Olga PENINA*, France MESLÉ**, Jacques VALLIN**

Correcting for Under-Estimation of Infant Mortality in Moldova

In the countries of the former Soviet Union, life expectancy has fluctuated erratically over recent decades. Everywhere, the general trend is one of stagnation or, in some cases, of decline. But this underlying pattern is punctuated by major disruptions linked to particular circumstances or events. Gorbachev's anti-alcohol campaign, the grave economic and social crisis following the collapse of Communism and the abrupt transition to a market economy all produced large fluctuations in mortality (Grigoriev et al., 2010; Meslé and Vallin, 2003; Meslé et al., 1994, 1998, 2006; Shkolnikov et al., 1995; Shkolnikov and Nemtsov, 1997). In some of these countries, however, changes in statistical data quality may produce a distorted picture of actual trends. This is notably the case in Georgia and Armenia, where registration of deaths, and estimations of migration and of reference populations are all highly problematic, as shown by a recent detailed study (Duthé et al., 2010). The same is true, though to a lesser extent, in Moldova, where infant death registration improved substantially in the 1970s, but still remains imperfect today.

In order to follow long-term mortality trends in this country and analyse the various factors at play, notably by studying causes of death, a vital first step is to determine the extent of under-registration, particularly of deaths at young ages, so that its effects can be taken into account. The purpose of this paper is to re-estimate Moldavian infant mortality trends since the Second World War.

Two types of infant mortality under-estimation must be distinguished here. The most important is linked to genuine under-registration of infant deaths in Moldova up to the mid 1970s. The second, less crucial, question concerns the problem of defining live births and hence the very notion of infant mortality.

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I. Improved registration in the 1970s

After the spectacular decline in Soviet infant mortality after the Second World War which closed much of the gap between the USSR and Western Europe, a sudden trend reversal was observed in the 1970s, hastily interpreted by the West as clear proof of the failure of the Soviet system. As a consequence, the authorities ceased issuing detailed information on mortality (notably by age and, above all, by cause) from 1974. While it is true that the Communist regimes, in the USSR as in the other Comecon countries, totally failed in the late 1960s to enter the "cardiovascular revolution" initiated by Western countries and experienced a spectacular increase in adult mortality (among men especially), the case of infant mortality is quite different.

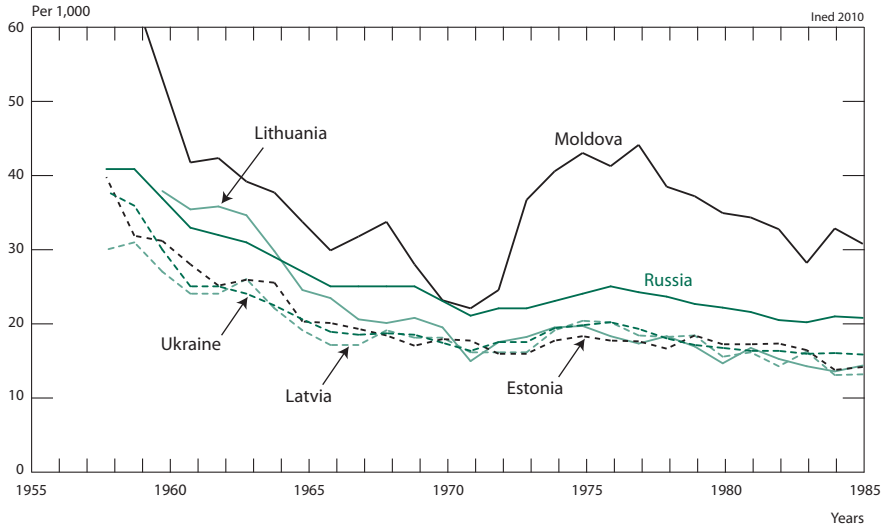
For V. Petukhov and O. Nikolaev (1981; cited in an unpublished document by Carlson and Bernstam referred to by Velkoff and Miller, 1995) this increase in Soviet infant mortality reflected a change in health strategy implemented in the late 1960s which involved withdrawing certain facilities (midwives and paediatric beds in village healthcare units) from villages with fewer than 700 inhabitants (90% of the Soviet rural population in 1970), on the grounds that they were under-used. This may indeed have caused an infant mortality upsurge in rural areas. However, if this hypothesis were true, the effects would doubtless have become visible before 1970. Yet infant mortality continued to decline up to the early 1970s, and the trend reversal did not begin until 1972.

