HEALTH TRANSITION IN BRAZIL – REGIONAL VARIATIONS AND CONVERGENCE/DIVERGENCE IN MORTALITY

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Abstract

The present paper analyzes the main characteristics of the health transition in the five Major Regions in Brazil from 1980 to 2010. We use the health transition approach proposed by Frenk, Bobadilla, et al. (1991), in which they argue for the importance of defining a research agenda with particular attention to the subnational level, so that social and regional inequalities in health may be better documented. The methodology proposed by Vallin and Meslé (2004) is also employed, allowing for analysis of convergences and divergences in mortality, considering specific age groups and causes of death. Results show that mortality change in Brazil has follow the epidemiologic transition theory to some extent during the period under analysis, for instance, the sharp decline in infant mortality in all regions and the increase in the participation of chronic and degenerative diseases as the main causes of death. However, there are some features of Brazilian transition that has not followed the linear and unidirectional pattern proposed by the epidemiologic transition theory, which helps to understand some periods of regional divergence in life expectancy and life-span, despite the long-term trends showing reducing regional inequalities.

1. Introduction

The term “epidemiological transition” was first used by Omran (1971) in order to explore the complex change in patterns of health and disease. His theory is based on the idea that degenerative and the so-called “man-made” diseases replace infectious diseases as the primary causes of morbidity and mortality.

According to Omran (1971, 516–517), the epidemiologic transition consists of three successive stages: i) the "Age of pestilence and famine", when mortality is high and fluctuating; ii) the "Age of receding pandemics", when mortality declines progressively; iii) the "Age of degenerative and man-made diseases", when mortality continues to decline and eventually approaches stability at a relatively low level.

These stages vary in pattern, pace and determinants, leading to different models of the epidemiologic transition: the first one is the "classical" or Western model, which shows a gradual and progressive transition that was supposed to happen in most of the developed world. The contemporary or delayed model refers to the transition yet-to-be completed in most developing countries[1].

The epidemiological transition also describes interactions between the observed mortality patterns and their demographic, economic and sociologic determinants and consequences. In this sense, Omran (1971) indicates three main different determinants for mortality decline: ecobiological factors, which relates the disease agents with environmental factors; socioeconomic, political and cultural determinants, which include standards of living, health habits, hygiene and nutrition; and medical and public health determinants. He states that ecobiological and socioeconomic factors were the most important determinants of mortality decline in the European transition.

In agreement with the epidemiological transition idea, Olshansky & Ault (1986) added a fourth stage to the theory, which they called "The Age of Delayed Degenerative Diseases". This concept includes a rapid decline in mortality, concentrated mostly at advanced ages and caused by the postponement of mortality from degenerative diseases.

The idea of convergence is a general premise of the demographic transition theory, in both fertility and mortality[2], and it is implicit in the third stage of the epidemiologic transition theory, when mortality would stabilize at very low levels. This idea is also is used in most population projections, including the official population projection of Brazil and its states (IBGE 2013b).

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[1] Omran (1971) also talks about the accelerated mortality transition model, which occurred most notably in Japan.

[2] See Coleman (2002) for a discussion about the demographer’s views on this convergence and its plausibility.

However, Vallin and Meslé (2004) identify some important failures and unexpected improvements that contradict some points of the epidemiological transition theory. They argue, for example, that Omran's "Age of degenerative and man-made diseases" is not the final stage of the transition and the successful fight against cardiovascular diseases cannot be interpreted as its fourth stage. Rather, they put these changes into their idea of a divergence-convergence process, based on a new approach to health, where success in this field depends on societies' abilities to implement progresses.

Lerner (1973) was the first to present a formulation that considers the epidemiologic transition as part of the broader concept of "health transition". This idea was later explored by Frenk, Bobadilla, et al. (1991), who included elements of the social conceptions and behaviors regarding health determinants and consequences of health change. This approach, according to the authors, has the advantage of being sufficient to be applicable to different contexts, in opposition to the epidemiological transition theory, which does not completely take into account the complexity of several transition patterns observed within and between different countries.

