Abstract
In 2004, Vallin and Meslé proposed a new theory of segmented health transition that consists in successive cycles of divergence convergence. It gave a conceptual basis for understanding unexpected changes in life expectancy trends. The main idea is that any major innovation resulting in massive health progress can initially be a source of divergence between countries or population groups because some are better prepared to take advantage of it than others. These countries benefit from an economic, social, political, and organizational configuration particularly favourable to the spread of this particular innovation, and rapidly distance themselves from the rest. Convergence occurs when the laggards finally catch up with the leaders, eventually closing the initial gap, a phenomenon that produces an accordion-like pattern of international disparities, with a succession of expansion and compression phases. In the history of industrialized countries, three major cycles were identified, each driven by a leading group of causes of death: infectious diseases, cardiovascular diseases, and ageing-related diseases.

Such historical cycles are difficult to evidence in Latin America, because of the lack of reliable data in most countries before 1950. Thanks to the Latin American Mortality Database (LAMBdA), it is possible to have an overview of life expectancy trends in most Latin America countries since the mid 1950s. It is not enough to get an idea of the beginning of the first (infectious) cycle but the clear convergence observed until the late 1980s corresponds to the end of this cycle certainly. By contrast with industrialized countries, where this step was followed a new divergence induced by the cardiovascular revolution, all Latin American trends seem to have stabilized since the beginning of the 2000s. Is Latin America missing the cardiovascular revolution?

To answer the question, we will use as a basis decennial estimates of life tables displayed by LAMBdA. However, these scarce points in time could hide some informative changes that
could appear in annual series, differently from country to country. Such series will be estimated by applying to the average measures given by LAMBdA annual changes shown by registered deaths. We will try to check if this current stagnation is due to the complete absence of progress or to a balance between real progress in terms of cardiovascular diseases and deterioration in the field of man-made diseases (accidents, suicide, homicide, tobacco, diabetes, obesity).

**Key Words:** Health Transition, Latin America, divergence-convergence cycles, Latin American Mortality Database (LAMBdA),

LIFE EXPECTANCY IN LATIN AMERICA: THE END OF CONVERGENCE?

I. Estimation of annual life tables

In LAMBdA, mortality estimates after correction for under-registration of deaths and census correction are available for mid-intercensal periods only. It means that not only annual fluctuation are not considered but, more important, mortality changes after the last mid-census period are unknown. This prevents the user to compare recent changes in order to determine if there was a continuation of trends observed between the two last mid-census periods or any trends reversal. Fortunately, annual crude death counts from the civil registration systems are available. In spite of the fact that such crude data are subject to more or less important under-registration, it can be assumed that rate of under-registration is not fluctuating deeply and is probably diminishing smoothly. Consequently, age- and sex-specific mortality rates have been computed for each year in all countries by using annual population estimates (by interpolation between censuses) as populations at risk. As expected, derived life expectancies proved to be more or less overestimated according to the country but they also show the occurrence of annual fluctuations and, more important, indicates possible trend changes in the most recent years.
Annual age- and sex-specific mortality rates were then corrected for under-registration in three steps. First, for the year of each mi-census LAMBdA estimate (i.e. the central year of the inter-census period), age- and sex-specific ratios between LAMBdA’s mortality estimates and the average rate given by our computation on crude death counts for the same period, were calculated. Second, these ratios were interpolated between the two successive central years of inter-census periods, assuming that the pace of change is constant during the relevant period. In the same way, ratios were extrapolated linearly to the years after the central year of the last inter-census period. And, if necessary, we did the same for the years before the central year of the first inter-census period. Third, annual ratios were applied to mortality rates based on crude data to obtain complete series of sex- and age-specific mortality rates for each year for which annual death counts are available. Finally, annual life tables were computed for each sex and each of the 16 countries included in LAMBdA. Figure 1 compares our crude and corrected estimates of annual life expectancy to those given by the database for the central year of each inter-census period.

It appears that, except Honduras for which no crude death count is available after the year 1982, countries can be classified in three categories according to the existence or not of a slowing down in life expectancy during the recent period. In 5 countries no clear slowing down appears (Argentina, Chile, Colombia, Guatemala, Uruguay). In 9 other ones, a more or less pronounced slowing down (sometimes even a trend reversal) occurred for both sexes (Brazil, Cuba, Ecuador, Mexico, Nicaragua, Panama, Peru, Dominican Republic), while in the two remaining countries life expectancy slows down for males only (Costa Rica, Venezuela).