B. Anderson and B. Silver (1986) were the first to point out that this renewed increase in infant mortality was probably due more to improvements in registration than to a real deterioration in newborn survival. Referring to declarations by R. K. Ignat'eva,[(1)] they mention that in 1970 the Soviet Central Statistical Administration (Tsentral'noe statisticheskoe upravlenie, TsSU) established specific sets of tables for perinatal mortality for each republic and for the Soviet Union as a whole (Ignat'eva et al., 1981). To construct these tables, the TsSU needed more precise information on deaths occurring in the first week of life, which it duly requested from the civil registration offices, the ZAGs (Zapis'aktov grazhdanskogo sostoianiia) of the different republics. The ZAGs were thus obliged to pay closer attention to the distinction between still and live births, and in areas where under-registration was evident, to ensure that all deaths were effectively registered. Finally, to clarify its requirements on a permanent official basis, the TsSU introduced a "certificate of perinatal death" (*svidetel'stvo o perinatal'noi smerti*). Of course, the effects of this new focus on perinatal deaths varied from one republic to another, depending on the extent to which infant mortality (notably neonatal death, but not exclusively) was actually under-registered.

(1) At the conference to issue recommendations on the definition and collection of perinatal mortality data in the context of the 9th revision of the International Classification of Diseases published in 1975.

Figure 1 shows clearly that in the European part of the former USSR, Moldova is the country where the apparent upsurge in infant mortality was by far the strongest, indicating equally clearly that under-registration was a severe problem in that country. The sudden leap in infant mortality in 1973 is particularly spectacular. The infant mortality rate, which stood at 24.5 per 1,000 in 1972, rose by more than 50% to 36.8 per 1,000. Almost 60% of the total increase observed between the low of 1971 (22 per 1,000) and the peak of 1975 (43.2 per 1,000) occurred in 1973 alone. This suggests that the impact of the new TsSU instructions on registration practices was strongest in that year. We will therefore concentrate on what happened between 1972 and 1973 to attempt an estimate of the degree of under-registration and to adjust the data accordingly.

Figure 1. Infant mortality rates recorded in Moldova, 1959-1985, compared with those of Russia, Ukraine and selected Baltic countries

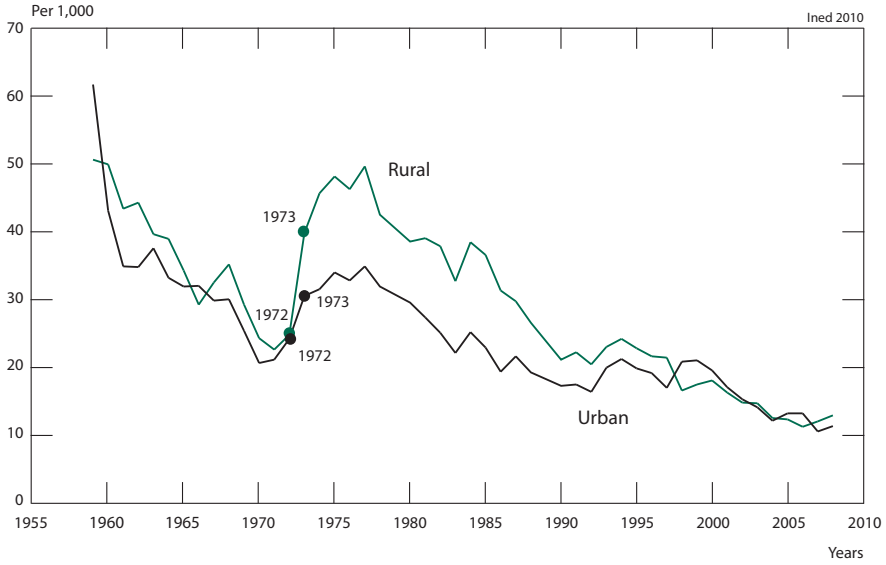


Source: Authors' calculations from archives or from data published by the statistical offices: before 1991, Goskomstat USSR; after 1991, Latvian Central Statistical Bureau, Rosstat, National Bureau of Statistics of Moldova, Statistics Estonia, Statistics Lithuania, Ukrainian State Committee of Statistics.

The observed increase in infant mortality is much higher in rural than in urban areas (Figure 2). Yet this is not proof of a worsening situation due to the withdrawal of certain health facilities from villages of below 700 inhabitants, but rather testifies to an improvement in registration. Indeed, the increase, though smaller, is equally manifest in urban areas, notably in 1973. The stronger rural increase is probably due simply to much higher rural under-registration.

Improved registration produced a sharp increase in the figures for early neonatal mortality (0-6 days), whose level was similar to that of late neonatal

Figure 2. Rural and urban infant mortality rates recorded in Moldova since 1959



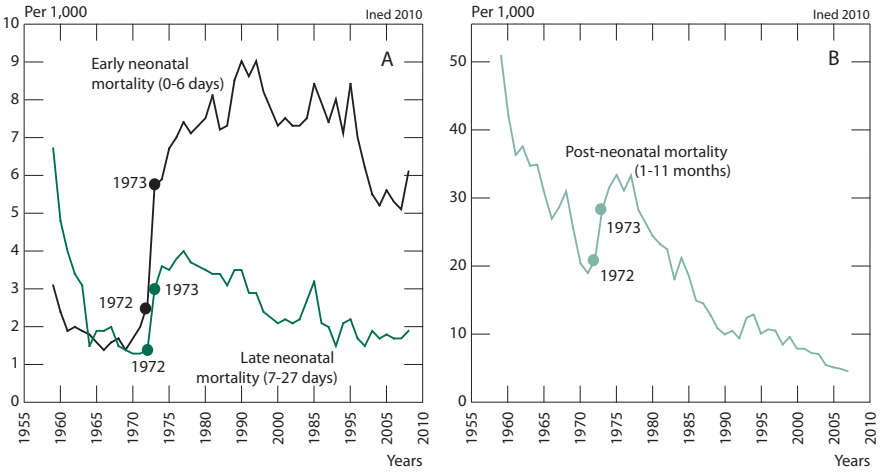
Source: Authors' calculations from archives or from data published by the National Bureau of Statistics of Moldova.