The main criticisms to the epidemiologic transition by the health transition theorists are the existence of a linear and unidirectional view of the processes and the sequence of the stages. It has been observed that actual transitions often contain many nonlinear processes, in addition to an overlapping of different patterns (Frenk, Bobadilla, et al. 1991).

Transformations resulting from health transition are particularly complex in middle-income countries. In Latin America, for example, mortality improvements have been reflecting advances in medical technology, progresses in health care systems and changes in lifestyles and living conditions of the populations (Palloni and Pinto-Aguirre 2011). However, the population has a very heterogeneous health profile, which leads to the development of a peculiar epidemiologic polarization, not only between countries, but also within them in different geographic areas and among different social classes. These experiences are called "prolonged polarized model" (Frenk, Frejka, et al. 1991). The paradigmatic examples of this "new transition model" are Brazil and Mexico. Polarization is associated with the concept of a double burden of infectious and chronic diseases, but the authors also emphasize the existence of a "protracted" period when these two kinds of diseases coexist, without a clear expectation of resolving the transition process, mostly due to the persistence of social and regional inequalities. Such inequalities reinforce the coexistence of the two stages as a result of subpopulations experiencing different stages of the transition, but these subpopulations themselves frequently also suffer from both types of diseases – infectious and degenerative – at the same time.

The epidemiological transition in Brazil has not followed the model experienced by most developed countries. Old and new health problems coexist: despite the predominance of the chronical and degenerative diseases, the communicable ones still play an important role. The reintroduction of diseases like dengue and cholera, and

intensification of others like malaria, leprosy and leishmaniasis indicates a non-unidirectional nature in the process, also called counter transition (Schramm et al. 2004). Such a counter transition, referring to the resurgence of these infectious and parasitic diseases, does not have a large impact on overall mortality trends, even though short-run increases in mortality from infectious diseases have been observed (Teixeira et al.(2002); Campelo et al. (2005); Palloni and Pinto-Aguirre (2011). However, these process have great importance for morbidity (Luna 2002). Also, external causes have been playing an important role in changing mortality patterns in the country (Gawryszewski, Koizumi, and Mello-Jorge 2004).

In this context, the objective of this paper is to analyze the main characteristics of the health transition in the five Major Regions in Brazil, considering the great regional inequalities in the country. We discuss further whether there is a regional mortality convergence/divergence process and what are the contributions of specific age groups and causes of death to mortality changes over time and across regions.

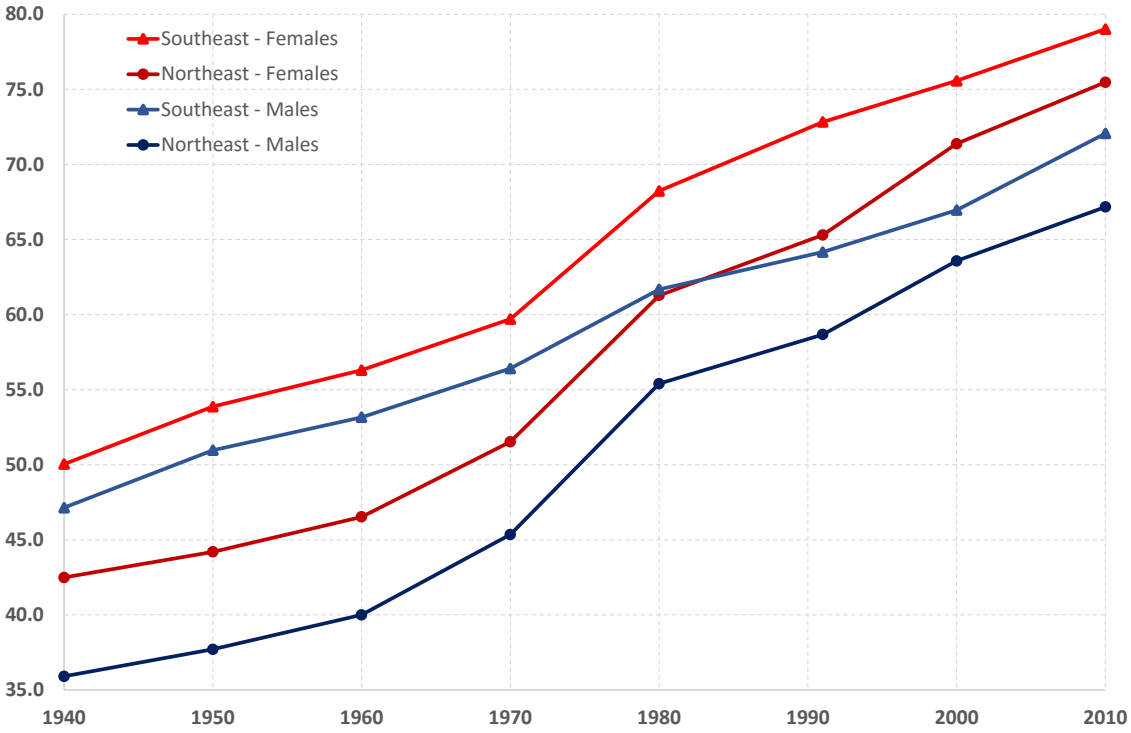
For this purpose, we use the health transition approach proposed by Frenk, Bobadilla, et al. (1991), in which they argue for the importance of defining a research agenda with particular attention to the subnational level, so that social and regional inequalities in health may be better documented. We also employ the health transition methodology proposed by Vallin and Meslé (2004, 38), which analyzes convergences and divergences in mortality, considering specific age groups and causes of death. The authors also suggest taking this matter further to see how it might apply to trends and differences in mortality observed within countries, either in terms of internal geographical variations or even in terms of economic, social, cultural, gender, and other differences.

