About Belarus Data on Causes of Death

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General

Currently, the National Statistical Committee of Belarus (Belstat) is responsible for collecting, processing and disseminating population data for Belarus. Belarusian statistics passed through several historical stages before the establishment of this Committee. Initially, it was incorporated into the statistical system of the Russian Empire. At the beginning of the 20th century, each of the four governor's districts ("gubernias") included a statistical division: Minsk, Vitebsk, Mogilev and Grodno. These statistical divisions were primarily responsible for conducting the population censuses. The official establishment of a Belarusian statistics office took place in August 1920 when the Central Statistical Bureau was founded (Minstat, 2007).

Until the break-up of the Soviet Union, the Central Statistical Bureau of Belarus functioned as a regional subdivision of the Cental Statistical Office of the USSR (the *Tsentralnoe Statisticheskoe Upravlenie*, or TsSU). After Belarus gained independence in 1991, the main responsibility for population statistics in Belarus was assigned to the State Committee of Statistics and Analysis (Goskomstat). In 1994, this was reorganized into the Ministry of Statistics and Analysis of the Republic of Belarus (Minstat). In 2008, the Minstat was reorganized into the National Statistical Committee of Belarus (Belstat).

The socio-economic transformation in Belarus required significant changes and the entire statistical system had to be rebuilt. In 1992, the Belarusian authorities adopted the State Programme of transition to a new statistical system to comply with international standards. In the frame of this programme, two major methodological changes were introduced to population statistics: the transition towards the World Health Organization (WHO) definition of live births in 1994 and the adoption of the 10th revision of the International Classification of Diseases (ICD) in 2002.

The main sources of demographic data in Belarus are population censuses and vital and migration statistics. The first official population census in Belarus was conducted in 1897 as part of the first population census of the Russian Empire. During the Soviet period, six population censuses took place (1926, 1939, 1959, 1970, 1979 and 1989). In February 1999, the first census under independence was conducted in Belarus. In October 2009, another population census took place.

The vital statistics system in Belarus is highly centralized and relies upon principles established during the Soviet period. The local and district civil registration offices, the district statistical bureaus, the regional statistical offices and the National Statistical Committee are integrated into the system of vital statistics. The registration of all vital events in Belarus takes place in the civil registration offices. Official statistics exclude vital events occurring to Belarusian citizens while living abroad as well as in-country events that are not registered.

According to current regulations, Annexat the end of each month and no later than the second day of the following month, the local civil registration offices compile and forward duplicate copies of individual vital event records to the district civil registration offices (ZAGS). Death records are accompanied by medical certificates of death. By the seventh day of the month, the district ZAGS assembles and transmits all individual records (for the previous month) along with the medical certificates of death to a district statistical bureau. District statistical bureaus forward all collected data to a regional statistical office. Then, the regional statistical offices assemble and compile regional individual records. Finally, verified data are aggregated at the national level by Belstat.

The international migration statistics in Belarus are based on data collected by the Ministry of Internal Affairs, the Committee of Migration of the Ministry of Labor, and the Ministry of Foreign Affairs (Minstat, 2001). Data on migration between Belarus and the Commonwealth of Independent States (CIS)[1] and the Baltic States (Latvia, Lithuania and Estonia) are obtained by tabulation of registered arrivals and departures, which are compiled by the local "militia" (police). Data on migration between Belarus and other countries are obtained from the permanent system of registration of arrivals and departures.

As in the majority of other former Soviet republics, detailed data on deaths and population size by single year of age have never been published in Belarus. Early statistical annuals on population were rarely published and included demographic indicators that were so highly aggregated that analytical use was limited. More detailed information became publicly available in the mid-1980s, an era of significant political changes declared by the Soviet government. These data included deaths and population by sex and by five-year age groups. Since that time, Belarus has made mortality data by broad age groups publicly available.

Following classifications of causes of death were used in Belarus since 1965:

1965–1969: Soviet Classification of 1965 based on the ICD–7 (SC–1965)

1970–1980: Soviet Classification of 1970 based on the ICD–8 (SC–1970)

1981–1987: Soviet Classification of 1981 based on the ICD–9 (SC–1981)

1988–2001: Soviet Classification of 1981 modified in 1988 (SC–1988)

since 2002: Abridged Belarusian classification based on the ICD–10 (BC–2002).

Territorial Coverage

There was no territorial change in Belarus during the period covered by cause-specific mortality series (since 1965).

Part 0 – vital registration

1. Death count data

Coverage and completeness

According to Belarusian law, a death must be registered within seven days of occurrence (disclosure of a body) on the basis of the medical death certificate and the statement of death made by the relatives or other people related to the deceased. Deaths can be registered at the place of permanent residence of the deceased, the place of death, or the place of burial. Upon registration, two duplicates of the death certificate are issued by the local (district) civil registration office: one for relatives, and the other for the district statistical bureau.

[1] CIS does not include the Baltic States. There is separate registration of international migration for the countries of the former USSR (12 republics of CIS plus the Baltic States) and for the rest of the world.

Afterwards, the death is recorded in accordance with the standard procedure described above.Since 1959 the territory of Belarus has been covered adequately and the registration of deaths has been satisfactorily completed. Most experts dealing with mortality data for Russia, the Baltic States, Ukraine and Belarus believe that registration of deaths in these countries is complete (Murray & Bobadilla, 1997). Anderson and Silver (1997) note that recent mortality data for Belarus (as for the other former Soviet republics mentioned above) “are generally trustworthy, especially at the working ages.”

On the basis of death registration data (1981-2001), Mathers and colleagues consider the quality of Belarusian mortality data to be of a *medium level*. They assessed the completeness of death registration (the proportion of all deaths that are registered among the population covered by the vital registration system of the country) to be 100 percent. The coverage of death registration (the total number of deaths recorded by the vital registration system for a given year divided by the total number of expected deaths for that year) has been estimated as 98 per cent (Mathers et.al., 2005).

The problems related to the quality of mortality statistics in Belarus during the period of Soviet rule have been well documented. It is widely recognized that mortality data in the former Soviet Union suffered from various kinds of measurement errors such as the under-registration of infant mortality, age heaping, and age exaggeration at old ages (Anderson & Silver, 1997; Kingkade & Arriaga, 1997).

Although evidence on the validity and reliability of mortality data for Belarus in recent years is scarce and no scientific studies regarding this matter have been conducted, it is unrealistic to assume that since the dissolution of the USSR the quality of mortality statistics has improved. In fact, the quality may even have deteriorated because of the socio-economic constraints of the transitional period, which affected all spheres of life including the statistical system of Belarus. On the other hand, Belarus has taken some steps towards the improvement of mortality statistics such as shifting towards the WHO definition of a live birth since January 1994.

Specific details: infant mortality

Perhaps the most notable inconsistencies in terms of the distortion of overall mortality statistics were those related to the reporting of infant deaths. Before the 1970s, the infant death records in the USSR were incomplete. In 1974, with the introduction of a new certificate of perinatal death, the registration of infant mortality improved, and the infant mortality rate therefore increased[2] (Anderson and Silver 1986). One source of inconsistency originated from the more restricted Soviet definition of a live birth and an infant death that was used in Belarus until 1994. Under this definition, infants born before 28 weeks of gestation, weighing less than 1000 grams or measuring less than 35 centimeters in length were not counted as either live births or infant deaths if they died before completing the first seven days of life. As a result, a considerable share of infant deaths was unreported. According to the widely cited estimates made by Anderson and Silver (1986), the infant mortality rate would increase by between 22 and 25 percent if the Soviet definition of live birth conformed to the WHO criteria. A second source of inconsistency resulted from a change in the registration system starting in 1974 in the former USSR, which caused an increase in the number of registered infant deaths (Anderson and Silver, 1986).

The Soviet definition of live birth was in force in Belarus until 1994, when the transition to the WHO definition was officially announced. The adoption of the international standards of live and stillbirths was expected to lead to a considerable increase in early neonatal mortality, and thus in neonatal and infant mortality (Grigoriev, Meslé, Vallin 2012). For example, the implementation of the WHO definition in the Baltic countries resulted in a 50 per cent increase in early neonatal mortality (Estonian Medical Statistics Bureau, Latvian Medical Statistics

[2] Some scholars however argued that deteriorating infant mortality trends were real and attributable to the poor performance of the Soviet health care system (Davis and Feshbach 1980)

Bureau, Lithuanian Medical Statistics Bureau, 1993). According to some estimates, the shift in the registration procedures in these countries resulted in an average 23% increase of the infant mortality rate (Anderson & Silver, 1997). However, no such increase was reflected in the official infant mortality rates in Belarus. In 1993, the infant mortality rate reported in the *Statistical Yearbook* was 12.5 deaths per one thousand live births compared with 13.2 in 1994 and 13.3 in 1995. In 1996, the infant mortality rate declined to the 1993 level and continued a dramatic decline reaching 9.3 per thousand in 2000. By 2007, it had reached 5.2 deaths per one thousand live births (Minstat, 2008). These trends differ from those observed in the Baltic States after the switch to the WHO definition of live births. Our estimates based on official data indicate that the increase in early neonatal mortality in Belarus after the declared shift to the WHO definition constituted only 20 per cent. This suggests that the announced transition to the standard WHO definition was only partially implemented in Belarus.

