Cause-specific mortality trends in two Caucasian countries since the early 1980s

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(Do not quote)

In light of unfavourable mortality trends observed in the former Soviet republics, Caucasian countries experience specific evolution. In this region, civil registration of vital events remains not complete. We re-estimated mortality levels and trends in Armenia and Georgia since the early 1980s, confirming specific mortality patterns, but very similar in both countries. To what extent are differences in life expectancy levels and trends associated with the specific cause-of-death patterns? Providing continuous series of deaths by cause supposes to deal with changes in the classification of causes of death during the soviet period and even later. To do so, we used a method based on the detailed examination of the medical content of the cause of death and statistical continuity. This paper aims to present cause-specific mortality trends in both countries since the early 1980s and discusses issues related to the pathway of the health transition in the Caucasus.

1. Introduction

In light of unfavourable mortality trends observed in the region of the former Soviet Union since the 1960s, it is of particular interest to look at the specific evolution of Caucasian countries. In order to discuss mortality patterns in the Caucasus, a preliminary stage is to propose estimates of mortality levels and trends. In this region, data quality has always been at issue, but since the collapse of the Soviet Union in 1991 the question has become even more acute. Not only did the region experience a failure in the follow-up of dramatic international migration flows, along with a series of political conflicts in the Caucasian countries that disrupted many statistical series, but the current data collection systems for births and deaths have been deteriorating (Badurashvili and Kapanadze 2003; Meslé *et al*. 2006). However, both countries carried out new censuses at the beginning of the 2000s. These new counts provide a much more reliable basis for re-estimating recent mortality trends in these two Caucasian countries. New estimates of mortality trends during the last two decades in these two Caucasian countries have been proposed, correcting infant mortality rates and life expectancy at age 60 (Duthé *et al*., 2010). This re-estimation is presented in the first section. To what extent are differences in life expectancy levels and trends associated with the specific cause-of-death patterns? Providing continuous series of deaths by cause supposes to deal with changes in the classification of causes of death during the soviet period and even later. In the second section, we present the method used to do it, which is based on the detailed examination of the medical content of the cause of death and statistical continuity. This paper aims in the third section to present cause-specific mortality trends in both countries since the early 1980s and finally discusses issues related to the pathway of the health transition in the Caucasus.

2. Re-estimating life expectancy

2.1. Infant mortality

In order to measure the under-registration of infant mortality rates, official statistics can be compared to results from retrospective surveys. In Armenia, two Demographic and Health Surveys (DHS) were carried out in 2000 and 2005, while Georgia also produced results from two Reproductive and Health Surveys (RHS), very similar to DHS, conducted in 1999 and 2005. We assume that the survey results give a better view of the general levels and trends than current vital statistics but also that current statistics capture the actual short term changes in infant mortality, and we estimated annual coverage infant mortality rates to correct infant mortality since the early 1980s (1982 for Georgia and 1983 for Armenia) (Duthé *et al*., 2010).

2.2. Mortality at old ages

The above correction of infant mortality gives a solid basis for re-estimating life expectancy. If infant deaths are clearly under-registered, registration of deaths after age one is also likely to be incomplete. Actually, young adult mortality rates in former USSR countries are much higher than predicted by any model life table (Shkolnikov *et al.* 1996). Using such model life tables is thus not very relevant for estimating young adult mortality in Caucasian countries. Model life tables can be used as a reference to assess a possible underestimation of mortality at old ages. We have examined the relationship between corrected infant mortality and life expectancy at age 60 from official statistics. The comparison with levels given by Coale and Demeny regional life tables reveals an overestimation of life expectancy at age 60 in both countries until the early 1990s and we corrected life expectancy at age 60 until 1991 in Armenia and in Georgia according to the West regional model for males and the North model

for females. In the most recent years female Georgian e_{60} levels are also questionable and were corrected in the same way (Duthé *et al*., 2010).

2.3. Life expectancy at birth

For both countries, 1 to 60 age-specific mortality rates were computed from official data. Life tables were then built on the basis of these age-specific rates plus our estimates of IMR and life expectancy at age 60.

Figure 1 presents life expectancy in Armenia and Georgia for both sexes according to authors' estimates, and compared with Russian and Ukrainian ones. First, we can see the dramatic impact of the 1988 earthquake in Armenia. Second, despite a common decrease in the early 1990s, trends appear quite different from those observed in Russia or Ukraine. The divergence is obvious for males, between the Russian and Ukrainian patterns and the Georgian and Armenian ones. For females, while life expectancy level was lower in Georgia and Armenia than in Ukraine or Russia in the 1980s, it is much higher in the 2000s, thanks to a rather regular increase, except for some short interruptions just after Independence. For males, the downtrends were much sharper in Georgia and the up trends have levelled off since the end of the 1990s.

These corrected trends in life expectancy provide a more reliable basis for comparison with recent mortality trends in European republics of the former USSR (Meslé 2004). They pave the way for a deeper analysis of mortality trends and patterns in these two Caucasian countries relaying on cause-of-death statistics.

