GENUS, **LVIII** (n. 1), 9-51

GRAZIELLA CASELLI – FRANCE MESLÉ – JACQUES VALLIN

Epidemiologic transition theory exceptions

1. INTRODUCTION

Abdel Omran's 1971 theory of epidemiological transition is an attempt to account for the extraordinary advances in health care made in industrialized countries since the 18th century. According to Omran, all societies experience three "ages" in the process of modernization: the "age of pestilence and famine", during which mortality is high and fluctuating, with an average life expectancy under 30 years; the "age of receding pandemics", during with life expectancy rises considerably, from under 30 to over 50[1]; and the "age of degenerative and man-made diseases", during which the pace of the mortality decrease slackens, while the disappearance of infectious diseases increases the visibility of degenerative diseases, while man-made diseases become more and more frequent. At the time Abdel Omran was developing his theory of epidemiologic transition, the most competent specialists, along with United Nations experts, saw life expectancies as generally converging towards a maximum age, the most advanced countries seeming very close to it. According to the United Nations World Population Prospects, the point of convergence was 75 years (United Nations, 1975). And as things now stand in the most advanced countries, the increase in life expectancy has slowed down since the 1960s and in some countries has even halted, in particular as concerns men.

The "cardiovascular revolution" of the 1970s launched a new period of progress. However, Jay Olshansky and Brian Ault (1986), followed by Richard Rogers and Robert Hackenberg (1987), without criticizing the basic premises of the theory of epidemiologic transition, introduced the idea of a "fourth stage"[2] during which the maximum point of convergence of life expectancies would seem to increase thanks to achievements in the treatment of cardiovascular diseases. Jay Olshansky *et al.* (1990) set this new

[1] See also Caselli (1991) for a description of epidemiologic changes in Europe at the turn of the 20th century.

[2] Olshansky and Ault: "A fourth stage of the epidemiologic transition". The others refer to a "new" or "hybristic" stage.

maximum at 85 years, the same as that chosen by the United Nations at the end of the 1980s for all countries (United Nations, 1989).

Today, the 85-year threshold is strongly criticized by many authors who believe that such a limit cannot be determined (Barbi *et al.*, 1999; Vaupel, 2001; Carey and Judge, 2001). However, our aim in this article is not to discuss this aspect of the epidemiologic transition, but to study the numerous exceptions observed since the 1960s in the general trend of increasing life expectancy. Not only have many countries (in particular Eastern European countries) lacked the means to experience the "cardiovascular revolution", but a number of others, especially in Africa, have not yet completed the second phase of the epidemiologic transition and are now hard hit by the arrival of new epidemics such as AIDS, or by the reemergence of older diseases.

After a brief overview of the first "disruption" of the 1960s, which put an end in the advanced countries of the North to the convergence observed in previous decades, and of the second failure which affected countries of the South, in particular due to the AIDS epidemic, we will see that the fact that Africa has lagged behind the North can be interpreted as a failure to complete the second phase of the epidemiologic transition; in the third part of this article, we will examine the reasons why Eastern Europe has failed to enter the fourth phase.

2. FROM CONVERGENCE TO DIVERGENCE

At the time Abdel Omran was developing his theory of epidemiologic transition, events seemed to justify his views. The least-developed countries, in full transition, were gaining control over infectious diseases, and they seemed to be rapidly catching up with the most advanced countries; these, for their part, seemed to have reached a threshold, since the incidence of infectious diseases had been so far reduced that any further reduction could not represent any significant gain in the average life expectancy. What was most feared at the time was that some of these gains in life expectancy might be lost due to the increase in man-made diseases[3] – caused by smoking or car accidents, for instance; these dangers seemed more probable than the prospects of new progress in fields then thought to be governed by the

[3] "Man-made diseases" are diseases linked to the side effects of modernization (alcoholism, smoking, car accidents, *etc.*)

inevitable degeneration of age, such as cancer and cardiovascular diseases. Thus, towards the end of the 1950s, life expectancy in the United States had reached a threshold of about 70, and Russia and Japan were close to reaching that level (see Figure 1).

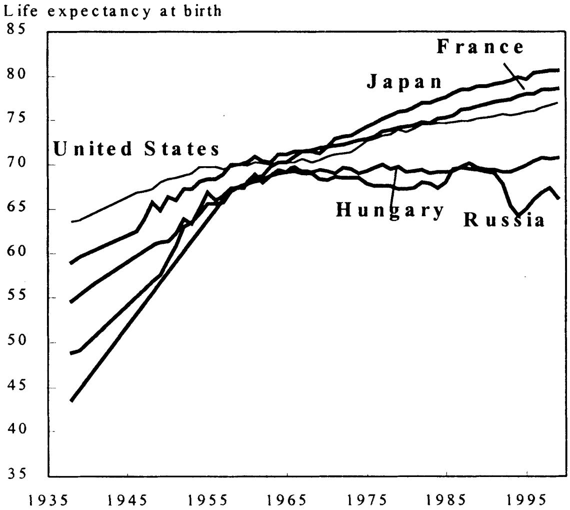
What Omran's theory could not foresee was that the rise of man-made diseases would be curbed by efficient policies, and especially, that a true revolution was going to take place in the treatment of cardio-vascular diseases. Towards the end of the 1960s, this revolution triggered new advances in life expectancy in countries where it had reached or even exceeded 70 years (Caselli, 1996). However, the countries which reached the latter level were not all able to enter this new phase of the health transition. In the mid-1960s, life expectancy in countries of Eastern Europe and the USSR began on the contrary to stagnate or even decline, due to an increase in mortality from cardiovascular diseases and to the spread of man-made diseases (linked in particular to alcoholism and violence).

The developing countries began their health transition process at a later stage, and by the early 1950s, their average life expectancies were much lower than those of developed countries. However, after World War II, most countries made huge progress and joined the general trend of convergence. Thus, from the 1950s to the 1990s, countries like Korea in Asia, Chile in Latin America, or Tunisia in Africa (to name but a few) nearly caught up with the countries of the North (see Figure 2A).

However, once again this pattern suffers many exceptions. On one hand, though the struggle against infectious diseases, especially tropical diseases, was at first successful, some countries, mainly in Africa, were unable to reach a pace of progress sufficient to reduce the gap separating them from developed countries. During the 1980s and 1990s, this pace began to slacken and in some cases all progress even ceased. For instance, Figure 2B shows that Nigeria, which began at the same level as Tunisia in the 1950s, was far less successful than the latter; today, life expectancy in Nigeria is 20 years shorter than in Tunisia. Worse still, and this is particularly true of Africa, the arrival of AIDS often caused severe reversals and towards the end of the 1980s, life expectancy levels suddenly dropped. This was the case in Zambia, which lost 11 years of life expectancy between 1980-1985 and 1995-2000, or in Zimbabwe, which lost almost 17 years of life expectancy during the same period (see Figure 2B). Today, Zambia's life expectancy has dropped back to its level of the early 1950s, that is, to 40 years, while Zimbabwe's life expectancy has fallen far below its 1950 level (42.9 as compared to 47.7).

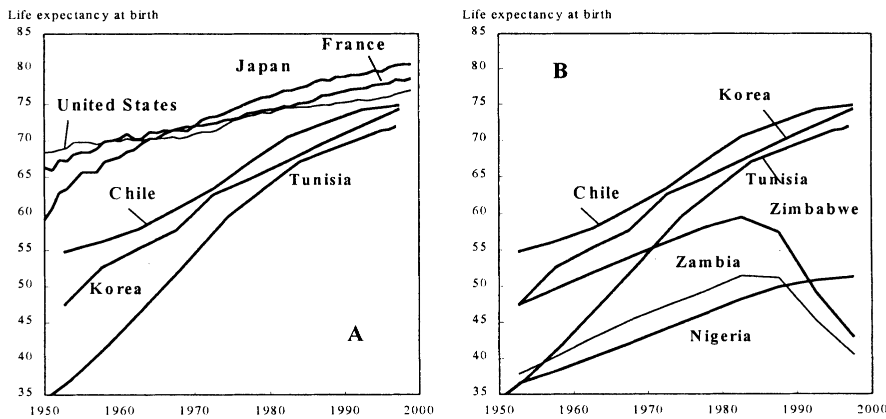
These disruptions strongly modify the overall pattern governing life expectancy trends until the 1970s.

Figure 1 – *Life expectancy trends since the 1930s: East-West convergence and divergence*



Sources: United States: Bureau of the census 1975, 1985, 1992, US Census Bureau 1999, Japan: Institute of population problems 1993, Nanjo *et al.* 1985, Statistics Bureau 2001, Russia: Shkolnikov *et al.* 1994, France: Vallin and Meslé 2001, other countries: United Nations 2001.

Figure 2 – *Changes in life expectancy since the 1950s : North-South convergences (A) and South-South divergences (B)*



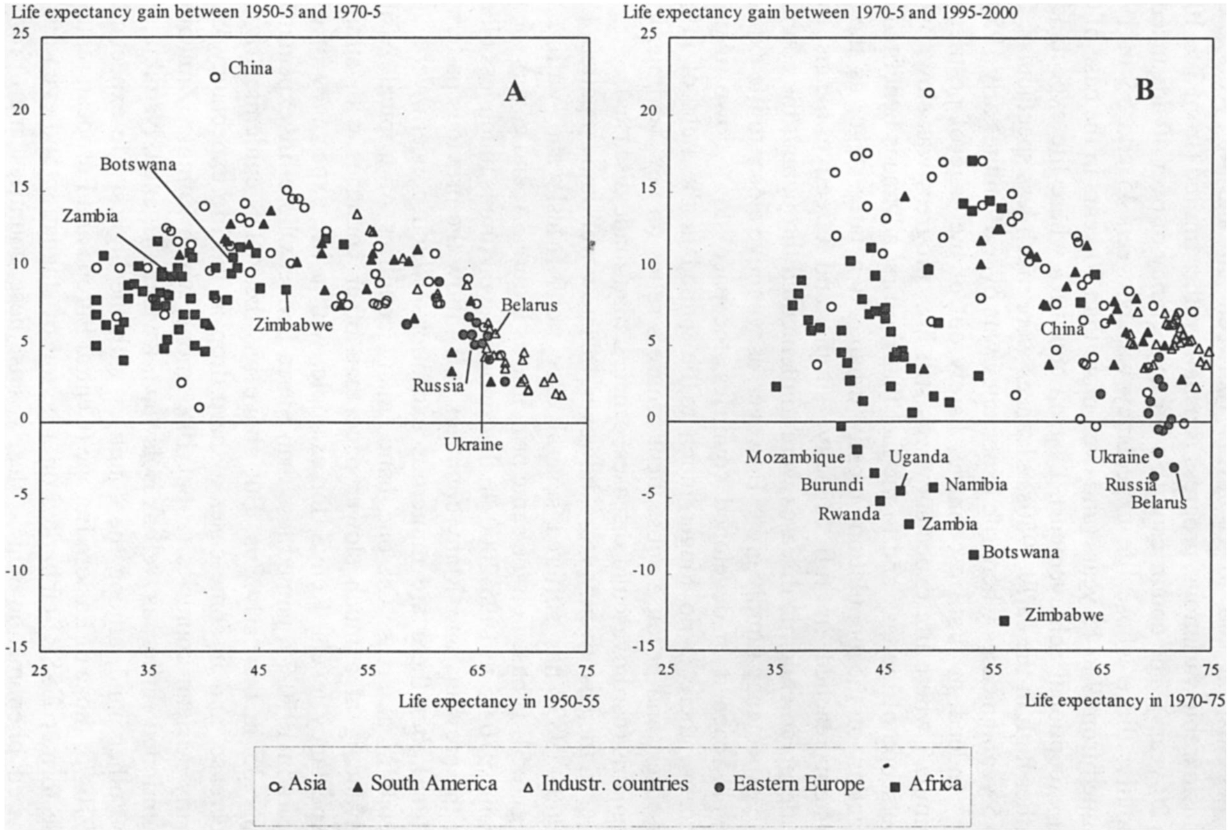
Source: United Nations 2001.

Figure 3A compares life expectancy gains between 1950-1955 and 1970-75 with the level reached by 1950-55. A glance to the figure clearly shows that at the lower levels (between 30 and 40 years), despite considerable variations, progress is usually rather limited (from 3 to 10 years in 20 years). The countries with a life expectancy of over 40 advanced more rapidly: those whose life expectancy was between 45 and 55 in 1950-55 gained from 9 to 15 years (and even more than 20 years in the case of China, an exceptional achievement). Last, in countries where life expectancy was rather high in the early 1950s, advances were much less spectacular: from 2 to 5 years in cases where life expectancy was over 65 in the early 1950s.

