends during the 1960s

and the 1970s was, the author noted, the “large and probably continuing increase in male adult mortality in the post-1964 Soviet Union.” Dutton also suggested that this trend was “.. puzzling in light of apparent changes in economic and social conditions in the Soviet Union,” and that the rise in male mortality might be related “to a voluntary shift toward less healthy patterns of living,” and “in part be attributed to the increased alcohol consumption.” Dutton also made important observations regarding the increasing role of mortality from cardiovascular diseases (CVD), the excessive mortality among Russian males relative to mortality among men living in other parts of the USSR, and the significant and unexplained increase in infant mortality in the early 1970s. The latter observation attracted considerable interest, as infant mortality had been (and it continues to be) viewed as one of the key development indicators.

Davis and Feshbach (1980) conducted a careful and statistically grounded study to investigate this rise in infant mortality. The authors concluded that the increase in infant mortality observed in the USSR that took place in the 1970s was real. Given the rapidly declining infant mortality in the industrialized countries and the claims of the USSR to be a superpower, the rise in infant mortality observed in the Soviet Union was absolutely extraordinary, and prompted further investigations. Apart from this increase in infant mortality, Davis and Feshbach also detected a notable rise in adult mortality in the USSR. At this point it became clear that something in Soviet life was going wrong.

In 1981, Eberstadt published his influential article “Health crisis in the USSR” (Eberstadt, 1981) as a review of Davis and Feshbach’s work. Unlike previous researchers, Eberstadt was far more critical in assessing the health situation in the USSR. In his essay he made a number of very strong and sometimes emotional statements to describe the health and mortality trends in the USSR, such as the following: “Measured by the health of its people, the Soviet Union is no longer a developed nation;” or, “Clearly, something in Russia is going very, very wrong;” or, “The spectacle of an industrial nation embarking on a path toward preindustrial standards of health is deeply disturbing.” In fact, Eberstadt was the first to characterize the epidemiologic situation in the USSR as a *health (mortality) crisis*.

Since then, this term has been widely accepted and used by many researchers. Eberstadt's essay still stands out as a remarkably accurate account of the Soviet reality, even though his main conclusions were not based directly on statistics (which were at that time unavailable), but rather on fragmentary data and circumstantial evidence coming from different spheres of Soviet life. Eberstadt not only provided evidence suggesting that the Soviet regime was unable to prevent the deterioration in the nation's health, he also proposed explanations for this failure. Among them were the growing problems of alcoholism, pollution, workplace accidents (often alcohol-related), the inefficiency of the economy, and the poor performance of the Soviet health care system.

Later, Feshbach (1984) provided extensive evidence of the shortcomings of the Soviet health care system, such as the nationwide shortage of essential medical supplies (aspirin, cotton bandages, needles, etc.); the lack of medical equipment, ambulances, and medical furniture; the poor qualifications of medical personnel, coupled with their often rude attitude to patients; and poor medical facilities, particularly in rural areas. Acknowledging "the remarkable Soviet achievements in reducing the level of infectious diseases," he noted that "something has gone awry in the scale, structure, and the direction of Soviet health indicators." Feshbach pointed to the extraordinary increase ("epidemic proportions") of coronary heart diseases during the 1960s and 1970s, and suggested a possible link between these conditions and alcohol abuse. Moreover, alcohol appeared to be largely responsible for male working-age mortality. Feshbach concluded with the following statement: "The importance of the alcohol issue to the health of Soviet society appears to be very serious and of growing concern to the leadership."

Mortality research in the USSR was constrained because of a lack of appropriate data until the early 1970s, and the absence of data from 1974 to 1987 (Shkolnikov, Meslé, Vallin, 1997). In the late 1980s, in light of the new policy of openness and *glasnost* introduced by Gorbachev, the Soviet authorities resumed publishing mortality data. Archives containing valuable information were progressively made open to the public. The availability of these data created new opportunities for further research. Anderson and Silver (1986) revisited the controversial issue of

rising infant mortality in the 1970s, claiming that “the evidence of any real increase in infant mortality in the Soviet Union after 1971 is weak.” They challenged the views advocated earlier by Davis and Feshbach by presenting convincing evidence that the increase in infant mortality occurred mostly due to significant changes in reporting rules and procedures. Anderson and Silver also suggested that, because Soviet statistical practice used a specific definition of live birth (which was not compliant with the standard WHO definition), the true infant mortality rates were substantially understated. They argued that the correction factor used by Davis and Feshbach (who published adjusted infant mortality rates earlier) was “too small,” and suggested an upward infant mortality rate correction of 23.5 percent to reflect the difference between the Soviet and WHO definitions of live birth.

A few years later, the same authors tested three hypotheses related to research on the increase in mortality in the 1960s and 1970s: worsening health conditions, cohort replacement, and the improvement in data quality (Anderson and Silver, 1989). They came to the conclusion that people born during World War II experienced elevated cohort mortality, and that this was especially true for the European parts of the USSR affected most severely by the war. This was also found to be the case for males who were in early adolescence during the war. However, the authors concluded that these cohort mortality effects were small, and did not explain the increase in adult male mortality between 1964 and 1982. They also found that the improvement in data quality was not responsible for the rise.

Blum and Monnier (1989) were among the first scholars to gain access to the detailed mortality data, including the age- and cause-specific data. Apart from addressing infant and childhood mortality trends, the French researchers examined long- and short-term variations in adult mortality by means of a decomposition analysis, and explored the evolution of cause-specific mortality in the USSR. They demonstrated that males at middle age were mainly responsible for the decrease in life expectancy between 1958-59 and 1984-85, and that this age group contributed the most to the short-term increase in life expectancy in the mid-1980s. They attributed this increase to the positive impact of the Gorbachev’s anti-alcohol campaign on mortality trends, but also emphasized the short-term nature of the

rise, as “it is neither due to changes in the system of health care, nor is it a continuation of long-time trends.” Blum and Monnier concluded that high mortality from violent death “which is undoubtedly linked to alcohol abuse” was the main feature of Soviet mortality.

Meslé, Shkolnikov, and Vallin (1992) conducted a more comprehensive analysis of the cause-specific mortality trends in the USSR during 1970-1987. Within the framework of the collaborative project of the Russian and French scholars, original statistical tables were extracted from archives, computerized, and verified. Subsequently, the cause-specific mortality trends were reconstructed to eliminate the effect of changes that occurred in the Soviet nosological system in 1981. In order to accomplish this task, the precise reconstruction method was applied (Meslé and Vallin, 1996). Then, the time series that had been obtained were analyzed with reference to France, Sweden, Finland, and Hungary. The trends in cardiovascular mortality in the USSR were found to be “particularly unfavorable” compared to those of the three Western countries, but to be close to those observed in Hungary. The contrast was shown to be less pronounced for ischaemic heart diseases, but fairly obvious for cerebrovascular diseases. The evolution of Soviet mortality trends from injury and poisonings was, according to the authors, even more alarming. They noted that alcohol consumption played a “dominant role” in the mortality fluctuations of the 1980s. They clearly attributed the increase in life expectancy between 1985 and 1987 to the short-term effect of the anti-alcohol campaign (launched by the Soviet government in 1985), rather than to fundamental changes in the epidemiologic profile, which could place the USSR “on the path to the modern phase of the health transition.” Finally, Meslé and colleagues noted that, because of the high degree of heterogeneity of the Soviet population, the reconstruction and analysis of cause-specific mortality trends for each of the Soviet republics could provide greater insight into mortality dynamics.

1.3.2. Evidence and interpretations of the mortality rise in the post-Soviet countries

Over the last two decades, such a large number of studies have been conducted in an effort to describe and explain the adverse health trends in the FSU that it would

be very difficult to cover them in a short summary. Thus, I focus below on just a few of the most significant studies, which are important in terms of both their contributions in explaining the mortality crisis, and their relevance for understanding mortality trends in Belarus. This sub-section is organized as follows. First, I will review the earliest studies that provided provisional explanations for the mortality rise in the post-Soviet countries. Then I will turn to a few studies that emphasized the importance of specific mortality determinants, such health lifestyles, economic conditions, and psychological stress. Subsequently, I will review studies that assess the wide range of mortality determinants on the basis of accumulated research evidence and available data. Finally, I will summarize existing evidence regarding the principal determinants of mortality change.

Mortality rise in the FSU: Initial evidence

The mortality trends in Russia have received more attention than the trends in any of the other former Soviet republics. This is not surprising given that Russia is the largest country in the region and the legal successor of the USSR, and that it is also the country where the mortality crisis has been the most devastating.

Ellman (1994) analyzed the morbidity and mortality patterns in Russia in the late 1980s and early 1990s, and concluded that the collapse of the USSR "… had severe adverse effects not only on macroeconomic indices but also on the mortality and morbidity of the population." He stated that no definitive analysis of the causes underlying the steep mortality increase since 1991 could be made at the moment, but proposed "provisional, tentative, and necessarily speculative" explanations. Among them were impoverishment; the institutional collapse of the Soviet political system; the inadequate financing of the health care system; the deterioration in public hygiene; the economic, social, and political disintegration; and inter-state military conflicts. In the broader context, the complex combination of social, psychological, and medical causes appeared to drive the increase in morbidity and mortality rates. Yet it was not possible to assess the effects and relative importance of all of these factors.

Soon after, Field (1995) produced a report on the health crisis from the "post-war zone," which was his term for the former Soviet Union after its dissolution. Field claimed that the adverse health trends observed in the region were in part the result of the long-running Cold War, which the USSR ultimately lost. Distracted by their efforts to match the West in defense outlays, Field argued, Soviet authorities failed to address adequately the needs of the civilian sector, including public health funded by the 'residual' principle. The poor performance of the Soviet health care system contributed to the long-term deterioration of the epidemiologic situation. Following the collapse of the USSR, the health trends worsened. According to Field, health care was not, however, the only factor responsible for the health crisis; instead, he asserted, other social, economic, and ideological factors also contributed. The population of the former USSR suffered "a humiliating national defeat with all the consequences of a 'post-war' situation, including inflation, anomie and social polarization." Field predicted further deterioration of the situation until "a viable political, economic, and social order is established."

Bobak and Marmot (1996) discussed a number of potential explanations for the growing East-West mortality divide in Europe (with Russia largely representing the "East"), such as the quality of medical care, environmental pollution, and socioeconomic forces. Lifestyle (smoking, exercise), diet, alcohol, and psychological stress were considered to be among the factors mediating the effects of social and economic forces. The authors stated that no firm conclusions on the causes of the East-West mortality divide can be made because of the lack of representative and reliable data. Yet Bobak and Marmot suggested that "the failure of the political and economic system to satisfy population needs, both material and psychosocial, is probably the cause." They also concluded that a combination of environmental pollution and medical care could explain up to 20 percent of the mortality gap. Lifestyle (particularly smoking), behavior, and diet appeared to be among the more important factors, although the precise magnitude of their effects was difficult to quantify. Education, real income, and access to information were identified as the forces that largely determined the high prevalence of unhealthy behaviors.