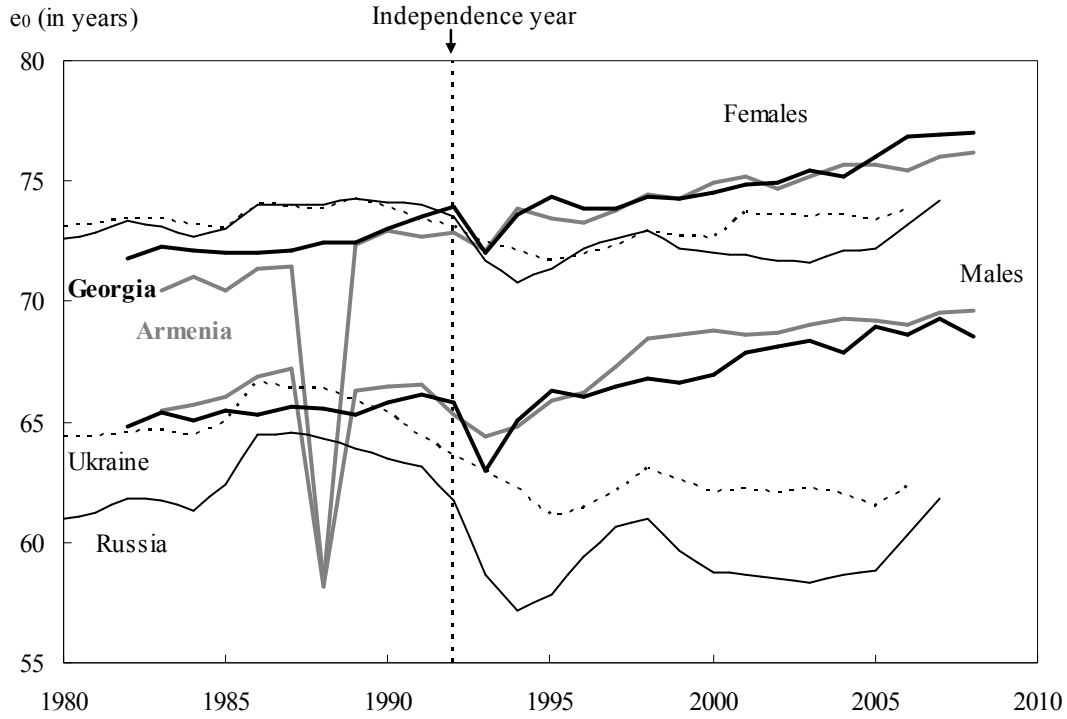

Figure 1. Trends in Armenian and Georgian life expectancy at birth since the early 1980s according to authors' estimates and compared with Russian and Ukrainian ones.

3. Providing continuous series of deaths by cause

The second methodological issue of this work consists in providing continuous series of deaths by cause. To do so, we need (i) to compute the so-called "hidden causes", (ii) to treat the changes in cause-of-death classification which lead to statistical discontinuities in absence

of any double count. We used a method developed for the French deaths by cause series (Vallin and Meslé, 1988) which has been used in many countries such as Russia or Ukraine (Meslé et al., 1996, Meslé and Vallin, 2003).

3.1. Cause-of-death classifications

Since early 1980s, different classifications of causes have been used in both countries: the 1981 Soviet Classification the 1988 Soviet Classification, and the ICD-10.

However, from the 1960s until 1987, regular cause-of-death tables (*Form 5*) did not contain detailed number of deaths for few causes (cholera, plague, injuries at work, suicide, and homicide) and deaths due to these causes were gathered with ill-defined[1]. Second tables (*Form 5b)* nevertheless existed and provided the detail of these "hidden causes". In the beginning of the 1980s, thanks to a collaborative project between INED and the Centre for Demography and Human Ecology in Moscow, it was possible to extract from different Moscow archives the *Forms 5* since 1959, for all republics of the former USSR as well as a couple of *Forms 5b* for some republics. For Armenia, the missing pieces of information were found in national archives in Yerevan, but for Georgia it was not possible to complete all the missing data and to distinguish in the total of hidden causes the numbers of deaths due to each specific cause.

In 1988, the distinction between injuries occurring at work and other injuries disappeared. As a consequence, all injuries for which the previous classification contained two items (such as"falls at work" and "other falls") were gathered into one item each (such as "falls"). The other items which correspond to diseases, ill-defined causes and other external deaths remained unchanged. The 1988 classification thus counted 10 items less than the 1981 one (175 instead of 185).

After the independence, Georgia used this classification until 1997. Since 1998, causes of deaths are classified according to the 10th revision of the International Classification of diseases (ICD-10) which led to major changes compared to the previous nomenclature. Considering the small annual number of deaths in Georgia (less than 50,000), we gathered deaths using an abridged list[2] of 197 items. In Armenia, ICD-10 was adopted more recently, in 2004 but the statistical office publishes data in an ICD-10 abridged list of 229 items which we used here to reconstruct continuous series.

Thus, for each country and for the studied period, we have to deal with two transitions. The first one is relatively simple and common to both countries, whereas the second one is more complex and different in each country.

3.2. The method of reconstruction

The difficulty of the reconstruction is that we have no dual coding to establish a logical correspondence between the two classifications. This problem has been explored by Vallin and Meslé (1988) to reconstruct homogeneous causes of death series in France since 1925. In this way, they developed a method which is based on two principles: (i) the correspondence of the medical contents of old/new items, and (ii) the statistical continuity over the period of change by age group and sex. The reconstruction work can be decomposed in different steps (i) to draw up correspondence tables between the two classifications (ii) to build associations between old and new items, (iii) to calculate coefficients of transition between those items and to constitute continuous series, and finally, (iv) to make corrections for statistical disruptions independent from the transition.

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[1] they were added in the item "other accidents" in the two last year of the use of this classification (1986-1987).

[2] on the basis of the work which has been done for Baltic countries (Hertrich and Meslé, 1997)

3.3. Estimation of cause-specific mortality rates

Before providing cause-specific mortality rates, it was necessary to take into account the correction proposed for mortality levels and missing deaths were added in causes of deaths counts by age group.

Deaths (in black at Figure 2) were added to infant deaths (the proportion of the registered deaths among neonatal and post-neonatal periods has been used to distribute those infant deaths), and over age 60 according to mortality rates by age group estimated through Coale and Demeny model life tables.

For Armenia in 1983, 8 thousands additional deaths have been included in statistics, which represent around 30% of the estimated total number of deaths for the year 1983. The number of added deaths has decreased over time, with only 321 deaths added in 2008 (1% of the total).

For Georgia, we also had to consider missing deaths which result from the difference between official statistics of deaths counted by age group and sex and the number of deaths for which there is a medical certificate. This difference exists from 1989 to 2003 (in light grey at Figure 2). In 1993, there were no detailed statistics according to civil registration, especially deaths by cause. In the beginning of the period, 9.5 thousands of deaths were missing that represent 18% of the estimated total number of deaths. In 1989, our correction goes down in contrast with the official one which goes up until 1996. The year 2004 is characterized by the beginning of a new system to count deaths which cross data from civil registration and health services. This led us to consider this year as quite reliable for the estimation of the mortality level without any correction. A centralisation of the civil registration in 2005 has nevertheless implied a new deterioration of death counts (Duthé et al., 2010). In 2008, there are still 4.4 thousands of deaths added to the series (9% of the total).