mortality (7-27 days) in the early 1970s but leapt suddenly – by a remarkable 120% – in 1973. Late neonatal mortality also rose sharply, however (+110%). Post-neonatal mortality (4 weeks – 11 months) increased much less than neonatal mortality in relative terms (+38%), but contributed strongly to the rise in overall infant mortality (Figure 3).

Without a doubt, the apparent increase in early neonatal mortality was due mainly to efforts by the statistical authorities to establish accurate records of mortality in the first days of life by distinguishing clearly between early neonatal and late fetal deaths. It is equally plausible that this new focus on accurate registration also had a major knock-on effect on the recording of late neonatal mortality and even – to a lesser extent – of post-neonatal mortality. Hence, not only did the improved recording of premature births produce an apparent increase in mortality beyond the early neonatal period, but above all, the context created by the directive on registration of early deaths had a generally beneficial effect on registration of infant mortality which extended beyond the neonatal period.

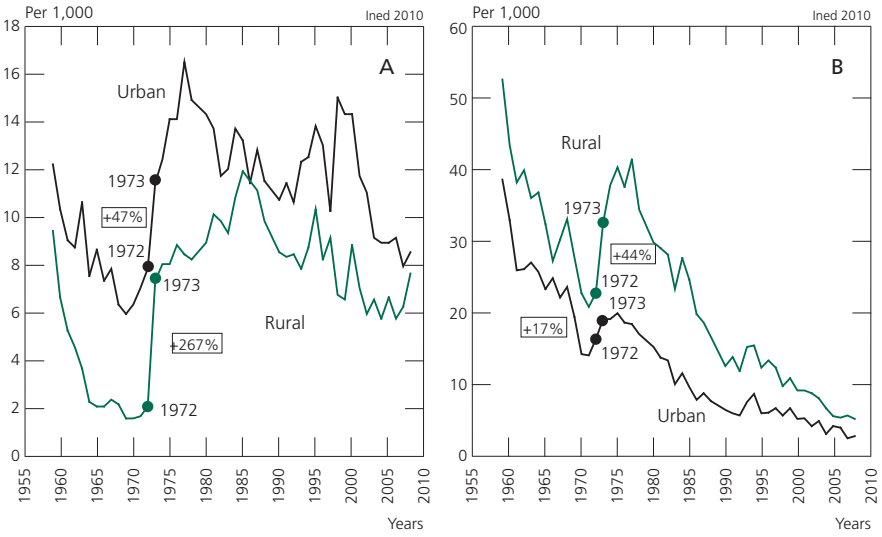
Figure 4 shows that the mortality increase observed in 1973 was much stronger in rural than in urban areas, both for neonatal mortality (267% versus 47%) and for post-neonatal mortality (44% versus 17%). As a result, the urban-rural gap in neonatal mortality has since become much narrower (rural neonatal mortality was curiously much lower than urban neonatal mortality before 1973).

Figure 3. Early neonatal (0-6 days) and late neonatal (7-27 days) mortality rates (A), and post-neonatal mortality rates (B) recorded in Moldova since 1959



Source: Authors' calculations from archives or from data published by the National Bureau of Statistics of Moldova.

Figure 4. Rural and urban neonatal mortality (A) and post-neonatal mortality (B) recorded in Moldova since 1959



Source: Authors' calculations from archives or from data published by the National Bureau of Statistics of Moldova.

The fact that a gap nonetheless remains could be interpreted as a sign of under-estimation that persisted well beyond 1973. In fact, neonatal mortality continued to increase very sharply in rural areas until 1985, while in urban areas it started falling again from 1978. The low rural neonatal mortality still recorded today may no longer be a sign of under-registration, however, since it is likely that rural women with high-risk pregnancies (and hence with a higher risk of neonatal mortality) more often give birth in a town or city, especially now that there are fewer health facilities in small villages.

Last, the registration of stillbirths increased considerably over the same period, in rural areas especially. Contrary to the situation observed in certain western European countries, improved registration of neonatal deaths is not simply the result of a category transfer. This shows clearly that the problem arose not from poor knowledge of the distinction between stillbirths and infants born alive, but rather from indifference to the under-registration of deaths at early ages.