According to the WHO definition, a newborn who breathes or shows any sign of life is counted as a live birth, regardless of the length of gestation. Yet, the “new” definition of live births in Belarus imposes as an additional requirement that the birthweight be greater than 500 grams and the length 25 centimeters or more, or that the duration of gestation is at least 22 weeks. Thus, even the “new” definition does not conform to the WHO criteria.

Moreover, after the announcement of the transition to the WHO definition, the statistical office of Belarus developed a system that calculated infant mortality according to ‘old’ and ‘new’ criteria of viability. The infant mortality figures noted in the previous paragraph appear to have been actually based on the “old” definition (which required more than 28 weeks of gestation, a birthweight greater than 1000 grams, and a body length of at least 35 centimeters). The infant mortality rate according to the “new” definition was 14.8 per thousand in 1994, 14.5 in 1995, and 10.5 in 2000; on average, during the period 1994-2000, the infant mortality rate based on the new definition was 8.8-12.9% higher than that calculated based on the old criteria (Shakhotko, 2003). It appears that, for a number of years after the new definition of live birth was adopted, the officially published infant mortality rates were calculated on the basis of the old Soviet definition of live birth.

However, an increase in neonatal mortality in 1994 suggests that there were indeed some changes in the registration of live births. One decade later, in 2005, there was again a noticeable increase in neonatal mortality in Belarus (Figure 1). It is likely that this undocumented change occurred not because of the change in the definition of live birth and in its practical interpretation, but simply because infant mortality rates were calculated on the basis of the new criteria for viability, which had finally been released for publication.

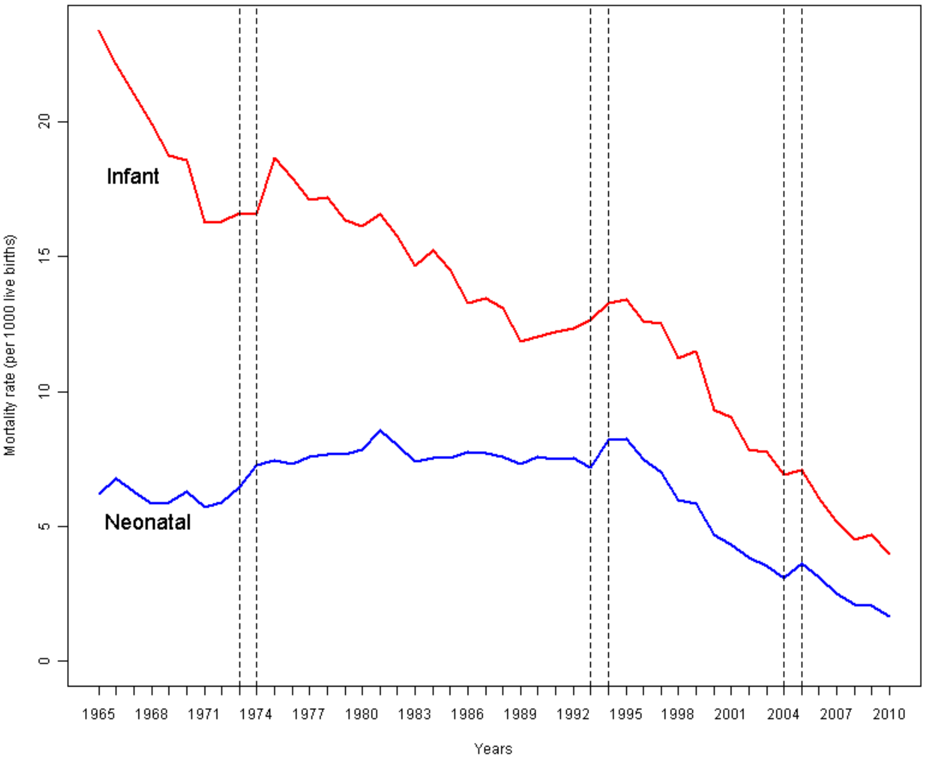


Figure 1. Neonatal and infant mortality rates in Belarus; both sexes, 1965–2010

Given the problems and the informations mentioned above, we decided to correct the data on infant deaths. Since the problems with the registration of infant mortality were primarily related to the registration of deaths during the first days of life, neonatal mortality rates were corrected first. On the basis of the adjusted neonatal mortality rates, we calculated the under-counted neonatal deaths, keeping in mind that these extra deaths should have also counted as live births.

Subsequently, the nominator and denominator of the infant mortality rates were adjusted for missing deaths and live births, respectively. The correction was accomplished in three steps. Figure 2 shows the results of these corrections.

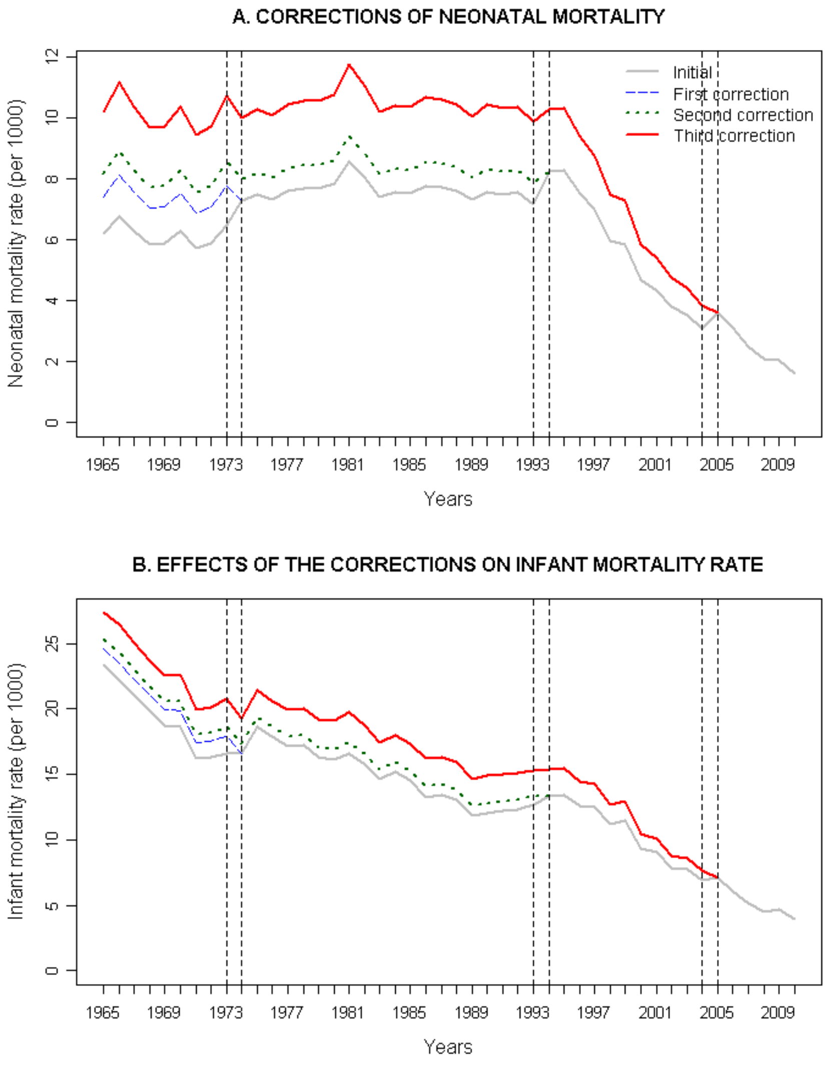


Figure 2. Corrections of neonatal mortality and their effects on infant mortality in Belarus; both sexes, 1965–2010

First, we corrected neonatal mortality rates during 1965–1973. We applied the correction factor[3] of 20 per cent to account for the under-registration of neonatal deaths during this period. Second, neonatal mortality trends during 1965–1993 were adjusted while taking into account the change that occurred in 1994. As was mentioned above, no real transition to the standard WHO definition happened at this point, but some changes regarding the definition of live birth did indeed occur. To account for them, we applied the correction factor of 10 per cent. This resulted in a further increase in the IMR. Finally, neonatal mortality trends over 1965-2004 were adjusted using the correction factor of 25 per cent.

In the next step, we needed to make the adjusted IMR consistent with the data on causes of death. To bring these figures into line, we first performed a redistribution of the extra deaths among causes of death within the age group 0-27 days. The numbers by each cause of death were then added to deaths at age zero, and to the

[3] Applied correction factors are arbitrary values based on the assumption that neonatal mortality rates in the two successive years (before and after the change) remain at nearly the same level

total number of deaths. All of these manipulations were performed separately by sex. Population exposure was adjusted accordingly for under-counted live births.

The adjustments for the under-counting of infant deaths and live births had significant effects on the neonatal and infant mortality trends. But to what extent did the adjusted IMR affect the dynamics of life expectancy at birth? To answer this question, we computed life tables before and after the correction of the IMR for each year since 1965. As expected, the correction of infant mortality did not have a very significant impact on life expectancy trends in Belarus (Table 1). The difference between the initial and the adjusted life expectancy throughout the entire period did not exceed 0.3 years.