All those missing deaths which were not registered with a death certificate are considered as deaths from unknown cause and added to this category (in dark grey at Figure 2). To produce cause-specific mortality rates, deaths from ill-defined causes were proportionally redistributed among the other groups of causes.

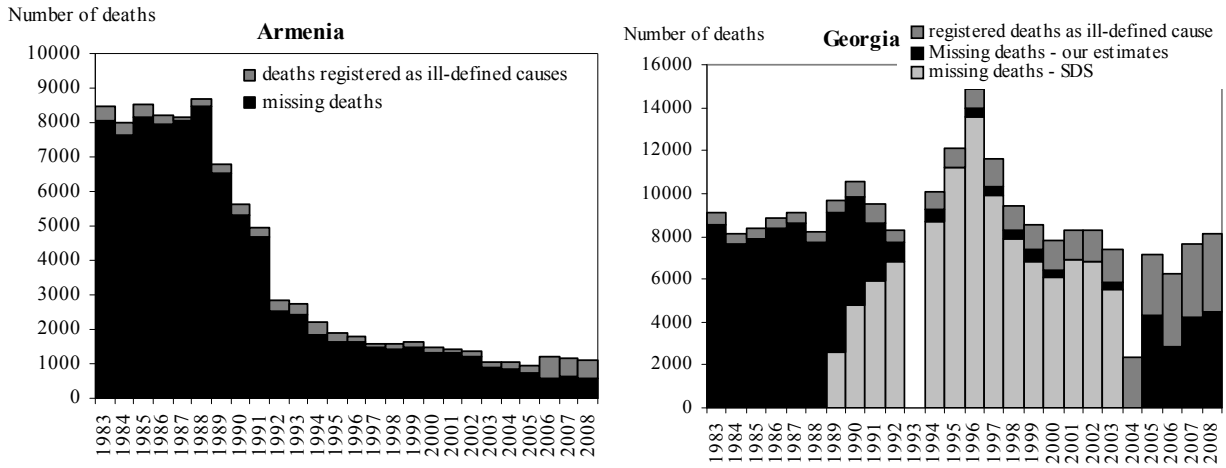


Figure 2. Number of ill-defined deaths in the author's causes of deaths statistics according to corrections in Armenia and Georgia, by year since 1983.

On the basis of our estimation of mortality level and the reconstruction of continuous series of deaths by cause, cause-specific mortality trends are presented in the next section. However, in Georgia, there is a very suspicious distribution of deaths by cause for the year 2004 with dramatic increase for specific groups such as diseases of the respiratory system or external causes (Annex 1). Those peaks cannot be explained by the social context or health situation. But 2004 is the year of the change of the statistical system with crossing data from two sources and whereas statisticians succeed to count deaths, causes of death statistics are very doubtful. We thus decided not to take into account 2004 data and to estimate the distribution of deaths by cause for this year proportionally to the average distribution using 2003 and 2005 data.

4. Cause-specific mortality trends

4.1. Standardized mortality rates

Figure 3 displays standardized mortality rates by group of causes since 1983, for males in Armenia (on the left) and Georgia (on the right). Trends are reported on semi-logarithmic scales, which are the same for all the graphs.

For both countries, the burden of cardiovascular diseases is massive and trends are quite stable during the period, especially in Georgia whereas in Armenia series show more fluctuations with two periods of increase during the early 1990s and the early 2000s.

The second most important category groups neoplasms and is characterized by a low increase in Armenia since 2000, where it is more stagnating in Georgia. This increase in Armenia has to be questioned: it can be a real increase in mortality by cancer and more specifically of respiratory organs which could be explained by an increase of tobacco consumption (annex 2); but the increase is not limited to tobacco-related cancers which could argue for a consequence of changes in diagnosis habits. During the Soviet period, deaths by cancer had to be specifically recorded and that complicated the procedure of registration of the death and its cause. This could lead to an under-estimation of the mortality due to neoplasms, but which progressively disappeared over time since 1991.

In the early 1980s, respiratory diseases were the third group in order of importance in both countries. Mortality by this group of causes decreased in the 1980s and early 1990s more rapidly in Georgia than in Armenia. Since the mid-1990s, however, it stagnates in the former and even increases in the latter so much that it is still ranking at the 3rd place in 2008 in Armenia while it is only at the 5th place in Georgia.

In Armenia, mortality by digestive diseases increases steadily during the period and is now at the same level as mortality by respiratory diseases. Trends in external causes are more chaotic because of two events: first, the 1988 earthquake, and second, political conflicts with Azerbaijan in 1992-1994.

In Georgia, mortality due to external causes and mortality due to diseases of the digestive system are ranking at the 3rd and 4th place respectively. The impact of the 1993 war cannot be seen as there are no statistics by cause for this year but the 2008 armed conflict between Georgia and Russia about South Ossetia raised violent deaths significantly. For this last year, the group ‘injuries and poisoning’ is not the only one which jumped: infectious and digestive diseases are also characterized by a peak, after a period of decrease.

For both countries, infectious diseases represent the less important group of causes with an overall decline in both countries, stronger for Georgian males than Armenian ones.

Figure 4 displays cause-specific standardized mortality rates for females. Trends are quite similar to male ones but clearer. A slight decrease among cardiovascular mortality trends and an obvious decrease of infectious mortality can be observed for Armenian females. For Georgian ones, trends are more stable for the first category but more fluctuating especially during the most recent years for the latter. In Armenia, the impact of the earthquake has been much larger for females than for males, whereas political conflict in the 1990s did not impact injuries and poisoning series. The increase of mortality due to diseases of the respiratory system and of the digestive one in the most recent years is also clearer for females. This has to be questioned regarding health progress, annex 3 shows that among digestive mortality cirrhosis and fibrosis of liver increased quite a lot in Armenia for the recent period. Is it a real increase which could be due to a fast spread of unhealthy behaviours such as smoking and alcohol consumption?