Indeed, at first, in countries barely out of the "age of pestilence and famine", where life expectancy was still low, progress was slow, owing to the scope of the task and to the fact that the first advances benefited only a fraction of the population, mostly urban. At a later stage, as the health system reached its full capacity, simple and effective means to curb widespread endemic diseases were implemented throughout the country and life expectancy rapidly grew. However, as we move closer to life expectancy levels reached in developed countries, the pace slows down again, both because there is no longer much to be gained in the field of infectious diseases, and because subsequent progress relies on new findings in other domains (cardiovascular diseases, cancers, man-made diseases).

In the past twenty years, however, this now well-known pattern (Vallin, 1968, 1989) has suffered several exceptions (Meslé and Vallin, 1997). Figure 3B is based on the same principle as Figure 3A, and covers the period from 1970-75 to 1995-2000. In this figure, the picture is much less clear than in the previous one. Many countries still follow the previous pattern (even China), but there are numerous exceptions which concern very specific geopolitical areas. On one hand, many countries of tropical Africa are advancing at a much slower pace than other countries with similar life expectancy levels. Kenya, for example, with a life expectancy of over 50 years in 1970-75, gained less than Sierra Leone, whose life expectancy was only 35 in the early 70s. But above all, the AIDS epidemic triggered a decrease, and in some cases a sharp drop in the life expectancy levels of many African countries (about 10), among which Zambia, Zimbabwe, as mentioned earlier, as well as Botswana, Rwanda, Uganda, Namibia, *etc.* On the other hand, among the countries with the highest life expectancies in 1970-75, those of Eastern Europe (Central Europe and European republics of the former USSR) embarked on a period of stagnation and even decline, a shared phenomenon which clearly sets these countries apart from other industrialized countries.

Figure 3 – *Relationship between initial level and life expectancy gains during two periods: A) from 1950-55 to 1970-75; B) from 1970-75 to 1995-2000*



These developments have radically modified the distribution of the world population in terms of life expectancy. Figure 4 illustrates, at three different points in time (1950-55, 1970-75 and 1995-2000), the cumulated populations of all the countries of the world, grouped per five-year sections of life expectancy at birth; developed and developing countries are identified separately, according to the UN definition (Figures 4A, B and C). The dominating trend, from one period to the next, is the massive convergence of southern levels towards northern levels. In 1950-55, the life expectancies of most of the developing countries hovered somewhere between 35 and 45 years, far behind most developed countries, which for the most part neared a life expectancy of 65-70. In 1970-75, the wealthy countries still remained a close-knit group, adding another five years to their life expectancy, but the poor countries suddenly broke into separate groups, with a large portion of their populations nearly catching up, in terms of life expectancy, with the rich countries. In 1995-2000, the change is even more marked, since the histogram of developing countries shows a very high concentration at the 60-70-year level, very close to the life expectancy level of most developed countries which for their part gain another 5 years.

However, Figure 4 also clearly shows that some regions were not included in the overall process of health improvement: Sub-Saharan Africa on the one hand and Eastern Europe on the other stand quite distinctly apart from their former groups, even though their relative weight in the total world population is minor compared to those that follow the traditional transitional phases. This paper will be devoted to the study of these two exceptions. To do so, it will be necessary to use various methodological approaches to face the heterogeneity of available data.

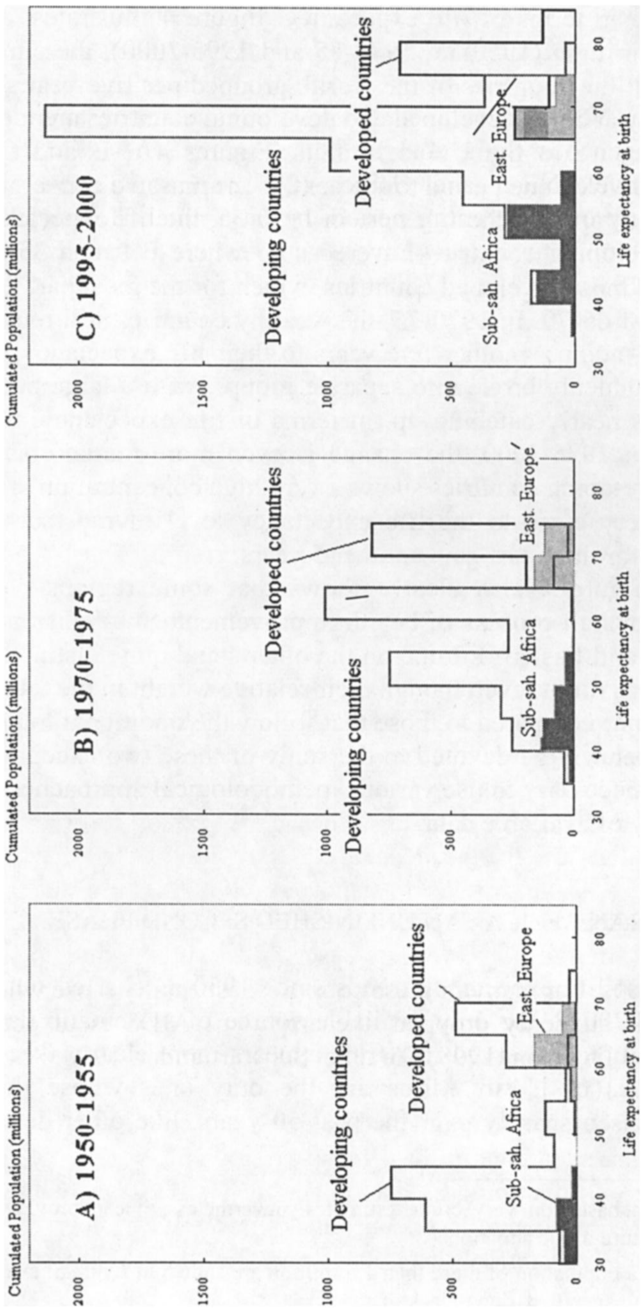
3. SUB-SAHARAN AFRICA : AN UNFINISHED SECOND PHASE

If we look at life expectancy trends since 1950 as charted out by the United Nations (2001), the only available source of systematic data[4], the diversity of situations observed in Africa appears more clearly (see Figure 5)[5]. The countries of North Africa are the only ones whose their life expectancy has risen sharply over the past 50 years, like other developing

[4] This data is often based on very crude estimates; nevertheless, it can provide a fairly plausible overall picture of the situation.

[5] All countries with a population of more than 1.5 million are shown in figure 5, even though their names are not all specified, due to lack of space.

Figure 4 – *Cumulated populations according to life expectancy levels*



countries which have succeeded in catching up with developed countries (see 1st graph of Figure 5).

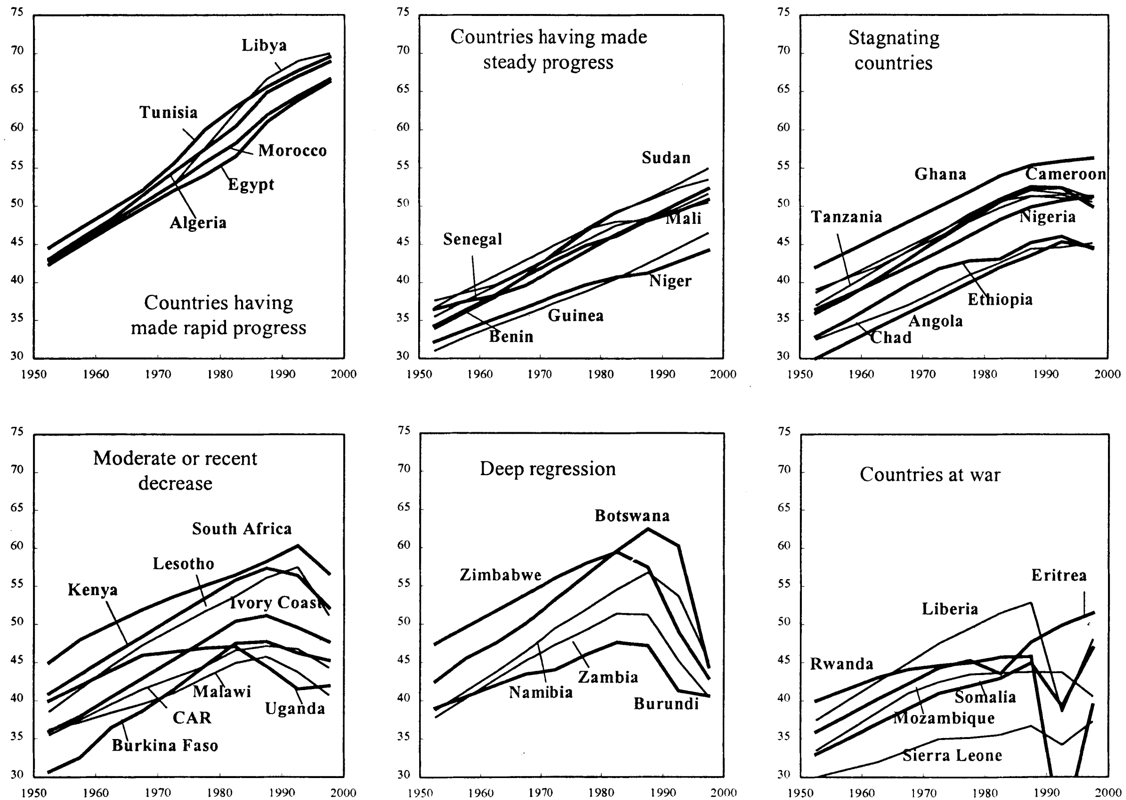
None of the countries of Sub-Saharan Africa have been able to follow suit, not even those whose life expectancy in 1950 was at the same level or higher than that of North Africa. In addition, as a region, Sub-Saharan Africa is far from homogeneous. Some countries, like Sudan, Senegal, Mali or, at a lower starting level, Niger and Guinea (2nd graph of Figure 5) have progressed steadily over the entire period, but at a much slower pace than average for developing countries. Many other countries (3rd graph, Figure 5) which until the 1980s had been following the same trend stopped in their tracks or even slightly regressed. This is the case of Ghana, Tanzania, Cameroon, Nigeria, Angola, *etc.*

Next are the countries whose life expectancy actually declined over the last two decades, either slightly, like Côte d'Ivoire, the Central African Republic or Burkina Faso, or too recently for purposes of evaluation, such as South Africa, Lesotho or Kenya, Uganda being somewhere in between (Figure 5, 4th graph); in other countries, the decline was very sharp, as in Botswana, Zimbabwe, Namibia and Zambia (5th graph). The 6th graph of Figure 5 illustrates the cases of countries where the increase of life expectancy was hampered in various ways by war or other forms of political violence.

In addition to the consequences of the latter situations, Sub-Saharan Africa faces two basic, though different problems. On one hand, it seems that unlike other developing countries, the countries of Sub-Saharan Africa failed to make rapid advances in the field of health once they had reached a certain level of life expectancy. At best, they managed to preserve the slow pace characteristic of the "take-off" phase. Thus, South Africa, which had already exceeded a 45-year life expectancy in the 1950s, did not progress any faster than Guinea or Chad, which had a life expectancy of barely over 30 years in 1950. In addition, in many cases, all progress stopped towards the end of the 1980s. For many of these countries, especially those where life expectancy levels suddenly dropped, the arrival of AIDS is of course to blame (Population Division, 1998; Caraël et Schwartländer, 1998; Awusabo-Asare *et al.*, 1997; IUSSP, 1997).

However, this disruption could also be due either to the economic crisis which hit Sub-Saharan Africa in the 1980s (Coussy and Vallin, 1996) or to the reappearance of infectious diseases other than AIDS – a reemergence linked indirectly with economic crisis, but doubtless with other factors as well (Feachem and Jamison, 1991; Gruénais and Pourtier, 2000).

Figure 5 – *Life expectancy at birth: trends since 1950 in all African countries with a population of over 1.5 million in 2000*



Source: United Nations, 2001.

3.1 Slower progress than might have been expected

Unfortunately, the only information at our disposal concerning age-specific and cause-specific death probabilities is incomplete. Concerning infant and child mortality, however, which in Sub-Saharan Africa determines for a large part life expectancy at birth, the data provided by various studies and in particular demographic health surveys (DHS-Demographic Health Survey) are a solid basis for analysis.

In almost all the African countries where several surveys have been carried out since the 1950s[6], infant and child mortality declined significantly, at least until the 1980s (Hill, 1989, 1991, 1993; Barbieri and Vallin, 1996, Timaeus, 1998). However, in all these countries, the pace of the decline was relatively slow.

Figure 6 compares the findings obtained for several countries where life expectancy grew relatively steadily, at least until the end of the 1980s, with infant-child mortality trends observed in Tunisia, a North African country where life expectancy followed the traditional pattern, in other words gained momentum after a slower "take-off" phase.