To analyse these changes in life expectancy trends more deeply, we decided to study a restricted number of countries to get more readable results, paying attention to countries quite representative of these three categories, including the most important ones (in terms of population) like Brazil, Mexico, and also excluding countries affected by long lasting interruption in death counts time series like Nicaragua and Panama or by artificial jumps possibly produced by sudden changes in either census or vital statistics quality like the Dominican Republic. Finally, 7 countries will be considered for the next steps: Brazil, Cuba, Mexico, with a recent slowing down, Argentina, Chile, Uruguay that continued to progress fast in the recent years, and Costa Rica where recent trends vary between males and females.
Figure 1. Trends in life expectancy at birth in 16 Latin American countries according to LAMBdA and authors’ estimates. Males and females.
Figure 1 (continued). Trends in life expectancy at birth in 16 Latin American countries according to LAMBdA and authors’ estimates. Males and females
II. General mortality trends in 7 selected countries

Figure 2 displays trends in life expectancy of the seven selected countries since the early seventies for males and females separately. During the whole period males in Cuba and Costa Rica are doing much better than all other countries, while Brazil was always in the worst position. However, the distance in-between has strongly reduced, from 12 years in 1979 (first available year for Brazil) to only 5 years and half in 2012, indicating a general convergence during the last three decades. The convergence is even more spectacular between Chile and the two leaders while the Mexican trend is quite similar to the Brazilian one although at a slightly higher level. The cases of Argentina and Uruguay contrasts in the reverse direction since these countries evolve at a similar pace as Cuba or Costa Rica in spite of their lower initial levels. In fact in a further past (before World War 2, and until the fifties, these two countries had experienced the best Latin American levels of life expectancy, but lost their advantage later on, with rather regular but not very rapid improvement. Although less acute, the same trends and contrasts feature female trends: strong convergence between Cuba/Costa Rica at the top and Brazil at the bottom, Chile catching up the leaders (even sooner than for males) and Argentina and Uruguay progressing very regularly but less rapidly than Cuba and Costa Rica. However, female Mexican life expectancy progressively slowed down since the end of the eighties and was caught up by the Brazilian one at the beginning of the years 2000s.

Figure 2. Annual trends in life expectancy in 7 selected countries. Males and females
Even if it admits important specificities between countries, that general convergence is quite representative of the Omran “epidemiologic transition” (Omran, 1971) or more precisely the end of the first cycle of divergence-convergence of the health transition that was driven by the successful fight against infectious diseases (Vallin and Meslé, 2004). But in this paper, we would like to focus more on the divergence that seems recently at work between countries where life expectancy increase has slowed down or even stopped during about the last observed decade (2000-2010), while other countries are still progressing. This contrast appears quite independently from the levels of life expectancy already reached at the end of the 1990s. For example, Chile caught up Cuba and Costa Rica not only because Chile made much more rapid progress from the 1970s to the 1990s, but also because Cuba and Costa Rica improvement slowed down since 2000 (and even very recently started to get down in male Costa Ricans). At lower levels of life expectancy, the same phenomenon recently appeared between both Argentina and Uruguay versus Mexico and Brazil, especially for males. Is it an evidence that a second cycle of divergence is starting, based on the fight about cardiovascular diseases (and/or what Omran called “man-made diseases”, especially violence)?

A first approach towards an answer is to look at the respective roles of mortality declines at various age-groups in life expectancy changes at different period. Figure 3 compares age-components of life expectancy changes\(^1\) in the 7 countries during 3 ten-year periods since 1980 (1980-1990, 1990-2000 and 2000-2010).