Table 1. Life expectancy at birth in Belarus before and the correction of infant mortality by sex, 1965–2004 (in years)

Year	Males			Females		
	Before	After	Difference	Before	After	Difference
1965	68.96	68.64	-0.32	76.14	75.86	-0.28
1970	67.86	67.53	-0.33	75.95	75.65	-0.31
1975	67.15	66.94	-0.21	76.25	76.08	-0.17
1980	65.94	65.69	-0.25	76.20	76.01	-0.19
1985	67.70	67.46	-0.24	76.29	76.12	-0.18
1990	65.52	65.31	-0.21	75.47	75.31	-0.16
1995	63.04	62.90	-0.14	74.30	74.19	-0.11
2000	62.75	62.67	-0.08	74.52	74.46	-0.06
2004	63.17	63.11	-0.06	75.00	74.95	-0.05

2. Population count data

Coverage and completeness

Data on population cover all permanent residents of the territory of Belarus including those who are temporarily living abroad. As in most countries, the census-based component method has been used in Belarus to obtain population estimates (as of January 1st) by age, sex, and geographical sub-divisions.

Official estimates of population size for the inter-censal periods between 1959 and 1989 were produced by the Central Statistical Office of the USSR. They were based on the Soviet censuses conducted on the 15th of January in 1959 and 1970, on the 17th of January in 1979, and on the 12th of January in 1989. The population estimates since 1990 onwards have been produced by Belstat. The last census has been used as the starting point for these estimations. First, the results of the census have been adjusted to represent the population as of January 1st of the census year. Then, on the basis of population, deaths, births and migration data, post-censal population estimates have been produced incrementally for the following years. After obtaining the results of the next census, previously calculated post-censal population estimates have been adjusted retrospectively. Thus, the population counts for the period 1990-2009 represent official inter-censal population estimates adjusted in accordance with the results of the last three censuses (1989, 1999, and 2009). Population counts since 2010 are post-censal population estimates based on the 2009 Census. They will be adjusted after the results of the next census become available.

Specific details

The reliability of population data has been affected by two major problems: age heaping and age exaggeration at advanced ages (especially pronounced in the mid-1960s), and the quality of migration statistics in the most recent period. Some discussion regarding the age heaping effect is provided in the "Data Quality" section.

Although there is only weak evidence for this, there are some reasons to assume that the registration of migration in Belarus is incomplete and that the overall quality of migration statistics has deteriorated compared to the period of Soviet rule. The demise of the USSR intensified migration flows between Belarus and other neighboring countries and increased opportunities for moving abroad. High population mobility, especially in the 1990s, was accompanied by a lack of suitable technical equipment for the collection of statistical information and for dealing with other organizational and methodological problems. All of these factors made the registration of migratory movements more complicated and eventually affected the reliability of migration statistics, and consequently, the quality of population estimates. The fact that there are virtually no controls on the border between Belarus and Russia complicates the situation, especially with regard to the registration of emigration.

A comparison of the official post-censal population estimates based on the 1989 census with the adjusted inter-censal estimates based on the 1989 and 1999 censuses points to an overestimation of total population size during 1990-1998, ranging from 0.2% in 1990 to 1.1% in 1998. Almost the same pattern remained for the next inter-censal period, namely 2000-2008. During this period, the overestimation of total population ranged from 0.2% in 2000 to 1.5% in 2008. The overestimation of the total population is consistent with the above-mentioned problem of under-registration of out-migration in Belarus.

3. Birth count data

Coverage and completeness

The national law requires that birth be registered within three months of occurrence. Registration is based on the medical certificate of birth issued by a medical institution and the statement of birth made by the parents. Births can be registered at the place of birth or at the parents' place of permanent residence. The registration of a stillbirth or a newborn who died during the first seven days of life is based on the information provided within three days of occurrence by a medical institution. Upon registration, two duplicates of the birth certificate are issued by the local (district) civil registration office: one for the parents and the other for the district statistical bureau. Afterwards, the birth count is recorded in accordance with established procedure. The completeness of birth registration in Belarus has depended predominantly on the parents' willingness to register the birth of their child, which is strongly motivated by the possible financial and legal consequences of non-registration. Thus, it can be assumed that the registration of birthduring the entire period has been satisfactorily complete. Nonetheless, because the definition of a live birth has since long differed from the one used by the World Health Organisation (see section "Death count data"), the number of live births is probably under-estimated.

Part I – Information on CoD coding

4. Death certificate

For detailed description of death certificate during the Soviet time please refer to the B&D file for Moldova. The death certificate currently used in Belarus as well as detailed instructions how it should be filled are provided in Annex [in Russian only].

5. Coding system

The detailed description of the coding system during the Soviet time please refer to the B&D file for Moldova.

6. Specific details of ICD revisions and collected data

Before Belarus became an independent state, all of the activities of the national statistical office were supervised by the Central Statistical Office of the USSR (*Goskomstat*). Since Belarus gained its independence (in 1991), the principles regarding the collection of data on causes of death that were established during the Sovi et period have changed very little.

During the Soviet era, the standard International Classification of Diseases (ICD) by the World Health Organization (WHO) was not used in statistical practice. Instead, the *Goskomstat* relied on brief Soviet classifications, which were based on current ICD revisions[4]. Since 1965, following the implementations of the ICD7, ICD8, ICD9, and ICD10, the classification of causes of death has been revised four times: three times during the Soviet period (1970, 1981, 1988), and again in 2002, when the ICD–10 was implemented in Belarus (Table 2).

Table 2. Classifications of causes of death used in Belarus since 1965[5]

Period in use	Name	Number of items
1965–1969	Soviet Classification of 1965 based on the ICD–7 (SC–1965)	210+13*
1970–1980	Soviet Classification of 1970 based on the ICD–8 (SC–1970)	185+10*
1981–1987	Soviet Classification of 1981 based on the ICD–9 (SC–1981)	185+10*
1988–2001	Soviet Classification of 1981 modified in 1988 (SC–1988)	175+10*
since 2002	Abridged Belarusian classification based on the ICD10 (BC–2002)	277+44*

Note: *extra items used to classify the external causes of death by character of trauma

Collected data

Before the late 1980s, mortality data were not publicly available. Moreover, access to data on certain causes of death—such as cholera, smallpox, suicide, homicide, and work-related accidents—was highly restricted (Meslé et al., 1996). These so-called 'hidden' causes were listed separately in a secret statistical table (Forma 5b), while the rest of causes were tabulated in Forma 5. To produce final statistical tables by causes of death, the total number of deaths from Forma 5b was added to the number from Forma 5. To ensure that the sum of all the items in Forma 5 yielded the total, all of the 'hidden' causes were assigned to ill-defined causes. In 1988, Gorbachev's new policy of *glasnost* resulted in the release of mortality statistics, and the notion of 'hidden' causes was abolished. Since then, the cause-of-death data for Belarus have been produced in the format of the electronic statistical Table C51. Over the entire period since 1965, cause-specific mortality data have been reported using the same age grouping scale: 0, 0-27 days, 1, 2, 3, 4, 5-9, 10-14,…, unknown age, 85+, all ages combined.

Fortunately, the Belarusian data of the Soviet period (1965–1990) were readily available to us in computerized format, thanks to the work done by a joint project of the Russian Center for Demography and Human Ecology and the French National Institute for Demographic Studies. Within the framework of this project, which was launched in 1990, cause-specific mortality data were gathered from archives and computerized for all 15

[4] For detailed description of the Soviet system of data collection and classification see Shkolnikov, Meslé, and Vallin (2012)

[5] Classifications of causes of death appear in Annex I

republics of the former USSR (Shkolnikov, Meslé, Vallin, 1997). For the post-Soviet period (except 1991–1996), data were obtained directly from the National Statistical Committee of Belarus (Belstat). The final pieces of the data (1991–1996) were obtained in a computerized format from the WHO Office for Europe.

Data quality

Many factors, such diagnostics, coding, and the specific characteristics of medical schools (which also evolve over time), can affect the quality of cause-specific mortality data. One of the most reliable ways to assess the quality of mortality data is to conduct special surveys that examine the validity of diagnoses in the medical death certificates. 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 their coding. According to the results of this survey, the overall proportion of erroneous diagnoses constituted 6.6 per cent. The highest share (23.2 per cent) of errors was observed in the diagnosis of infectious diseases, followed by in the diagnosis of digestive (12.8 per cent) and respiratory (11.8 per cent) diseases. In coding, most errors occurred while coding deaths from diseases of the genitourinary system (11.8 per cent). For the remaining causes, the share of errors did not exceed eight per cent. Since in many cases errors in diagnostics and coding balanced each other out, the percentages of errors that were finally reflected in the statistics turned to be quite acceptable at the level of broad groups of causes (Shkolnikov, Meslé, Vallin, 2012).