II. Correcting for under-registration in years prior to 1973

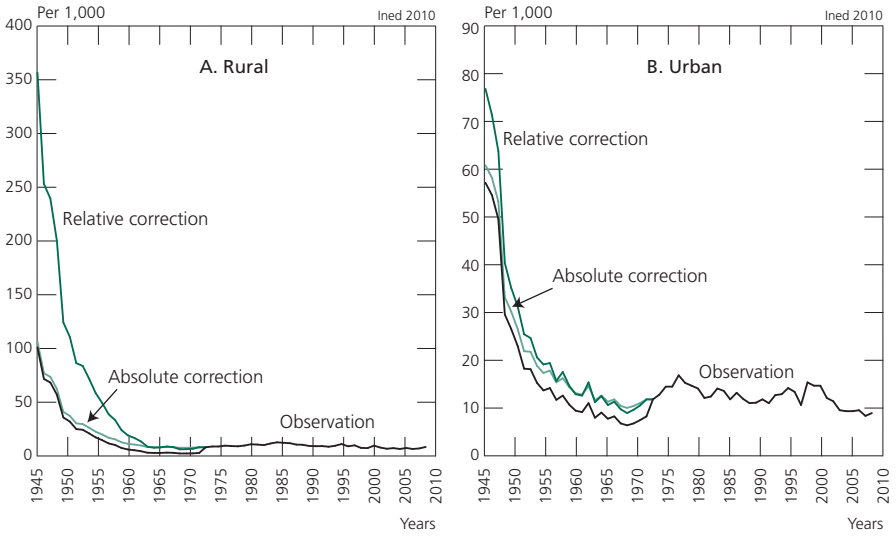
To re-estimate infant mortality in the countries of the former Soviet Union, Ward Kingkade and Cheryl Sawyer (2001) used mortality at ages 4-9 months to correct mortality at 0-3 months. Apart from the fact that their adjustments for Moldova only cover the years after 1988, by which time the problem examined here was no longer an issue, we believe that the method used is inappropriate, given that changes in registration practice introduced in the mid 1970s clearly also concerned post-neonatal mortality as a whole and not simply mortality at the very youngest ages. Rather than applying a theoretical coefficient of mortality structure by age, we prefer to focus more pragmatically on the size of the 1972-1974 upsurge to estimate the effect of changes in practice on registration.

We cannot assume without risk that the totality of this increase is due to improved registration. Despite the many arguments in favour of this assumption, it would be imprudent to totally refute the thesis of a genuine upsurge in infant mortality in the early 1970s (Davis and Feshback, 1980). However, we have no obvious means to distinguish between actual mortality and apparent mortality due to improved registration. We therefore chose a minimal adjustment option, which takes account solely of the sudden improvement observed in 1973 while excluding the more moderate progress of subsequent years. In doing so, we perhaps over-correct for 1973, when the actual rise in infant mortality may already have begun, and under-correct for 1974 and 1975, when registration may have continued to improve. However, Moldova is a small country, and while we can assume that the Moscow directives were applied with a timing that varied between the different republics of the USSR, it is unlikely that this timing diverged substantially within Moldova itself. However, to give an idea of possible error, we will compare this default estimate with an overestimate that attributes the entire 1972-1974 increase to improved registration alone.

To re-estimate infant mortality in the years preceding 1973 by attributing the sudden rise in 1973 to improved registration, we naturally distinguished both between neonatal and post-neonatal deaths, and between rural and urban contexts so that the enormous differences observed between these four categories could be taken into account.

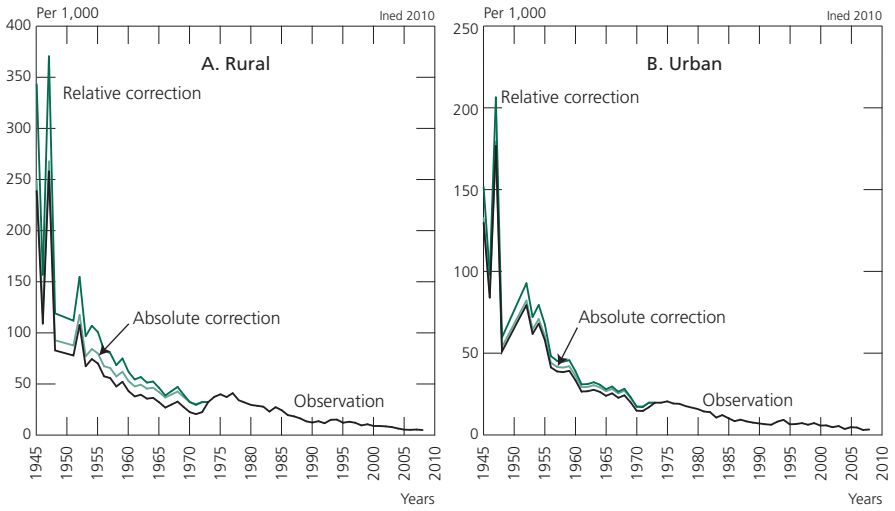
Two different methods can be used. The most "natural" method is to reason in terms of under-registration rate. We consider that the relative increase in number of deaths observed between 1972 and 1973 corresponds to this rate and we apply it to the numbers of deaths observed in each previous year, based on the (minimalist) assumption that under-registration was constant. However, while such a procedure works well for post-neonatal mortality, it is less obviously the right choice for neonatal mortality. The number of post-neonatal deaths depends entirely on the health conditions of the time and it is reasonable to believe that the number of missing deaths is directly linked to the number of reported ones. It might, at a stretch, even become more than proportional as we go back in time, assuming that registration improvements were already under way before the reform. Neonatal mortality, on the other hand, is only partly dependant on the health conditions of the time. It is also largely governed by the proportion of fragile newborns who were unlikely to survive. At a time when pregnancy monitoring and perinatal medicine were still not widely available, this proportion must have been partly independent of health conditions. In fact, Figure 5A shows that if we applied a constant under-registration rate, we would obtain rural neonatal death rates of more than 200 per 1,000 in the