2. The Brazilian health transition and convergence/divergence in mortality

Life expectancy has increased substantially in Brazil since the 1930s, presenting more rapid improvements than those observed in the European countries when they had the same mortality levels. However, there have been persistent regional inequalities, even though the long-term trends show reducing differences. In the 1930s, life expectancy in the South Region was around 50 years, 15 years higher than the figure observed in the Northeast Region (Carvalho 1980). The difference in life expectancy at birth between these two regions fell to 4.6 in 2010. Despite the long-term convergence trend, mortality decline has happened unequally in all Brazilian regions. Figure 1 shows life expectancy at birth by sex, from 1940 to 2010 for the Southeast and Northeast Regions. From 1940 to 1960, the difference between the life expectancies in these two regions increased 2.0 and 2.2 years for males and females respectively, as a result of the health policy model that followed the profound social stratification in the country, prioritizing more developed regions, already engaged in the new dynamic of the expanding labour market. From the mid-70s there was an acceleration of mortality decline, driven by the decline in infant mortality. These changes were the consequence of governmental action, such as the generalization of health and sanitation services and immunization, leading to a reduction in regional inequalities in mortality

(Simões 2001). New convergence in the regional life expectancy rises as a result of the expansion and decentralization of health and sanitation services, offering these services to areas excluded in the past (Simões and Oliveira 2010).

Figure 1 - Life expectancy at birth (e_0) by sex – Southeast and Northeast Regions - 1940/2010