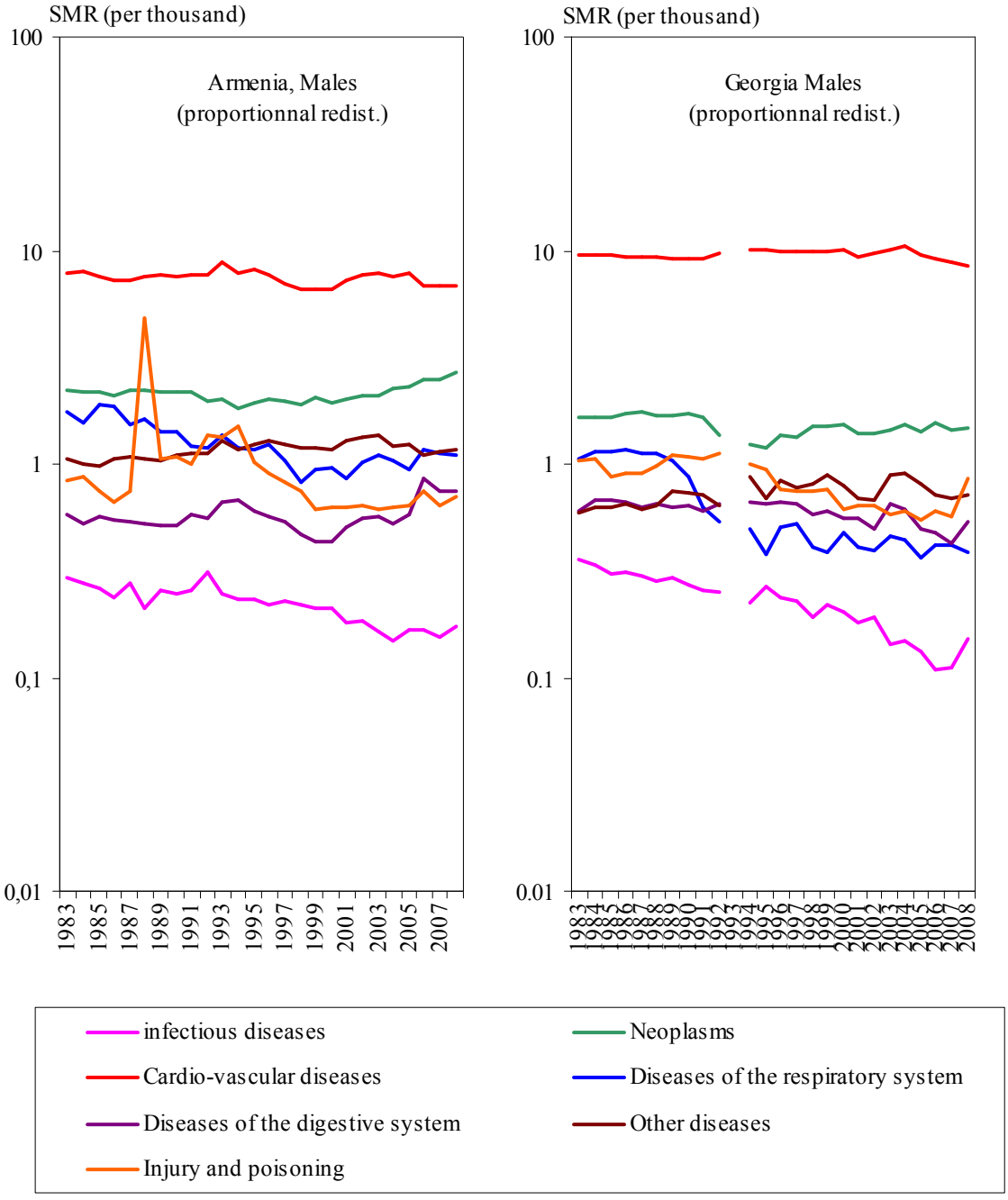


Figure 3. Trends in standardized death rates for 7 large groups of causes in Armenia and Georgia. 1983-2008, Males.

Figure 4. Trends in standardized death rates for 7 large groups of causes in Armenia and Georgia. 1983-2008, Females.

4.2. Contribution of causes of death to changes in life expectancy

To study cause-specific mortality changes by age group over time, we used here the algorithm proposed by Andreev *et al.* (2002) to compute age and cause contributions to the variation in life expectancy. Figure 5 presents results of the decomposition of the variation between the1983, first year of observation and 2008, the last available year, for Armenia (on the left) and Georgia (on the right), males (on top) and females (down).