Figure 5. Rates of rural (A) and urban (B) neonatal mortality re-estimated after relative or absolute correction



Source: Authors' calculations from archives or from data published by the National Bureau of Statistics of Moldova.

Figure 6. Rates of rural (A) and urban (B) post-neonatal mortality re-estimated after relative or absolute correction



Source: Authors' calculations from archives or from data published by the National Bureau of Statistics of Moldova.

early 1950s, and even 350 per 1,000 in 1945, a level which has never been observed anywhere.

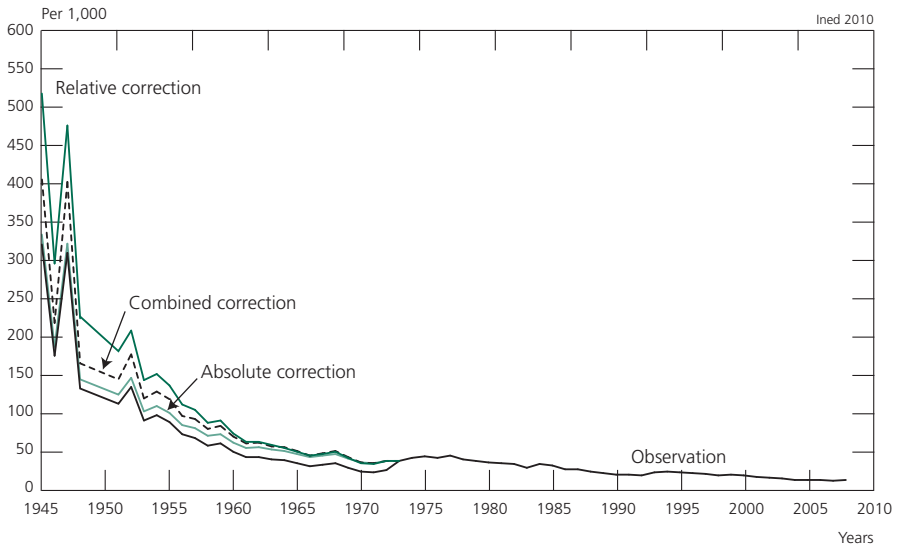
Another approach involves applying the absolute difference observed between the 1972 and 1973 rates to all the previous years. This probably leads to under-estimation of under-registration that increases as we go backwards in time, but the error is certainly smaller, at least in rural areas. So we chose this method for neonatal mortality, preferring to make a minimum adjustment rather than over-correct the existing data. In urban areas (Figure 5B), the correction difference is much smaller, but for the sake of consistency in our assumptions, we also adopt an absolute correction of neonatal mortality.

By contrast, for post-neonatal mortality, relative correction produces re-estimations that are quite acceptable and more plausible than absolute correction, for both urban and rural areas (Figure 6). This type of mortality is much more sensitive than neonatal mortality to the external context and hence to the severe crises of the 1940s and 1950s, notably the 1947 famine which affected Moldova and many other regions of Russia and Ukraine (Adamets, 2002).

Figure 7 shows the final adjusted rates for years prior to 1973 obtained using this combined method (absolute for neonatal and relative for post-neonatal) compared with those obtained by applying absolute or relative correction to both components of infant mortality.