Towards 1950, according to the United Nations, Niger had one of the lowest life expectancies in the world: barely over 30 years. Today, its life expectancy is still under 45. Given such a low starting level, it is not surprising that the increase has been slow, and these UN estimates may even be optimistic. Indeed, according to the two demographic health surveys, the death probability between 0 and 5 years seems to have stagnated around 300 per 1,000 from the end of the 1970s until the beginning of the 1990s, and towards 1995, was still close to 275 per 1,000. If one looks at the national survey conducted just before Independence by the French national statistics institute (INSEE – *Institut national de la statistique et des études économiques*), it may be that the death probability has not even declined since the 1950s. These early figures, however, may have been an underestimation. Similarly, the 1992 DHS figures, for the 10-15 years preceding the survey, may also have been an underestimation, in which case, it is possible that life expectancy did increase, since at that stage it is very dependent on infant mortality. Nevertheless, it is clear that this country is now only at the very beginning of the second phase of Omran's

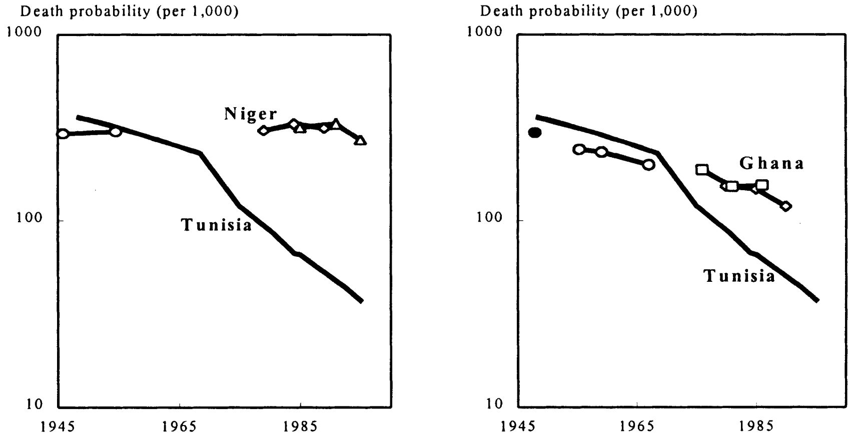
[6] World fertility survey, demographic health surveys, national specific surveys, *etc.* Overall, about thirty countries of Sub-Saharan Africa now have at least two precise surveys which can reveal a real trend.

epidemiologic transition. Infant mortality and infectious diseases still have a considerable impact on life expectancy.

The data for Ghana is more reliable. Even if, for the earlier periods, some data may be underestimated, infant and child mortality notably decreased until the end of the 1980s; however, unlike what happened in Tunisia, the pace of the decline did not accelerate. Whereas in Tunisia, the death probability suddenly plunged after reaching the level of 200 per 1,000, in Ghana no such acceleration occurred, even when the death probability dropped to 150, or even 120 per 1,000.

There are many such examples. Other than a few rare exceptions (see below for Zimbabwe), in most countries of Sub-Saharan Africa, infant and child mortality did not decrease rapidly and even today, there are very few countries where the infant and child death probability has dropped below 100 per 1,000[7].

Figure 6 – *Comparative trends of death probability between 0 and 5 years in two countries of Sub-Saharan Africa and in Tunisia*



Sources: Waltisperger *et al.*, 2001, for Tunisia; Hill, 1993, for the less recent data; Kourguéni *et al.*, 1993 and Attama *et al.*, 1999 for Niger, Timaeus, 1998, for Ghana.

[7] According to recent DHS surveys, the only countries in this case are: Botswana, whose probability had dropped to 50 per 1,000 before AIDS, South Africa, to 59 per 1,000 in 1996, Zimbabwe, to 77 per 1,000 in 1991 and Namibia, to 84 per 1,000 in 1989. The case of Kenya, to 96 per 1,000 in 1990, is more suspect (Timaeus, 1998).

3.2 The economic crisis, AIDS and the reemergence of infectious diseases

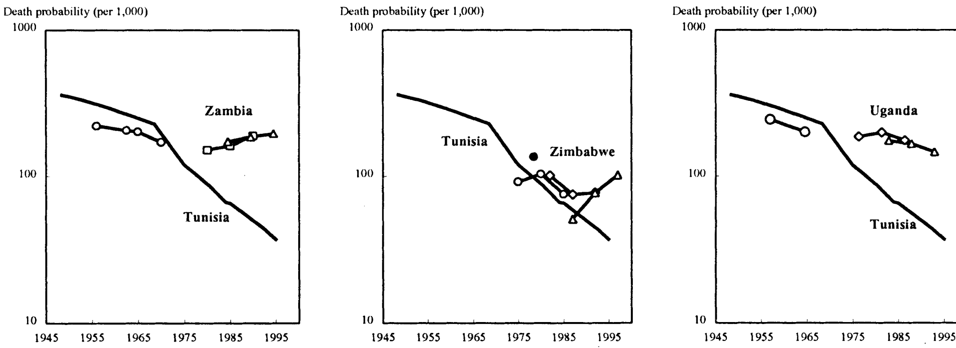
Above and beyond the generally observed slow decline of infant and child mortality, in recent years many countries of Sub-Saharan Africa have not made any progress at all in this domain; in some cases, the mortality of young children has even increased.

This is particularly true in countries most affected by AIDS. A comparison with Tunisia shows a striking contrast: in Zambia, Zimbabwe or Uganda, the declining trend is reversed, whereas in Tunisia, it speeds up (see Figure 7). We also note that in Zambia, the reversal was sudden and lasting, whereas in Uganda, it was less spectacular and soon replaced by a renewed phase of decline. This is probably is due to the fact that the epidemic spread in different ways in each country. In Uganda, the epidemic began earlier, but its progress has slowed down in recent years. It could be that in this context, mother-to-child transmissions were less widespread than in Zambia, where the epidemic broke out more recently but with greater violence.

The case of Zimbabwe is the most striking, even though there has been some criticism of survey results. Demographic health surveys usually provide three relatively reliable angles of observation, respectively the periods covering 0-4 years, 5-9 years and 10-14 years preceding the survey. In some cases, however, the data collected for the earlier period is less reliable, not only because of the respondents' memory lapses, but also because the samples do not include women aged over 55 at the time of the survey. Also the mortality of children born to the older women 10 to 14 years before the survey was probably higher than that of children born to younger women. These problems seem to have had a greater impact on the Zimbabwe surveys of 1988-1989 and 1999 than on the others (CSO, 1989). In fact, if we overlook the earlier periods of each survey, the trend observed in Zimbabwe appears very coherent and, of the 3 countries, clearly shows the most sudden reversal: thus, from 1976-80 to 1985-89, infant and child mortality declined almost as fast in Zimbabwe as in Tunisia, an exceptional feat in Sub-Saharan Africa. However, as the country was particularly hard hit by the AIDS epidemic, this caused a sharp increase in infant and child mortality beginning in the early 1990s.

In this respect, it is interesting to establish a distinction between infant mortality in the stricter sense of the term and the mortality of children aged 1 to 4 (see table 1). Both the decline and the recent rise are more marked for the second group, which is more vulnerable to infectious diseases than the first. Unlike the other countries of Sub-Saharan Africa, until the 1980s, Zimbabwe was going through a phase of eradication of mortality from infectious diseases, which the advent of AIDS has completely undermined.

Figure 7 – *Comparison of death probability trends between 0 and 5 years in three countries of Sub-Saharan Africa affected by AIDS and in Tunisia*



Sources: Waltisperger *et al.*, 2001, for Tunisia; Gaisie *et al.*, 1993 and CSO, 1997, for Zambia; CSO, 1989,1995 and 2000 for Zimbabwe; Kaijuka *et al.*, 1989 and Statistics Department, 1996 for Uganda; Hill, 1993 for the earlier data.

However, although AIDS affects more children aged 1 to 4 than newborn babies, one must not forget that it is mainly an adult's disease. Unfortunately, data on adult mortality is even more rare and deficient than child mortality data. The demographic health surveys nevertheless provide some interesting findings thanks to the sibling method (women are asked about the survival of their brothers and sisters).

Ian Timaeus (1998) has recently carried out an excellent systematic analysis of the data pertaining to 11 countries for which this type of information was available. In the 6 countries highly affected by AIDS, adult mortality increased sharply, whereas in the 5 others, it decreased. In Zimbabwe, for example, the death probability at 15-60 years nearly tripled for males and more than doubled for females between the 1988-1989 and the 1994 surveys, whereas in Senegal, it declined by 25% for males and 40% for females.

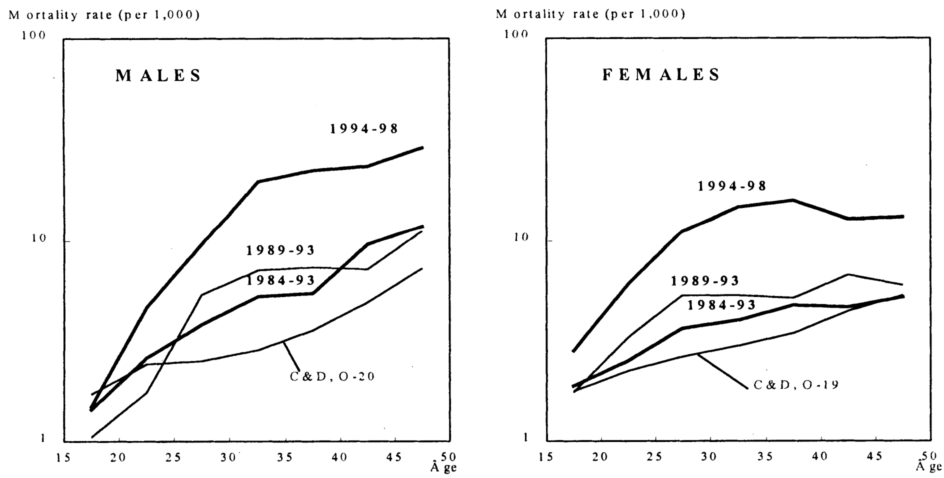
The survey findings, however, cover different periods depending on when the surveys were carried out, and as concerns Zimbabwe, a new survey has been made since Ian Timaeus's study. The 1999 survey shows that the situation has largely deteriorated since the 1994 survey (Figure 8). In order to show the changes in adult age-specific mortality from one survey to the next, we referred to a model table corresponding to the child mortality level observed during the first survey, at a time when AIDS had not yet reached its present proportions.

Table 1 – *Death probability trends in Zimbabwe at age 0 and ages 1 to 4, according to the last two DHS*

Period	Probability of death (p. 1000)		
	${}_1q_0$	${}_4q_1$	${}_5q_0$
		DHS 1994	
1880-84	59.6	44.4	101.0
1985-89	49.6	26.5	75.0
1990-94	52.8	25.6	77.0
		DHS 1999	
1990-94	53.8	24.4	76.9
1995-99	65.0	39.6	102.1

Sources: CSO 1995 and 2000.

Figure 8 – *Trends of age-specific mortality rates in Zimbabwe, compared to the Coale and Demeny model life tables, model West, level 20 for males and 19 for females*

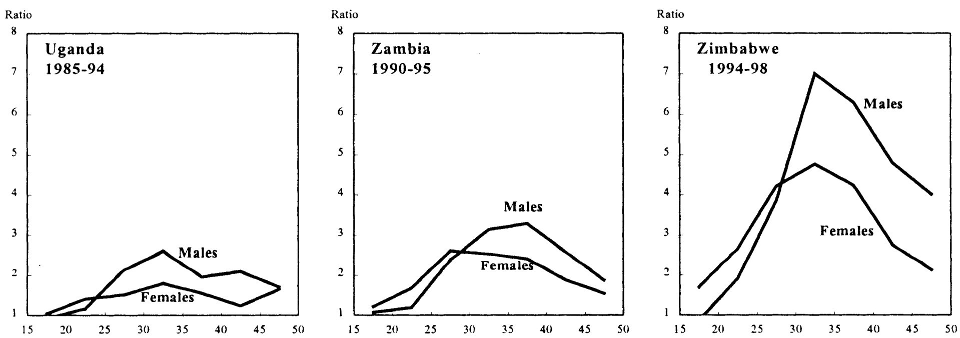


Sources: CSO, 1995 and 2000.

The 1994 survey report provides age-specific rates for the ten years preceding the survey, 1984-1993. The 1999 survey report provides separate estimates for the two preceding 5-year periods: 1989-1993 and 1994-1998. Figure 8 includes 3 time periods, the first overlapping the first half of the second. In 1984-1993, excess mortality was already clearly apparent among males aged 25 to 50 and females aged 20 to 40; the trend then intensified and spread to both younger and older age groups. During the latter period, female mortality at 30-35 was 4.5 times higher than that of the model and even 7 times higher for males.

It is true that of all the countries with such data, it is in Zimbabwe that the consequences of AIDS are the most acute. In Figure 9, we applied the age-specific mortality rates observed between the ages of 15 and 50 during the last available survey in Uganda, Zambia, and Zimbabwe, to the appropriate model tables. The gravity of Zimbabwe's situation appears quite clearly. Even in Uganda, where the situation is far from being as serious, the rates among females aged 30-34 are nearly twice as high as those of the model, and three times as high among males of the same age.