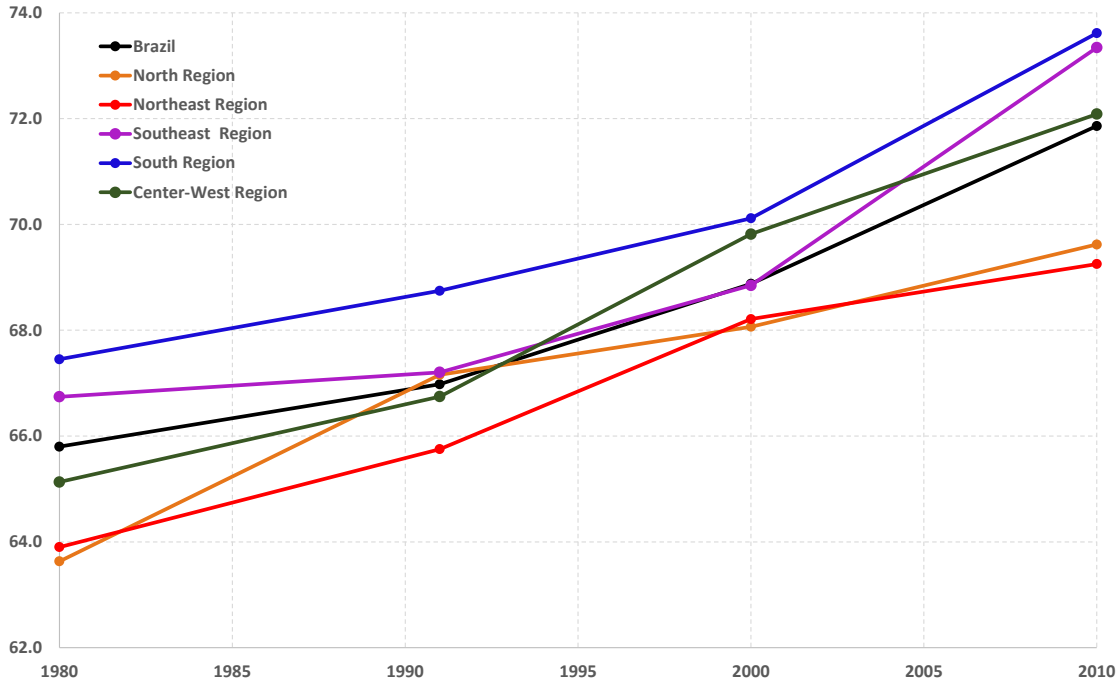


Source: Simões (2001), Albuquerque and Senna (2005), IBGE (2013a)

Life expectancy at birth is often taken as an index of overall mortality, but gives a poor idea of lifespan, since it is heavily affected by infant mortality (Wachter 2014). In order to show the regional differences in mortality without the effect of infant mortality,

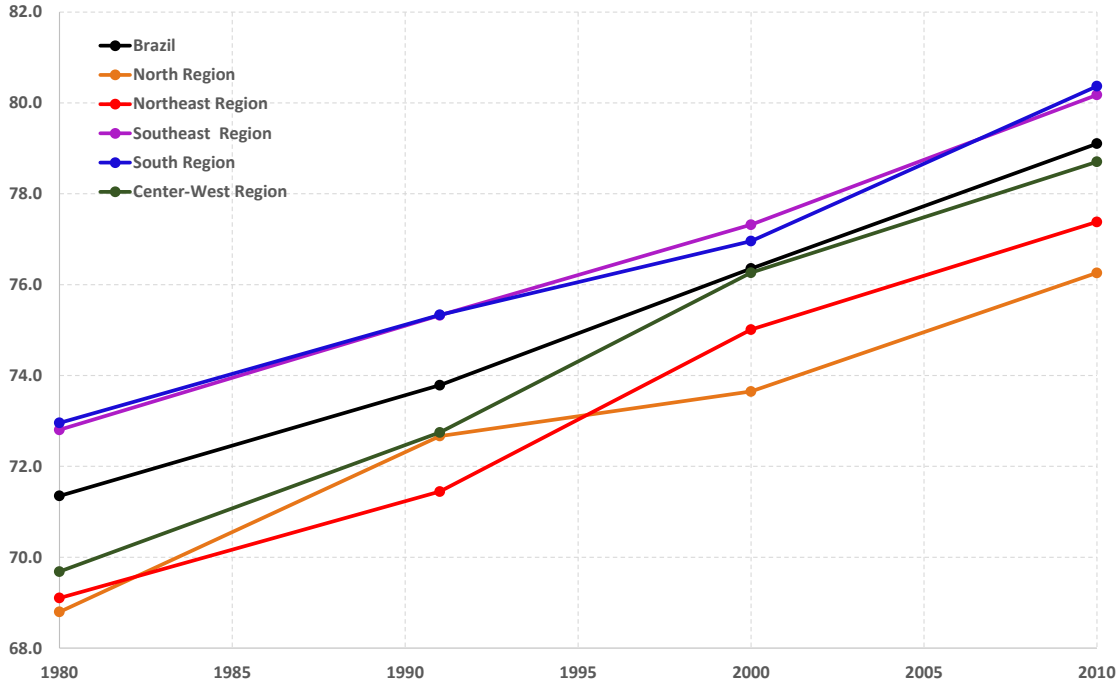
Figure 2 and Figure 3 show the lifespan indicator at age 10 ($10 + e_{10}$), by sex, for all regions, from 1980 to 2010. There was convergence process from 1980 to 2000, showed by a narrow difference between the lifespan in the less developed regions (North and Northeast) and the more developed regions (South and Southeast), with a divergence in the last decade, much clearer for males than for females.