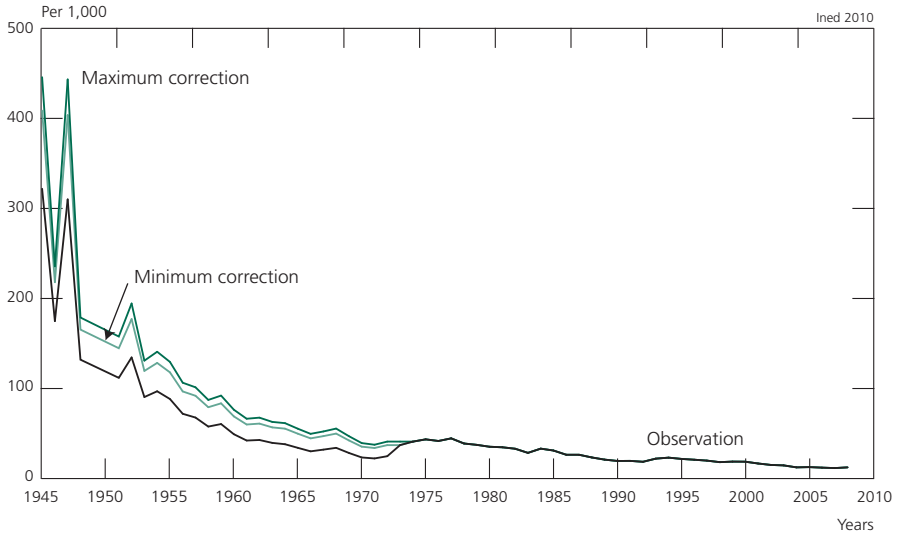
Last, Figure 8 illustrates the difference between re-estimated infant mortality obtained using this method and that obtained if the entire observed upsurge

Figure 7. Infant mortality rates for the whole of Moldova re-estimated after relative, absolute or combined correction



Source: Authors' calculations from archives or from data published by the National Bureau of Statistics of Moldova.

Figure 8. Re-estimated infant mortality taking account of the sudden 1973 upsurge only (minimum correction) plus that of 1974 (maximum correction)



Source: Authors' calculations from archives or from data published by the National Bureau of Statistics of Moldova.

in infant deaths from 1972 to 1974 is taken into account. The difference is quite small (around 20%). Moreover, for all the reasons mentioned above, the minimum correction is closer to reality than the maximum one. By selecting it, we are unlikely to under-estimate reality by more than 5%.

III. Application of WHO definitions

Despite this improvement in the registration of infant deaths in the 1970s, Moldavian infant mortality has remained slightly under-estimated to this day because the definition of live birth used in the country includes restrictions that the World Health Organization (WHO) no longer applies. For WHO, all newborns showing a sign of life must be considered as born alive, whatever their weight or gestational age, even if they die just a few moments after birth.(2) Moldova, on the other hand, continues to apply the Soviet definition, which considered infants presenting a sign of life as live born only if they had a gestational age of 28 weeks at least, weighed more than 1,000 grams and measured more than 35 centimetres. One way to estimate the impact of this difference on the measurement of Moldavian infant mortality is to see how the transition to the WHO standard affected mortality statistics in the former Soviet countries where it was adopted.

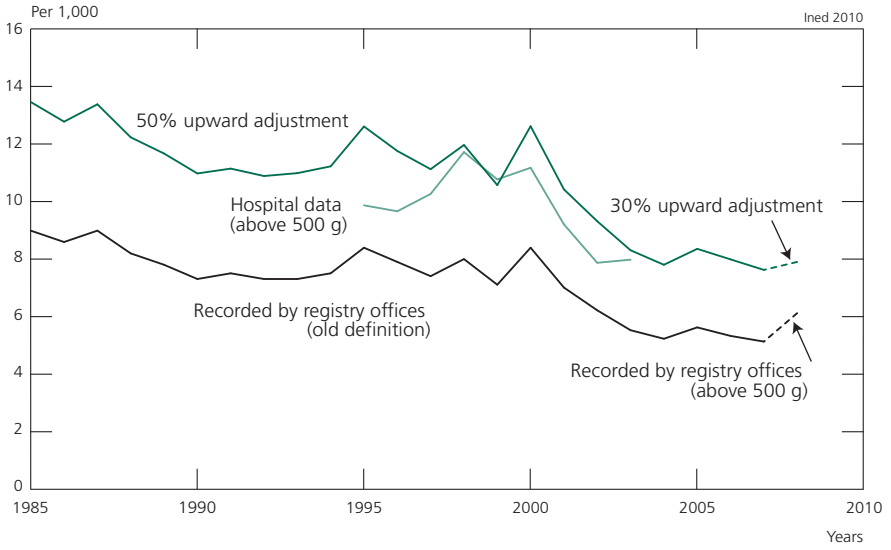
The Baltic countries made the change just after independence, Latvia and Lithuania in 1991 and Estonia in 1992 (Estonian Medical Statistics Bureau et al., 1993), immediately giving rise to a sudden break in the regularity of the corresponding statistical series. For these republics, an estimated 50% of the increase in early neonatal mortality (0-6 days) was attributable to this change of definition (Shkolnikov et al., 1995). In theory, Russia adopted a definition close to that of the WHO in 1993. However, the decision had little effect, since a circular was sent to the registry offices requiring them to continue the practice of registering as live born only those infants who weighed more than 1,000 grams. The only difference with respect to the situation prior to 1993 is the lifting of the restrictions on gestational age and on size. The observed break in the infant mortality statistics (incidentally, very difficult to interpret(3)) is not a good reference, therefore.