Shkolnikov, Meslé, and Vallin (1996) performed a meticulous analysis of mortality trends in Russia over the period from 1970 to 1993. This work complemented and extended the previous analysis conducted by the same authors for the whole USSR (Meslé, Shkolnikov, Vallin, 1992). As a first step, cause-specific mortality trends were harmonized (reconstructed) in accordance with the most recent classification of causes of death used in Russia (the extensive documentation of this work was published in Meslé et al., (1996)). Then, based on the data obtained, Meslé and collaborators analyzed the evolution of Russian mortality with reference to France and England and Wales. The results demonstrated that cardiovascular mortality was the main determinant for the long-term deterioration, while mortality from external causes was largely responsible for the short-term fluctuations. Accounting for more than a half of all deaths, CVD mortality was clearly the driving force in the growing gap between Russia on one hand, and France and England and Wales on the other. Cancer mortality in Russia was among the leading causes of death, but, compared to the two Western countries, the level was not high. The authors argued that the issue of the underestimation of cancer mortality in Russian statistics had been exaggerrated. Instead, they suggested that the low cancer mortality rates in Russia could be better explained by the fact that Russia is "at an earlier stage of the development of cancer mortality than Western countries." With respect to more specific causes of death, an increase in mortality from diabetes attributable to the improved registration and the decline in the quality of medical treatment was noted. In addition, mortality from cirrhosis of liver increased substantially in Russia in the late 1980s. This occured after the short-term decline in the middle of the 1980s (which was attributable to the effects of the anti-alcohol campaign), and pointed to the possible problem of an increase in alcoholism. Overall, the mortality trends in Russia were characterized as unfavorable, particularly among adult males. According to Shkolnikov and collegues, the observed mortality trends expressed "unambiguously the failure of the health system to make any headway in cardiovascular mortality and to contain the upsurge in 'man-made diseases'."

Health lifestyles

Cockerham (1997) studied the social origins of the decline in life expectancy in Russia and Eastern Europe. Three explanations for the observed trends were considered: Soviet health policy, social stress, and health lifestyles. Cockerham argued that poor health lifestyles, particularly those involving hazardous alcohol consumption; as well as smoking, lack of exercise, and high-fat diets; were the major determinants of the increase in deaths.

Leon and colleagues (1997) analyzed the age- and cause-specific patterns of mortality decrease and increase in Russia during 1984-1994. They used the reconstructed cause-of-death series to examine the plausability of different explanations for the observed mortality variations. With the exception of neoplasms, mortality from all major causes of death declined between 1984 and 1987, and increased between 1987 and 1994. Alcohol-related deaths and accidents and violence showed the largest declines and quite symmetrical subsequent increases. However, similar fluctuations were observed in deaths from infectious, circulatory, and respiratory diseases. The absence of variations in mortality from neoplasms was used by Leon and colleagues as the main argument against the possibility that the changes in life expectancy in Russia merely reflected an artifact due to the underestimation of population exposure. Recognizing the possible involvement of other factors, such as nutrition and health care services, the authors suggested that the substantial changes in alcohol consumption could plausibly explain the main features of the observed mortality fluctuations in the mid-1980s and mid-1990s.

Cockerham and colleagues (2006a) elaborated on the lifestyle explanation of the health crisis, while examining the relationship between psychological distress, gender, and health lifestyles in Belarus, Kazakhstan, Russia, and Ukraine. The data were obtained by means of face-to-face interviews (n=10,406). The nationally representative sample surveys of the adult population over age 18 were conducted by experienced survey research organizations in each country. Psychological distress was measured by 12 psychological distress symptoms (such as

"constantly under strain," "losing confidence in one's self," "insomnia," etc.). Healthy lifestyles were measured by alcohol consumption, smoking, and diet. It was found that women carried a much heavier burden of psychological distress than men. However, neither for women nor for men did this distress translate into greater alcohol consumption and smoking. Cockerham and colleagues argued that "it is the normative demands of a particular lifestyle, rather than distress, that principally shapes the pattern of heavy male drinking."

Economic conditions, psychological stress, and other factors

Brainerd (1998) examined the link between mortality and the speed and depth of market reforms using aggregate data on 22 transition economies for the period 1989-1994. A correlation between mortality rates and measures of reform success, such as GDP growth and the inflation rate, was found. Higher crime rates and higher unemployment rates (Russia) were also shown to be related to greater increases in death rates.

Shkolnikov and colleagues (1998a) investigated the causes of the unprecedented mortality increase in Russia by a thorough examination of the available evidence. Their findings suggested that the rise in Russian mortality could not be attributed to absolute deprivation, the collapse of the health care system, or environmental pollution. It is more likely, they asserted, that psychological stress triggered by the shock of an abrupt socioeconomic transition was the main determinant, mediated in part by the adverse health effects of excessive alcohol consumption.

The study by Walberg and colleagues (1998) was among the few studies that relied on regional data. They found that the fall in life expectancy in the early 1990s did not affect all Russian regions equally. The fact that the greatest mortality increments were observed in some of the wealthiest regions, they noted, suggested that the "impoverishment" explanation was insufficient. Factors related to the effects of poorly executed economic reforms—such as high labor force turnover, the collapse of social cohesion, and the rise in income inequality—were found to be associated with larger mortality increases. The results of the study also

strengthened the evidence that alcohol was an important proximate cause of premature death in Russia.

Bobak and colleagues (1998) examined the association between social and psychological factors and self-reported health using the data obtained from the multi-stage sample of Russian population aged 18 years and over (n=1,599). Two indicators of self-reported health were used: self-rated health (shown to predict individual-level mortality in prospective studies), and physical functioning (validated against more objective health measures). Perceived control over one's life and material deprivation were found to be strongly related to both health outcomes. Education was also shown to be inversely related to self-rated health, and unmarried males more frequently reported being in poor physical health. Bobak and colleagues argued that the absence of informal social networks seems to affect adversely self-rated health. They also stated that deprivation and low perceived control "may be important mediators between the broad social environment and health in populations undergoing transition…"

Systematic assessments of potential mortality determinants

A number of studies providing systematic assessments of a wide range of potential mortality determinants of the Russian health crisis deserve particular attention. Cornia and Paniccia (2000) reviewed a number of possible explanations for the mortality crisis in Russia and other transitional economies. Among them were that the crisis is a statistical artifact that it is attributable to environmental pollution, impoverishment, the erosion of health care services, health behavior, alcohol consumption, or psychosocial stress. For each of the factors considered the authors provided arguments for and against including the factor among the main mortality determinants. The "statistical explanation" for the sudden rise in mortality rise was instantly rejected. They found little evidence to support the notion that mortality rates could increase as a result of the improved quality of death registration combined with the significant overestimation of the population size (due to the incompleteness of migration statistics). Cornia and Paniccia also stated that "it is not true that poor environmental conditions are a main factor in the

transition countries." The fact that the mortality pattern in Russia from respiratory diseases among children and the elderly remained unchanged was used as an argument against Feschbach's "ecocide" as a factor in the mortality crisis. The absolute "impoverishment" explanation was also not among the main suspects, although an increase in deaths could be observed among a very small share of the marginalized population, which might be attributable to insufficient food intake, reduced access to shelter, and basic health care. The hypothesis of the "erosion of health services" as a major factor in the mortality rise was found to be more plausible. On the one hand, the cases of the Czech Republic and the former GDR demonstrated how greater allocations of funds could result in increases in the number of cardiovascular interventions and improvements in health care. On the other hand, the countries of the Former Soviet Union (FSU) experienced significant reductions in health care expenditures, which coincided with the rises in mortality related to conditions amenable to health care. At the same time, Cornia and Paniccia found the 'health care' explanation to be inconsistent with the fact that mortality among men was growing faster than among women. Moreover, the mortality increase was related to only a few specific causes, not to all causes. Indeed, the surge in mortality from external causes was absolutely irrelevant to the functioning of the health care system. All these considerations led the authors to conclude that "it is unlikely that the reduced access to, and declining quality of health services played a major role in the current mortality crisis." The impact of changes in health behavior (diet and smoking) on mortality also appeared to be very questionable. The "slow" nature of these risk factors (in terms of the speed of changes over time), as well as their rather long-term effects on mortality, were not consistent with the rapid increase in circulatory and violent deaths in Russia in 1992-94. Unlike in all of the previous explanations, the role of alcohol consumption was not in question. Cornia and Paniccia characterized alcohol consumption as "an important intermediary factor in the transition mortality crisis, and to account for 27-40 percent of the rise in male mortality and for a much smaller proportion of female mortality." However, they argued that the "alcohol thesis" alone does not explain the mortality rise, especially when we seek to interpret the huge

fluctuations in cardiovascular mortality, which are not necessarily mediated by alcohol intake. Finally, they concluded that “acute psychosocial stress is a key factor in sudden deaths, i.e., those due to cardiovascular problems, psychosis, neurosis, suicide, and accidents; as well as in deaths due to ulcers and cirrhosis of the liver, i.e., the main causes of the transition’s mortality crisis.” Acute stress can, in turn, be caused by the negative socioeconomic consequences of the transitional period, such as unemployment, rapid labor turnover, job insecurity, growing family instability, social stratification, distress migration, and personal insecurity. Furthermore, according to Cornia and Paniccia, “changes in stress factors often tended to reinforce each other and to interact negatively with greater alcohol consumption and reduced access to health services.”

Shkolnikov and colleagues (2004) provided a comprehensive summary and discussion of the accumulated scientific evidence on the causes of the mortality reversal in Russia. As in the work of Cornia and Paniccia, the broad spectrum of explanations of the mortality crisis were considered. Unlike in the previous study, however, the recent mortality trends in Russia were also viewed in the context of past developments and historical circumstances, or so-called “echoes of the past.” The authors stated that “an understanding of contemporary mortality in Russia must take into account events and conditions in the past.” To exemplify the point, they provided evidence of how changes in mortality from lung and stomach cancer can be linked to events in the past. However, they concluded that “past” factors were not among the main explanations for the adverse dynamics of Russian mortality in recent decades; instead, they moved on to the examination of the role of certain behavioral and lifestyle factors (alcohol, tobacco, poor nutrition), the inadequacies of the health care system, and the psychological response to the socioeconomic and political shocks. Smoking was considered as one of the conventional risk factors associated with lung cancer, ischaemic heart disease, and cerebrovascular disorders. They concluded that smoking appeared to contribute substantially to a high basic level of mortality, but that it was not responsible for mortality fluctuations after 1985, and, in particular, the sudden mortality rise in the 1990s. In addition, they found that smoking could explain only

a part of the mortality gap between Russia and the West, and that it did not appear be the major determinant of mortality differentials within the Russian population. Another factor suspected of having an enormous impact on Russian mortality was alcohol. According to Shkolnikov and colleagues, the impact of alcohol on mortality, and, in particular, on mortality fluctuations in the 1980s and 1990s, appeared to be stronger than expected. The authors argued that the rise in alcohol-related mortality could be attributed to the episodic pattern of 'binge' drinking, which involves the consumption of large amounts of vodka on a single occasion. Hazardous alcohol consumption results not only in excessive alcohol-related and external cause mortality; it is also largely responsible for premature deaths from cardiovascular causes. Unlike the role of alcohol, the role of nutrition was found to be less clear, although the authors noted that a low intake of micronutrients (mainly derived from fruits and vegetables) could contribute to high cardiovascular mortality and mortality from some cancers. The inadequacies of the Russian health care system were seen as an important factor responsible for about 20-25 percent of the Russia-West gap in life expectancy at birth. The authors also viewed psychological stress as an important contributor to the adverse mortality trends in Russia. Triggered by the chaotic political and socioeconomic transformation of the 1990s, it could have been a direct cause of various ailments and even deaths. More often, it could have operated indirectly as the force "leading to heavy drinking and other health damaging behavior as a way to cope with it and so to 'escape' from the grim reality that is life for many people in Russia today." Finally, Shkolnikov and colleagues emphasized that the health crisis in Russia started much earlier than the 1990s. They authors argued that the core of the problem was related to the nature of the communist and post-communist ideology in Russia. For a long time, the people's material and social needs had been neglected, and the health of individuals was given a low priority. With the collapse of the old system, no efficient institutions capable of facilitating the fair distribution of resources, including access to health care, were created. All of these circumstances placed restrictions on the life and health opportunities of people, especially those belonging to lower social strata.