Figure 2 – Lifespan at age 10 (10 + e_{10}) by sex and Major Region - 1980/2010 – Males



Source: Albuquerque and Senna (2005), IBGE (2013a)

Figure 3 - Lifespan at age 10 (10 + e_{10}) by sex and Major Region - 1980/2010 – Female



Source: Albuquerque and Senna (2005), IBGE (2013a)

Females' life span for South and Southeast Regions have been presenting very similar patterns, whereas for males it has been significantly higher in the South Region than for those in the Southeast, with a great divergence during the 1980s and 1990s. In the last decade, life expectancy for males in the Southeast have increased more than five years, leading to convergence between these regions.

In order to understand the reduction in regional differences from 1980 to 2000 and the recent divergence or, at least the permanence of the differences, especially for males, the following sections discuss mortality trends for the Brazilian regions by sex, age and cause of death.

3. Data and Methods

The method used to estimate variations in life expectancy over time due to changes in mortality by age and cause of death is the one described by Shkolnikov et al. (2001):

$$\varepsilon_x = e_x^2 - e_x^1 = \frac{1}{2}\sum_x^w \begin{Bmatrix} [l_x^2(e_x^2 - e_x^1) - l_{x+1}^2(e_{x+1}^2 - e_{x+1}^1)] - \\ [l_x^1(e_x^1 - e_x^2) - l_{x+1}^1(e_{x+1}^1 - e_{x+1}^2)] \end{Bmatrix}$$

where e_x^t is life expectancy at age *x* and time *t* and l_x^t the number of survivors at age *x* and time *t*.

A further decomposition by cause of death (*j*) is performed: $\varepsilon_{x,j} = \frac{M_{x,j}^1 - M_{x,j}^2}{M_x^1 - M_x^2} \times \varepsilon_x$,

where $M_{x,j}^t$ is the age-specific mortality rate at age *x*, time *t* and cause of death *j* and M_x^t the overall age-specific mortality rate at age *x* and time *t*.

The period chosen for this analysis is 1980-2010, for which life tables constructed using administrative records and information by causes of death are available.

Life expectancy estimations come from the official life tables released by the Brazilian Institute of Geography and Statistics (IBGE) by age, sex and Major Region, for 1980, 1991 (Albuquerque and Senna 2005), 2000 and 2010 (IBGE 2013a). These life tables were constructed using the information of deaths from the Civil Registration System, vital statistics from the Ministry of Health (SIM - Mortality Information System) and census population

counts for the corresponding years. The life tables have been corrected by the Statistics Office for the underestimation of infant[3] and adult mortality[4] using indirect estimation methods.

In order to maintain temporal consistency in the estimates, two adjustments were made. The first one was to reconstruct the life tables for Regions North and Central-West in 1980, considering the territorial adjustment necessary to account for the separation of Tocantins from Goiás, as it became part of the North Region. The second adjustment is related to a procedure adopted when building in 1991 life tables, in which reduction factors were applied to the rates at older ages (Albuquerque and Senna (2005)). In order to maintain the methodological comparability in the procedures adopted for the other years (1980, 2000 and 2010), the mortality rates for 1991 were adjusted using the inverse of the reduction factors.

Deaths by Major Region, age, sex and cause of death from 1980, 1991, 2000 and 2010 (three-year moving average) come from the Brazilian Mortality Information System (SIM).

Description of the chapters used for reconciling ICD-9 and ICD-10 and the codes used for the groups of causes-of-death are in the Appendix (Table 1).