In Ukraine, the WHO definition was not adopted until 2007, but an initial improvement in registration seems to have occurred in 2005 when the 10th revision of the International Classification of Diseases was brought into

(2) The WHO defines live birth as follows: "complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of the pregnancy, which, after such separation, breathes or shows any other evidence of life – e.g. beating of the heart, pulsation of the umbilical cord or definite movement of voluntary muscles – whether or not the umbilical cord has been cut or the placenta is attached. Each product of such a birth is considered live born" (WHO, 1977).

(3) In fact, the 1993 increase in infant mortality mainly concerns post-neonatal mortality and only marginally neonatal mortality. This suggests that it may have been due mainly to the severe economic and social crisis affecting Russia at that time.

Figure 9. Early neonatal mortality rates based on registered births and deaths (before and after the 50% upward adjustment) and based on hospital data



Source: Authors' calculations based on data from archives or published by the National Bureau of Statistics of Moldova and the Moldavian Ministry of Health.

use. The break observed in 2007 must therefore be aggregated with that of 2005 to fully capture the effect of the new WHO definition. This gives us a change whose order of magnitude is similar to that observed in 1991-1992 in the Baltic countries: a 50% increase in registered early neonatal deaths (Meslé and Vallin, 2007).

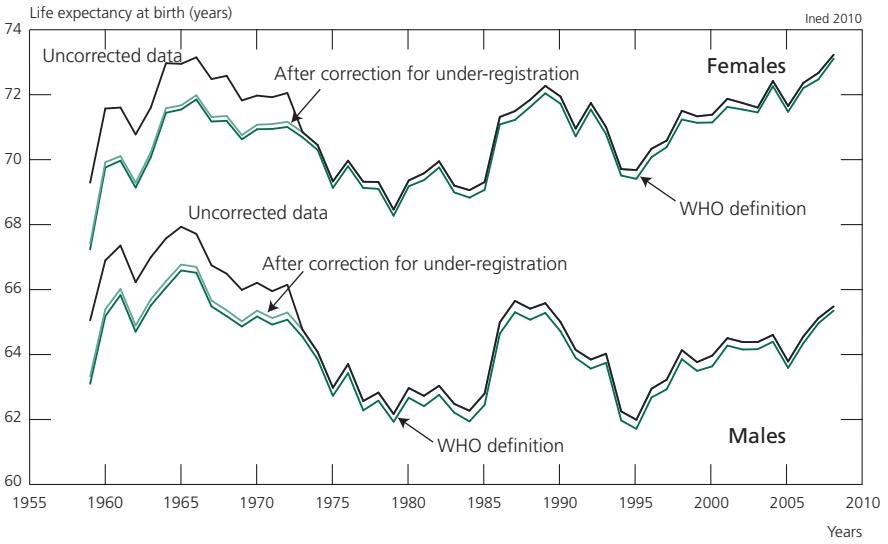
Since 2008, Moldova has adopted a new definition of live birth with a minimum gestational age of 22 weeks and a minimum weight of 500 grams, which is very similar to the WHO definition. However, these new criteria have only increased the number of registered neonatal deaths by 20%, suggesting that registration probably remains incomplete. Referring to the Baltic precedent, we therefore decided to increase early neonatal mortality by 50% for all years preceding 2008 and by 30% in 2008.

In fact, an initial attempt was made in 1995 by the health services (and not by the registry offices) to register as live births all newborns weighing more than 500 grams with a gestational age of 22 weeks or more who presented any evidence of life. The results for the available years (1995-2003) are very close to our own upward adjusted estimates (Figure 9).

IV. A readjustment of trends in life expectancy at birth

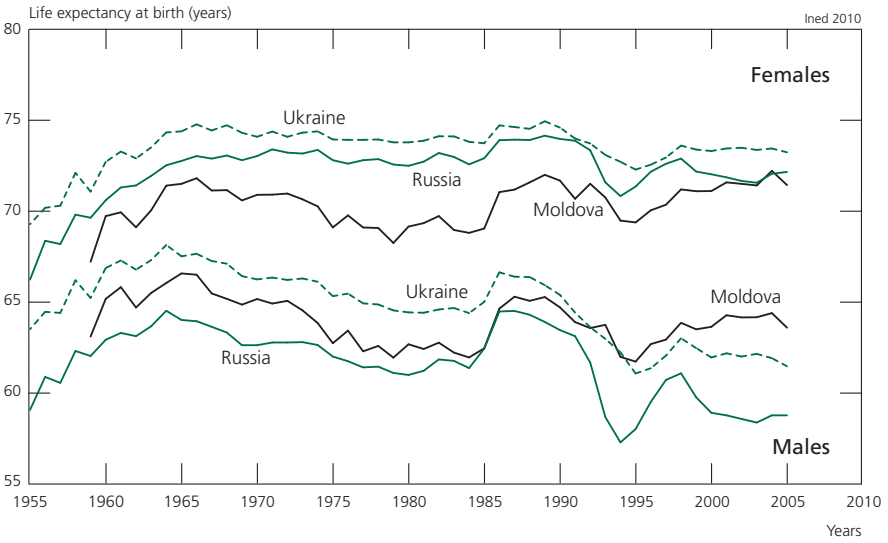
Figure 10 illustrates the respective consequences of these two infant mortality adjustments. The second correction (to current WHO standards) has

Figure 10. Re-estimated trends in life expectancy at birth since the late 1950s



Source: Authors' calculations from archives or from data published by the National Bureau of Statistics of Moldova.