To our knowledge, no surveys similar to one conducted in Minsk were undertaken in post-Soviet Belarus. Generally, evidence regarding the validity and reliability of recent mortality data for Belarus is scarce. It has been suggested that the mortality data in the countries of the European part of the former USSR are trustworthy. Anderson and Silver (1997) noted that the recent mortality data in these countries “are generally reliable, especially at the working ages.” On the basis of data quality indicators—such as timeliness, completeness, coverage of death registration, and the proportion of deaths assigned to ill-defined causes during the period 1981-2001—the WHO has assigned Belarus to the category of countries with mortality data of medium quality (Mathers et al. 2005).

7. Additional transition documents

The applied reconstruction method partially relies on the results of similar work previously conducted for Russia (Meslé et al., 1996). For the transition to ICD10, unlike for the previous transitions, we could not rely upon the Russian experience. Instead, we used the official document released by the Ministry of Statistics and Analysis of Belarus in 2004 as the starting point for our work. This document contains the items of the so-called “abridged nomenclature” based on the ICD10, their correspondences to the full list of the ICD10 items, as well as the theoretical correspondences to the items of the previous nomenclature (SC–1988).

Part II – reconstruction information

8. Specific treatment of raw data

We performed a number of checks, including, for example, of whether the death counts by age groups were in line with the totals, and of whether the input data contained duplicated records. Next, we compared our raw data (all causes combined) with the death counts from the Human Mortality Database (HMD)[6]. The data available at the HMD originated from the statistical table Forma 4 (now Table 42), “Distribution of deaths by

[6] www.mortality.org

single year of age and sex." In theory, there should be no differences between two datasets: the total numbers of death from all causes of death in Forma 5 (now Table C51) should be exactly equal to the death counts in the HMD by each age group. In fact, there were some deviations, which were corrected accordingly. Finally, after checking the data, we redistributed the deaths of unknown age proportionally among the other age groups.

9. Reconstruction information

At the initial stage, the original data consisted of five blocks corresponding to the four Soviet classifications (SC–1965, SC-–1970, SC–1981, SC–1988) and one Belarusian classification (BC–2002). In order to obtain the coherent time series by causes of death in terms of the BC–2002 for the whole period 1965 to 2010, the following sequence of four stages was performed (Figure 3):

Initial stage	**SC–1965** **1965–1969** **(n=210)**	**SC–1970** **1970–1980** **(n=185)**	**SC–1981** **1981–1987** **(n=185)**	**SC–1988** **1988–2001** **(n=175)**	**BC–2002** **2002–2010** **(n=277)**
Stage I	**1965-1980 (n=185)**				
Stage II	**1965-1987 (n=185)**				
Stage III	**1965-2001 (n=175)**				
Stage IV	**1965-2010 (n=277)**				

Figure 3. Four Major Stages of Reconstruction

Note: *n* is number of items in the cause-of-death classification

The first stage of the reconstruction enabled to overcome the transition from the SC–1965 to the SC–1970, and to obtain coherent time series for 1965-1980 in terms of the SC–1970. The next stage included the reconstruction of cause-specific mortality trends in terms of the SC–1981 for the period 1965-1987. The third stage aimed at reconstructing cause-specific mortality trends in terms of the SC–1988 for the period 1965–2001. Finally, we reconstructed continuous series for the whole period of 1965 to 2010 in terms of the BC–2002.

Transition to the SC–1970: a detailed example

As it is impossible to provide all of the details of the laborious reconstruction procedure, we will demonstrate only its principal steps by focusing on the transition that occurred in 1970. Here, we will show how we reclassified the items of the SC–1965 as items of the SC–1970. The main steps of the procedure (defining the fundamental associations of items and estimating the transition coefficients) will be accompanied by detailed examples. We will then briefly address the main methodological issues related to the other transitions (SC–1981, SC–1988, and BC–2002).

Fundamental associations

The first step of the reconstruction was to overcome the transition that occurred in 1970. Formally, we were supposed to begin the reconstruction from the construction of correspondence tables. Fortunately, we could skip this step and rely on the results of similar work previously conducted for Russia (Meslé et al., 1996). Theoretically, Belarus and Russia, belonged to a single system of data collection and classification, and were supposed to follow the same coding rules and instructions.

This was found to be only partially the case after we examined the time series by each cause of death and applied the Russian TC. In some cases, the transition coefficients fitted well, while in others they did not. In some cases, the precision of the Russian TC (estimated for a much larger population) was not justified, especially when the TC varied across ages. Taking all of these limitations into account, we decided to start the work by rebuilding the FA. First, we filled the existing Russian FA with the death counts for two successive years (1969 and 1970). We then visually inspected the statistical balance for each FA (Figure 4). The strategy at this stage was to identify and then modify all of the 'unbalanced' FA (i.e., those exhibiting notable ruptures between the trends before and after the transition year). After several rounds of inspections and modifications, the FA were established.

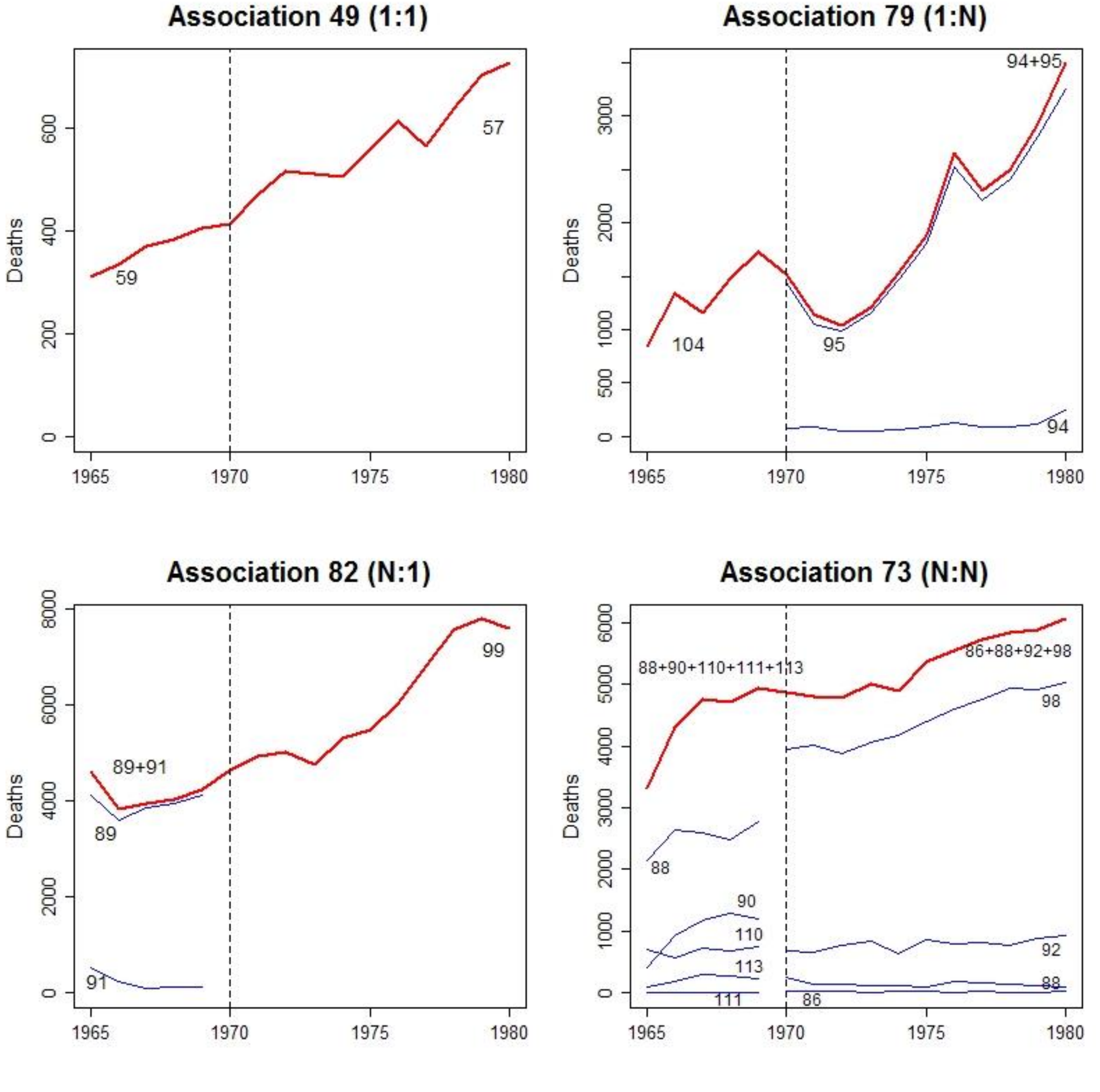


Figure 4. Four types of fundamental associations and the initial (unreconstructed) items included in them

Note: The labels on the left-hand side of the graphs (before year 1970) are numbers of items in the SC–1965, while the labels on the right-hand side are numbers of items in the SC–1970. Their names are provided below in the text.