Figure 9 – *Recent trends of adult mortality in three countries affected by AIDS: proportional ratio of age-specific mortality rates provided by the last DHS to model life tables*



Note: For each country and each sex, we have chosen the Coale and Demeny model life tables, West model, with the infant mortality level closest to those observed during the survey: levels 15 (female) and 16 (male) for Uganda and Zambia and levels 19 and 20 for Zimbabwe.

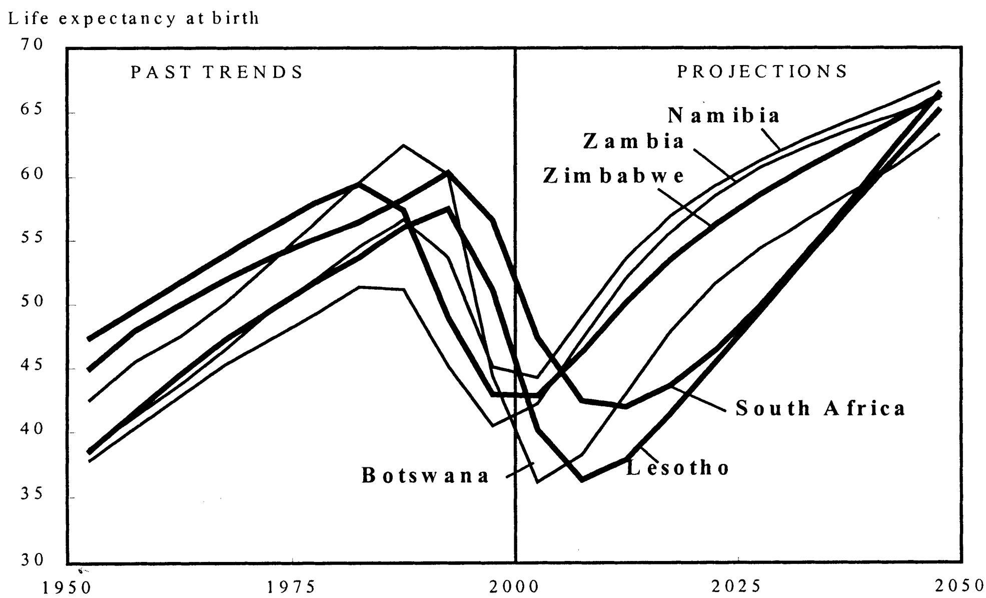
Sources: Statistics Department, 1996, for Uganda; CSO, 1997 for Zambia; CSO, 2000, for Zimbabwe.

The distortion of the mortality curve is of course the consequence of AIDS, which affects mainly sexually active adults. We can see that HIV is transmitted heterosexually in the fact that excess mortality in comparison to model tables affects females at a much younger age than males, especially in Zambia and Zimbabwe, where the epidemic is more recent and more violent than in Uganda.

To conclude on the failure of the process of epidemiologic transition due to AIDS, it must be recalled that in some countries the epidemic has broken out only recently and that the consequences will probably be much more extensive than what can be surmised from available surveys. Using models simulating the development of the epidemic, the United Nations has calculated possible consequences on life expectancy in 29 African countries, 3 Asian countries and 2 Latin American countries (Population Division, 2000). On the basis of the estimated prevalence of HIV infections, the authors of the study elaborated a model of HIV incidence and expected trends with a view to calculating the incidence of deaths caused by AIDS.

Among these 34 countries, six will be particularly affected by AIDS. All are located in eastern or southern Africa (see Figure 10). Between the highest level of life expectancy ever observed and the estimated or projected lowest point, Zambia should lose 11 years of life expectancy, Namibia nearly 13, Zimbabwe almost 17; South Africa runs the risk of losing more than 18 years, Lesotho over 21 and Botswana over 26. When the results obtained for each country are reinserted into global regional projections, the most strongly affected regions are clearly southern and eastern Africa; but no part of Sub-Saharan Africa has been spared, and in that respect the contrast with North Africa is striking (see Figure 11).

Figure 10 – *Past and projected trends for life expectancy at birth in the six countries most affected by AIDS*

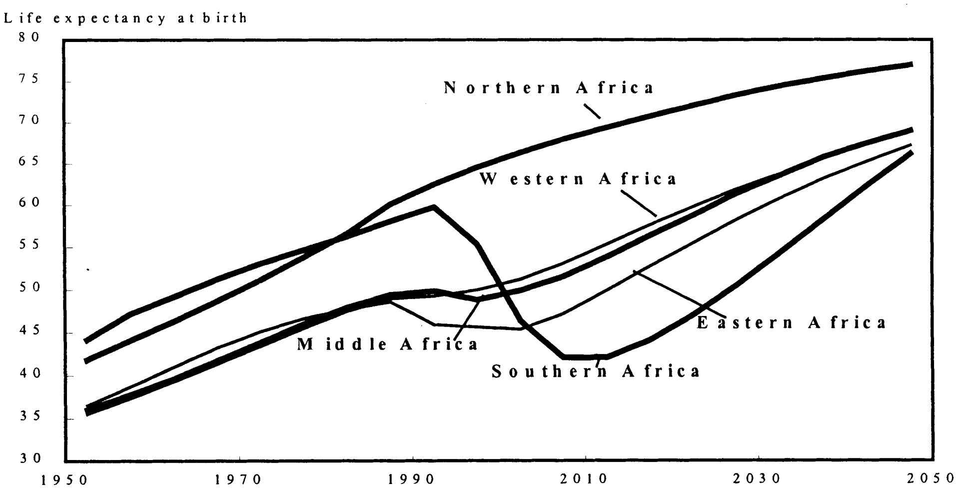


Source: United Nations 2001.

Thus, as regards Africa, the AIDS factor has the strongest deviating impact on the classical pattern of epidemiologic transition. The sudden arrival of this new infectious disease along with its host of opportunistic diseases might even pull many African countries back to life expectancy levels that were prevalent at the very beginning of the second phase of Omran's transition. It is true that once the epidemic is curbed, their situation should improve much faster than before the epidemic, according to UN projections.

However, AIDS is not the only deviating factor. We have already mentioned the impact of wars and other forms of political violence, which unfortunately are quite frequent in Africa – in Mozambique, Ethiopia, Rwanda, Sierra Leone, Liberia, Eritrea, Somalia, Angola, Democratic Republic of Congo, *etc.* Some data is available concerning these factors, but most often information is lacking, either owing to the nature of the situation itself, or because the countries most affected are also those where government statistics are most deficient. In some cases, like Rwanda for example, genocide has reduced life expectancy as much as AIDS. Once again, Africa seems to have trouble getting rid of a death cause typical of the first and second phases of the epidemiologic transition.

Figure 11 – *Past and projected trends for life expectancy at birth in the six regions of Africa*



Source: United Nations 2001.

The consequences of the economic crisis of the 1980s and 1990s on life expectancy are not quite as clear. A systematic analysis of the trends in infant and child mortality based on the demographic health surveys in comparison to macro-economic data was carried out in the early 1990s, but no link between the two (Barbieri and Vallin, 1996) was identified. This probably does not mean that none exists, rather that it was too early at the time for such a link to be detectable. Today, given the extent of the AIDS epidemic, such a link has become even more difficult to identify.

In any case, the second phase of Omran's epidemiologic transition is far from having ended in Africa, due to the slowness of health care advances since the 1950s and the impact of AIDS, which has undone the little that had been achieved.

4. EASTERN EUROPE: THE FOURTH PHASE HAS YET TO BEGIN

If Sub-Saharan Africa has not yet reached the third "age" of Omran's theory, Eastern Europe on the other hand seems stranded there and unable to move on.

Figure 12 compares the life expectancy reached in 1995 (ordinate) with that of 1965 (abscissa), and shows the extent to which the gap between Eastern European countries and other developed countries has widened since the mid-1960s. On either side, the countries are shown by geographic zone, in order to make the overall opposition between East and West appear more clearly. For males, there is a total opposition on either side of the diagonal between the 1995 and 1965 values. A large cloud of highly correlated points ($R = 0.79$), parallel to the diagonal and far above it, faces another cloud, also highly correlated ($R= 0.72$) and located parallel to the diagonal, but this time far beneath, while a third cloud is located right on the diagonal. The first cloud includes countries which made considerable progress from 1965 to 1995, with, as can be seen, life expectancy gains of about 5 years. These are countries of the north, west, and south of Europe or non-European developed countries. The second cloud is that of countries where life expectancy on the contrary declined, also in a very homogenous way, with a loss of about five years. These are the European states of the former USSR. Lastly, the third cloud is made up of countries where life expectancy hardly changed between 1965 and 1995. These are countries of Central Europe.

The opposition is less spectacular among females because the gap is smaller between the countries where life expectancy advanced and those in which it declined. This is mainly due to the fact that in the countries where female life expectancy decreased, the decline was not as steep as that of male life expectancy, and in the countries where it grew, the increase was not much greater than that of male life expectancy. However, if we draw a diagonal corresponding to a gain of a little less than two years of life expectancy, we obtain just about the same picture as that of the male situation[8], with the cloud representing Central Europe, where male life expectancy did not increase, located right on the diagonal.

In order to better illustrate the East-West divergence, we will first carry out a demographic analysis of trends in mortality and death causes, and we will next examine whether a multidimensional statistical analysis can help us shed more light on the subject.

4.1 Reemergence of the East-West divergence

Although none of the Eastern European countries took part in the health improvements made by most industrialized countries since the 1970s, Central Europe and the former USSR experienced this health crisis in different ways (Vallin and Meslé, 2000). Let us add that the Asian states of the former USSR, both in Central Asia and in the Caucasus, were also affected in different ways. In any case, given the lack of reliable data, the latter countries are not included in the present analysis.

4.1.1 Specific Eastern Europe trends

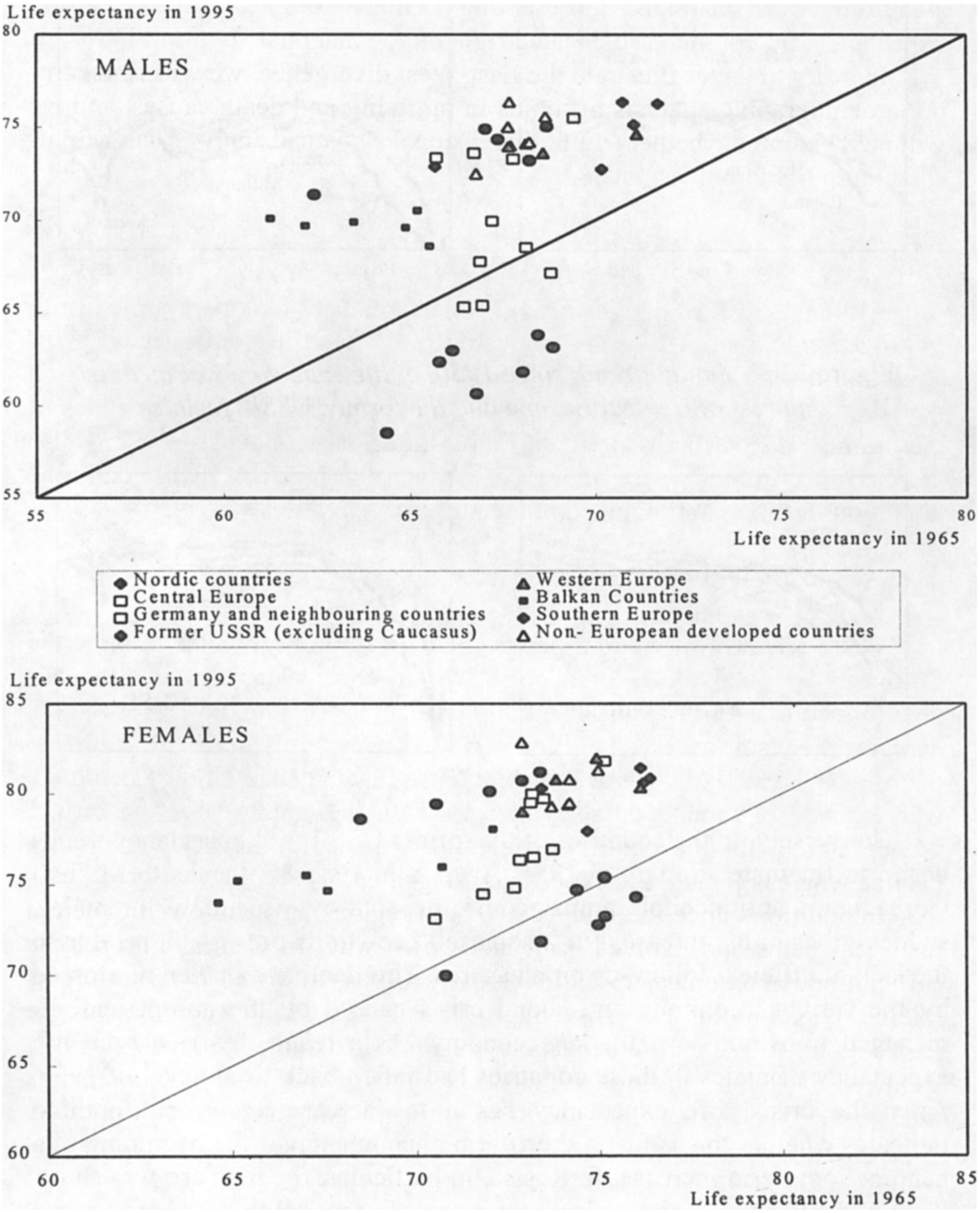
There are two differences between Central European countries and the European states of the former USSR. First, since 1965, the situation has deteriorated to a lesser extent in the former than in the latter countries (which explains the result observed in Figure 12). As shown in Figures 13a and 13b, the life expectancy of Central European males stagnated or slightly declined, whereas that of females slightly increased. In the countries of the former Soviet Union, on the contrary, male life expectancy underwent a sharp decline whereas female life expectancy stagnated.