Limitations in the mortality information regarding the cause of death persist, despite some improvements over time. Also, there are great regional differences and, in areas where the proportion of ill-defined causes of death is high, there is no evidence that the proportional distribution of well-defined deaths is a suitable procedure (Jorge et al. (2002) and França et al. (2014)). For this reason, cause of death information was used in the analysis only when the information was considered of adequate quality according to Mathers and colleagues' (2005) definition (i.e., ill-defined codes for the underlying cause appear on fewer than 20% of the death certificates). In these cases, deaths of ill-defined causes were redistributed proportionally by age group, sex and year. Thus, decompositions by age and cause of death were performed for Brazil and the Southeast, South and Central-West Region, but not for the North and Northeast Regions, for which gains in the life expectancy were decomposed only by age groups.

Despite some limitations in the raw data, since they are not completely reliable, and in the procedures used to correct underreporting deaths and ill-defined causes, these statistics, as claimed by Laurenti et al. (2004), have been important instruments for epidemiological analysis and, even though there could be some biases, general trends appear to be fairly reliable.

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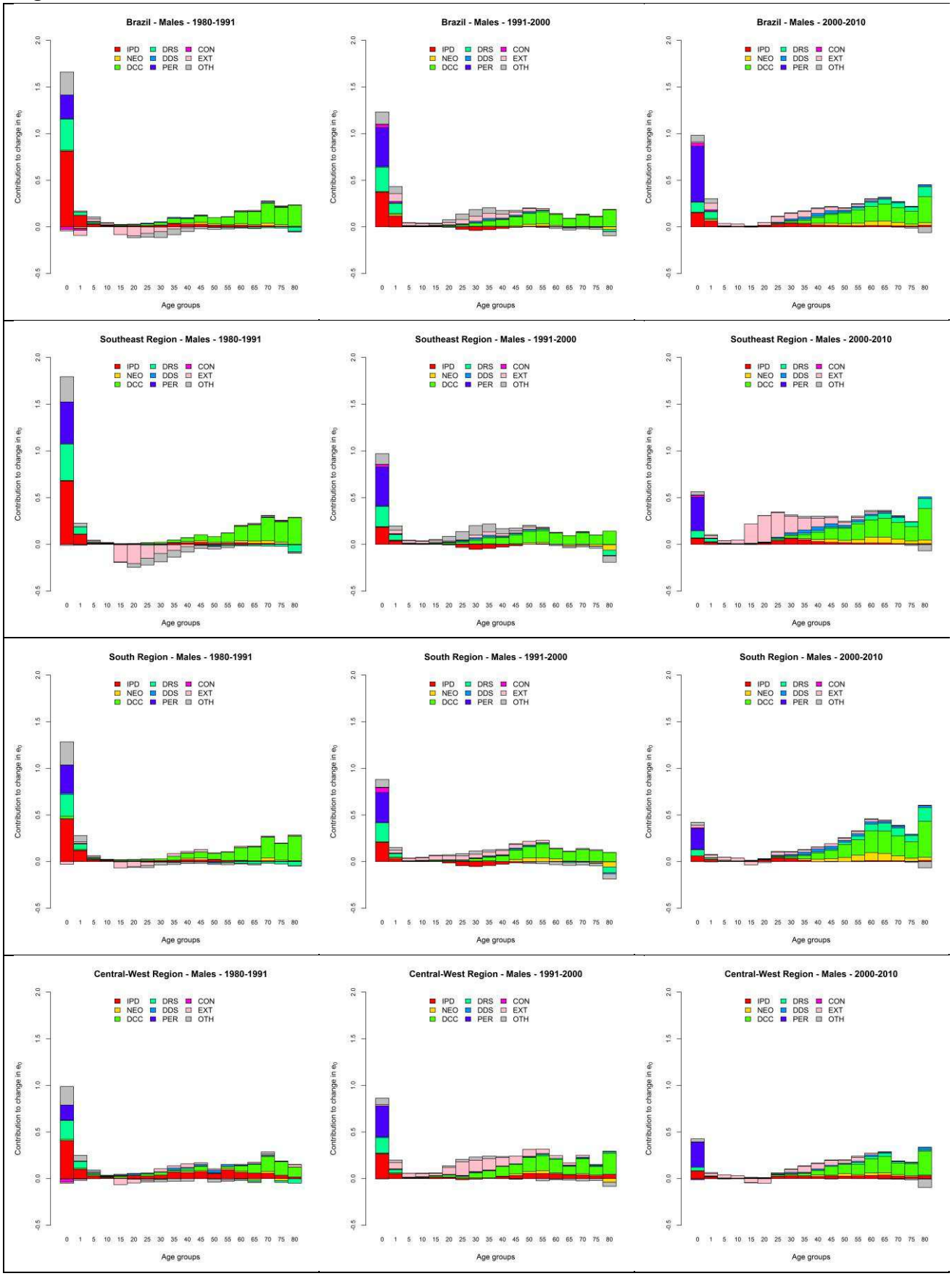
[3] Brass et al (1968); Trussell (1975)