Brainerd and Cutler (2005) offered different explanations for the unfavorable mortality trends in Russia and the former Soviet Union. In their analysis, the authors relied on two approaches: one was based on national-level data for 23 countries of the former USSR and Eastern Europe, while the other was based on individual-level data from the Russian Longitudinal Monitoring Survey (RLMS). By combining statistical evidence from all of the available sources, Brainerd and Cutler evaluated the relative importance of each of the plausible mortality determinants, or, as they called them, "suspects." Several suspects were identified: medical care, traditional cardiovascular risk factors, disease, alcohol, the composition of the diet, material deprivation, and psychological factors. Brainerd and Cutler found alcohol and stress to have been the two most significant factors that led to the crisis. They determined that increased alcohol consumption explains about one-quarter of the mortality increase in Russia, and that this estimate is supported by both cross-country and micro-data. They attributed another quarter of the mortality rise to heightened psychological stress from the "shock" transition to a market economy. The data did not provide evidence supporting any of the other suspects in the Russian mortality crisis. Brainerd and Cutler concluded that, because the factors considered in the analysis could explain only about one-half of the mortality variation, there is a need to seek additional explanations for the mortality crisis.

1.3.3. Mortality research in Belarus: Fragmentary evidence and knowledge gaps

The first evidence on mortality in Belarus traces back to the 19th century. Maskov (1975) examined the long-term mortality dynamics in Belarus, starting from the middle of the 19th century up to the 1970s. According to Maskov's estimates, in the 1850s, the crude death rate in Belarusian gubernias ranged from 34 to 41 per thousand. Poverty, poor sanitation, miserable working conditions, starvation, the absence of basic health care, and religious prejudice led to high mortality. Following the abolition of serfdom in 1861 and the expansion of capitalist institutions, the mortality level decreased to about 30 per thousand. Nevertheless, the mortality dynamics were very unstable: the crude death rate fluctuated from

year to year as a result of epidemics and famines. In 1913, the crude death rate in Belarus was 25.5 per thousand versus 13.8 per thousand in England, 13.7 per thousand in Sweden, and 15.2 per thousand in Germany. Yet mortality in Belarus was lower than in the European part of Russia, Poland, Romania, and Hungary. During the World War I, mortality in Belarus increased dramatically, and reached its peak in 1918 (37.4 per thousand), due to the Spanish flu. After the proclamation of the BSSR in 1921, a great deal of attention was paid to the reduction of mortality, and priority was given to measures aimed at tackling child mortality. The Soviet authorities issued legislative regulations which gave pregnant and breastfeeding women and children priority in food provision. Infant care allowances were established and free meals for children were provided. Several child clinics, hospitals, and ambulance stations were opened in the Minsk gubernia. All these measures eventually led to a reduction in child mortality, with the rate falling 40 percent between 1913 and 1922. In 1923, overall mortality was reduced to 16.2 per thousand. After some stabilization in 1928-1930, mortality in Belarus again started to decline slowly, and by 1939 the crude death rate reached 12.4 per thousand. The notable success in mortality reduction was primarily a result of medical interventions against infectious diseases. The initial success was largely supported by funds of 639 million rubles received from Russia in 1920.

World War II had devastating consequences for Belarus. The mortality increase was catastrophic. According to Maskov's estimates 1,409,000 civilians and 810,000 war prisoners were killed in Belarus; 378,000 were captured and sent to Germany for forced labor during the war. After World War II, the entire infrastructure of Belarus was rebuilt with the help of the whole USSR: during the initial post-war years, two-thirds of Belarusian expenditures on the economy, housing, and health care were covered by the consolidated budget of the USSR. Improved living standards and medical care resulted in remarkable achievements in the fight against mortality. Compared to the end of the 19th century, infant mortality in Belarus had decreased about tenfold by the end of the 1960s (19 versus 186 per thousand live births). During the same period, life expectancy at

birth increased by almost 35 years. While at the beginning of the 20th century life expectancy in Belarus was among the lowest in Europe (38.5 years), by the middle of the 1920s it had already reached 52.6 years[1]; by the end of the 1960s, it was among the highest in the world (73 years). In light of these developments, Maskov made a forecast for future mortality trends in Belarus. He predicted a further reduction in infant mortality, and also a reduction in mortality from infectious and respiratory diseases among both children and adults of working ages. Furthermore, Maskov said, mortality from neoplasms and cerebrovascular diseases would shift toward older ages. The latter causes would appear to be the main reasons for a further life expectancy increase in Belarus.

Chernysh (1992) analyzed several socio-demographic aspects that may have contributed to the mortality changes in Belarus over the 1970s and 1980s. First, the author acknowledged that the incompleteness of the "demographic transition" in Belarus coincided in time with a deep social crisis, which resulted in growing depopulation, particularly in rural areas. Mortality increases may be expected in the future, he said, adding that the impact of the Chernobyl accident could lead to a rise in mortality due to congenital malformations among children. Second, Chernysh noted that the empirical analysis of mortality trends did not indicate that these trends were associated with the Chernobyl accident. Third, he observed that the quality of the health care provision had played a crucial role, and that life expectancy in Belarus would have been higher in the presence of more effective health care. Finally, he concluded that mortality among the working-age population determined changes in overall mortality. In order to reduce mortality, Chernysh suggested that priority be given to measures tackling violent death. If mortality from injuries and alcohol-related accidents were eliminated, life expectancy in Belarus would increase by 3.1 years (estimations based on 1989-1990 Belarusian life tables).

Antipov (2001) analyzed mortality trends in Belarus, and also two regions of the country, the Gomel and Vitebsk oblasts, over the period of 1976-1995. The author

[1] As suggest the adjustments for underreporting of deaths made by Adamets and Shkolnikov (1994) this figure is very likely to be a significant overestimation the true value of live expectancy at that time

concluded that, during the post-Chernobyl period, all causes of death and age groups were demonstrating considerable mortality growth. This growth was particularly pronounced among males. The analysis of the eliminated mortality effects showed that cardiovascular mortality and mortality from external causes were the main reasons for the higher mortality. The author argued that there was a deterioration in the quality of the diagnostics of causes of death after 1986, specifically in the growth of the diagnoses attributable to symptoms and ill-defined conditions accompanied by the under-registration of diseases of the cardiovascular system. Antipov estimated that about 12 percent of all deaths in Belarus were attributable to inadequate health care, with about two-thirds of these deaths occurring because of late diagnostics, one-fifth because of the late arrival of emergency services, and 17 percent because of wrong diagnostics.

Razvodovsky (2003) examined the association between mortality and alcohol consumption (by type of alcohol) in Belarus over the period 1970-1999. The results indicated the existence of a positive statistically significant association between per capita consumption of strong spirits and overall mortality, while no statistically significant association was found between mortality and overall alcohol consumption. According to the results of this study, the increase in the consumption of spirits was associated with an increase in total mortality, mortality from external causes (including suicide, homicide, traffic accidents, accidental poisoning by alcohol), mortality from liver cirrhosis, alcoholism and alcoholic psychoses, myocardial infarction, hypertension, breast cancer, and mortality from cancer of the esophagus.

One of the most detailed analyses of the mortality trends in Belarus was published as a report of the Research Institute of Statistics (Shakhotko et al., 2003). Recent mortality trends in Belarus were analyzed using the aggregated mortality data as well as the data of the 1989 and the 1999 population censuses, and the data from the Income and Expenditures of Households Survey. Shakhotko and colleagues assessed mortality trends by causes of death over the period 1990-2001. Crude cause-specific mortality rates by cardiovascular and external causes were compared over time. Changes in the composition of causes of death within each of

these two classes were also analyzed. Cardiovascular mortality was found to be the leading cause of death responsible for more than half of all deaths. Within this class, atherosclerotic cardiosclerosis was shown to be the major contributor. Mortality from external causes of death was identified as the second most important cause. Within this class, transport accidents, suicide, and alcohol poisonings were the principal causes. The main limitation of the analysis was the usage of non-standardized mortality rates by very broad groups of causes. Furthermore, no quantitative assessment of the impact of particular ages and causes of death on total mortality and life expectancy changes was made. Finally, the analysis was limited to the brief period since 1990.

In order to fill this gap and provide some clues about the evolution of mortality in the past, the authors used the results of the decomposition analysis of life expectancy by periods performed for Russia, based on the assumption that something similar should be the case for Belarus.

Shakhotko and colleagues also considered the impact of potential risk factors, such as diet, exercise, smoking, and alcohol consumption. The results of this study suggested that the unfavorable medico-demographic situation persisted in Belarus in the 1990s. This was linked to falling living standards, the deterioration of working conditions, poor diet, lack of exercise, psychological stress, and the deterioration in the provision of health care. The authors speculated that these negative developments were responsible for rises in cancer mortality, mortality from diseases of endocrine system, nutritional and metabolic diseases, and external-cause mortality. However, no assessment of the relative importance of each of these factors was made.

The authors also noted that, compared to Russia, the pace of mortality growth in Belarus was much slower. Yet no explanation for this difference was proposed. The potential impact of the Chernobyl accident on mortality levels in the contaminated areas of Belarus was considered in the study as well. Although the authors tended to attribute some part of the excess mortality to the radiological impact, they were not able to find sufficient evidence for such a link.

1.3.4. Summary of evidence on the main causes of mortality crisis in the FSU

Despite extensive research, the precise mechanisms and driving forces of the recent mortality crisis in the former USSR are not fully understood. In particular, it is very difficult to establish causal links, as there are many factors (long-term and contemporary) operating at different levels. In order to gain a better understanding of the forces that have been driving the mortality crisis, it is important to distinguish between its two major phases. The first phase, the chronic crisis, refers to the Soviet period since the middle of the 1960s. The second phase, which started with the acute exacerbation of mortality trends in the early 1990s, refers to the post-Soviet period. Previous studies have offered several kinds of explanations for the pre- and post-transition mortality crises in the former USSR. Most researchers have concluded that the poor performance of the Soviet health care system (in particular, the inefficiency in combating cardiovascular mortality), the neglect by the Soviet authorities of the social and material needs of people (reflected in the totalitarian communist ideology), and unhealthy lifestyles (growing alcohol consumption, poor diet, the lack of health-promoting activities, and general lack of attention to personal health) are mainly responsible for the long-term deterioration of the health situation in the USSR (Eberstadt, 1981; Feshbach, 1984; Field, 1995; Shkolnikov et al., 1996; Cockerham, 1997; Shkolnikov et al., 2004; Shkolnikov and Leon, 2006).

The explanations provided in the huge and growing body of literature of the causes of the post-transition mortality crisis can be broadly classified into three main groups: health lifestyles (alcohol, smoking, diet); psychological stress caused by abrupt and poorly executed reforms; and other explanations, including the preventive and curative role of the health care system. These core explanations have tended to complement each other, rather than to stand alone and contradict each other. Yet their relative importance has remained an issue of open debate, as it is very problematic—if not impossible—to come up with a quantitative assessment of each individual factor.

The health lifestyle explanation found considerable support in the literature. Some researchers have suggested that the excessive mortality among Russian working-age males can be mainly explained by unhealthy lifestyles, such as heavy drinking, smoking, poor diet, and the lack of exercise (Cockerham, 1997). Some have argued that these long-term, persistent patterns of unhealthy behaviors have had their origins in political (communist) ideology (Cockerham et al., 2006a). Yet researchers who have studied this question have also suggested that, although high smoking prevalence (among men), poor diet, and a lack of exercise have contributed to a high basic mortality level; these factors are not the main ones behind the abrupt mortality crisis of the 1990s (Cornia and Paniccia 2000; Shkolnikov et al., 2004; Brainerd and Cutler, 2005). By contrast, hazardous alcohol consumption has long been viewed as the most obvious cause of the health crisis. Numerous past and recent studies point to the importance of alcohol consumption in influencing the mortality variations in the USSR and the FSU (Dutton, 1979; Eberstadt, 1981; Feshbach, 1984; Blum and Monnier, 1989; Meslé, Shkolnikov, Vallin, 1992; Shkolnikov et al., 1996; Leon et al., 1997; Shkolnikov and Nemtsov, 1997; Walberg et al., 1998; Cornia and Paniccia, 2000; Razvodovsky, 2003; Shkolnikov et al., 2004; Brainerd and Cutler, 2005; Leon et al., 2009). The long-suspected causal link between alcohol consumption and mortality was confirmed recently with the appearance of a number carefully designed epidemiological studies conducted in some cities of Russia. These case-control studies demonstrated that working-age mortality is strongly associated with hazardous patterns of alcohol consumption (Malyutina et al. 2002; Leon et al., 2007; Tomkins et al., 2007; Zaridze et al., 2009). Alcohol is known to be directly associated not only with violent mortality, as research has shown that heavy alcohol consumption is an important determinant of cardiovascular mortality in Russia and Belarus (McKee and Britton, 1998; Malyutina et al., 2002; Razvodovsky, 2009). Although the influence of alcohol on mortality can hardly be denied, it is not obvious that it should be viewed as an indisputable proximate mortality determinant. In fact, alcohol can act not only as an immediate, but also as an intermediary factor reflecting the influence of other factors. Thus, even though it indeed plays a

dominant role as a direct and an indirect mortality determinant, alcohol does not appear to be the only driver of the mortality crisis.