Transition coefficients

Once the FA were determined, we could proceed to the estimation of the TC. Obviously, in the case of a simple association, there is only one transition coefficient equal to one. Thus, in association 49, item 59 of the SC–1965, “Malignant neoplasm of the breast,” was reclassified as item 57 of the SC–1970. Obtaining TC for FA 79 and 82 was also straightforward. Item 104, “Coronary atherosclerosis,” in FA 79 was distributed proportionally (based on death counts in 1970) between the new items 94, “Other forms of ischemic heart disease with hypertensive disease,” (4.7%) and 95, “Other forms of ischemic heart disease without hypertensive disease” (95.3%). In the case of FA 82, the new item 99, “Cerebrovascular disorders without hypertensive disease,” was obtained by summing up old items 89, “Cerebrovascular disorders with cerebral atherosclerosis,” and item 91, “Other and unspecified cerebrovascular disorders.”

Complex associations, such as association 73, were handled differently. In order to estimate the transition coefficients for the items gathered in this association, it was necessary to construct a double classification table (Table 4) corresponding to this association 73 (Table 3).

Table 3. Fundamental association 73

SC-1970		Number of deaths		SC-1965		
Item	Name of cause of death	1970	1969	Item	T/P*	Name of cause of death
86	Hypertensive heart disease	242	747 215	110 113	P P	 Heart and cerebral hypertensive disease
88	Hypertensive heart and renal disease	12	“ “	110 113	P P	
92	Atherosclerotic cardiosclerosis with hypertensive disease	676	“	110	P	
98	Cerebrovascular disorders with hypertensive disease	3952	“ 2777 1196 0	113 88 90 111	P T T T	 Cerebrovascular disorders with hypertension Cerebrovascular disorders with hypertension and cerebral arteriosclerosis Cerebral hypertensive disease except disorders of the central nervous system
73	86,88,92,98	4882	4935			88,90,110,111,113

*T/P – total/partial exchange between items

Part A of Table 4 establishes quantitative correspondences between the old and the new items involved in fundamental association 73 using distributions of deaths by the old items in 1969 (the last year when SC–1965 was in use) and by the new items in 1970 (the first year of the SC–1970). The cells shaded in gray (closed cells) indicate that there is no exchange between the respective new and old items. The numbers in bold are the reported deaths in 1969 and 1970; 1970 is the first year when the new classification was implemented. Presumably, an FA gathers the items sharing the same medical context on both sides. It is clear that, in 1970, the total number of deaths obtained from items of either the old or the new revision must be the same (4882). To 'solve' the table, we needed to calculate the hypothetical number of deaths in 1970 in terms of the old revision (estimated deaths). To do so, we simply redistributed the total number of deaths in 1970 among the old items 88, 90, 110, 111, and 113 in accordance with their composition in 1969 (e.g., 2,747=(2,777/4,935)*4,882, 1,183=(1,196/4,935)*4,882, and so on).

Table 4. Double classification of deaths gathered in association 73 and estimated transition coefficients

A. Double Classification of Deaths

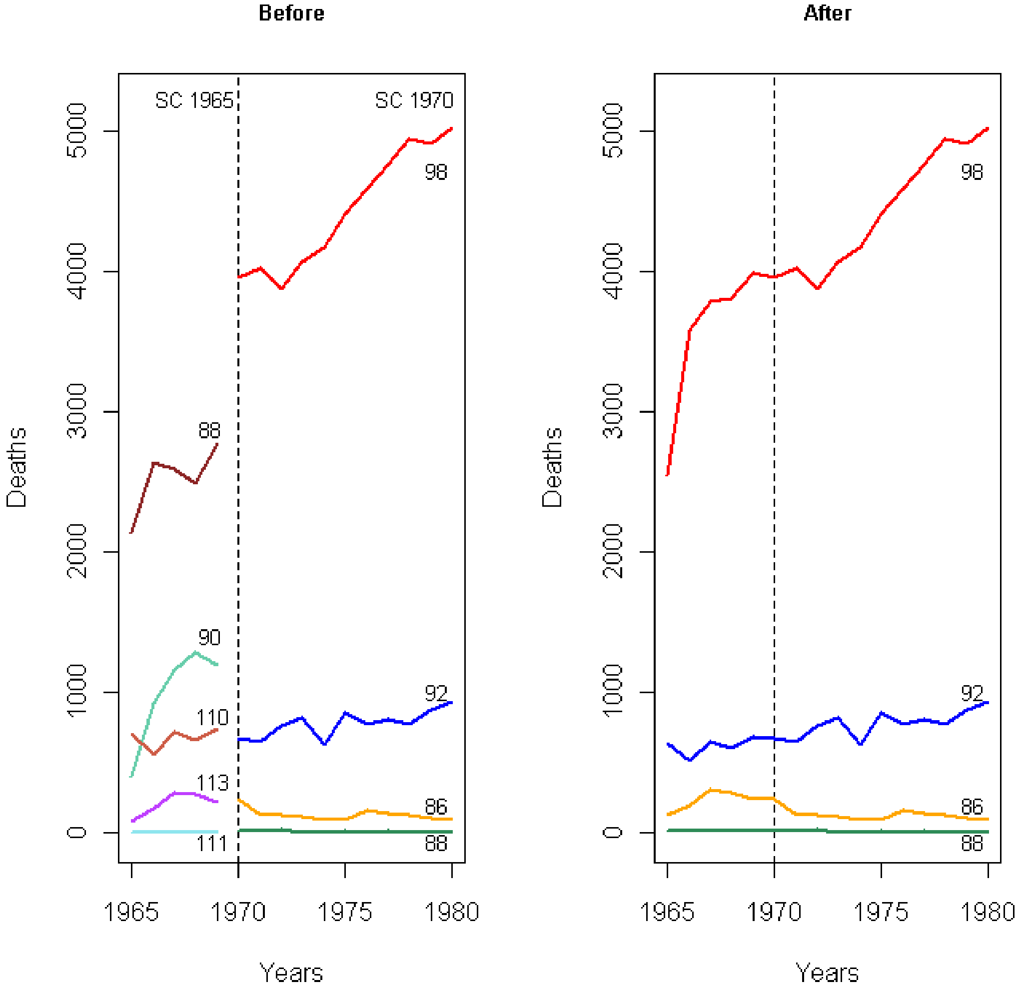
Items of the SC-1970	Items of the SC-1965					Deaths 1970, observed
	88	90	110	111	113	
86			54		188	**242**
88			9		3	**12**
92			676			**676**
98	2747	1183		0	22	**3952**
Deaths 1970 (estimated)	2747	1183	739	0	213	**4882**
Deaths 1969, observed	**2777**	**1196**	**747**	**0**	**215**	**4935**

B. Estimated Transition Coefficients

Items of the SC 1970	Items of the SC-1965				
	88	90	110	111	113
86			0.073		0.884
88			0.012		0.014
92			0.915		
98	1.000	1.000		1.000	0.102
Sum	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**

The next step was to redistribute deaths among the non-shaded cells of the table so that the column and row totals equaled the known marginal totals shown in bold. To accomplish this, we first filled in the cells corresponding to a 100-per cent exchange between the old and the new items. All of the 2,747 deaths of old item 88 were distributed into new item 98.

The same logic applied to old items 90 and 111, for which all deaths had to be transferred to new item 98. New item 92 took 676 deaths from old item 110. We could then see that the number of deaths corresponding to items 98 and 113 must have been equal to 22 (22=3,952-2,747-1,183-0). After this was done, there was not a unique solution for the redistribution of deaths among the remaining cells. This could have been applied in several different ways. In this particular case, we assumed that the total number of 12 deaths in new item 88 could be distributed between old items 110 and 113 according to their shares in 1969 (78=747/(747+215)*100 and 22=215/(747+215)*100 per cent, respectively. Consequently, new item 88 received nine deaths (78 per cent) from old item 110, and three deaths (22 per cent) from old item 113. Finally, the remaining non-shaded cells were filled in by subtraction. Once the deaths had been redistributed and the totals were verified, we could obtain the transition coefficients (Part B of Table 4). These TC were linked to the transition matrix in such a way that they could be filled in and updated automatically. Table 5 depicts a fragment of the transition matrix filled with the transition coefficients estimated from the association. The items of the SC-1965 (from one to 210) appear in columns (from left to right), and the items of the SC-1970 (from one to 185) appear in rows (from top to bottom). The sum of the transition coefficients always had to be equal to one to ensure that no deaths 'got lost' during the transition to a new classification.



	Items of SC 1965		Items of SC 1970
88	Cerebrovascular disorders with hypertension	86	Hypertensive heart disease
90	Cerebrovascular disorders with hypertension	88	Hypertensive heart and renal disease

	and cerebral arteriosclerosis		
110	Hypertensive heart disease except myocardial infarction	92	Atherosclerotic cardiosclerosis with hypertensive disease
111	Cerebral hypertensive disease except disorders of the central nervous system	98	Cerebrovascular disorders with hypertensive disease
113	Heart and cerebral hypertensive disease		

Figure 5. Trends in deaths by causes of death involved in association 73 before and after the reconstruction

Figure 5 depicts the results, including the trends by each cause of death involved in association 73 before and after the reconstruction.

Other transitions

Applying the described procedures, we overcame incrementally the three remaining transitions of 1981, 1988, and 2002. In the following, we will briefly highlight the main issues related to these transitions.