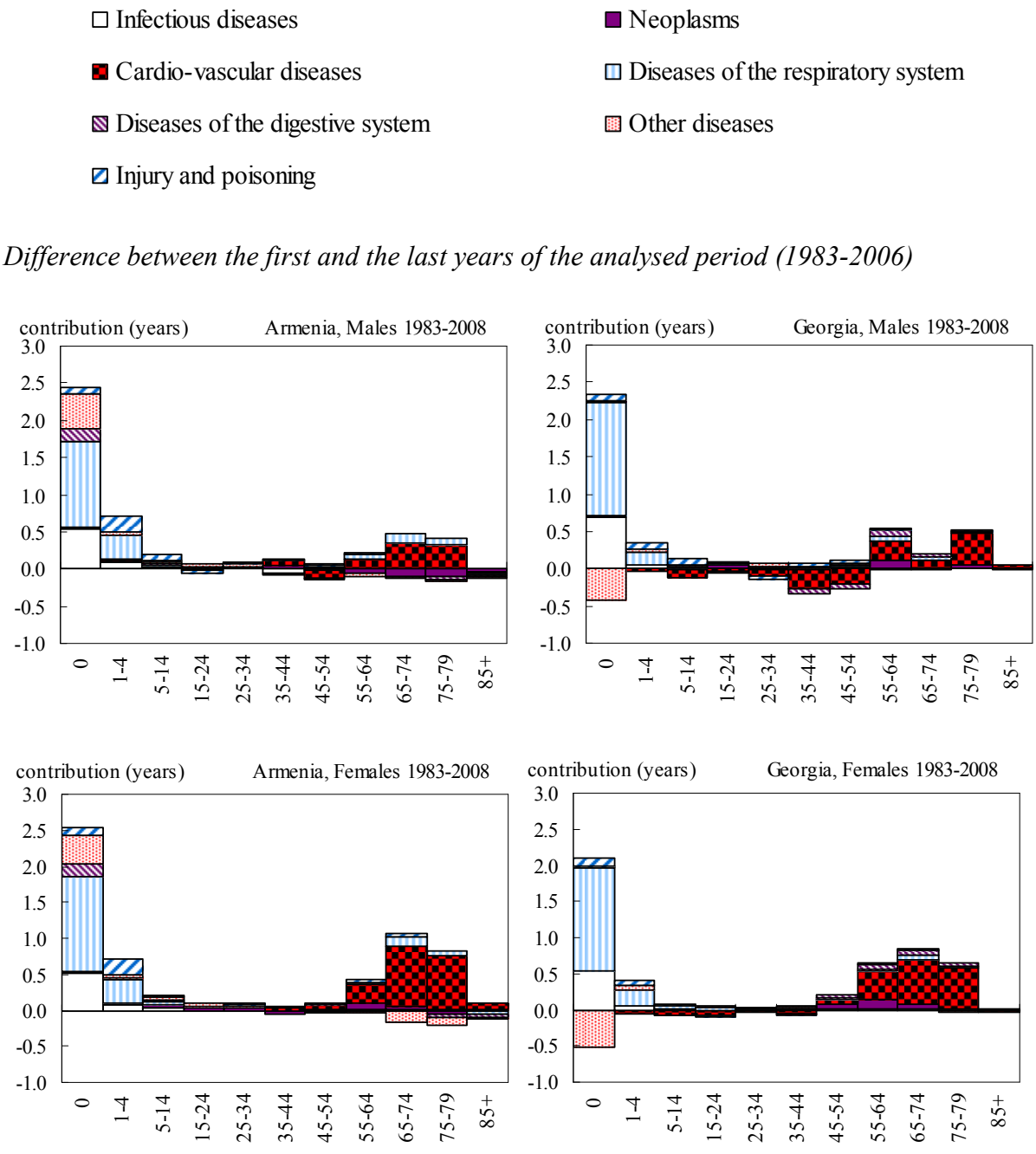


Figure 5. Decomposition of the e_0 variation between 1983 and 2008 by age group and large groups of causes in Armenia and Georgia. Males and females.

The graphs show some specific changes for each country. Progress in life expectancy between 1983 and 2008 is mainly due to infant mortality (+2.5 years for males and females in Armenia, +2 for the first ones and +1.5 for the second ones in Georgia) and especially a reduction of mortality due to diseases of the respiratory system and infectious diseases in both countries. In Armenia, progress among infants is also observable for mortality due to digestive diseases, as well as all the other causes. In contrast in Georgia, the other causes contributed to decrease in life expectancy (especially birth trauma and other perinatal causes).

In both countries, progress has been done for child mortality until age 5 in Georgia and age 15 in Armenia. In Georgia, among young ages we can see the negative impact of cardiovascular diseases on life expectancy which counteract with progress at older ages since 55. After age 5, cardiovascular diseases are the only group which has a large impact on changes in life expectancy between 1983 and 2008.

Looking at the life expectancy trends, we can distinguish in the period specific years according to political and health situation: 1992 which corresponds to the first year of independence and 1998 which is a year where life expectancy recovered a relatively normal level after political and socio-economic difficulties of the 1990s. We can then study by sub-period the changes in life expectancy at birth by age group and causes of deaths. Graphs are presented in following pages for males (Figure 6) and for females (Figure 7).

For Armenian males, infectious diseases among infant mortality have known a decrease during the 1990s, but not during the Soviet time, which is not true for Georgian infants who experienced already important progress in mortality for infectious diseases but also diseases of the respiratory system. We can also see a reversal situation for young adults regarding injuries in Armenia which is due to already high level of injuries 1992. In Georgia, progress on injuries and violent deaths has been done between 1992 and 1998.

Regarding cardiovascular diseases, unfavorable trends are noticeable in Georgia for young adults during the first period which has never been recovered, the last period is characterized by progress among adults older than age 55, with however a suspicious high level of contribution for the age group 55-64.

In Armenia, the increase of cancer is related to mortality after age 65. Generally, old Armenian males experienced a negative contribution for the last period, which can be discussed. It can be due to a real deterioration of their health or, as we did not correct old mortality after 1991, an artefact due to the recent improvement in civil registration.

Compared with males, we can observe two differences for females: (i) there are no changes in injuries and poisoning which are very specific to males and (ii) in Armenia, progress is regular for cardiovascular diseases all over the period which is not the case in Georgia where it is only noticeable for the last period.