Psychological stress has been considered to be among the main factors of the mortality crisis. The stress explanation does not contradict, but rather complements the lifestyle explanation: changes in health behavior that affect health can be related to psychological stress, and vice versa. Cornia and Paniccia (2000) have argued that acute psychological stress is "a key factor in sudden deaths," while alcohol is an intermediate factor, "a stress-reliever" that helps individuals "cope" with rapidly emerging stressful situations. Stress can affect mortality, not only through heavy drinking, but also through other risky and health-damaging behaviors, which can serve as a means of escape from a depressing reality (Shkolnikov et al., 2004). Indeed, there are mechanisms linking psychological stress directly to health losses and death (Marmot et al., 1991; Kristenson et al., 2001). It has been suggested that the mortality upsurge in Eastern Europe in the early 1990s is attributable to an "adaptation crisis." The adverse consequences of the adaptation to a rapidly changing and sometimes chaotic and unpredictable socioeconomic environment, the lack of law and order, and the weakening of social institutions resulted in uncontrolled stress, which in turn manifested itself in violence, family breakdown, and the erosion of health (Cornia and Paniccia, 2000). Individual data in Russia have provided some evidence for the existence of a relationship between psychological stress and health. Researchers have suggested that stress (operationalized as control over one's life) is associated with self-perceived health (Bobak et al., 1998). The question is, then, how accurate the subjective indicator of self-rated health is in predicting mortality; and, more importantly, whether it can be assumed that determinants of both self-rated health and mortality are the same (Perlman and Bobak, 2008).

Although the deterioration in the quality of health care does not seem to be responsible for the large mortality fluctuations in the 1980s and the 1990s, the low effectiveness of the Soviet and post-Soviet health care systems has undoubtedly been an important factor in the high basic mortality level observed in the countries of the former USSR since the 1960s. The unfavorable long-term trends in

cardiovascular mortality suggest a chronic crisis of the system, which is reflected in its inability to develop effective strategies against “man-made” disease (Shkolnikov et al., 1996). Other explanations for the mortality crisis—such as cohort effects, environmental pollution, nutrition, impoverishment, and material deprivation—are less supported by the evidence.

1.3.5. The contribution of this study in the context of flaws in prior research

Previous research created a solid theoretical background for future studies. However, as can be anticipated, the existing literature on health and mortality in the FSU is not without limitations. One of the important shortcomings of prior studies has been their predominant focus on Russia. Compared to Russia, other countries of the FSU, especially Belarus, have received little attention. While in the past there were quite a few similarities between the former Soviet republics, and evidence obtained from Russia could be projected onto Belarus, two decades after the dissolution of the USSR this is no longer the case. In the coming years, the socioeconomic, political, and, eventually, the demographic divergences among countries are expected to grow. Thus, there is a need to extend the geographical focus of research, and bringing missing pieces of evidence together is a matter of priority.

The second important limitation of prior research is the direct consequence of the first one. Because mortality trends in Belarus have not received sufficient attention from the international research community, the available evidence is mainly limited to a few descriptive studies conducted by Belarusian researchers. Generally, these studies provide rather limited insights. They cover short time periods, use highly aggregated mortality data, and suffer from a number of methodological weaknesses. Moreover, many of them tend to overemphasize the impact of the socioeconomic crisis of the early 1990s, as well as the Chernobyl accident, on the mortality trends in Belarus, often without seeking support for these claims in the data.

Several aspects of health and mortality trends in the former USSR have remained underexplored, mainly for reasons of data availability. Because of a lack of micro-

data, the overwhelming majority of studies have relied on the aggregated mortality data, while much less is known about factors associated with mortality at the individual level. Compared to aggregated mortality indicators, health and morbidity indicators have been less frequently used in the analysis of population health. Even today, little is known about health status at the individual level and the factors associated with it, and even less is known about the trends in self-perceived health.

The unique value of the present study is that it expands the dimensions of previously conducted research. An analysis of the long-term mortality series by causes of death has never been conducted in Belarus. Moreover, the cause-specific regional mortality trends, and the patterns of spatial distribution of mortality within the country have not been previously explored. It would appear that the association between potential mortality determinants and mortality from different causes of death has never before been assessed statistically. Furthermore, a detailed analysis of cause-specific mortality in Belarus has never before been conducted at the district level. An analysis of this kind allows us to compare mortality patterns in specific contaminated areas with the rest of the country in order to obtain stronger evidence regarding the impact of the Chernobyl accident. Finally, to our knowledge, no analysis of the trends and determinants of self-perceived health has previously been conducted. Yet such an analysis is important as an addition to analyses of mortality because it provides an alternative view on population health and well-being.

Another and more utilitarian outcome of this research is that this study produces harmonized mortality series by causes of death for Belarus that will be freely available for researchers[2]. The absence of detailed data has been one of the main obstacles for mortality research on Belarus in the past. Additionally, periodic changes made in the classifications of diseases have complicated the analysis of cause-specific mortality, which is essential for establishing causal links between mortality and its determinants. By eliminating this obstacle, the present study

[2] The data and extensive documentation of the reconstruction work will be soon available in the form of working paper on the website of the Max Planck Institute for Demographic Research. (www.demogr.mpg.de)

opens up new opportunities for further research. The experience of Russia shows that the reconstruction and the analysis of cause-specific mortality trends can create a good platform for in-depth mortality research. Taking this into account, we can assert that this study not only performs a systematic analysis of Belarusian mortality; it also provides the basis for further research in this country.

1.4. Research hypotheses

Based on the previous research, the following main hypotheses regarding the nature and causes of the health crisis in Belarus can be formulated.

Hypothesis I (Paper I)

The Belarusian health crisis may have certain features in common with the Soviet and post-Soviet health crisis, such as excess male mortality, very high mortality from cardiovascular diseases, and external causes of death. Both the persistence of unhealthy behavioral patterns and the low level of efficiency of the health care system, especially in terms of preventing and curing cardiovascular mortality, are expected to be the main drivers of the crisis.

Hypothesis II (Paper II)

The postponement of market reforms and the preservation of a 'quasi-socialist' socioeconomic system was associated with a slower mortality increase in the early 1990s. It is expected that, in the long run, the policy of gradualism chosen by Belarusian authorities will be shown to be inefficient, and to result in a prolongation of the unfavorable long-term trends that began the mid-1960s.

Hypothesis III (Paper III)

Alcohol, economic conditions, and the efficiency of the health care system may explain a large part of the mortality variation in Belarus. However, a number of other factors, including the radiological impact of the Chernobyl accident, might also play roles.

Hypothesis IV (Paper IV)

Given the stagnating life expectancy trends, no notable changes should have occurred in self-perceived health over the last decade. A better self-perceived status is expected to be associated with higher educational attainment, income, and urban residence.

1.5. Data and Methods

1.5.1. Collected data

As was mentioned above, studying mortality in Belarus has been made more difficult by a lack of data. Therefore, our first task was to collect as much relevant data as possible. The following chart shows the data used in this study across several time periods (Figure 3).

This study mainly relies on data on deaths and population exposure by age, sex, and cause of death at the national, regional (oblast), and district (rayon) levels. National-level data from various sources were assembled for the period 1965-2008.

Fortunately, the Belarusian data of the Soviet period (1965-1990) were available to us thanks to the prior collaborative project of the Russian Center for Demography and Human Ecology and the French National Institute of Demography. (Shkolnikov, Meslé, Vallin, 1997). The original data for the post-Soviet period (except for 1991-1996) were obtained directly from the National Statistical Office of Belarus (Belstat). The final piece of the data (1991-1996) was obtained in computerized format from the European regional office of the WHO. The national-level data on population exposure were taken from the Human Mortality Database.

	1965-1989	1990-1996	1997-2002	2003-2007	2008
Data on deaths and population exposure by age, sex, and cause					
levels:					
national					
Regional					
District					
Data on socioeconomic indicators					
levels:					
National					
Regional					
Individual data from IEHS		only for 1996, 2000, 2003, 2005, 2007			

Figure 3. Data used in the analysis and their availability by periods

Regional- and district-level data were obtained from Belstat. These data included original unpublished detailed files on causes of death and mid-year population (exposure) by age, sex, type of residential area, and region. The regional (oblast-level) data were obtained for the period 1997-2007, and the district-level data were obtained for the period 2003-2007. Both the regional- and the district-level data were received in the format that was designed for printing, but not for data processing. Thus, I had to transfer and arrange these data in the format suitable for further computations. Also, while the administrative borders of districts have remained unchanged over time, there have been some minor changes: some cities that had been treated as separate territorial units early in the period were later merged with surrounding districts. To ensure data comparability, I had to merge these cities with their corresponding districts for earlier years.

The national data on socioeconomic indicators for the period since 1990 were gathered from the TransMONEE Database[3] and the World Income Inequality Database[4]. Similar regional data for the period 1997-2007 were retrieved from the official statistical publications of Belstat (Belstat 2009).

[3] Data on children in Central and Eastern Europe and the Commonwealth of Independent States: The TransMONEE database (http://www.unicef-irc.org/databases/transmonee/)

[4] http://www.wider.unu.edu

One of the few data sources in Belarus that provides information on individuals is the Income and Expenditures of Household Survey (IEHS). IEHS micro-files for 1996, 2000, 2003, 2005, and 2007 were obtained from Belstat. The IEHS is based on a representative national sample, which can be used for estimating prevalence rates for various factors and for assessing their relationships with reported health. The survey questionnaire contains a number of variables, including health characteristics (such as health self-evaluation, medical visits, expenditures on medical service), demographic characteristics (such as age, sex, place of residence), socioeconomic characteristics (such as working status, education, income), and health lifestyles (such as smoking and exercise).

1.5.2. Data quality

It is known that, in the past—and during the 1960s and the 1970s in particular—mortality data in Belarus suffered from various kinds of measurement errors, such as the under-registration of infant mortality, age heaping, and age exaggeration at old ages. The under-reporting of infant mortality, which is attributable to the more restricted Soviet definition of live birth and infant death, was the most significant data problem (Grigoriev, 2008). Yet despite these problems, the all-age mortality data in Belarus are generally considered to be trustworthy and of good quality, especially in relation to the working-age population.