Soviet Classification of 1981 (SC–1981)

The transition to the SC–1981 was conducted in the same manner as the previous one. As in the case of the transition to the SC–1970, the direct application of the *Russian* TC on *Belarusian* data was not enough to eliminate discontinuities in trends produced by the implementation of the new classification in 1981. Once again, the best strategy was to use the earlier experience, and to rely on the Russian FA at the initial stage. Thus, we first filled the Russian FA with Belarusian death counts. We then checked the statistical balance for each association, re-built the FA when necessary, and compiled the final list of FA to be used for estimating the TC. After applying the newly estimated TC, we extended the series up to 1987.

Soviet Classification of 1988 (SC-1988)

The next step was to bridge 185 reconstructed items (1965-1987) with 175 items of the SC–1988 , and extend the series until 2001. In 1988, the notion of ‘hidden’ causes of death was abolished. It was also decided that work-related accidents would no longer be classified as separate items. For example, deaths from accidental falls had previously been assigned to two separate items: “accidental falls” and “work-related accidental falls.” After the change, all deaths from accidental falls were assigned to just one item, “accidental falls.” As a result, items 160 to 185 in the SC–1981 were transformed into items 160 to 175. Since the first 159 items in the modified classification remained unchanged, and the correspondences between the remaining items were simple, dealing with the changes introduced in 1988 was not problematic.

Belarusian abridged version of the ICD10 (BC–2002)

There are two principal differences between the classification changes implemented during the Soviet era and the transition to the ICD10. First, unlike in the case of this transition, the earlier classification changes were outlined and implemented in Belarus under the centralized supervision of the *Goskomstat*. The role of the local statistical authorities was simply to ensure the proper execution of the process. Second, and more importantly, the implementation of the ICD10 produced many more changes than the previous revisions. The complexity of the ICD10, the lack of experience of the governmental bodies responsible for the process, and the financial constraints of the transition period might explain why the ICD10 implementation in Belarus occurred relatively late, in 2002.

The existence of the theoretical associations (see section “Additional transition documents”) between items was very helpful. But after filling in the death counts in these associations and checking the statistical balance, we found that many of the associations showed significant breaks, and required modifications. After several rounds of adjustments, we were finally able to compile the ultimate list of associations. Then, by following the sequence of standard steps, we overcame the last transition, and extended the harmonized series up to 2010.

We encountered much more complex problems during the last transition than in the previous transitions. These problems were not only related to the transition year, but also to the period thereafter. One of them was the diagnosis of cardiovascular diseases (CVD) with the distinction of conditions either involving or not involving hypertensive heart disease (HHD). Unlike the original ICD10, the special abridged version of the ICD10 currently used in Belarus makes this distinction. The dynamics of the reconstructed trends indicated an almost symmetrical exchange between items *with* and *without* HHD after the transition in 2002 (Figure 6).

It appeared that there were significant changes in the diagnosis of cardiovascular mortality, as growing numbers of deaths from CVD were diagnosed as involving HHD. Clearly, in this case, breaks in the time series could not be eliminated through a reconsideration of the associations between items. To overcome the problem, other solutions had to be considered. Aggregating items into bigger groups (e.g., *ischemic heart diseases, cerebrovascular diseases*) appeared to be an appropriate solution, as it allowed us to avoid making the distinction between problematic hypertensive and non-hypertensive CVD deaths.

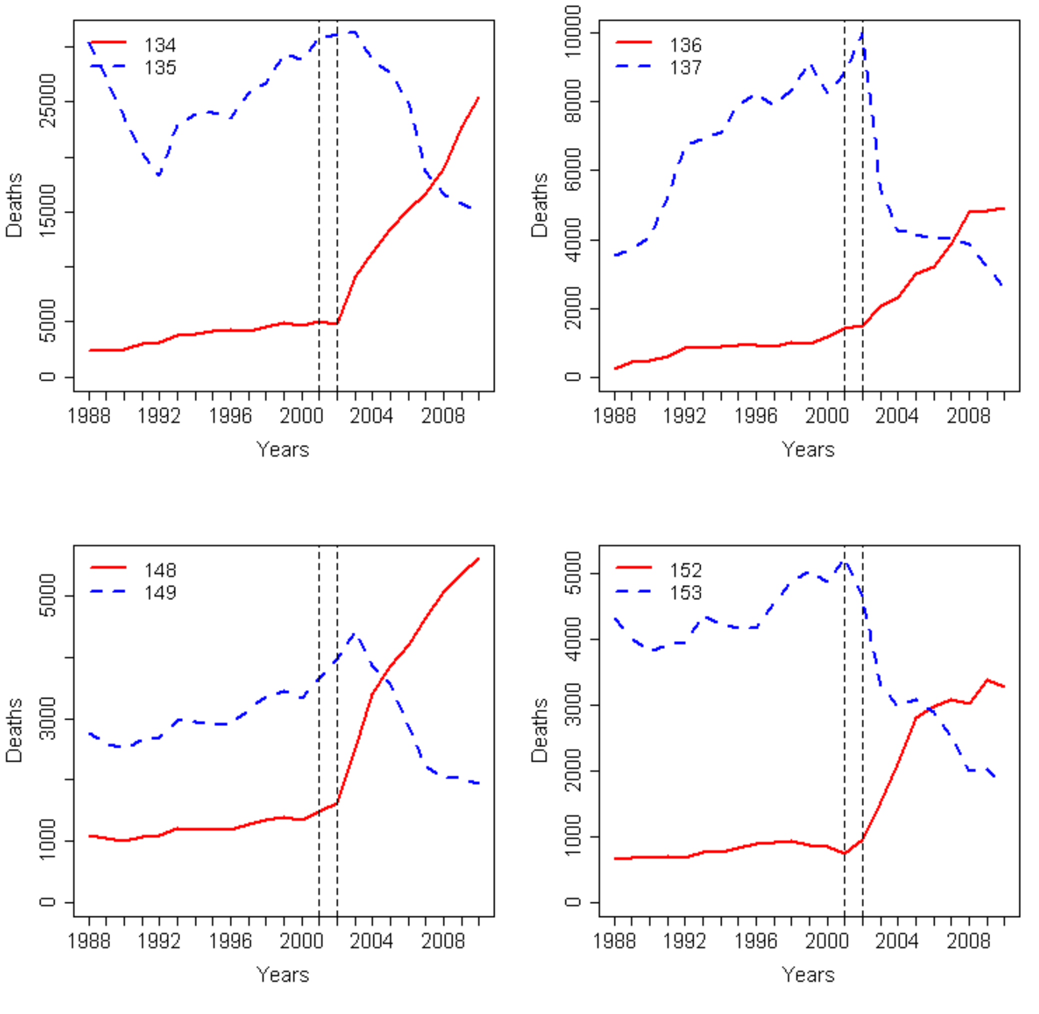


Figure 6. Trends by selected causes of death after the transition to the BC-2002; both sexes, 1965–2010

Notes:
134 “Atherosclerotic cardiosclerosis with HHD”
135 “Atherosclerotic cardiosclerosis without HHD”
136 “Other forms of chronic ischemic heart disease with HHD”
137 “Other forms of chronic ischemic heart disease without HHD”
148 “Cerebral infarction with HHD”
149 “Cerebral infarction without HHD”
152 “Other cerebrovascular disorders with HHD”
153 “Other cerebrovascular disorders without HHD”

A posteriori corrections

Not all of the discontinuities observed in the reconstructed trends are related to official classification changes. Independent of the transitions to new classifications, changes in coding practices might occur at any time. In such cases, the trends are subject to so-called *a posteriori* corrections.

Let us recall the reconstructed trends of association 73 (see Figure 4). The trends show no ruptures around the transition year. However, in 1966, there was an unusually large increase in the number of deaths in item 98 which was not related to the transition to the SC–1970. Presumably, in 1965, some share of the deaths belonging to item 98, “Cerebrovascular disorders **with** hypertensive disease,” were mistakenly classified as item 99, “Cerebrovascular disorders **without** hypertensive disease.” A closer examination of the trends of both items revealed that the exchange between the two items occurred due to incorrect registration at old ages. Figure 7 shows the results of an *a posteriori* correction, applied in this case to ages 75 and above.