[4] Brass (1975); Courbage and Fargues (1979); Preston & Coale (1980)

4. Results

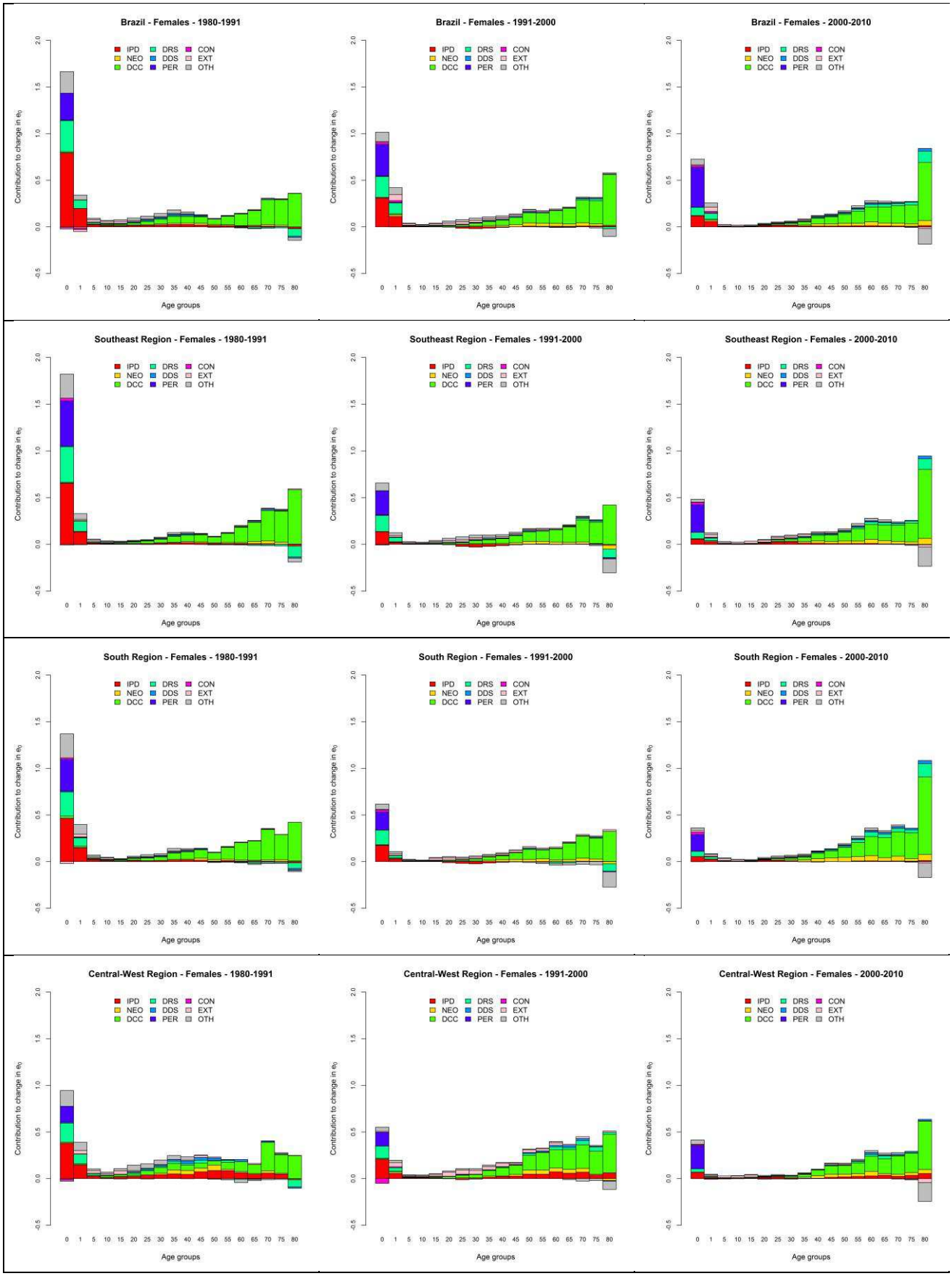
Table 2 in the Appendix shows the contribution to change in e0 by age group according to the Major Region, sex and period under analysis. Figure 4 and Figure 5 show the same information, with the additional decomposition by age-of-death.