The quality of the data becomes a much more important issue when the reliability of cause-of-death registration is considered. Many factors—such as diagnostics, coding, specifics of medical schools (which also evolve over time)—affect the data quality. One of the most reliable ways of assessing the quality of mortality data is by conducting special surveys that investigate the validity of the diagnosis on the medical death certificate. One such survey was conducted in the Belarusian capital of Minsk in 1981-1982. Using a sample of medical death certificates, qualified physicians checked both the validity of diagnoses and the correctness of the coding. According to the results of this survey, the overall proportion of erroneous diagnoses constituted 6.6 percent. The highest share (23.2 percent) of errors was observed in the diagnoses of infectious diseases, followed by diagnoses of

digestive (12.8 percent) and respiratory (11.8 percent) diseases. In coding, most errors occurred while coding deaths from diseases of the genitourinary system (11.8 percent). For the remaining causes, the share of errors did not exceed eight percent. Since in many cases errors in diagnostics and coding proved to balance each other out, the percentage of errors which were finally reflected in the statistics turned out to be quite acceptable at the level of broad groups of causes (Meslé et al., 1996).

To our knowledge, no surveys similar to the one conducted in Minsk were organized in post-Soviet Belarus. Nevertheless, it can be assumed that, as in the past, the quality of the mortality statistics in Belarus in recent years should not be a factor that influences the interpretation of mortality trends. In general, mortality data in the countries of the European part of the former USSR are considered to be trustworthy. Anderson and Silver (1997) have noted that the recent mortality data in these countries "are generally reliable, especially at the working ages." On the basis of various data quality indicators, Mathers and colleagues (2005) assessed the current status of global data on cause-of-death registration, and ranked Belarus as a country with mortality data of 'medium quality'. The quality of cause-of-death data in Belarus would be ranked as 'high' had the high proportion of deaths coded as ill-defined been lower.

1.5.3. Methods

Reconstruction method

Of all the methods used in this study, the central position belongs to the method for the reconstruction of continuous time series by cause of death. This method was developed by Jacques Vallin and France Meslé (Meslé and Vallin, 1996). Bridging the gap between 'old' and 'new' sets of causes of deaths is the central problem this method seeks to solve. As the first step, the method assumes the construction of two *correspondence tables*. It is based on the systematic comparison of the medical content between two successive revisions of causes of death. Correspondence tables consist of two reciprocal directories. One directory assigns

to each item of a 'new' classification all items of the 'old' classification that share at least a part of its medical content. In the second directory, all mutual correspondences are listed again, but sorted by items of the 'old' revision (Pechholdova, 2009). The correspondence tables serve as the basis for building *fundamental associations*; i.e., the smallest possible clusters of causes of death sharing exactly the same medical content in the two successive cause-of-death classifications[5].

Fundamental associations allow us to estimate *transition coefficients.* These are the positive values between zero and one that determine explicitly the mathematical correspondence between items of the 'old' and 'new' revisions.

Finally, the transition coefficients are applied to death counts of the 'old' revision that are to be transformed into respective items of the 'new' revision. In the end, the coherent time series in terms of the 'new' classification are obtained. During the reconstruction work for Belarus, the redistributing procedure was refined by implementing of the so-called 'transition matrix'. The transition matrix (TM) is a summary table containing all transition coefficients, and therefore showing the correspondence between all items in the 'old' and the 'new' revisions simultaneously. Once the transition matrix is filled with transition coefficients, the cause-specific 'new' death counts can be obtained by using the following matrix equation:

$$D' = TM \cdot D \qquad (1)$$

where D' and D are the matrices of 'new' and 'old' death counts, respectively. The detailed expression of the product is:

$$\begin{bmatrix} d'_{11} & d'_{12} & \cdots & d'_{1\omega} \\ d'_{21} & d'_{22} & \cdots & d'_{2\omega} \\ \vdots & \vdots & \ddots & \vdots \\ d'_{n1} & d'_{n2} & \cdots & d'_{n\omega} \end{bmatrix} = \begin{bmatrix} tm_{11} & tm_{12} & \cdots & tm_{1m} \\ tm_{21} & tm_{22} & \cdots & tm_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ tm_{n1} & tm_{n2} & \cdots & tm_{nm} \end{bmatrix} \times \begin{bmatrix} d_{11} & d_{12} & \cdots & d_{1\omega} \\ d_{21} & d_{22} & \cdots & d_{2\omega} \\ \vdots & \vdots & \ddots & \vdots \\ d_{m1} & d_{m2} & \cdots & d_{m\omega} \end{bmatrix} \qquad (1a)$$

[5] Meslé and Vallin 1996 and Pechholdova 2009 provide detailed explanations on this point.

where *n* and *m* are the total numbers of items in the 'new' and 'old' classifications, *ω* is the maximum number of age groups (x), and *i* and *j* are two causes of death in the respective classifications ($i = \overline{1,n}$; $j = \overline{1,m}$; $x = \overline{1,\omega}$).

Thus, the value of an element tm_{ij}, indicates the proportion of *item j* in an 'old' revision to be assigned to *item i* of a 'new' revision. Clearly, if an element tm_{ij} is equal to zero (which is in fact the case with the majority of the TM elements), then there is no correspondence between items *i* and *j*. Element d_{12} is the number of deaths from cause 1 in age group 2 of the 'old' revision, whereas element d'_{12} is the number of deaths in the same age group, but classified as cause 1 in accordance with the 'new' revision.

Using the transition matrix proved to be efficient. First, it allowed for a simultaneous redistribution: all items get redistributed at once, which saves a lot of calculus time. Second, with the transition matrix it is easier to control the redistribution process. In the TM, all column totals must be equal to one so that 'old' cause-of-death items are fully redistributed among 'new' items. Finally, matrix algorithms can be easily implemented in programming.

Mortality rates

In this study, mortality rates were used very extensively and for various purposes: testing *Hypothesis I* and *Hypothesis II* by exploring long-term mortality trends by causes of death and contrasting them with those observed in other countries (Paper I and Paper II), exploring regional mortality differences and assessing the factors associated with mortality change (Paper III). To ensure the comparability of mortality rates over time and across different European populations, they were standardized using European standard population (HFA-DB, 2011).

Life expectancy decomposition

The decomposition technique was among the main methodological tools for testing *Hypothesis I* and *Hypothesis II*. It was used to explore major changes (over time) and differences (between countries) in life expectancy (Paper I and Paper II).

The method of the decomposition allows us to split a difference between two life expectancies into age- and cause-specific contributions. The discrete version of the method was independently developed by three different researchers in the 1980s (Andreev, 1982; Arriaga, 1984; Pressat, 1985). Here, Andreev's method of decomposition was used. First, the life expectancy difference is to be split by additive age-components:

$$e_0^2 - e_0^1 = \sum_{x=0}^{w} {}_n\varepsilon_x^{2-1} \qquad (2)$$

where, e_0^2 and e_0^1 are life expectancies in populations 2 and 1, respectively;

${}_n\varepsilon_x^{2-1}$ is an age-specific contribution to the total life expectancy difference due to the difference between mortality rates 2 and 1 in age group [x, x+n].

The age-specific contribution to the difference $e_0^2 - e_0^1$ is calculated as:

$${}_n\varepsilon_x^{2-1} = \left[l_x^2 \left(e_x^2 - e_x^1 \right) - l_{x+n}^2 \left(e_{x+n}^2 - e_{x+n}^1 \right) \right] \qquad (3)$$

The symmetrical component of the difference $e_0^1 - e_0^2$ is calculated as:

$${}_n\varepsilon_x^{1-2} = \left[l_x^1 \left(e_x^1 - e_x^2 \right) - l_{x+n}^1 \left(e_{x+n}^1 - e_{x+n}^2 \right) \right] \qquad (4)$$

In equations (3) and (4), the life table radix is assumed to be equal to one $\left(l_0^1 = l_0^2 = 1 \right)$. Because equations (3) and (4) do not yield identical results, the ultimate age-component is calculated as the average:

$${}_n\varepsilon_x = \frac{1}{2}\left[l_x^2 \left(e_x^2 - e_x^1 \right) - l_{x+n}^2 \left(e_{x+n}^2 - e_{x+n}^1 \right) \right] - \frac{1}{2}\left[l_x^1 \left(e_x^1 - e_x^2 \right) - l_{x+n}^1 \left(e_{x+n}^1 - e_{x+n}^2 \right) \right] \qquad (5)$$

Second, the age-components ${}_n\varepsilon_x$ can be further decomposed into age-cause components:

$$ {}_n\varepsilon_x = \sum_j {}_n\varepsilon_{x,j} \quad (6) $$

The age-cause contributions are estimated using the following equation:

$$ {}_n\varepsilon_{x,j} = \frac{{}_nM^1_{x,j} - {}_nM^2_{x,j}}{{}_nM^1_x - {}_nM^2_x} \cdot {}_n\varepsilon_x \quad (7) $$

where, ${}_nM_{x,j}$ is the mortality rate for age group [x, x+n] and cause of death *j, and* ${}_nM_x$ mortality rate for age group [x, x+n] and all causes combined.

Analysis of statistical associations

In order to test *Hypothesis III* and explain the changes in mortality at the oblast-level over the period from 1997 to 2007, the following one-way fixed-effects panel regression model was used:

$$ Y_{it} = \beta_0 + \beta_1 x_{1,it} + \ldots + \beta_k x_{k,it} + y_2 E_2 + \ldots + y_n E_n + u_{it} \quad (8) $$

where,

Y_{it}- dependant variable (i=territorial unit, t=time);

$x_{1,it} + \ldots + x_{k,it}$ - explanatory variables;

$\beta_1 + \ldots + \beta_k$ - regression coefficients for the explanatory variables reflecting their impact on dependant variable Y;

$E_2 + \ldots + E_n$ - territorial dummies. There are n-1 territorial effects with E_1 serving as the reference category;

$y_2 + \ldots + y_n$ - coefficients for the binary regressors reflecting the remaining territorial effects on the dependant variable;

u_{it} - error term.

The mortality rate (SDR) for all causes combined, as well as for cardiovascular diseases (including ischemic heart diseases and cerebrovascular diseases) and external causes of death (including suicide and homicide), was set as the

dependant variable. Separate models were run by sex for each of the selected causes of death. Poverty and unemployment rates, the SDR from accidental poisoning by alcohol and the number of doctors per capita were selected as independent variables which could capture the regional differences in socioeconomic conditions, the degree of alcohol abuse, and the availability of health care. Because of the lack of data, a large number of possible explanatory variables remained unobserved. In this case, applying the panel regression model was a reasonable solution, as it allowed us to account for the 'omitted variable' bias. Furthermore, although it was not possible to disentangle ethnic and cultural factors, the model still allowed us to control for differences in these time-invariant, region-specific contextual characteristics. As the data used in the regression analysis were not a typical 'large N small T' panel dataset, greater caution was needed to ensure that the produced standard errors were robust to various disturbances. With this in mind, all of the regression models were adjusted for the presence of cross-sectional dependence, autocorrelation, and heteroskedasticity.

To test *Hypothesis IV* and assess the associations between various socioeconomic, demographic, and lifestyle variables; and self-perceived health at the individual level, the following binary logistic regression model was used:

$$LOGIT(\hat{Y}) = \ln\left(\frac{\hat{Y}}{1-\hat{Y}}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k \qquad (9)$$

where,

$\hat{Y}$ - the predicted probability of the event coded with 1 ('poor' state of self-reported health) and with 0 (otherwise);

$x_1 + \ldots + x_k$ - explanatory variables;

$\beta_1 + \ldots + \beta_k$ - coefficients for explanatory variables; unknown parameters to be estimated.

Among the explanatory variables were: education, place of residence, income, working status, smoking, and body mass index. The regression analysis was based on the pooled data from four cross-sectional surveys (2000, 2003, 2005, 2007), containing in total about 40,000 individual records. Because the

observations were drawn from independent cross-sectional samples taken in different years, the 'year' dummies were incorporated in the model to capture changes in the average level of health over time.