Difference by sub-period

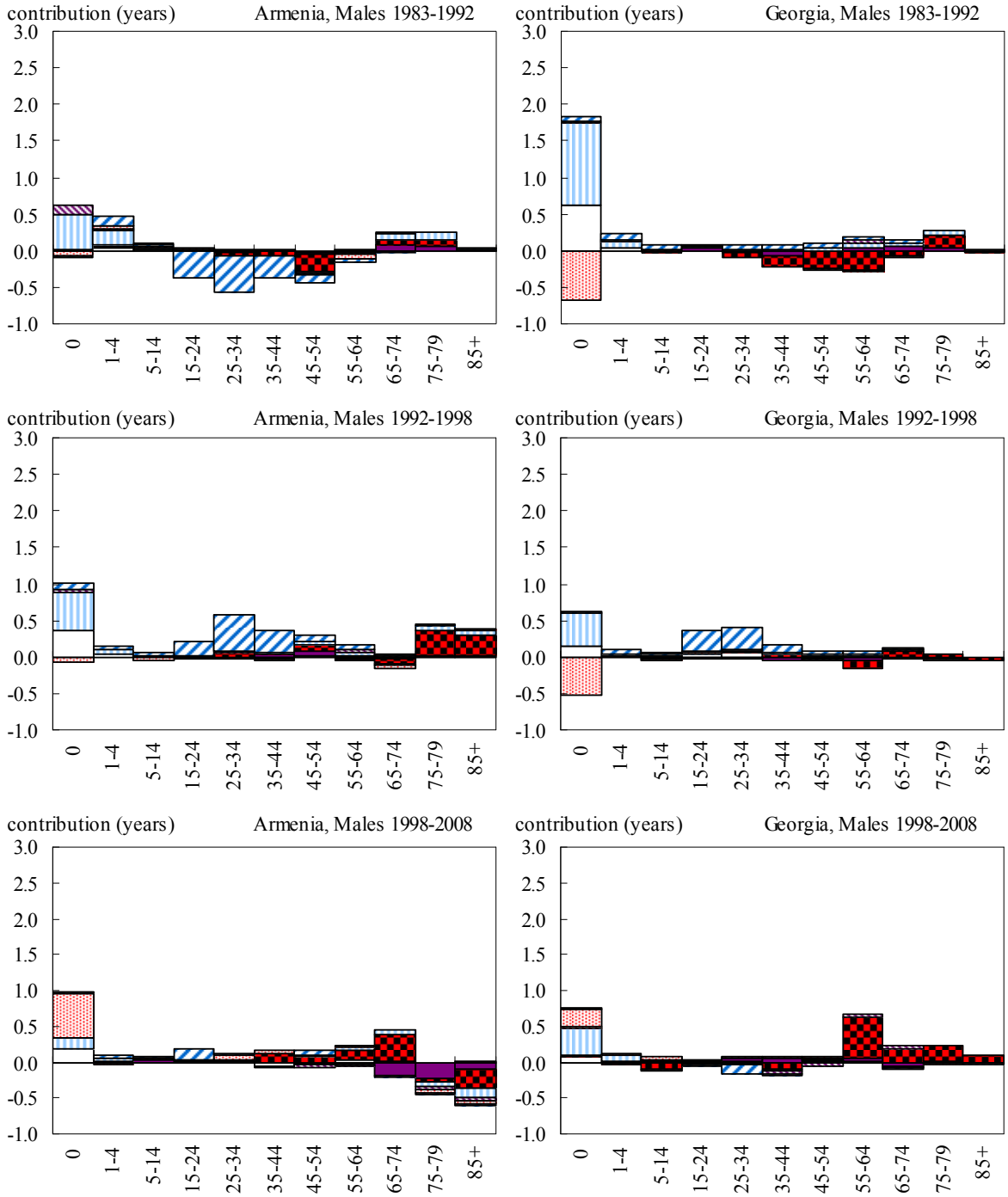


Figure 6. Decomposition of the e_0 variation between different years by age group and large groups of causes in Armenia and Georgia. Males.