In addition, since the mid-1980s, both regions have followed different historical paths and evolved each in its own way. In Central Europe, the earlier trends continued up until the early 1990s, followed by what seems like the beginning of a decisive improvement. The Czech Republic was the first country to see its life expectancy begin increasing again in 1990-1991, followed by Poland towards 1992-1993. The situation in Hungary remains unclear and the trend is too recent in Bulgaria and Romania to draw any

[8] The coefficients of correlation are just as high (0.83 and 0.84).

precise conclusions, but the overall upwards trend seems quite convincing (Figure 13a).

Figure 12 – *Life expectancy in 1995 compared to life expectancy in 1965*



Note: one point on the diagonal implies that life expectancy in 1995 and 1965 are the same.

Figure 13a – *Annual trend, since 1950, of life expectancy at birth in countries of Central Europe and the former USSR, males*

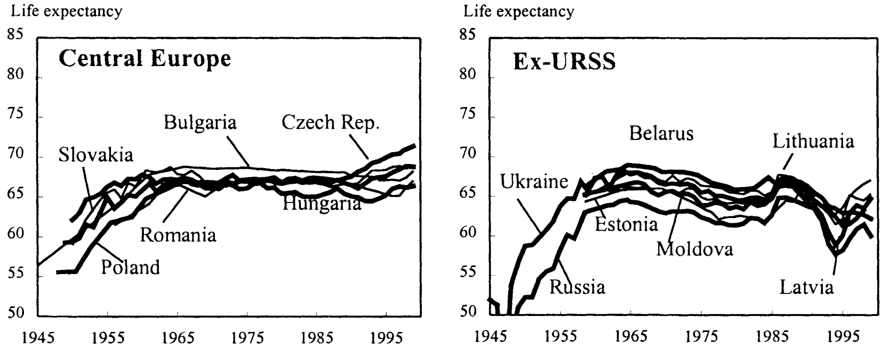
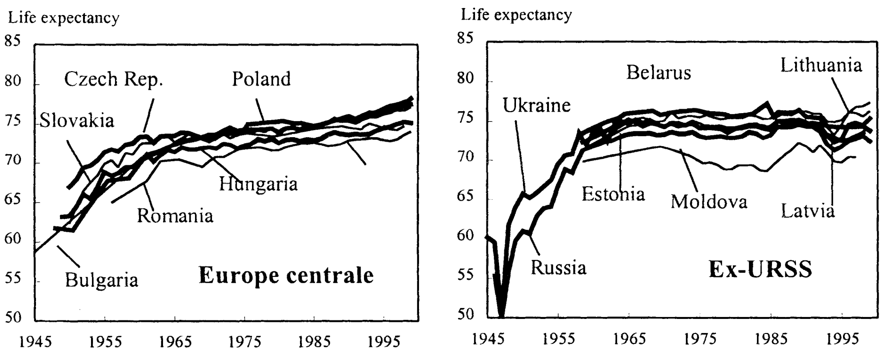


Figure 13b – *Annual trend, since 1950, of life expectancy at birth in countries of Central Europe and the former USSR, females*



Conversely, in the countries of the former USSR, life expectancy trends began to fluctuate strongly in 1985. At first, in 1985-87, thanks to Mikhail Gorbachev's anti-alcohol campaign, life expectancy, especially for males, suddenly began to increase, but it soon fell back to its previous level due to the lack of efficient follow-up on measures. This decline was then reinforced by the serious economic and social crisis caused by the abrupt and ill-managed transition to a market economy. As a result, by 1994, the life expectancy of males in these countries had fallen back to its level of 1950. After the crisis, life expectancy began to increase again, but nothing indicates whether this is just a short-term phenomenon or the beginning of a genuine long-term increase. In Russia, in particular, the increase was short-lived and life expectancy is declining again. In the Baltic countries, on the contrary, the increase seems to be lasting and there is hope these countries will follow Poland's example.

4.1.2 Atypical age patterns

The decline of life expectancy in Eastern European countries is closely linked to the uncommon distortion of the structure of age-specific mortality. In order to illustrate this phenomenon, we compared age-specific mortality rates in different countries of Central Europe and the former USSR to model tables. We used as a reference the Coale and Demeny model life tables, model West (1983), at life expectancy levels corresponding more or less to the average observed in Eastern Europe towards 1965: level 21 (e_0 = 66.0 years) for males and 22 (e_0 = 75.5 years) for females.

In 1965, among females in all the countries and among males in Central Europe, the age-specific mortality structure was not very different from that of the models (see Figure 14). However, in the countries of the former USSR, age-specific male mortality was already atypical, with a significant excess mortality between the ages of 25 and 55. By 1995, this problem had become more acute in the countries where it already existed and had spread to almost all the countries of the former USSR, for both male and female life expectancy.

The phenomenon is particularly widespread among males in Russia and Latvia. Conversely, there is practically no sign of it in the Czech Republic. More generally speaking, there is a significant difference between the countries of Central Europe and those of the former USSR, not only in terms of intensity, but also in terms of the ages concerned: in the countries of the former USSR, excess mortality is already quite high between the ages of 20 and 35, whereas in Central Europe, it becomes really apparent only after 35.

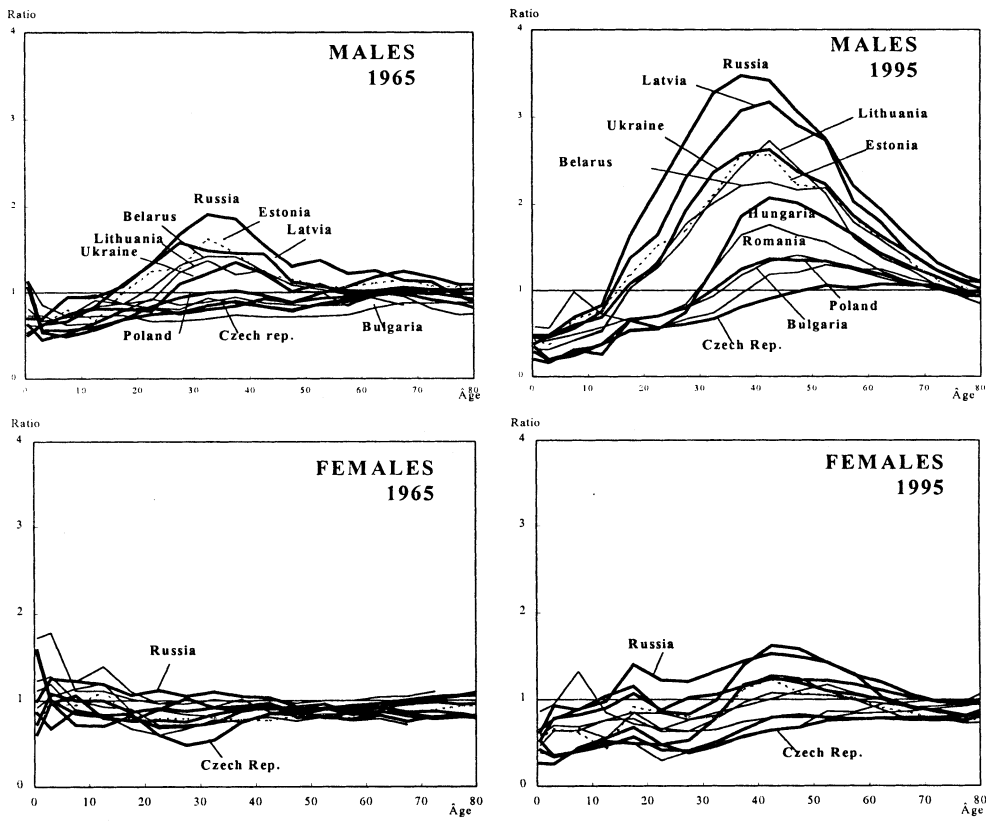
In reality, as can be seen through the life expectancy changes described in Figures 13a and 13b, the comparison between the situations of 1995 and 1965 covers different historical developments for each region, each having gone through its own specific phases. These must be identified in order to provide a correct interpretation of the present consequences of these more or less long-lasting health crises.

4.1.3 The importance of cardiovascular and man-made diseases

The most important difference between East and West concerns mortality due to cardiovascuar disease. To illustrate this fact, we will compare mortality trends due to cardiovascular disease in France, the United Kingdom, Poland and Russia (see Figure 15). In the early 70s, both Western countries were successfully overcoming cardiovascular diseases, while the Eastern countries, on the contrary, were unable to curb the increase in mortality due to these diseases.

The difference is quite significant, regardless of sex. True, towards the mid-60s, in Poland and Russia, the situation of males had deteriorated much more than that of females. But in France and in the United Kingdom, on the contrary, females made rapid progress as early as the early 1950s, much earlier than males, and as a result the sudden progress of the 1970s was less marked for females than for males. Since these two phenomena are complementary, the gap between East and West is just as wide for either sex.

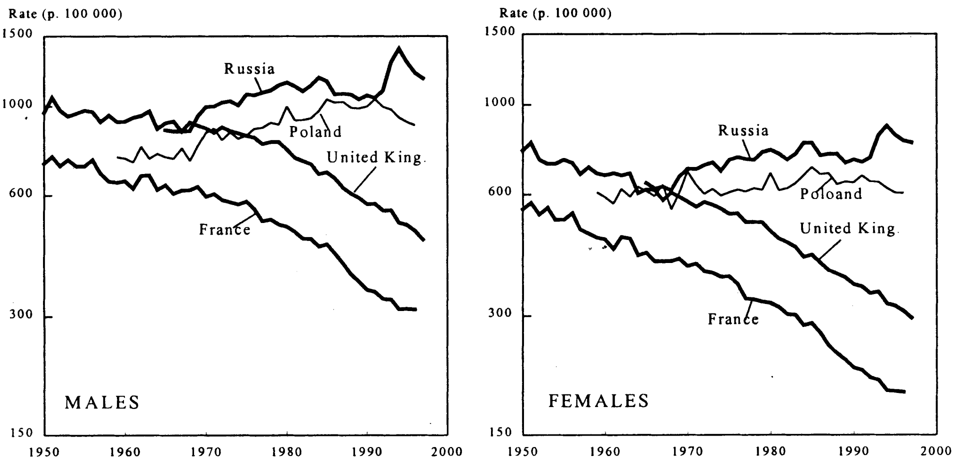
Figure 14 – *Ratio of age-specific mortality rates observed in Eastern European countries to those of the model life tables of Coale and Demeny, model West*



Notes: males level 21 (e_0 = 66.0 years); females level 22 (e_0 = 72.5 years).

Mortality due to cardiovascular disease is not the only explanation for the gap between East and West. In Eastern Europe, the increase in the incidence of man-made diseases must also be taken into account. Gorbachev's 1985 anti-alcohol campaign revealed to what extent Soviet mortality was related to alcohol consumption, since life expectancy suddenly shot up during the campaign and fell again afterwards (Meslé *et al.*, 1994, Shkolnikov and Nemtsov, 1997). Overall, since the 1960s, the increase in man-made diseases (alcoholism, smoking, suicides, homicides, *etc.*) has played a large part in the deterioration of the health situation (Shkolnikov *et al.* 1996; Meslé *et al.*, 1998).

Figure 15 – *Comparative trends of the standardized mortality rate due to cardiovascular diseases since 1950 in two Eastern European and two Western European countries*



4.2 The input of multiple factor analysis

A multiple factor analysis (MFA) can help us place the "East-West" gap in a general context which takes into account the diversity of age or cause-specific patterns and their various developments in industrialized countries [9].