Detecting spatial mortality clusters

The **Local Indicators of Spatial Association** (LISA) was used in the analysis of spatial mortality patterns and the assessment of the potential health impact of the Chernobyl accident (related to *Hypothesis III*). The LISA can be useful in identifying statistically significant clusters (or 'hotspots') that take into account the spatial neighborhood structure. Unlike the global measure of spatial autocorrelation *Moran's* I, the LISA statistics does not assume global homogeneity. In other words, even if there is no global autocorrelation or no clustering, it is still possible to detect clusters at a local level using local spatial autocorrelation (Anselin, 1995). So, for a given *i*, clustering can be assessed by calculating and evaluating the statistical significance of the Local Moran's I:

$$I_i = \frac{z_i}{m_2} \sum_j w_{ij} z_j \qquad (10)$$

where, an estimate of the global variance

$$m_2 = \frac{\sum_i z_i^2}{n}, \qquad (11)$$

I_i is the local measure of spatial autocorrelation for an observation *i ;*

z_i and z_j are the deviations of the variable of interest from the mean for areas *i* and *j*, respectively; and the summation over *j* runs for areas that are neighboring area *i* ($j \in J_i$);

w_{ij} are dichotomous weights expressing neighboring

$$w_{ij} = \begin{cases} 1 & \text{if areas } i \text{ and } j \text{ are neighbors} \\ 0 & \text{otherwise} \end{cases}$$

n is the number of observations (areas);

The most useful presentation of the LISA is the so-called LISA cluster map, in which there are five categories coded in accordance with the type of spatial autocorrelation. The *high-high* (high rates-high neighbors) and *low-low* (low rates-low neighbors) locations represent local spatial clusters. According to Anselin (2005) "…the cluster is classified as such when the value at the location (either high or low) is more similar to its neighbours … than would be the case under spatial randomness. Any location for which this is the case is labeled on the cluster map." *High-low* and *low-high* locations are spatial outliers. Spatial autocorrelation that is statistically not significant is labeled as *not significant.* To obtain LISA, it is first necessary to decide on the spatial neighborhood structure. In this study, the *first order queen* structure was chosen. This type of structure is widely used in spatial analyses. It assumes that the districts that share a common border are neighbors. All of the calculations were performed in GeoDa[6], and the results were mapped in ArcGIS 9.3[7].

[6] GeoDa is a free software program that serves as an introduction to spatial data analysis (see http://geodacenter.asu.edu)
[7] ArcGIS is a software for spatial analysis (see http://www.esri.com)

II. SUMMARY OF PAPERS

PAPER I

Health Crisis and Mortality Trends by Causes of Death in Belarus (1965-2008)

Status: **published** in *Population: English Edition (2012),* 67:1, 7-38.

This study is devoted to the reconstruction and analysis of continuous cause-specific mortality trends in Belarus over the period from 1965 onwards.

Background

Compared to the other countries of the former USSR, mortality trends in Belarus have received very little attention. The lack of cause-specific mortality data has been a significant obstacle for mortality research in this country.

Aims

This study pursues two main objectives. The first objective is to reconstruct continuous cause-specific mortality series for Belarus for the period from 1965 onwards. The second one is to perform an analysis of the obtained series, focusing on the most important trends.

Data and methods

The analysis is based upon the original unpublished data on causes of death and data on population exposure obtained from the HMD. In order to overcome the problem of discontinuity in mortality series caused by the periodic revisions in classifications of diseases, I apply the *method of reconstruction*. In the analysis of mortality trends, I rely on standardized mortality rates and the method of the decomposition of life expectancy differences into age and cause components.

Main findings

The harmonized cause-specific mortality series are now freely available to the international research community. The analysis of the obtained data suggests that the evolution of mortality in Belarus over the past half century can be characterized as reflecting a chronic health crisis. Deteriorating trends in mortality from cardiovascular diseases and mortality from violent and alcohol-related causes have been the main features of this period. Both the inefficiency of the health care system in tackling cardiovascular diseases and excessive alcohol consumption have been the main drivers of this crisis. The core peculiarity of the Belarusian health crisis is the absence of a large mortality increase immediately after the dissolution of the USSR (as was seen in Russia). While in the 1990s this could be interpreted as demonstrating the advantages of the quasi-socialist Belarusian model, now it is clear that this temporary success is over. In terms of mortality, contemporary Belarus is only slightly better than Russia; whereas in the past, Belarus' advantage was more apparent. This recent convergence is remarkable given the fact that Belarus and Russia underwent very different transition paths and now maintain different economic systems.

PAPER II

Mortality in Belarus, Lithuania, and Russia: divergence in recent trends and possible explanations

Status: **published** in *European Journal of Population* (2010), 26: 245-274

This study analyzes the diverging mortality trends in Belarus, Lithuania, and Russia after the collapse of the communist system, and proposes possible explanations for the observed trends.

Background

The collapse of the USSR contributed to a significant worsening in the health of the people in all of the post-Soviet societies over the first half of the 1990s. Yet the overall mortality trends suggest that the magnitude and nature of this deterioration differed from country to country.

Aims

This study aims at exploring and understanding the potential causes of the variations in mortality levels and trends in the three countries.

Data and methods

The analysis covers the period 1990-2005, and it is based upon original statistical data on causes of death, all-cause mortality data obtained from the HMD, as well as aggregated data on socioeconomic indicators obtained from the TransMONEE database and the World Income Inequality Database. In our analysis, we rely on standardized mortality rates and the method of the decomposition of life expectancy into age-cause components.

Main findings

Differences in the speed and the extent of the transition to a market economy resulted in quite different mortality trends. Russia experienced the sharpest mortality rise in the beginning of the 1990s, which was caused by painful market reforms that were not accompanied by a strong commitment of the state to fulfill its social obligations. Lithuania experienced drastic market reforms as well, but, unlike Russia, it managed to maintain a relatively stable health care system during the period of severe economic crisis. As a result, the mortality increase in Lithuania in the early 1990s was less acute. By contrast, Belarus, which did not implement any major changes to the health care system, experienced the lowest increase in mortality in 1990-1994. Yet, in the long run, the quasi-socialist socioeconomic model maintained by Belarusian authorities failed to break the adverse health trends that have persisted for decades. The situation may deteriorate even further; sooner or later, Belarus will have to face the need for more radical economic reforms, which may bring negative health consequences on top of the existing health problems.

PAPER III

Regional mortality in Belarus: trends, patterns and determinants
Status: ***published*** in *Population Studies* (2012), iFirst Article, 1-22.

This study is the first systematic analysis of regional mortality trends and patterns in Belarus over the two decades following the collapse of the USSR.

Background

Compared to the substantial evidence from studies of national populations, little is known about regional mortality within post-Soviet countries. A few studies looking at the geographical diversity in mortality trends have been conducted in Russia and the Baltic states, but not in Belarus.

Aims

This study aims to provide new evidence on the geographical diversity in overall and cause-specific mortality in Belarus. It also seeks to explore the factors behind the regional mortality variations, as well as to compare areas contaminated due to the Chernobyl accident with the rest of the country.

Data and methods

The analysis is mainly based on official unpublished detailed files on causes of death and mid-year population by age, sex, type of residential area, and region. Mortality maps were produced in ArcGIS-9.3^{TM} using the *quintile method* of classification. For the analysis of mortality determinants, we used a one-way fixed-effects panel regression model. In the analysis of mortality patterns in the contaminated areas, we relied on the local indicators of spatial association (LISA).

Main findings

Mortality differentials between regions tend to rise, mainly due to the growing advantage of the capital over other regions. The increasing degree of variation is associated with diverging trends in mortality from external causes of death. Mortality tends to be higher in the eastern part of the country. The inter-regional variations are partially explained by both alcohol and socioeconomic conditions, as measured by poverty and unemployment rates. Mortality from cardiovascular diseases and external causes of death are strongly correlated with alcohol consumption and unemployment. Poverty appears to be an important predictor of suicide and homicide mortality. Clusters of elevated mortality from some cancers located in the contaminated zone point to the possible (but rather weak) mortality impact of the Chernobyl accident.

PAPER IV

Self-perceived health in Belarus: evidence from the income and expenditures of households survey

Status: **published** in *Demographic Research* (2011), 24(23): 561-578.

This study is the first analysis of self-perceived health in Belarus.

Background

Very little is known about health at the individual level in the countries of the former USSR. To our knowledge, until now no study on self-perceived health (SPH) has been conducted in Belarus. In the meantime, given the lack of micro-data on the one hand and the capacity of SPH to predict mortality on the other, exploring individual health is an important supplement mortality research.

Aims

This study aims at analyzing recent SPH trends and assessing factors that have been associated with it over the past decade.

Data and methods

The study is based on the Income and Expenditures of Households Survey micro-files for 1996, 2000, 2003, 2005, and 2007. The prevalence of "poor" health was estimated on the basis of the response of "bad" to the question, "How do you evaluate your state of health?" To obtain relevant life table functions and to estimate healthy life expectancy (HLE), we relied on Sullivan's method. Data on age-specific mortality rates were taken from the HMD. To assess the association between a number of socioeconomic, demographic, and lifestyle variables and SPH, we used a binary logistic regression model. This analysis was based on the pooled data from four cross-sectional surveys, containing in total about 40,000 individual records.

Main findings

There has been a compression of morbidity in Belarus. Self-perceived health has been improving steadily over time, for both sexes and at all ages. These findings are consistent with an overall improvement in the well-being of the population, and also with Belarusian morbidity statistics indicating a notable decline in the disability incidence rates. Despite notable increases in healthy life expectancy (HLE), Belarus still lags far behind Western Europe in this respect (12 and seven years' difference for males and females, respectively). This disadvantage is mainly attributable to higher mortality among the working-age population, but the lower health status of Belarusians at older ages also plays an important role. Consistent with other studies, women in Belarus tend to report poorer health than men. Education turned out to be the main factor associated with self-reported health: regardless of the type of model used, a clear educational gradient was found in both men and women. This finding is consistent with prior research suggesting that education is a strong and robust predictor of health and mortality.

III. CONCLUSIONS AND POLICY IMPLICATIONS

As a result of the study, long-term mortality series by causes of death were produced and analyzed for Belarus for the first time. For more recent years, mortality trends were analyzed in conjunction with the socioeconomic indicators, the regional mortality differences and spatial mortality variations within Belarus were explored, and the factors associated with mortality change were assessed statistically. This study also analyzed the trends in self-perceived health and the factors associated with it. In this section, I will first discuss the main results of the study and answer the research questions posed earlier. I will then highlight the major implications of this study for further research and health policies.

3.1. Main conclusions

The dramatic reversal in mortality and the persistent nature of the health crisis

In the 1960s, life expectancy in Belarus was comparable to that of Western countries. Towards the beginning of this period, life expectancy in Belarus looked favorable when compared with that of other republics of the former USSR, and also when compared with life expectancy in the other countries of the former communist block. In the years since, however, the situation has been steadily deteriorating. The prestigious position of being among the world leaders was lost, and the mortality gap between Belarus and Western countries started widening steeply. After the dissolution of the USSR, the situation further worsened, and today the position of Belarus no longer looks favorable even when compared with those of the other FSU countries.

Throughout the entire period, two groups of causes of death, diseases of the circulatory system and external causes, have been influencing the directions of mortality trends in Belarus. Both causes have been of equal importance for increasing male mortality. Mortality among middle-aged men has been driven by external causes of death, while mortality among elderly men has been more influenced by CVD. During the periods of short-term mortality fluctuations, however, it was mortality among middle-aged men that played the principal role.

Unlike for males, the trends in female life expectancy were not subject to large fluctuations. Generally, the overall dynamics of female mortality in Belarus have been marked by long-term stagnation; while in the case of males, the trajectory has clearly been one of long-term deterioration.