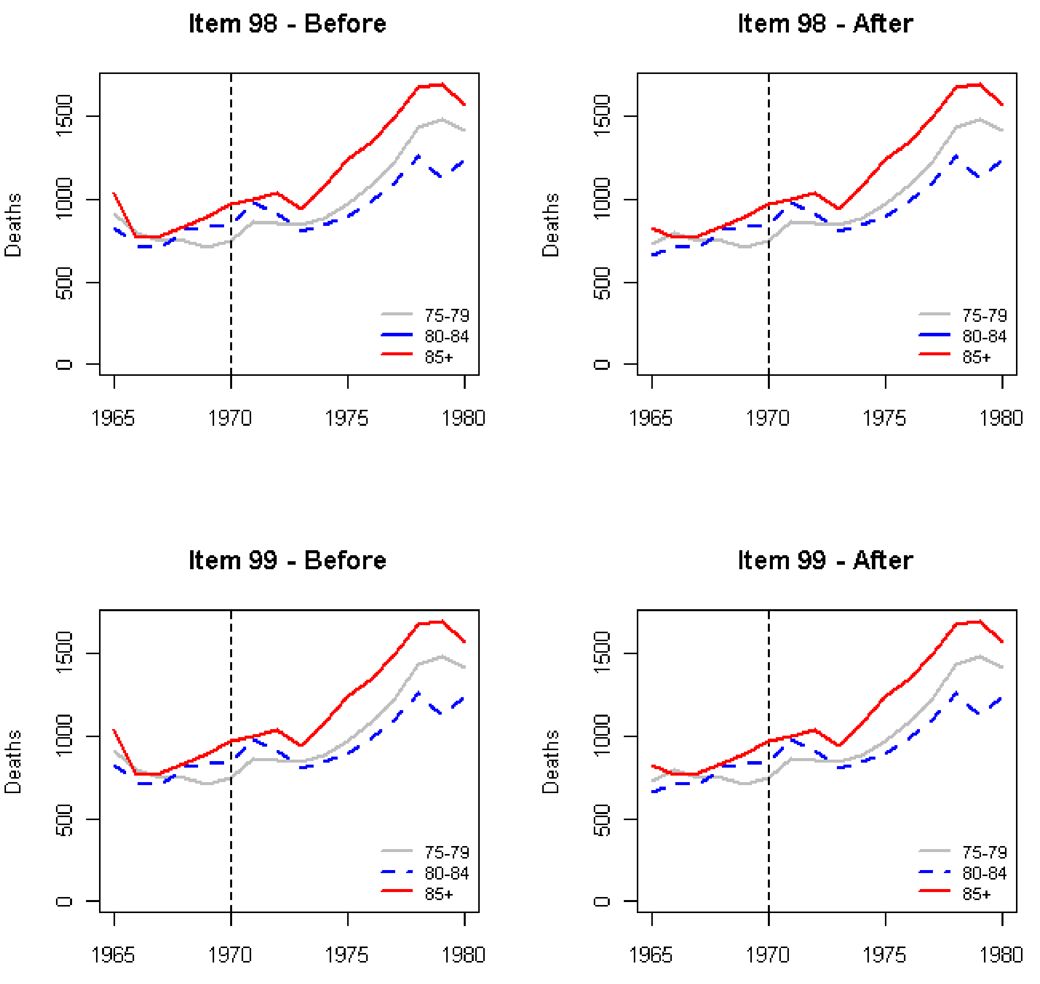


Figure 7. A *posteriori* corrections of items 98 and 99; 1965, both sexes, ages 75+, 20 per cent

Notes:
Item 98, “Cerebrovascular disorders with hypertensive disease”
Item 99, “Cerebrovascular disorders without hypertensive disease”

For this correction, we assumed that 20 per cent of the deaths assigned to item 99 should be reclassified into item 99. Figure 8 shows the effect of the correction at ages 75, and on the mortality trends from all ages combined.

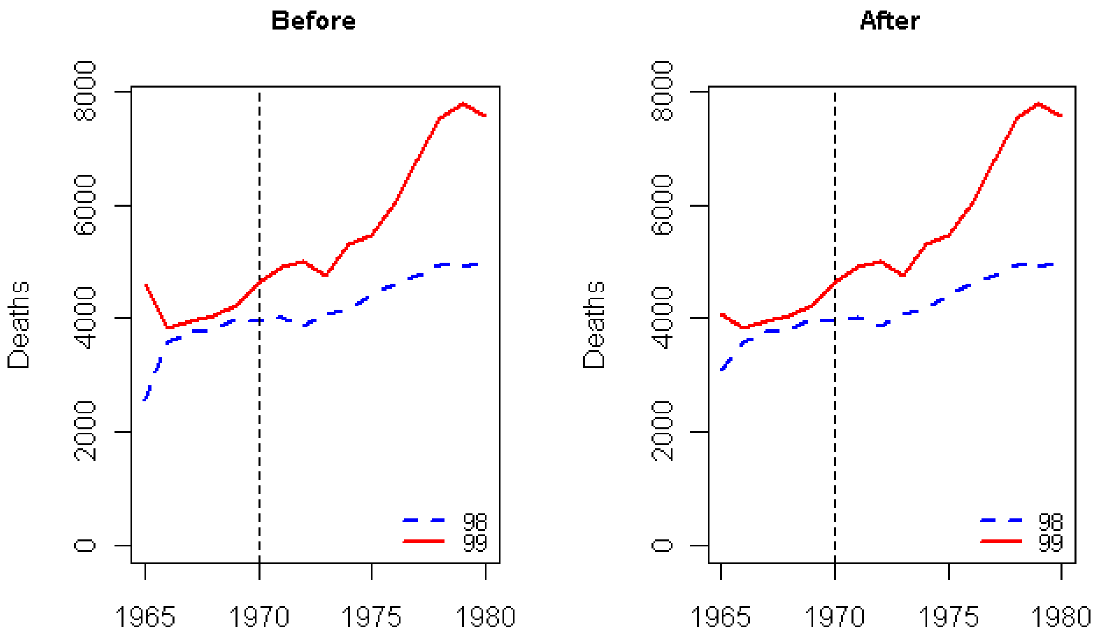


Figure 8. Results of a *posteriori* corrections of Items 98 and 99

Notes:
Item 98, “Cerebrovascular disorders with hypertensive disease”
Item 99, “Cerebrovascular disorders without hypertensive disease”

Another source of the discontinuities observed in the reconstructed trends could be the changes in coding practices after the transition to a new classification. Figure 9 depicts an example of the severe discontinuity in the trends in the numbers of deaths from “other congenital anomalies of the central nervous system” (item 149) and from “other congenital anomalies of the circulatory system” (item 151), which occurred in Belarus in 1974.

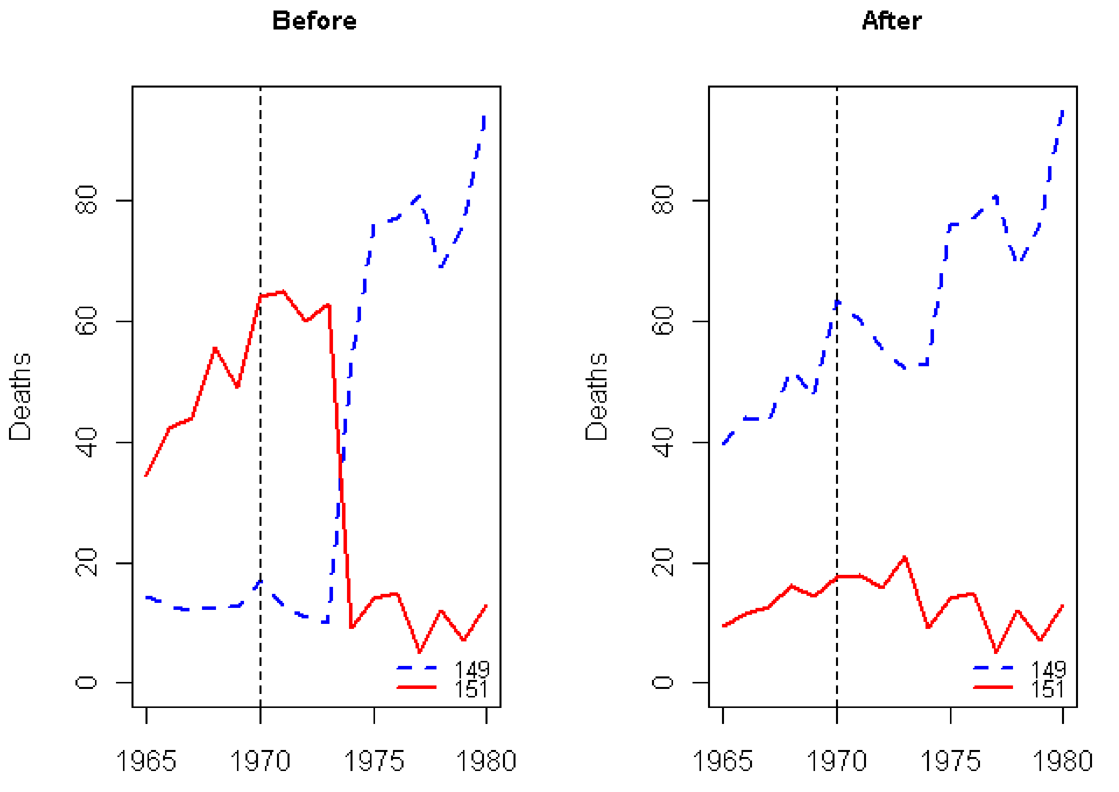


Figure 9. A *posteriori* correction items 149 and 151; 1965–1973, both sexes, ages 0–14, 75 per cent

The corrections shown are based on the reasonable assumption that, prior 1974, deaths from "other congenital anomalies of central nervous system" were classified as "other congenital anomalies of the circulatory system."