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\(^1\) Computed according to the Andreev method (1982).
Figure 3. Age-components of changes in life expectancy during three decennial periods in 7 selected countries. Males and females
It is clear that the long-term history of Argentina and Uruguay is quite different from that of the other countries. For all three periods the decline of mortality at ages above 35 explains the major part of life expectancy gains for both males and females. Mortality at young ages was reduced much earlier and its decline is no more producing substantial returns. If life expectancy is still in progress it is mainly due to the decline of mortality at later adult and old ages, what could have resulted from the start of cardiovascular revolution in the 1980s or before. For all other countries, not only total gains are much more changing from one period to the other (generally diminishing) but age components also varied a lot. At least for the first decade, the decline in young age mortality is prominent, sometime overwhelming like in male Brazilians and Chileans. It is still very important in the second period. Conversely, in the third decade, old age mortality decline is very important, but it is in the context of total gains much less important. And at this time of reduced gains, there are great differences in terms of age components of life expectancy changes. For example, in Chile, almost no additional gains are produced by young age mortality decline while the latter caused the major part of Mexican gains. Not only recent slowing downs of life expectancy progress varies a lot according to the country but their age-components are quite diverse, certainly in relation with diverging trends in cause-of-death mortality.

III. Cause-of-death components of life expectancy changes

To investigate cause-of-death mortality trends it would be necessary to reconstruct coherent death series, according to a constant classification of causes of deaths, in order to erase the statistical ruptures caused by the periodic revisions of the International Classification of Causes of deaths (ICD) in use in all Latin American countries (Meslé and Vallin, 1996). This is not possible in the frame of this paper (at least at the stage of the extended summary). However, it is quite possible to investigate the last period (2000-2010) for which cause-of-death series are entirely ruled by ICD-10, the last version of the international classification, adopted by all the 7 countries before the year 2000, thanks to the distribution of deaths by cause provided by LAMBdA. This distribution was applied to the corrected death rates and ill-defined causes of deaths were distributed by age and sex among other groups of causes proportionally.

Figure 4 displays the cause-of-death components of changes in male and female life expectancies in the seven selected countries for the 8 large groups of causes available in LAMBdA. The decline of circulatory diseases causes major gains in the 2000-2010 life
expectancy increase in all countries for both sexes, but in Mexico where it gives nothing for males and very little for females. The role of changes in mortality by neoplasm is very diverse from one country to another and between males and females: the reduction of cancer mortality contributes notably to the progress in life expectancy in Argentine, Uruguay and Chile for both sexes and in Mexico for females. Reversely the increase of cancer mortality in Cuba is quite important for males and also visible for females, as it is for women in Costa Rica. In Brazil cancer mortality plays a very modest role in the progress in life expectancy. In Mexico only, diabetes is an important factor in the slowing down of life expectancy progress, especially for males. Almost everywhere, except in Argentina and Uruguay, the decline in mortality by respiratory diseases contributed to life expectancy progress. Finally external causes have a strong impact on male life expectancy changes in male mortality: negative in Costa Rica and Mexico, but positive in the other 5 countries.

**Figure 4. Cause-components of changes in life expectancy between 2000 and 2010 in 7 selected countries. Males and females**

Contributions of causes of death to life expectancy changes can be split according to age groups (Figures 5a and 5b, for males and females respectively). A first look at these series of graphs reveals a large range of situations according to the country. Some common features are however visible: the importance of circulatory diseases at adult and old ages, the concentration of external causes at young adult ages in contrast with the impact of respiratory
diseases mainly at old ages. But these graphs show also several features specific to one or two countries: the importance of decreasing digestive diseases below age 55 and of increasing diabetes above age 50 among Mexican males; the persistence of a significant role played by the reduction of infectious and respiratory diseases among children in Brazil and in Mexico; the negative impact of changes in mortality from other causes in Cuba and Chile.

At this stage of our analysis, first results raise new questions that we need to investigate further. It also appears necessary to compare what occurred in the most recent period to what happened earlier, and to replace these recent trends in causes of death in an historical perspective. We’ll pursue further research in this direction in the next months and present additional results at the Conference. From this first rapid overview, it already seems that the recent slowing down of life expectancy progress in Latin America could be mostly related to the difficulty for some countries to fight man-made diseases and not really to a failure of the cardiovascular revolution. Further analyses on cause-of-death trends should allow us to confirm (or infirm) it in the next months.
Figure 5a. Age- and cause-components of changes in life expectancy between 2000 and 2010 in 7 selected countries. Males
Figure 5b. Age- and cause-components of changes in life expectancy between 2000 and 2010 in 7 selected countries. Females
References


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