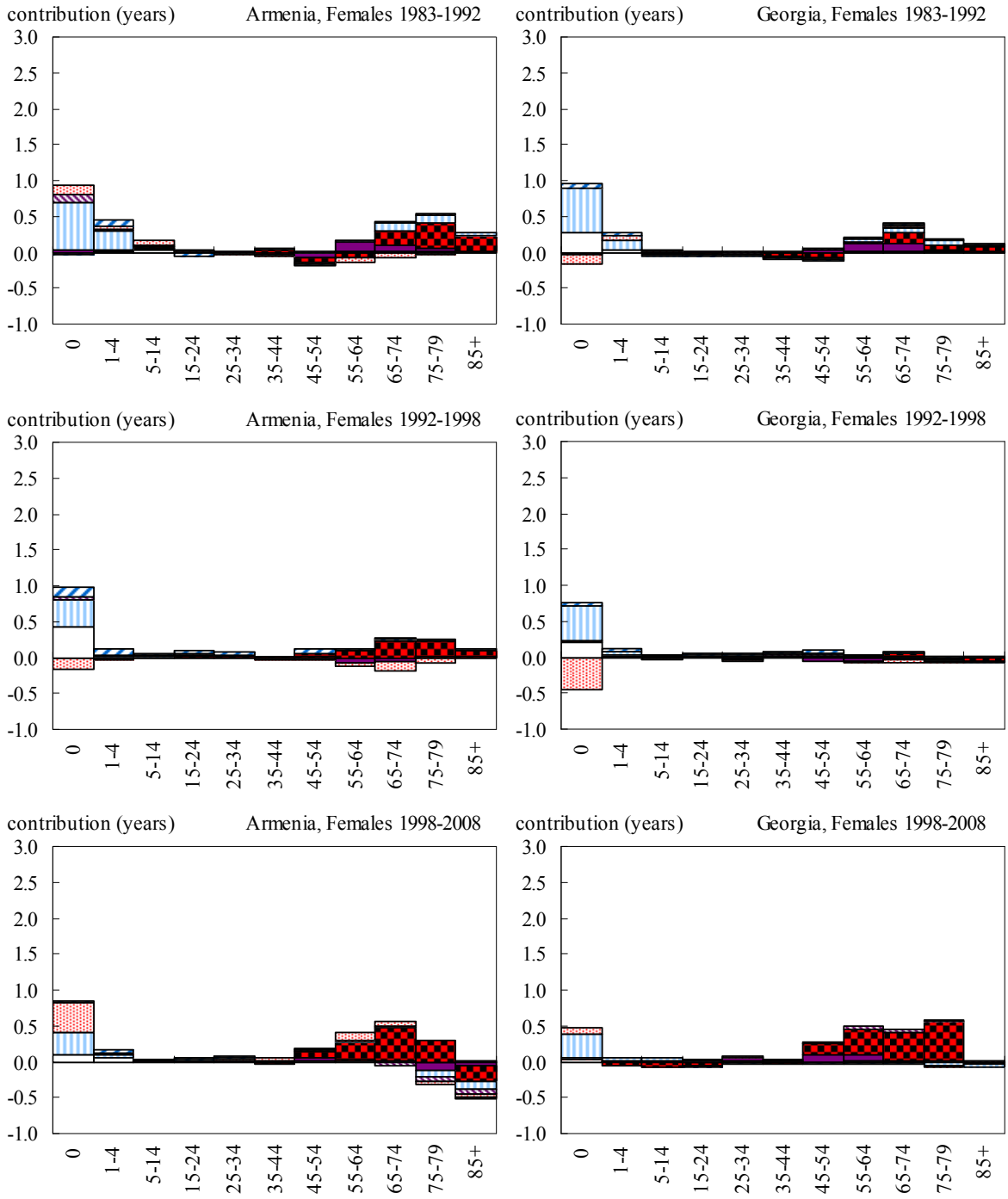


Figure 7. Decomposition of the e_0 variation between different years by age group and large groups of causes in Armenia and Georgia. Females.

5. Discussion

Before being able to draw conclusions about health progress in the Caucasus, present results have to be discussed as different points are still questionable.

First, we noticed a recent mortality increase at old ages in Armenia and this has to be studied: more precisely. It is not due to a specific cause and could express a global deterioration of the socio-economical situation of the elderly. It could also be due to the recent improvement in civil registration which may induce an apparent increase of the level because of a better data reliability.

Second, the reconstruction of continuous series of deaths by cause may be discussed: as the year 2004 in Georgia was very difficult to interpret without any clear documentation of the Georgian statistical office, we used a linear trend for this year which may be not satisfactory. In Armenia, recent increase of mortality due to respiratory or digestive diseases could also be a result of changes in the way to classify deaths as the country adopted ICD-10 in 2004 which is quite recent. It can take some time before statisticians become completely used to this new classification and its specific coding rules.

Third, correcting mortality level led to add in causes of death statistics a very high proportion of deaths as unknown or ill-defined deaths. This is true for the beginning of the period in Armenia but also for all over the period in Georgia. The redistribution in a proportional way according to age groups and causes of deaths appear to be the most reasonable solution but may lead to generate bias in cause-specific mortality trends.

Indeed, this study is still in progress and further analysis must be done before providing reliable cause-specific mortality data for these two Caucasian countries.

6. References

ANDREEV Evgueni M., SHKOLNIKOV Vladimir M., BEGUN Alexander Z. 2002. « Algorithm for decomposition of differences between aggregate demographic measures and its application to life expectancies, healthy life expectancies, parity-progression ratios and total fertility rates », *Demographic Research*, 7(14), 500-521.

BADURASHVILI Irina and Ekaterina KAPANADZE. 2003. South Caucasian Region: Armenia, Azerbaijan and Georgia, in Kalev KATUS, and Allan PUUR (eds.)*, Unity and diversity of population development: Baltic and South Caucasian regions*. Tallinn: Estonian Interuniversity Population Research Centre (RU Series D, n° 3), pp. 1-48.

DUTHE Géraldine, BADURASHVILI Irina, KUYUMJYAN Karine, MESLE France, and Jacques VALLIN. 2010. An attempt to reestimate recent mortality trends in two Caucasian countries. *Demographic Research*.

HERTRICH Véronique and France MESLE. 1997. Mortality by cause in the Baltic countries since 1970 : a method for reconstructing time series. *Revue baltique*, (10), p. 145-164.

MESLE, France, and Jacques VALLIN. 2003. *Mortalité et causes de décès en Ukraine au XXe siècle* [Mortality and causes of death in Ukraine in the 20th century]. Paris : INED, 396 p. (Les cahiers de l'INED, n° 152).

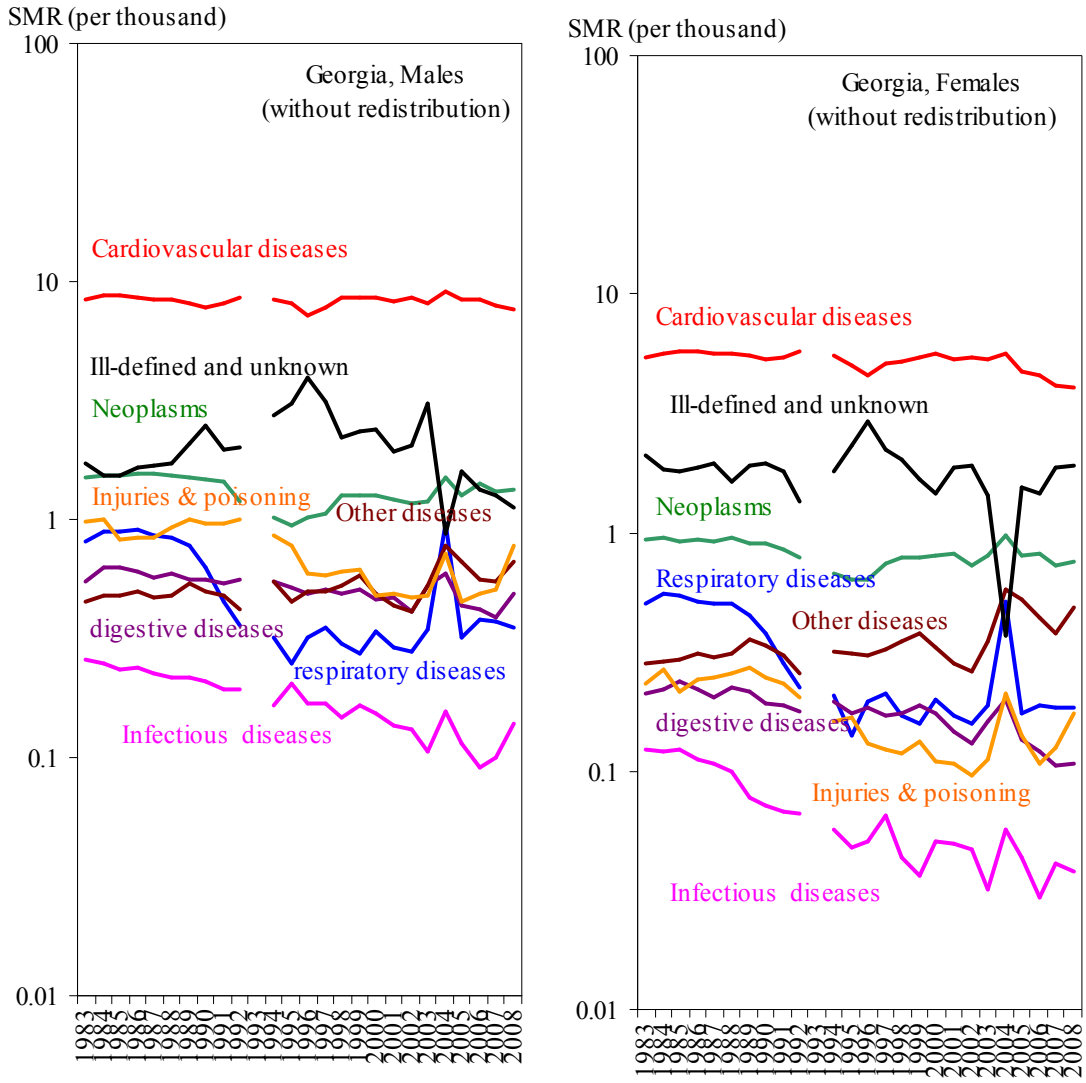
MESLE, France, Jacques VALLIN, and Irina BADURASHVILI. 2006. Data quality of population and vital statistics in Caucasian countries in post-soviet period, in: Institute for Demography and Social Studies (éd.)*, Mortality in countries of the former USSR. Fifteen years after break-up: change or continuity? International seminar, Kiev, 12-14 October 2006, Vol. 2,* p. 6-27. – Kiev: IDSS, CDHE, MPIDR, INED, IUSSP, UNFPA, 302 p.