This method is based on a weighted principal components analysis (PCA) and makes it possible to analyse a group of individuals qualified by

[9] A similar analysis has been carried out on age-specific mortality in European countries from 1930 to 1985 (Caselli, 1993 and 1994).

several groups of variables (Escofier and Pagès, 1993, 1994). In this case, we will consider the countries as individuals and study them on the basis of four groups of variables, crossing time spans (four periods) with, in turn, either age (age-specific mortality rates), or the cause of death (standardized cause-specific mortality rates).

The periods referred to are 1964-1966, 1974-1976, 1984-1986 and 1994-1996.

We selected 24 industrialized countries on the basis of the size of their population (at least 3 million) and the availability of coherent age-specific and cause-specific mortality data over the 4 periods. The selected countries included 5 Eastern European countries (Russia, Ukraine, Poland, Hungary, Bulgaria), 6 Northern European countries (United Kingdom, Finland, Sweden, Norway, Denmark, Ireland), 4 Western European countries (West Germany, France, Netherlands, Austria), 4 countries of Southern Europe (Italy, Spain, Greece, Portugal) and 5 non-European countries (United States, Canada, Japan, Australia, New Zealand)[10]. In the following two analyses, the MFA is weighted by the inverse of the first eigen value of each partial analysis, the partial axes being the factors of the PCA conducted within a single period.

4.2.1 Age-specific analysis

19 age groups were determined for this analysis : (0, 1-4, 5-9, 10-14,..., 80-84, 85 and over). The analysis was conducted separately for each sex, but we will only speak of the findings obtained for males, since, as we have seen, they present a clearer picture (the results of the analysis of female data are not very different, except that the image is not quite so sharp).

The first axis of the global analysis accounts for a large share of the total variance – 56% –, the second for a much smaller one – 14%. The first axis is highly explanatory (the partial axes are all quite highly positively

[10] Thanks to the research work on the reconstruction of death series per cause of death carried out at INED, we had access to very complete data for France (Vallin and Meslé, 1988, and the updated data base : http://matisse.ined.fr/~tania/causfra/data/) and for some countries of the former USSR : Russia (Meslé et al., 1996), Ukraine, (Meslé et al., 1998), the Baltic states, which were excluded from this analysis due to their small size. For the other countries, we used the WHO data base (Mortality data: http://www.who.int/whosis). Given the absence, for the earlier periods, of data for Germany as it is today we used only the data concerning the former BRD, using the available data in the WHO data base for the three first periods; for 1995, we used the data provided by courtesy of the Max Planck Institute for Demographic Research.

correlated) and can be considered as reflecting intensity, whereas the second (which has less of an explanatory value since the only strong correlation is that of the PCA of the first period) seems to show the age-specific mortality pattern.

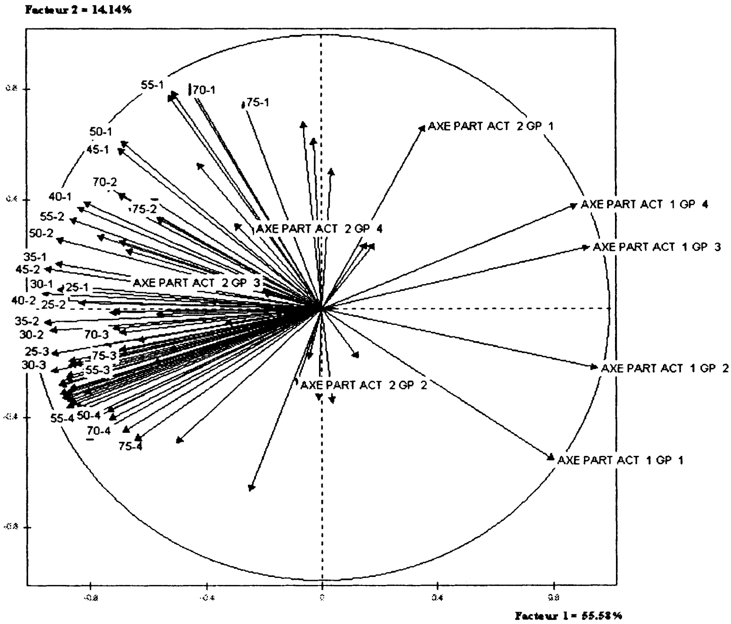
In Figure 16, the direction of the twice times four partial axes is projected onto the first plane (axes 1 and 2), as well as all the variables (age-specific mortality, per period), but only the most strongly correlated variables are specifically identified by an acronym (see appendix 1 for the correspondences between acronyms and variables).

On the first axis of the global analysis, which reflects intensity, the mortality rates best represented are, for all periods, those of young adults (between 20 and 55), and beginning with the second period, those of older adults (55-79). We can see the consequences of the very important role played by the striking distortion of the age structure in the discrepancy between life expectancies in Eastern European countries (and especially the former USSR) and other countries.

On the second axis, which reflects age-specific mortality patterns, we observe a significant downwards movement (from very high positive correlations to very low negative correlations) above the age of 40. This indicates that the countries which have a higher mortality during the last period have an age pattern that is very different from the average pattern and thus from the pattern of all the countries which are near the origin of the plane. This result plainly confirms the previous one.

The same idea appears again quite clearly if we project the countries on the plane and follow them from one period to the next (Figure 17). In order to make our point clear, we selected the more significant countries by isolating the five Eastern European countries on a separate graph (Figure 17a); the other graph (17b) shows the paths followed by France, Italy, Portugal, the United States, Canada and Japan. Russia and the Ukraine alone are responsible for 61% of the variance contained in the first axis of the global analysis: both countries are responsible for most of the difference in terms of intensity, with correlations which, in the 1970s, are all close to 1 for adult ages. In addition, as concerns the second axis, both countries shifted during the 3rd and 4th periods from positive to very negative correlations; this reflects the rapid distortion of the age structure of mortality in relationship to the standard model usually followed by Western countries. At first, Hungary, and to a lesser extent Poland, starting from positions which were not very far from average, slid down towards the negative positions of the Ukraine and Russia; then, in the 1990s, they moved back upwards towards their original starting point.

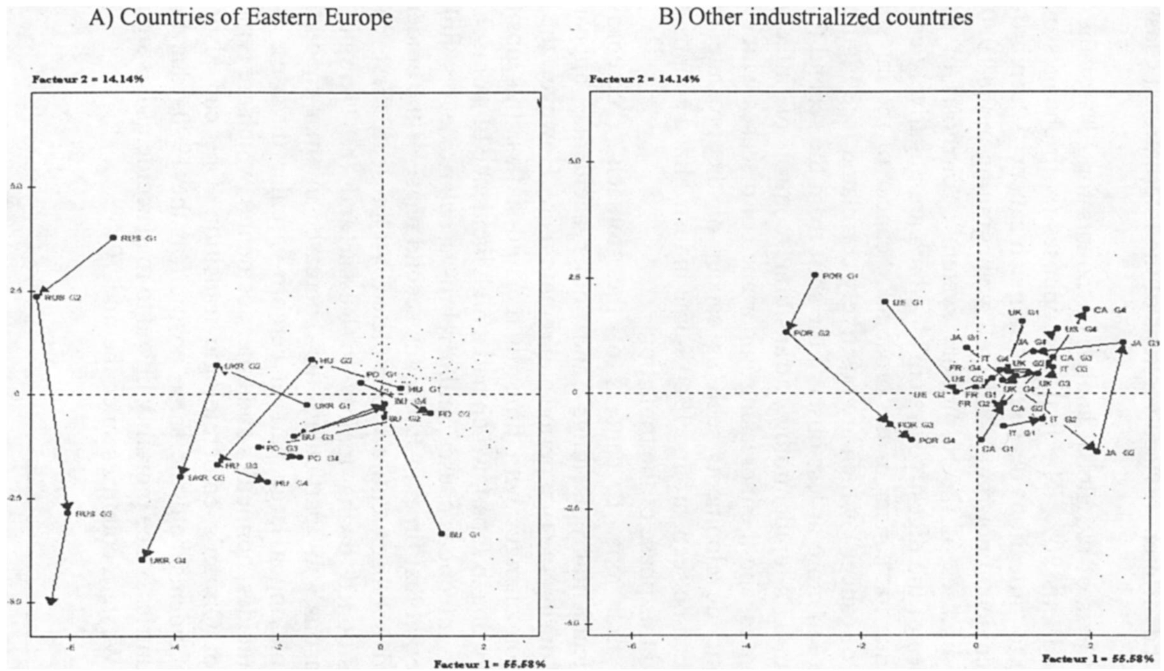
Figure 16 – *Principal MFA plane of the global analysis of 19 age-specific mortality rates, for four periods. Display of rates and partial axes, males*



Note: see appendix 1 for acronyms used.

The other countries (Figure 17b) generally tend to move closer to average on both axes. However, no immediate conclusion can yet be drawn since this movement is attributable to the extreme variations between the countries of the former USSR, rather than to the other countries' own specific trends. There are other interesting differences to be observed among the countries of the former USSR, but they lie outside the scope of this paper.

Figure 17 – *Principal MFA plane of the global analysis of 19 age-specific mortality rates, for four periods. Display of countries, males*



Note: see appendix 1 for acronyms used.

4.2.2 Cause-specific analysis

For the cause-specific analysis, we used standardized mortality rates[11] for 19 groups of causes (see in appendix 2 the categories of diseases according to the different revised versions of the International Classification of Diseases).

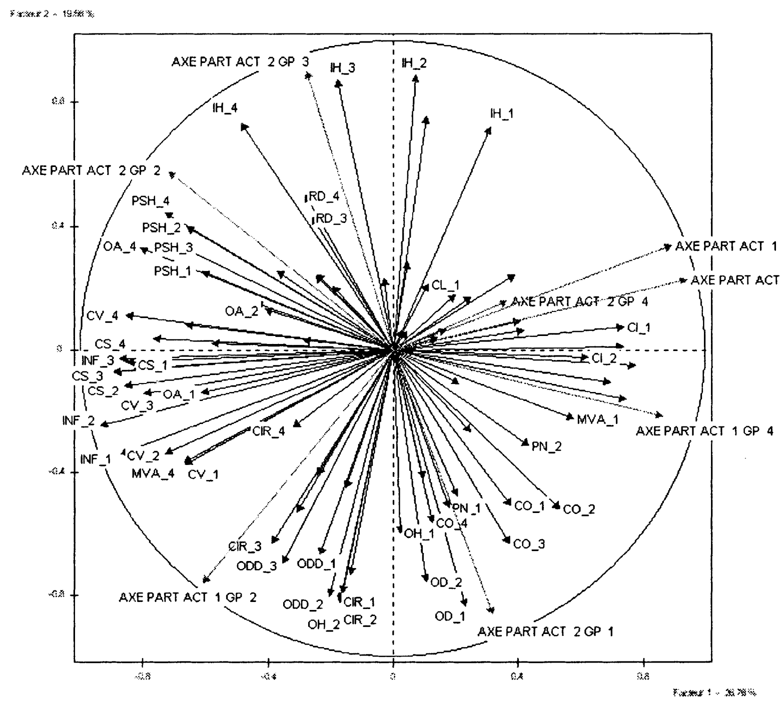
The first axis of the global analysis accounts for 27% of the variance and the second axis 20%. The first axis opposes (with changes over time) mortality due to "infectious diseases", "stomach cancer ", "cerebro-vascular diseases", "accidental poisoning", as well as, beginning in the 1980s, "other accidents", "diseases of the respiratory system", "cirrhosis of the liver", "other diseases of the digestive system" – which are negatively correlated – to mortality due to "cancer of the prostate", "cancer of the intestine", and "other forms of cancer", which are positively correlated (see Figure 18). On this axis, one can more or less observe the shift from the second to the third phase of Omran's epidemiologic transition: control of infectious and parasitic diseases, and the increasing importance of diseases which go along with economic development, such as cancer of the prostate or of the intestine. As can be seen, around 1960, some industrialized countries had not yet completed this phase of the transition.

On the first axis, t "cancers of the stomach", "cerebro-vascular diseases", "accidental poisonings" and "other accidents" appear on the negative side during the first period and remain there. However, the meaning of this position changes with time. In the mid-sixties, this position was almost entirely due to Japan, which had a high incidence of stomach cancers, often linked to infectious causes, and cerebro-vascular diseases, linked to an over-salty diet: at that time, in Japan, the second phase of the epidemiologic transition had not been entirely completed. At present, these causes are similarly positioned owing mainly to Russia and the Ukraine, but for different reasons, in particular the increase in man-made diseases (alcoholism playing a large part in cerebro-vascular diseases, accidental poisonings, suicides, homicides and other accidents), which are typical of the third phase of Omran's epidemiologic transition. One can also see that automobile accidents held the same position in the 1990s due to Eastern European countries, since mortality linked to road accidents has significantly decreased in Western countries since the mid-70s.

[11] Calculated on the basis of the age-specific structure of the European population, provided by the WHO (1992).