Figure 11. Comparative trends in life expectancy at birth since the late 1950s: Moldova, Russia and Ukraine



Source: Moldova, authors' calculations; Russia (Meslé et al., 2003); Ukraine (Meslé and Vallin, 2003).

only a modest effect on life expectancy (around 0.1 or 0.2 years), but taking account of registration improvements in the early 1970s not only changes life expectancy by a substantial 1 to 2 years, but also affects the trend observed before the mid 1970s, since it is limited to this period. For males, the new estimation of the life expectancy decrease between 1965 and 1985 appears much more regular and more consistent with trends observed in European countries under Communist rule at that time. Figure 11 permits comparison with Russia and Ukraine, whose infant mortality data have been corrected using the same method (Meslé et al., 2003, Meslé and Vallin, 2003).

For females, the correction of infant mortality makes the decline more regular by removing the sudden acceleration of 1973. The comparison with Russia and Ukraine reveals a striking divergence, with a decline in female life expectancy equal to that of males, while in Ukraine and Russia, females were much less adversely affected by the deteriorating health conditions. The less favourable female health trend in Moldova, the poorest European country of the former Soviet Union, is probably linked to the fact that Moldova is also the country where Mediterranean tradition weighs most heavily on women's status.

As part of the general objective to establish more consistent historical series of mortality by age and cause, a detailed study of causes of death, notably those more sensitive to socioeconomic conditions and to the status of women in particular, will shed new light on this question. More generally, the mortality patterns specific to Moldova will be understood more clearly through a comparison with trends already observed in other European republics of the former Soviet Union.

Keywords: neonatal and infant mortality, life expectancy, under-registration, Moldova, Soviet statistics.

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Olga Penina, France Meslé, Jacques Vallin • **Correcting for under-estimation of infant mortality in Moldova**

In certain countries of the former Soviet Union, apparent mortality trends are distorted by phases of improvement or deterioration in data quality. In Moldova, the quality of infant mortality statistics improved suddenly in the 1970s, but still poses problems to this day. The change in the 1970s is of particular importance, since by turning their attention to perinatal mortality, the authorities brought to light a more general problem of under-registration of infant deaths. In addition, although Moldova finally adopted the WHO definition of live birth in 2008, a small proportion of neonatal deaths still remains unregistered. This short paper examines infant mortality trends in Moldova since 1945, after correction for this observation bias, and analyses the effect of these corrections on life expectancy.

Olga Penina, France Meslé, Jacques Vallin • **Comment corriger la sous-estimation de la mortalité infantile moldave ?**

Dans certains pays de l'ex-URSS, les évolutions apparentes de la mortalité sont perturbées par des phases d'amélioration ou de dégradation de la qualité des statistiques. En Moldavie, la qualité de la mesure de la mortalité infantile s'est brusquement améliorée au début des années 1970, mais continue de poser quelques problèmes jusqu'à ce jour. Le changement des années 1970 est particulièrement important car l'attention alors portée par les autorités à la mortalité périnatale a mis à jour un sous-enregistrement plus général des décès infantiles. Par ailleurs, ce n'est qu'en 2008 que la Moldavie a adopté la définition OMS de la naissance vivante, sans pour autant que la part de décès néonataux échappant à l'enregistrement ait été totalement résorbée. Cette note de recherche propose de retracer l'évolution de la mortalité infantile moldave depuis 1945, corrigée de ces biais d'observation, et d'apprécier l'effet de ces corrections sur l'espérance de vie.

Olga Penina, France Meslé, Jacques Vallin • **Cómo corregir la sub-estimación de la mortalidad infantil moldava**

En ciertos países de la ex-URSS, la evolución aparente de la mortalidad está perturbada por fases de mejora o de de degradación de la calidad estadística de los datos. En Moldavia, la calidad de la medida de la mortalidad infantil ha mejorado bruscamente al principio de los años 1970, pero continúa planteando ciertos problemas hasta hoy incluido. El cambio de los años 1970 es particularmente importante porque la atención aportada entonces por las autoridades a la mortalidad perinatal reveló un subregistro más general de las muertes infantiles. Por otro lado, es sólo en 2008 que Moldavia ha adoptado la definición OMS del nacido vivo, aunque la parte de muertes neonatales que escapan al registro no ha sido hasta ahora completamente resorbida. Esta nota de investigación, se propone reexaminar la evolución de la mortalidad infantil moldava desde 1945, corregida de los mencionados sesgos de observación, y apreciar el efecto de estas correcciones sobre la esperanza de vida.

Translated by Catriona Dutreuilh.