The last example (Figure 10) shows how the erroneous exchange in 1981 of item 48, "Malignant neoplasms of small intestine," with item 49, "Malignant neoplasms of colon," was corrected. Prior the transition, both of these items were classified in the SC–1970 as item 49, "Malignant neoplasm of intestine including duodenum." It appears that in the transition year (1981), a large proportion of the deaths belonging to item 49 were classified as item 48.

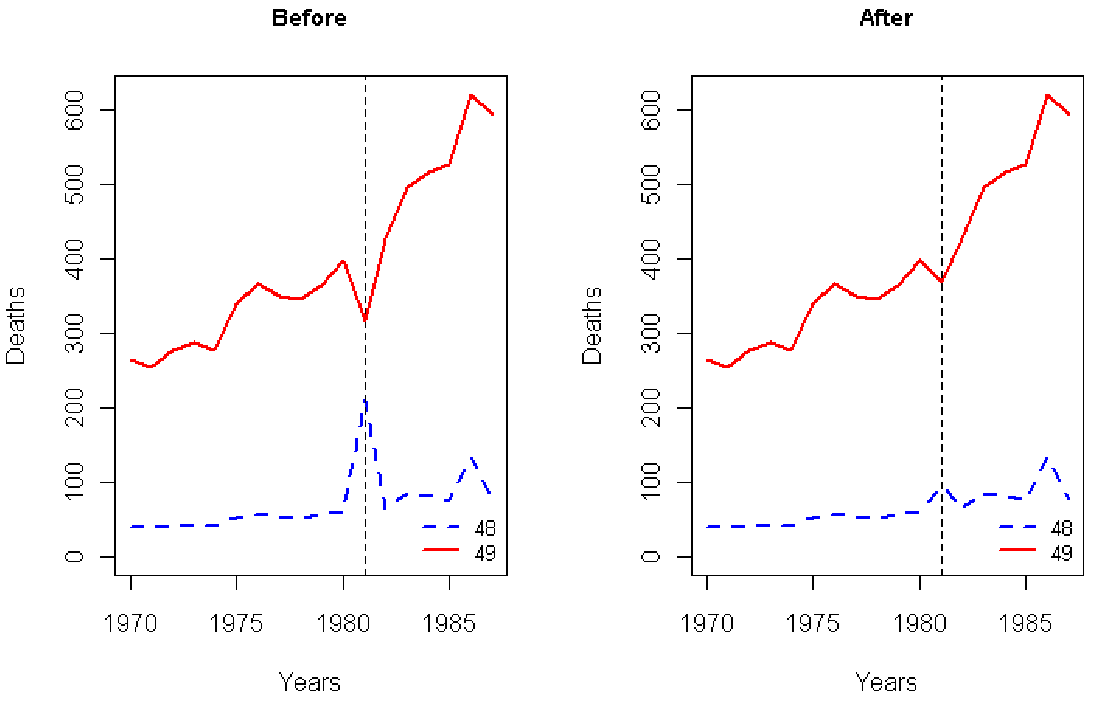


Figure 10. A *posteriori* correction of items 48 and 49, 1981, both sexes, ages 25+, 55 per cent

Redistribution of ill-defined causes

The final stage of our work was to deal with ill-defined causes of death. The share of ill-defined causes of death in the total number of deaths varies not only among countries, but also over time. In order to ensure the comparability of mortality trends, a redistribution of the ill-defined causes of death had to be considered. Under the assumption of independence, ill-defined causes can be redistributed proportionally among the other causes. Alternatively, they can be redistributed only among certain items that are believed to be related to ill-defined deaths.

In 1989, the Ministry of Health of the USSR issued an order regarding the registration of senility and diseases of the circulatory system among individuals aged 80 and older. Under the new instructions, all cases of death after age 80 had to be classified as senility, with the exception of violent deaths and deaths for which diagnoses were confirmed by autopsy or medical record. In addition, all of the cases of death from acute cardiovascular conditions under age 80 had to be confirmed by autopsy. Otherwise, they had to be classified as ill-defined (Meslé et al., 1996). Figure 11 demonstrates the sudden rise of senility in Belarus after the implementation of the new rule.

In 1988, senility was reported in just 0.07 per cent of the total number of deaths. But in the years that followed, the share of deaths attributed to senility rose dramatically: to two per cent 1989, to nine per cent in 1990, and to 12 per cent in 1991. Over the same period, the share of deaths from “atherosclerotic cardiosclerosis without hypertensive heart disease” (item 135 in BC–2002) underwent an almost symmetrical decrease. This decrease is implausible given the fact that, in the early 1990s, overall mortality in Belarus was rising. Because of these problems, and also because there were reasons to suspect an exchange between senility and item 135 (Meslé and Vallin, 2003, Vallin et al., 2005), we decided to combine these items. Figure 12 shows the results of this correction. The other ill-defined causes were redistributed proportionally among all of the causes.

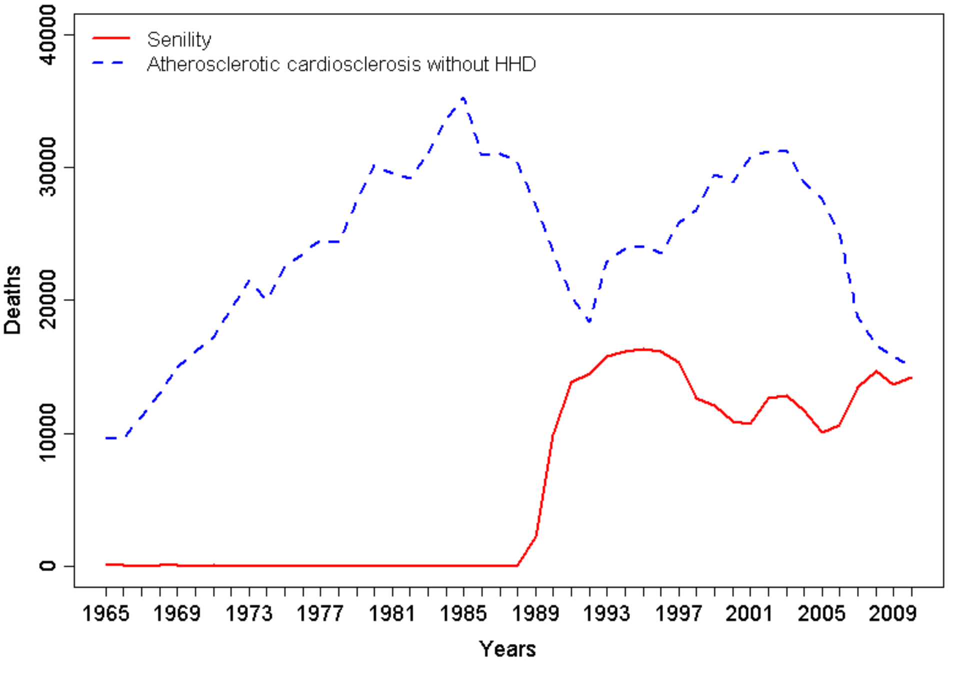


Figure 11. Deaths from senility and atherosclerotic cardiosclerosis; both sexes, 1965–2010

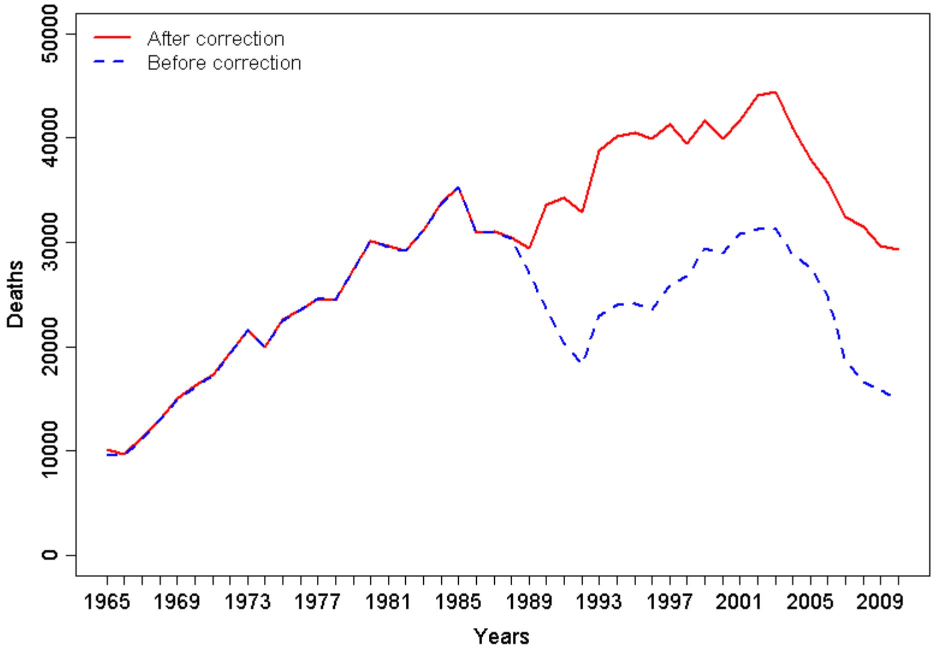


Figure 12. Deaths from atherosclerotic cardiosclerosis (item 135) before and after aggregating this cause with senility, both sexes, 1965–2010

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