The second factor opposes – with a positive correlation – "ischaemic heart diseases" (as well as "diseases of the respiratory system" during the 4th period, with a weaker correlation) to "cirrhoses of the liver", "other diseases of the digestive system", "other heart diseases", "other diseases", "other cancers", and "psychosis and neurosis", which are negatively correlated. In fact, at first, this opposition mainly reflected the very specific situation of France, where alcoholism has traditionally played an important part, while ischaemic heart diseases are much less frequent there than in other industrialized countries (in particular Anglo-Saxon countries).

Figure 18 – *Principal plane of the global analysis of 19 groups of causes for four periods. Display of causes and partial axes, males*

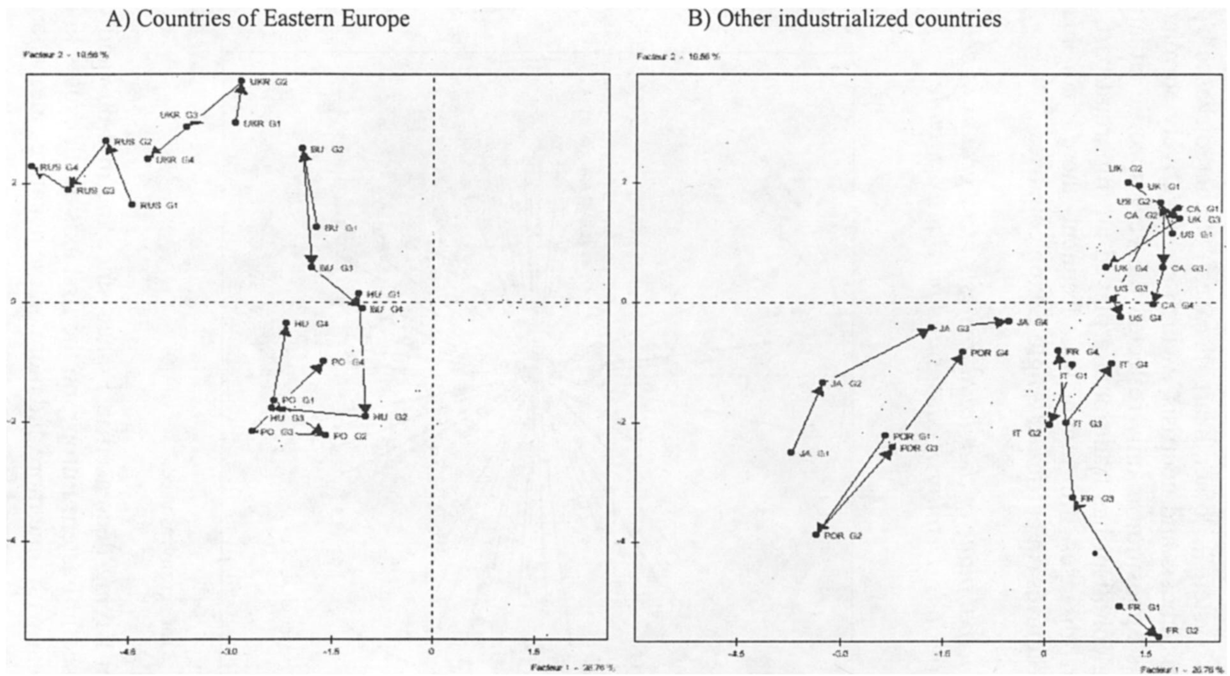


Note: see appendix 2 for acronyms used.

Alcoholism having decreased in France since the mid-60s and on the contrary increased in Eastern Europe, on the first axis death causes linked to alcoholism appear with time more and more on the negative side, whereas on the second axis this is less and less the case.

If we look at the projection of countries on the principal plane of the global analysis (Figure 19), we can see the difference between the Eastern

Figure 19 – *Principal plane of the global analysis of 19 groups of causes for four periods. Display of countries, males*



Note: see appendix 1 for acronyms used.

European countries and the others. Russia and the Ukraine are moving more and more towards the north-western angle of the fourth quadrant (Figure 19), which represents ischaemic diseases and accidental poisoning, whereas Japan and Portugal, on one hand, and France, on the other hand, but for different reasons, move closer to the centre, their specific characteristics becoming less marked. Thus, the gap between Russia/Ukraine and the other industrialized countries has widened considerably, due to the increase in ischaemic and man-made diseases.

Again, Central European countries are uneven, though for the time being they remain quite far from the centre.

As concerns Western countries, along with Japan, there is a strong tendency – and here it is even more apparent than in the age-specific analysis – to follow the same pattern, moving together within the framework of the fourth epidemiologic phase according to Rogers and Hackenberg.

We can observe that "lung cancer" does not appear separately on the principal plane. In fact, proceeding to a deeper analysis, we can see that lung cancer takes on more importance on the third axis which opposes mainly France, Hungary, Bulgaria and Russia to the countries which have already succeeded in curbing the rise in smoking-induced mortality.

Globally, today, the first axis opposes Western countries which have a lower overall mortality, but a relatively higher mortality due to malignant tumours (except for stomach cancers), to the countries of the former USSR which have a higher mortality for all other causes (including stomach cancers). In the 1960s, the second factor established an opposition between the centre and south of Europe, whose mortality pattern was governed by "other diseases of the digestive system", "cirrhosis of the liver", "psychosis and neurosis", and Anglo-Saxon and Nordic countries, which tend to have more "ischaemic heart diseases"; this opposition has partially decreased over time, at least as concerns diseases linked to alcohol consumption.

The same analysis was conducted among females. The results are similar. However, we may note two interesting differences and one striking fact. On one hand, in Eastern European countries, the situation of females has deteriorated less than that of males, which is not too surprising. On the other hand, on the first axis of the global analysis, lung cancer among women has gained more importance than it had among men: lung cancer among women clearly seems to affect Anglo-Saxon countries. Last, the two main female cancers, cancer of the uterus and breast cancer, are strongly opposed on this axis, since cancer of the uterus affects Eastern European countries and breast cancer affects Western countries. This goes along with the idea that cancer of the uterus, in which infection plays an important part, is typical of the second phase of the epidemiologic transition, whereas breast cancer is more frequent during the third phase.

Even if the multiple factor analysis does not really add any new insights to classical descriptions, it does confirm the gap between Eastern Europe and all other industrialized countries. Central Europe and especially the countries of the former USSR have long remained stranded in the third phase of the epidemiologic transition, and although some countries of Central Europe (Poland, the Czech Republic, Hungary, *etc.*) seem to have succeeded in pulling out of this stagnation, this has not been the case for the countries of the former USSR.

5. CONCLUSION

Nonetheless, however significant, these failures do not call into question the theory of epidemiologic transition in itself. Yet they do indicate that some countries, for reasons tied to their own history, economic development or culture, have encountered serious obstacles preventing them from completing certain stages of the transition. In Eastern Europe, on one hand, the communist regimes relied almost too exclusively on the centralized administration of modern health care, whereas the shift towards the fourth stage of the epidemiologic transition requires important changes in individual behaviour and being actively responsible for one's own health. In addition, the economies of these countries were involved in a ruinous arms race and space competition with Western countries, and as a result, the means necessary to create an efficient health system in the field of chronic diseases were unavailable. As concerns the countries of Sub-Saharan Africa, much more vulnerable to the generalized transmission of HIV due to widespread multiple partnership practices and to the wide variability of the age difference between partners, these countries were hit very hard by the epidemic at a time when their very fragile economic situations were facing a global economic crisis which had already, as it was, wrought its inevitable consequences on rather poor local health services. Prevention methods and more recently, medical treatments, do exist and have proven effective in countries of the North, but for the time being Africa cannot afford them. In both cases, health care policies must be improved and given adequate financial means in order for these countries to achieve their epidemiologic transition.

Abdel Omran's theory of epidemiologic transition encounters perhaps a deeper contradiction in the renewed rapid increase of life expectancy observed in Western countries since the 1970s. Would it suffice to account for such a phenomenon by adding a fourth phase to Omran's initial theory (Olshansky and Ault, 1986; Rogers and Hackenberg, 1987; Omran, 1998) and again a fifth to take on board AIDS (Olshansky *et al.*, 1998)? In our view, the theory itself must be revised. First, as we have said, the reasons behind the emergence or reemergence of infectious diseases are no different from those governing the second phase of Omran's transition: the danger of infection can never be completely eradicated, only brought under control, and if the battle is fought in unfavourable conditions, all that has been gained can suddenly be lost, as shown by the dramatic situation in Africa. In fact, rather than challenging Omran's theory, the situation of Eastern Europe and Africa questions the idea that life expectancies are rapidly converging towards a maximum level. In addition, Western advances in the treatment of cardio-vascular diseases since the 1970s can be explained by the development of a new strategy based on medical high technology and changes in individual behaviour, eating behaviour in particular. All countries are not equally prepared to adopt these new strategies, as can be seen in Eastern Europe. However, the question cannot but arise in many developing countries which have exceeded a life expectancy of 70 years: will they succeed in catching up with Western countries in this field, as they did with infectious diseases? Following the proposal made ten years ago by Julio Frenk *et al.* (1991), we might consider replacing the concept of "epidemiologic transition" by the wider concept of "health transition", which would include not only the development of epidemiologic characteristics within the overall health situation, but also the ways in which societies respond to the health situation and vice versa (Caselli, 1995; Meslé and Vallin, 2000).

References

ATTAMA S., SEROUSSI M., KOURGUENI I.A., KOCHE A., BARRERE B. (1999), *Enquête démographique et de santé, Niger, 1998*, Columbia, Macro International Inc.

AWUSABO-ASARE K., BOERMA J.T., ZABA B. (eds.) (1997), "Evidence of the socio-demographic impact of AIDS in Africa", *Health Transition Review*, 7(2), 1-188.

BARBI E., CASELLI G., VALLIN J. (1999), *Trajectories of extreme survival in heterogeneous populations*, Paper presented to the Annual Meeting of the Population Association of America, New York.

INED, *Tendances de la mortalité et causes de décès en Ukraine*, Paris, INED (Document de travail).

BARBIERI M., VALLIN J. (1996), "Les conséquences de la crise économique africaine sur l'évolution de la mortalité" in COUSSY J., VALLIN J. (eds.), *Crise et population en Afrique. Crises économiques, programmes d'ajustement et dynamiques démographiques*, Paris, CEPED, (Les Études du CEPED, 13), 319-343.

BUREAU OF THE CENSUS (1975), *Historical Statistics of the United States. Colonial times to 1970*, Washington D.C., US Printing office.

BUREAU OF THE CENSUS (1985), *Statistical abstract of the United States, 1985*, Washington D.C. (105th edition).

BUREAU OF THE CENSUS (1992), *Statistical abstract of the United States, 1992*, Washington D.C. (112th edition).

CARAËL M., SCHWARTLÄNDER B. (eds.) (1998), "Demographic impact of AIDS", *AIDS*, 12(1), S1-S50.

CAREY J.R., JUDGE D.S. (2001), "Principles of biodemography with special reference to human longevity", *Population, An English Selection*, 13(1), 9-40.

CASELLI G. (1991), "Health transition and cause specific mortality" in SCHOFIELD R., REHER D., BIDEAU A. (eds.), *The decline of mortality in Europe*, Oxford, Clarendon Press, 68-96.

CASELLI G. (1993), "L'évolution à long terme de la mortalité en Europe", in BLUM A., RALLU J.-L. (eds.), *European Population. II Demographic Dynamics*,– Paris, INED, John Libbey, 111-164. [English version (1994), *Long-term trends in European mortality, Studies on Medical and Population Subjects*, 56, London, OPCS.

CASELLI G. (1995), "The key phases of the European health transition", *Polish Population Review*, 7, 107-125.

CASELLI G. (1996), "National differences in the Health transition in Europe", *Historical Methods*, 29(3), 73-102.

COALE A., DEMENY P. (1983), *Regional model life tables and stable populations,* New York and Lonon, Academic Press, (Second edition).

COUSSY J., VALLIN J. (eds) (1996), *Crise et population en Afrique: crises économiques, politiques d'ajustement et dynamiques démographiques,* Paris, CEPED, (Les Études du CEPED, 13).

CSO (CENTRAL STATISTICAL OFFICE) (1989), *Zimbabwe Demographic and Health Survey 1988*, Columbia (Maryland), Macro International Inc.

CSO (CENTRAL STATISTICAL OFFICE) (1995), *Zimbabwe Demographic and Health Survey 1994*, Calverton (Maryland), Macro International Inc.

CSO (CENTRAL STATISTICAL OFFICE) (1997), *Zambia Demographic and Health Survey 1996*, Calverton (Maryland), Macro International Inc.

CSO (CENTRAL STATISTICAL OFFICE) (2000), *Zimbabwe Demographic and Health Survey 1999*, Calverton (Maryland), Macro International Inc.

ESCOFIER B., PAGES J. (1993), *Analyses factorielles simples et multiples: objectifs, méthodes et interprétation*, Paris, Dunod.