In light of previous research (Blum and Monnier, 1989; Meslé, Shkolnikov, Vallin, 1992; Shkolnikov, Meslé, Vallin, 1996) these findings are not surprising. What is surprising is how little has changed since the time when Belarus experienced a dramatic mortality reversal. The adverse pattern of high adult male mortality persisted in Belarus during the Soviet era; it still persists and drives overall mortality trends today, two decades after the dissolution of the USSR. Life expectancy in contemporary Belarus now approaches that of Russia, whereas in the past the advantage of the former country was apparent. It is remarkable that both Belarus and Russia, countries that traveled different transition paths and have different socioeconomic systems, now have very similar mortality profiles. The answer to the question of why this is the case might lie in the common political ideology imposed on the population of the Soviet Union. Giving priority to the needs of the state, this ideology did not encourage individual initiative in health matters, and undermined healthy lifestyles (Cockerham, 2006b). The psychology of 'Homo Soveticus'[8] may still have considerable influence on the behavior of individuals in both counties, but in Belarus, as a 'Soviet-like' country, it is expected be more persistent than in Russia.

Hazardous alcohol consumption as a leading factor in the health crisis

The prominent role of alcohol in the Belarusian health crisis is evident. The analysis of long-term mortality trends suggests that hazardous alcohol consumption is associated with both mortality from external causes and mortality from CVD. The link between alcohol consumption and mortality became especially evident when the short-term mortality decline coincided with the anti-alcohol campaign of 1985 (Blum and Monnier, 1989). Like elsewhere, mortality from many

[8] A collectivist who does not like to assume any individual responsibilities (Kon, 2000)

causes dropped considerably in Belarus during the campaign, but it quickly increased thereafter, pointing to the validity of the alcohol-mortality link.

Mortality from accidental poisoning by alcohol is known as a proxy for hazardous alcohol consumption, which has in turn proved to be highly correlated with overall mortality (Shkolnikov and Nemtsov, 1997, Leon et al., 1997). During the first half of the 1990s, mortality from accidental alcohol poisoning was growing continuously in Belarus; while in Russia there was an abrupt increase, which then followed by a decline. Remarkably, mortality trends from accidental poisoning by alcohol were very much mirrored by life expectancy trends in both countries: increases in accidental poisoning by alcohol have always coincided with declines in life expectancy. Thus, acting as both an intermediate and a direct factor, hazardous alcohol consumption seems to be a very influential mortality determinant of the crisis. It has been suggested that alcohol acts more as a factor mediating the link between psychosocial stress and mortality (Cornia and Paniccia, 2000). Therefore, the fact that, in the early 1990s, the role of alcohol was less pronounced in Belarus than that in Russia suggests that, in Belarus, the amount of psychological stress related to the socioeconomic crisis was indeed lower. However, when considering the long-term development, the situation in Belarus looks even more unfavorable than in Russia. Today, alcohol-related mortality in Belarus appears to be higher than in Russia, while in the past it used to be considerably lower. Both the rapid increase in mortality from cirrhosis of the liver and the high mortality from accidental poisonings represent very alarming trends. Given the historical role of alcohol in influencing overall mortality, these trends raise a serious concern about the sustainability of health and developments of Belarus in the future.

The regression analysis based on the regional data confirmed a strong, direct relationship between alcohol and mortality. Hazardous alcohol consumption was found to be strongly associated with violent deaths and cardiovascular mortality among both males and females. This finding is consistent with the results from other studies on mortality in post-Soviet countries (Meslé, Shkolnikov, and Vallin, 1992; Shkolnikov and Nemtsov, 1997; Razvodovsky, 2003). The recent epidemiological studies have provided especially convincing micro-level evidence

that mortality among the working-age population is strongly associated with certain type of hazardous alcohol consumption in Russia (Leon et al., 2007; Zaridze et al., 2009).

Preservation of the quasi-socialist economic system and the continuing health crisis

The comparative analysis of cause-specific mortality trends in conjunction with the available socioeconomic indicators in Belarus, Lithuania, and Russia suggests that differences in the speed and the nature of market reforms also had quite different mortality effects. Unlike its neighbors, Belarus did not implement radical market reforms, and experienced the slowest increase in mortality in the early 1990s. The dynamics of socioeconomic indicators supports this explanation. Belarus had one of the lowest transition scores of all of the transition countries. Although there was a substantial reduction in GDP per capita in Belarus, it was not dramatic compared to the reductions that occurred in neighboring Russia and Lithuania. Furthermore, income inequality, which is believed to be an important mortality determinant (Wagstaff and Doorslaer, 2000), did not increase in Belarus in the 1990s relative to the pre-transition period. Yet since the middle of the 1990s, the mortality trends in Belarus have become increasingly disassociated from economic performance. Despite increasing per capita income, relatively low inequality in income distribution, and increasing per capita health expenditures, the health situation in Belarus continued to deteriorate steadily in the second half of the 1990s, and stagnated in the 2000s. Thus, when the whole post-transition period is taken into account, the changes in socioeconomic determinants appear to have a very weak or no association with mortality changes over time. The observed pattern is not surprising given that the Belarusian model has preserved many features of the Soviet economic system. The weak link between economic performance and mortality was typical for the USSR, which started facing a health crisis at the same time as the country was at the height of its economic and military power and was experiencing a rise in wealth (Dutton 1979). Apparently, the mechanisms through which national income influences mortality via the income of the poor and public

health expenditures differ in countries with a market economy from those in countries with highly centralized economies. All of these factors should be taken into consideration when analyzing the relationship between the socioeconomic development and mortality across different countries.

Belarus does not seem to have developed efficient strategies and measures for coping with the health crisis which began several decades ago, and which has accelerated since the 1990s. The policy of the Belarusian authorities, which was focused on preserving and maintaining the Soviet-like socioeconomic system, has proved to be inefficient. The preservation of the old-fashioned system has resulted in the preservation of old health problems. Without fundamental socioeconomic reforms, it is difficult to imagine that fundamental changes will occur in the epidemiological situation in Belarus. The experiences of the other former Soviet republics show that it is indeed possible to break unfavorable trends. The case of Estonia is very illustrative. During the first half of the 1990s, Estonia underwent quite radical privatization which was accompanied by very sharp mortality growth. However, the country managed to recover quickly and showed very impressive and sustained improvement thereafter. By 2009, life expectancy at birth in Estonia reached 70 years among males and 80 years among females. The corresponding figures in Belarus were 64.7 and 76.4 years. By contrast, in 1994, the peak of the socioeconomic crisis in the post-Soviet countries, the advantage of Belarus over Estonia was three years of life expectancy for males and one year for females (HMD, 2011).

The case of Belarus appears to be a valuable lesson for policy makers and politicians. First, post-communist Belarus represents a quasi-socialist model of socioeconomic development, which can be viewed to a certain extent as a proxy of the USSR. Thus, with some degree of exaggeration, it can be assumed that the experience of Belarus roughly shows what the mortality profile of the USSR might look like now if the union still existed. Second, the experience of Belarus shows that the slower pace of transition in the 1990s was associated with slower mortality increases. At first glance, this observation supports the claim that mass privatization programs were associated with a short-term increase in mortality

among working-age men (Stuckler, King, and McKee, 2009). However, it is difficult to assert that slower reforms are always associated with less adverse health consequences, and that faster reforms are, by contrast, associated with more adverse consequences. I would argue that it is impossible to come to a definite conclusion. The results of this study (Paper II) suggest that the relationship between indices of economic performance and mortality are complex and often contradictory, even when the countries analyzed are close in terms of their historical and socioeconomic backgrounds. In order to assess this relationship, it is necessary to take into account the context and specifics of a given country, the starting socioeconomic and political conditions, and, indeed, past mortality trends.

The mortality effects of Chernobyl exist but they are rather small

The detailed assessment of the potential effects of the Chernobyl accident was far beyond the scope of this study, mainly because there were no appropriate data to perform such an analysis. However, this issue could not be ignored, as many people within Belarus and outside of the country strongly believe that the Chernobyl accident has had a considerable impact on mortality. In particular, the disaster is believed to be responsible for the mortality increase in solid cancers and leukemia. There are several reasons why it is very difficult to evaluate the mortality effects the Chernobyl accident. First, there is a lack of reliable longitudinal data. Such data could be obtained from carefully designed epidemiological studies only. Second, even if these data were could be obtained, it would be necessary to control for competing risk factors, such as alcohol and smoking. As far as I am aware, no studies of this kind have been conducted. The fact that influential events like the Chernobyl accident, the anti-alcohol campaign, and the socioeconomic crisis of the early 1990s closely coincided in time complicates the matter. The huge effects of the two later events on mortality overwhelm the smaller impact of Chernobyl, and makes it hardly detectable. Finally, many people who were exposed to radiation migrated to other regions of Belarus and abroad after the accident.

It may be anticipated that, if there were a pronounced long-term impact of the Chernobyl accident, it would be noticeable in the contaminated areas of Belarus. An examination of the specific causes of death related to the radiological impact—such as thyroid gland, leukemia, and lung cancer; as well as certain conditions originating in the perinatal period of the Chernobyl accident—did not provide a clear picture. The fact that the majority of mortality hotspots from cancers are located in the Mogilev and Gomel oblasts might have some significance. Yet these observations do not provide sufficient grounds to conclude that Chernobyl had a considerable impact on recent mortality in the contaminated areas since the causes involved contributed very little (if anything) to the adverse health trends during the 1980s through the 2000s. A pronounced effect of Chernobyl would have been reflected in a deviating pattern of overall and cause-specific mortality in the contaminated areas, and it would have influenced the mortality trends in the Mogilev and Gomel oblasts in the 1990s in a particular way. Yet the analysis of the aggregated regional data did not confirm these effects. The long-term and regional trends of cancer mortality in Belarus do not exhibit peculiarities that can be attributed to the pronounced impact of the accident. Cancer mortality trends in Belarus are remarkably similar to those observed in Russia, a country that was almost unaffected by the accident. Furthermore, since the mid-1990s cancer mortality in Belarus has been exhibiting a steady decline. An opposite trend would be anticipated in the presence of a severe long-term radiological impact.

Improving self-perceived health: A paradox or an anticipated trend?

Given the rather stagnating trends in life expectancy over the last decade, it was surprising to observe a notable improvement in self-reported health. Could the observed trends be an artifact? It is true that the assessment of self-perceived health, and particularly the comparison over time and inter-country comparisons, are associated with various methodological problems (Murray, Salomon, and Mathers, 2000). While it is impossible to disregard potential bias in data, there are a number of reasons to believe that the improved self-perceived health in Belarus is real. This finding is consistent with morbidity statistics indicating a marked

reduction in disability rates in recent decades. Furthermore, it is also likely that the stabilization and improvement of the economic situation resulted in better self-rated health. Finally, the improvement is consistent with the reduction in cardiovascular mortality and the slight increase in life expectancy in Belarus after 2005.

Even though self-perceived health is a highly subjective measure, it is known to predict mortality (Appels et al., 1996; Perlman and Bobak, 2008). At first glance, improvements in self-perceived health in Belarus have not been associated with overall mortality trends. However, given the prominent role of mortality from external causes of death as a factor of life expectancy changes over time, this observation does not appear to be paradoxical. Mortality from external causes mainly affects individuals of working ages, who are often in good health. Seemingly, improvements in individual health do contribute to a decrease in mortality, but this positive impact is counterbalanced by excessive premature mortality. The results of the decomposition of healthy life expectancy between Belarus and the EU-15 into 'mortality' and 'health' components indicate that the disadvantage of Belarus was mainly determined by higher mortality among the working-age population. Interestingly, the reported health status of Belarusian males was found to be not much different from that of men residing in Western Europe. This finding should, however, be interpreted with caution because of the potential bias caused by differences between the two populations in the ways health is reported.

Among all of the variables considered, education was found to be the most important factor associated with self-perceived health. Regardless of sex, a higher level of educational attainment was found to be associated with better self-rated health. This effect is particularly noticeable in the working-age population. The results concerning the role of education as a factor associated with self-perceived health are supported by prior research that demonstrated that education has been a very stable and reliable predictor of health and mortality (Kunst et al., 1995; Bobak et al., 1998; Shkolnikov et al., 1998b; Bobak et al., 2000; Perlman and Bobak, 2008). The prominent role of education suggests the importance of the behavioral component in influencing mortality trends in Belarus. More educated

people have a higher degree of self-awareness regarding behavioral patterns that are potentially harmful to one's health, such as excessive alcohol consumption, smoking, poor diet, and lack of exercise.