MESLE, France, Vladimir SHKOLNIKOV, Véronique HERTRICH, and Jacques VALLIN. 1996. *Tendances récentes de la mortalité par cause en Russie, 1965-1994* [Recent trends in cause-specific mortality in Russia]. Paris : INED, 140 p.

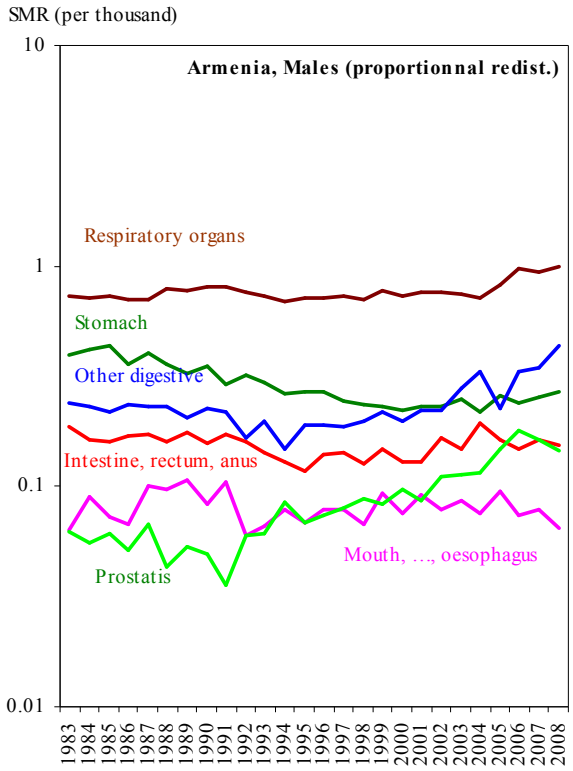
SHKOLNIKOV, Vladimir, France MESLÉ, and Jacques VALLIN. 1996. Health crisis in Russia. I. Recent trends in life expectancy and causes of death from 1970 to 1993, *Population, an English Selection*, Vol. 8, p.123-154.

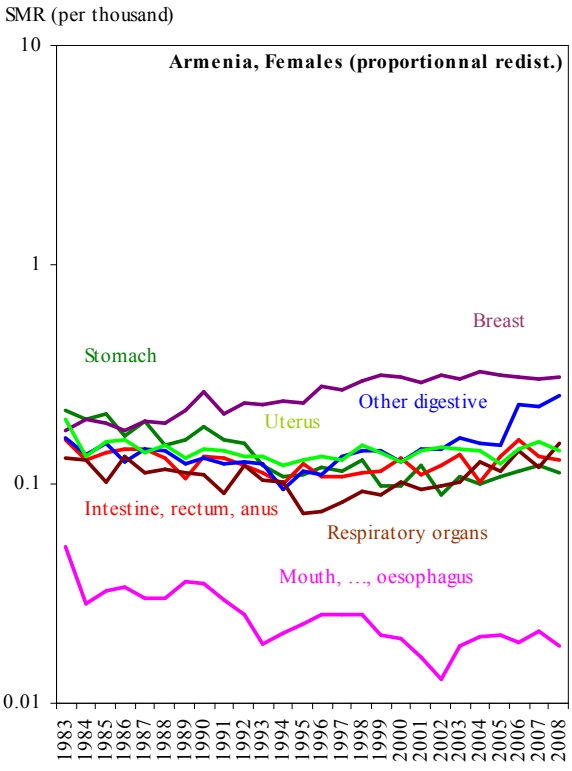
VALLIN Jacques, and France MESLE. 1988. *Les causes de décès en France de 1925 à 1978* [Causes of death in France from 1925 to 1978]. Paris : INED-PUF (Travaux et Documents, Cahier n°115), XX-607 p.

Annex 1. Standardized death rates for large groups of causes, without redistribution of ill-defined and unknown causes in Georgia. 1983-2008, without any correction for 2004



Annex 2. Cancer mortality trends in Armenia (specific locations)





Annex 3. Digestive mortality trends in Armenia