ESCOFIER B., PAGÈS J. (1994), "Multiple factor analysis (AFMULT package)", *Computational Statistics & Data Analysis*, 18, 121-140.

FEACHEM R.G., JAMISON D.T (eds.) (1991), *Disease and mortality in Sub-Saharan Africa*, Oxford, Oxford University Press (a World Bank publication).

GAISIE K., CROSS A.R., NSEMUKILA G. (1993), *Zambia Demographic and Health Survey 1992*, Columbia (Maryland), Macro International Inc.

GRUENAIS M.-É., POURTIER R. (dir.) (2000), "La santé en Afrique, anciens et nouveaux défis", *Afrique contemporaine*, 195, 1-282.

HILL A. (1989), "La mortalité infantile: niveaux actuels et évolution depuis 1945" in PISON G., VAN DE WALLE É., SALA DIAKANDA M. (eds.), *Mortalité et société en Afrique au sud du Sahara*, Paris, INED, PUF, Travaux et Documents, Cahier 124, 13-34.

HILL A. (1991), "Infant and child mortality: levels, trends, and data deficiencies" in FEACHEM R.G., JAMISON D.T. (eds.), *Disease and mortality in Sub-Saharan Africa*, Oxford, Oxford University Press, 37-73.

HILL A. (1993), "Trends in childhood mortality" in FOOTE K.A., HILL K.H., MARTIN L.G. (eds.), *Demographic change in Sub-Saharan Africa*, Washington D.C., National Academy Press, 153-217.

INSTITUTE OF POPULATION PROBLEMS (1993), *The 45th abridged life tables for Japan 1991-1992*, Ministry of Health and Welfare, Tokyo.

IUSSP COMMITTEE ON AIDS AND UNIVERSITY OF NATAL (1997), *Conference on the socio-demographic impact of AIDS in Africa, Durban, South Africa, 3-6 february 1997*, Liège, UIESP.

KAIJUKA E.M., KAIJA E.Z.A., CROSS A.R., LOAIZA E. (1989), *Uganda Demographic and Health Survey 1988-89*, Columbia (Maryland), Macro International Inc.

KOURGUENI I.A., GARBA B., BARRERE B. (1993), *Enquête démographique et de santé, Niger, 1992*, Columbia, Macro International Inc.

MESLÉ F., SHKOLNIKOV V., VALLIN J. (1994), "Brusque montée des morts violentes en Russie", *Population*, 49(3), 780-790.

MESLÉ F., SHKOLNIKOV V., HERTRICH V., VALLIN J. (1996), *Tendances récentes de la mortalité par cause en Russie, 1965-1994*, Paris, INED, (Données statistiques, 2).

MESLÉ F., VALLIN J. (1997), "La mortalité dans le monde: tendances et perspectives" in CHASTELAND J.-C., CHESNAIS J.-C (ed.), *La population du monde. Enjeux et problèmes,*. Paris, INED-PUF, Travaux et Documents, 139, 461-479.

MESLÉ F., VALLIN J. (2000), "Transition sanitaire: tendances et perspectives", *Médecine,sciences*, 16(11), 1161-1171.

MESLÉ F., VALLIN J., SHKOLNIKOV V. (1998), "Reversal of mortality decline: the case of contemporary Russia", *World Health Statistics Quarterly/Rapport trimestriel de statistiques sanitaires*, 51(2-3-4), 191-206.

MESLE F., VALLIN J., SHKOLNIKOV V., PYROZHKOV S. (1998), *Tendances de la mortalité et causes de décès en Ukraine*, Paris, INED, (Document de travail).

NANJO Z., KOBAYASHI K. (1985), *Cohort life tables based on annual life tables for the Japanese nationals covering the years 1891-1982*, Tokyo, Nihon University, Population Research Institute, (NUPRI Research Paper Series, 23).

OLSHANSKY J., AULT B. (1986), "The fourth stage of the epidemiologic transition: the age of delayed degenerative diseases", *The Milbank Quarterly*, 64(3), 355-391.

OLSHANSKY S.J., CARNES B.A., CASSEL C. (1990), "In search of Mathuselah: estimating the upper limits to human longevity", *Science*, 250, 634-640.

OLSHANSKY S.J., CARNES B.A., ROGERS R.G., SMITH L. (1998), "Emerging infectious diseases: the Fifth stage of the epidemiologic transition?", *World Health Statistics Quarterly/Rapport trimestriel de statistiques sanitaires*, 51(2-3-4), 207-217. (FRANK O. (ed.), *Historical epidemiology: mortality decline, and old and new transitions in health*, special number).

OMRAN A.R. (1971), "The epidemiologic transition: a theory of the epidemiology of population change", *Milbank Memorial Fund Quarterly*, 49(4), 509-538.

OMRAN A. (1983), "The epidemiologic transition theory: a preliminary update", *Journal of Tropical Pediatrics*, 29, 305-316.

OMRAN A.R. (1998), "The epidemiologic transition theory revisited thirty years later", *World Health Statistics Quarterly/Rapport trimestriel de statistiques sanitaires*, 51(2-3-4), 99-119. (FRANK O. (ed.), *Historical epidemiology: mortality decline, and old and new transitions in health*, special number).

OMS (1992), *Annuaire de statistiques sanitaires mondiales*, Genève, OMS.

PAGES J. (1996), "Éléments de comparaison entre l'analyse factorielle multiple et la méthode STATIS", *Revue de Statistique appliqueé*, 44(4), 81-95.

POPULATION DIVISION (1998), "The demographic impact of HIV/AIDS", *Population Newsletter*, December, 5-7.

ROGERS R.G., HACKENBERG R. (1987), "Extending epidemiologic transition theory", *Social Biology*, 34, 234-243.

SHKOLNIKOV V., MESLÉ F., VALLIN J. (1996), "Health crisis in Russia", *Population, An English Selection*, 8, 123-190.

SHKOLNIKOV V., NEMTSOV A. (1997), "The anti-alcohol campaign and variations in Russian mortality" in BOBADILLA J.L., COSTELLO C.A., FAITH M. (eds.), *Premature death in the New Independent States*, Washington D.C, National Academy Press, 239-261.

SPAD-TM (1997), *Analyse des tableaux multiples, Version 4.05*, Saint-Mandé (France), CISIA.

STATISTICS BUREAU (2001), *Japan Statistical Yearbook,* Tokyo, Management and Coordination agency.

STATISTICS DEPARTMENT (1996), *Uganda Demographic and Health Survey 1995*, Calverton (Maryland), Macro International Inc.

TIMÆUS I.M. (1998), "Impact of the HIV epidemic on mortality in Sub-Saharan Africa: evidence frome national surveys and censuses", *AIDS*, 12(1), S15-S27. (CARAËL M., SCHWARTLÄNDER B. (eds.), *Demographic impact of AIDS*).

UNITED NATIONS (1975), *World population prospects, 1970-2000 as assessed in 1973*, New York, United Nations, (ESA/P/WP.53).

UNITED NATIONS (1989), *World population prospects 1988*, New York, United Nations Publication (Population Studies 106).

UNITED NATIONS (2000), *World population prospects. The 1998 revision. Vol. 3: Analytical report*. New York, United Nations, Population Division.

UNITED NATIONS (2001), *World population prospects. The 2000 revision,* New York, Department of International Economic and Social Affairs, Population Division.

US CENSUS BUREAU (1999), *Statistical abstract of the United States 1999. The national data book*, Washington, Department of Commerce, (119th edition).

VALLIN J. (1968), "La mortalité dans les pays du tiers monde: évolution et perspectives", *Population*, 23(5), 843-868.

VALLIN J. (1989), "Théorie(s) de la baisse de la mortalité et situation africaine" in PISON G., SALA DIAKANDA D., VAN DE WALLE E. (eds.), *Mortalité et Société en Afrique au sud du Sahara*,. Paris, INED, PUF, (Travaux et documents, Cahier 124), 399-431.

VALLIN J. (1993), "Life expectancy, past, present, and future possibilities", in ROBINE J.-M. (eds.), *Calculation of Health expectancies: harmonization, consensus acieved and future perspectives*, Paris, John Libbey/INSERM, (Colloque INSERM, 226), 63-77.

VALLIN J., MESLÉ F. (2000), *Évolution de la mortalité en Europe depuis 1950*, Strasbourg, Conseil de l'Europe.

VALLIN J., MESLÉ F. (sous presse), *Tables de mortalité françaises 1806-1997 et projections jusqu'en 2102*, Paris, INED, (Données statistiques).

VAUPEL J.W. (2001), "Demographic insights into longevity", *Population, An English Selection*, 13(1), 245-260.

Appendix 1 – *Acronyms used for the variables of multiple factor analysis*

Acronym	Variable	Acronym	Variable
Pays		Age groups	
AS	Australia	0	0 year
AU	Austria	1	1-4 years
BU	Bulgaria	5	5-9 years
CA	Canada	10	10-14 years
DN	Denmark	15	15-19 years
FI	Finland	20	20-24 years
FR	France	25	25-29 years
GR	Greece	30	30-34 years
HU	Hungry	35	35-39 years
IR	Ireland	40	40-44 years
IT	Italy	45	45-49 years
JA	Japan	50	50-54 years
NL	The Netherlands	55	55-59 years
NO	Norway	60	60-64 years
NZ	New Zealand	65	65-69 years
POR	Portugal	70	70-74 years
RUS	Russia	75	75-79 years
SP	Spain	80	80-84 years
SW	Sweden	85	85 years and over
UK	United Kingdom		
UKR	Ukraine		
US	United States		
FRG	West Germany		
Partial axes			
AXE PART ACT 1 GP 1	First partial axis of period 1		
AXE PART ACT 1 GP 2	First partial axis of period 2		
AXE PART ACT 1 GP 3	First partial axis of period 3		
AXE PART ACT 1 GP 4	First partial axis of period 4		
AXE PART ACT 2 GP 1	Second partial axis of period 1		
AXE PART ACT 2 GP 2	Second partial axis of period 2		
AXE PART ACT 2 GP 3	Second partial axis of period 3		
AXE PART ACT 2 GP 4	Second partial axis of period 4		
Causes: see appendix 2			

Appendix 2 – *Acronyms used for the variables of the multiple factor analysis*

Cause of death	Acronym	Category of International Classification Diseases ICD			
		CIM-7 List A	CIM-8 List A	CIM-9 List B	CIM-10
Infectious diseases	INF	001-043	001-044	010-079	A000-B99
Stomach cancer	CS	046	047	091	C160-C169
Cancer of the intestine	CI	047-048	048-049	092-094	C170-C218
Lung cancer and larynx and bronchial cancers	CL	049-050	050-051	100-101	C320-C349
Breast cancer	CB	051	054	113	C500-C509
Cancer of the uterus	CU	052	055-056	120-122	C530-C55
Prostate cancer	CP	054	057	124	C61
Other cancers	CO	044-045, 055-060	045-046, 052-053, 058-061	080-089, 090, 095-099, 109, 110-112, 114-119, 123, 125-179	C000-C159, C222-C319, C37-C499, C510-C52, C56-C609, C620-D489
Ischaemic heart diseases	IH	081	083	270-279	I200-I259
Other heart diseases	OH	079-080, 082-084	080-082, 084	250-269, 280-289	I00-I159, I260-I528
Cerebro-vascular diseases and other diseases of the circulatory system	CV	070, 085-086	085, 086-088	290-299, 300-309	I600-I698, I700-I99
Diseases of the respiratory system	RD	087-097	089-096	310-329	J00-J998
Cirrhosis of the liver	CIR	105	102	347	K700-K719, K740-K746

Appendix 2 (cont'd)

Cause of death	Acronym	Category of International Classification Diseases ICD			
		CIM-7 List A	CIM-8 List A	CIM-9 List B	CIM-10
Other diseases of the digestive system	ODD	098-104, 106-107	097-101, 103-104	340-346, 348-349	K000-K678, K720-K739, K750-K938
Psychoses and neuroses	PM	067-068	069-070	210-217	F000-F699, F800-F99
Other diseases	OD	061-066, 069, 071-078, 108-135	062-063, 065-068, 071-079, 105-135	180-209, 218-249, 350-459	D500-E90, F70-F799, G000-H959, L00-Q999
Traffic accidents	MVA	138	138	471-472, 479-479	V01-V809, V820-V899, V98-V99
Accidental poisoning and suicide and homicide	PSH	140, 148-149	140, 147-148	480-489, 540-549, 550-559	X40-X499, X60-X849, X85-Y099
Other accidents	OA	139, 141-147, 150	139, 141-146, 149-150	470, 473-474, 490-539, 560-569	V810-V819, V90-V978, W00-X399, X50-X599, Y10-Y98

Notes: For the countries of the former USSR, which have their own denomination of death causes, we have used categories taken from successive versions of Soviet classification (Meslé *et al.*, 1996) corresponding to the categories based on those of the ICD.