To sum up all the conclusions, the main research questions of this study can be answered as follows:

"*What are the components, driving forces, and peculiarities of the Belarusian health crisis*?"

The nature and main features of the Belarusian health crisis are in many ways similar to those observed in the other countries of the former USSR. High mortality from cardiovascular diseases and excessive violence- and alcohol-related mortality, particularly among midlife males, have remained the major public health threats in Belarus. The long-term deteriorating dynamics of these causes make it reasonable to characterize the epidemiologic situation in Belarus as a chronic health crisis. Both the persistence of unhealthy behavioral patterns (especially the problem of alcoholism) and the inefficiency of the health care system in preventing and curing cardiovascular mortality appear to be its main drivers. One of the features of the Belarusian health is the faster pace of the deterioration during the Soviet period, especially with respect to cardiovascular mortality. The second feature is the ongoing, rather than an abrupt, mortality increase immediately after the dissolution of the USSR, which was found to be associated with the policy of the preservation of the old socioeconomic system. One of the emerging features of Belarusian mortality is the increasing inter-regional mortality difference, which is particularly seen in the widening mortality gap between the capital and the rest of the country.

"Has the policy of gradual transition chosen by Belarusian authorities been proven to be more appropriate than the rapid transition to a market economy in terms of population health?"

For Belarus, the postponement of fundamental changes and the slow pace of market reforms eased social pressure somewhat; and, as a result, mortality growth in the first half of the 1990s was not as abrupt as it was in the other FSU countries. Thus, in the short run, the policy of the preservation of the old socioeconomic system appeared to cause fewer adverse health consequences than the more radical policies adopted elsewhere. Yet the excessive deaths do not appear to have been prevented, but may rather have been postponed. Although some positive tendencies, such as a reduction in infant mortality and a very recent decline in CVD mortality, certainly can be observed, the most recent mortality trends do not indicate the emergence of fundamental changes in the epidemiological situation in Belarus. Thus, in the long run, the policy adopted by Belarusian authorities has turned out to be inefficient.

"*What are the main factors associated with mortality change in Belarus? Do existing explanations, such as alcohol and economic conditions, also explain the mortality variations in Belarus? What are the roles of other factors, including the impact of the Chernobyl accident, and how important are these factors?"*

The analysis of cause-specific mortality trends in Belarus suggests that alcohol consumption may be the factor responsible for both the high base level of excessive mortality and its changes over time. At the national level, alcohol-related mortality was found to be highly correlated with overall mortality. At the same time, only a very weak association, if any, was found between mortality and the indicators of socioeconomic development, such as GDP per capita and the Gini coefficient. The statistical analysis of the mortality determinants based on the regional data confirmed the prominent role of alcohol as a determinant of mortality change. Socioeconomic conditions measured by unemployment and poverty rates also turned out to be factors associated with cardiovascular mortality and mortality from external causes of death. Although the effectiveness of health care could be an important mortality determinant, no strong evidence supporting this was found either in the national or regional mortality data. The spatial analysis of cause-specific mortality suggests the possible relevance of the contextual factors (culture,

traditions). They seem to have an influence on the inter-regional mortality differentials within Belarus. The analysis of the available data did not confirm that the Chernobyl accident had a pronounced impact on mortality. While the potential mortality effects of the Chernobyl accident should not be ignored, when compared to the effects of other factors, they appear to be far less devastating for population health.

"How do individuals assess their own health? What are the trends in self-perceived health? What are the factors associated with better health status?"

The results of this study suggest that, in recent years, there has been a steady improvement in self-perceived health in Belarus. The trends in self-rated health suggest the compression of morbidity: there is the increasing share of person-years spent in good health on one hand, and the relatively constant total number of remaining person-years lived by individuals on the other. Despite notable improvements in self-reported health, there is still huge gap between Belarus and Western Europe in terms of healthy life expectancy. This disadvantage is mainly driven by higher mortality among males of working age and the poorer health status among females above working age. Among all of the possible explanatory variables, education appears to be the most important factor associated with self-perceived health. A clear educational gradient was found in both men and women, and was shown to be particularly pronounced among individuals of working ages.

3.2. Implications for further research

Several aspects related to health and mortality research in Belarus should be included in the agenda of further research. In a broad sense, these aspect can be divided into two interrelated streams: expanding the spectrum of the available data, and deepening our understanding of the observed patterns and exploring new trends. This study has made a significant step in both of these directions by collecting, harmonizing, and analyzing long-term mortality trends by causes of death; examining regional mortality trends and patterns; and assessing mortality determinants; as well as in exploring trends in self-perceived health and analyzing

the factors associated with it. Nonetheless, there is much to be done in the future to improve mortality research in Belarus.

The need for more data

First, efforts should be directed towards collecting additional data. In this area, the backwards reconstruction of cause-specific mortality trends would be desirable. This may be expected to shed more light on past developments so that contemporary mortality trends can be better understood. Furthermore, it is important to obtain long-term regional mortality series by causes of death. These series should then be reconstructed using the methodology applied for obtaining series at the national level. In this study, we relied on the most recent regional mortality data, and thus it was not possible to follow long-term mortality dynamics at the regional level. In addition, it would be very useful to examine the regional components of the health crisis in Belarus. It would be interesting to find out whether there were notable regional variations in the mortality responses to the anti-alcohol campaign and to the socioeconomic crisis of the 1990s. This would contribute to a better understanding of the factors behind mortality fluctuations. Furthermore, harmonizing cause-specific mortality series would shed more light on the effects of the Chernobyl accident on mortality, because it would then be possible to compare cause-specific mortality profiles in the affected regions before and after the accident. This analysis should be supplemented by routinely collected morbidity statistics, data from the national cancer register, and other sources.

The lack of individual-level data has remained a serious obstacle for mortality research in Belarus. Our experience of Russia has shown that nationally representative surveys (i.e., RLMS) are important supplementary data sources (see Cocherham, 2000; Brainerd and Cutler, 2005, Perlman and Bobak, 2009). Epidemiological studies, comparable to studies conducted in Izhevsk (Tomkins et al., 2007) and Novosibirsk (Malytina et al., 2002), have become valuable sources for research on alcohol-related mortality. Unfortunately, to date, neither of such surveys has been conducted in Belarus. Thus, the organization of various surveys should be considered a research priority.

Possible directions for future research

This study has yielded a number of interesting 'secondary' observations, but because they were not the main research focus, no explicit explanations have been given. One of the open questions is why Belarus enjoyed a favorable position in terms of mortality in the past. Could this advantage be explained by the cohort effects of World War II or specific features of the Belarusian population that distinguished them from the people of the other Soviet republics, or were some other factors involved? Another question that has yet to be answered is why mortality in the eastern part of Belarus is higher than in the western part. Apart from contemporary factors, the role of historical and cultural contexts may be important here. The fact that, until 1939, much of the territory of western Belarus was part of Poland might have had an impact on the recent demographic trends of these territories. This region may have its own cultural norms and behavioral patterns. The large cluster of low mortality from external causes located in the Brest region is absolutely unique for Belarus. To provide greater insight into the role of contextual factors, it would be useful to conduct cross-national studies comparing the spatial mortality patterns across national borders. It might turn out that certain 'basic' mortality patterns persist, despite the contemporary socioeconomic and political differences between countries.

Further mortality research in Belarus should put more emphasis on quantifying the impact on mortality of certain risk factors, such as alcohol, smoking, lack of exercise, and diet. The role of health care as a mortality determinant should be examined more specifically. The harmonized cause-specific mortality series could be very useful in this context, as they would allow us to estimate mortality amenable to medical care (Nolte and McKee, 2003). The obtained results could then be compared over time, and also with those of other countries.

Studying mortality differentials across population sub-groups remains an unexplored research area, and there is much work to be done with in this area in the future. The results of this study indicate that a substantial mortality differential exists between cities and other areas. Particularly pronounced is the mortality gap

between the capital and the rest of the country. The urban-rural mortality divergence has also been widening in recent years. It appears that better economic and living conditions, as well as better access to medical services in the cities than in rural areas, explain this difference. Yet evidence supporting this hypothesis is needed. It is assumed that substantial mortality differences exist between educational groups. In pre-transition Belarus (1988-1989), the difference in life expectancy between the highest and the lowest levels of educational attainment constituted about five years (RISG USSR, 1991). Recent data has shown that a clear educational gradient exists in self-perceived health, which is known to predict mortality. What is not clear is whether educational differences tend to widen in Belarus, as has been seen in Russia and the Baltic countries (Shkolnikov et al., 2006), To answer this question, one could estimate mortality rates by various characteristics around the census years 1999 and 2009, and then compare the results.

3.3. Public health policy implications

In order to develop effective health policies, it is crucial to recognize that the recent mortality trends in Belarus have been very much influenced by factors originating in the past. Many people within Belarus believe that both the dissolution of the USSR and the Chernobyl accident are mainly responsible for the current unfavorable health situation. However, the results of this study suggest that this popular view is an oversimplification of a complex reality. Indeed, the collapse of the communist system had some negative effects on mortality trends (though less than the contemporary effects in Russia and the Baltic countries) in the early 1990s, but it is also true that, with the stabilization and improvement of the economic situation in Belarus, no improvement in mortality was observed. Although the Chernobyl accident had dramatic socioeconomic and health consequences, it was difficult to detect a significant impact of the disaster on mortality; thus, the increase in mortality was likely due to the overwhelming impact of other, more influential factors. Therefore, it appears that these unfavorable trends can be reversed not only through the improvement of the economic

situation, but also by taking more fundamental actions that tackle the core problems. Thus, the policy measures should simultaneously address two issues: the need to improve the health care system (particularly its preventive role), and the need to improve people's attitudes towards their own health. Indeed, health care plays an important role in mortality, as has been confirmed by the significant progress made in the reduction of infant mortality and in infectious and respiratory diseases. The recent decrease in CVD mortality might be related to some positive changes in the health care system, which include substantial state financing of specialized medical facilities and the spread of modern medical technology. However, for all of these positive developments to be sustainable, significant changes in people's attitudes are needed. The results of this study suggest that excessive mortality among working-age males has been the major public health threat in Belarus. At the same time, as was suggested by the analysis of self-perceived health, adverse mortality patterns among men coincide with favorable changes in reported health. Deaths must be prevented through the development of effective programs promoting healthy lifestyles and personal security. It is important to disseminate information about the factors and behaviors known to be associated with the risk of premature mortality. Special emphasis and priority should be given to measures preventing hazardous alcohol consumption. Priority should be given to policies reducing the supply and availability of alcohol. These may include price regulations, reduced hours of sale, and policies regulating the number and location of sales outlets. Substantial restrictions should be imposed on all types of alcohol advertising. The mortality data suggest that alcoholism in Belarus has been rising in recent years. The promotion of healthy lifestyles should be conducted through mass media campaigns, as well as through educational programs in schools. Substantial changes in public opinion are needed so that it becomes the norm for each individual to look after his or her own health. It should be widely accepted that living a healthy life is both desirable and beneficial in terms of career development and income levels. Indeed, one of the key objectives of health policy makers in Belarus is not only to promote healthy lifestyles, but also to provide the opportunities and environment that will enable individuals to maintain

them. Improvements in the economic and socio-psychological situation in the country are indeed desirable for creating this environment. In light of very recent economic developments, however, there is little prospect of this goal being reached, at least in the near future. Today, Belarus faces a severe socioeconomic and political crisis; and thus even maintaining what has been achieved so far is a considerable challenge for Belarusian authorities.

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