Figure 4 - Contribution to change in e_0 by age group and cause of death – Brazil, Southeast, South and Central-West Regions – 1980, 1991, 2000, 2010 – Males



Source: Albuquerque and Senna (2005), IBGE (2013), SIM (1979/2011)

Figure 5 - Contribution to change in e_0 by age group and cause of death – Brazil, Southeast, South and Central – 1980, 1991, 2000, 2010 – Females



Source: Albuquerque and Senna (2005), IBGE (2013), SIM (1979/2011)

The decline in infant mortality was the main factor for the increase in life expectancy during the 1980s, representing 1.6 years out of the total gain of 2.9 and 4.3 for males and females respectively. Infectious and Parasitic Diseases (IPD), represented during this period in large part by intestinal infectious diseases, explained almost 50% of the gain in life expectancy for this group. Despite some reduction of infant mortality contribution over time, it is still important. The more recent decline in mortality below one is due especially to certain conditions originating in the perinatal period, mostly respiratory and cardiovascular disorders.

From 1980 to 1991, increases in mortality among young adult males, from 15 to 34 years old had a negative impact on life expectancy at birth. This increase was mostly due to external causes. In 1991, around ¼ of the deaths due to external causes among young males was attributable to transport accidents and around 40% to homicides. For the periods 1991-2000 and 2000-2010, mortality declined slightly in this age group. In 2010, 28% of the deaths by external causes among young males were due to transport accidents and the participation of homicides has raised to more than 50%. Mortality decline for females in the same age groups has also had only minor contribution to the overall life expectancy increase.

Mortality change among the middle-age adult males (35-59) has represented important contributions to life expectancy increase, especially in the last two decades (0.9 and 1.0 years, respectively for the periods 1991-2000 and 2000-2010). This was mostly driven by decline in mortality from cardiovascular diseases. For females, the gains in life expectancy at birth due to mortality decline in this age group have been more constant over time, representing 0.7 years per period.

There have been important contributions to increases in life expectancy at birth due to decline in mortality among the elderly population (60 or older), mostly due to a decline in mortality from Diseases of the Circulatory System (DCS). These improvements were higher for women, which, along with the difference in mortality from external causes, helps to explain the long-term widening of the gender gap in life expectancy.

It has been shown that mortality decline from Diseases of the Circulatory System (DCS) has played an important role in the Brazilian health transition and several changes in cardiovascular risk factors have been used to explain its health impact. Among the five most important causes of ill health and premature death in Latina America are tobacco consumption, hypertension, diabetes, obesity and physical inactivity (Pramparo et al. 2006). Malta et al. (2014) attribute the decline in mortality from cardiovascular diseases and general chronic non-communicable diseases in Brazil to improvements in access to health services, the noticeable decline in smoking, as well as improvements in socioeconomic conditions. Oliveira et al. (2006) claim that the historical decline in cardiovascular mortality in Brazil is more related to declining exposure to infectious agents, particularly early in

life, because of improvements in living conditions of the population, than to the control of biological risk factors or to technological advances in clinical practice.

Mortality decline due to neoplasia has contributed to increasing life expectancy, though to a much lower extent than circulatory diseases. Malta et al. (2014) point out that trend in cancer mortality varies depending on sex, age and location.

Regional analysis helps to understand the process for the country as a whole, since the regions present different timings in health transition, and sometimes contrasting trends.

The South and Southeast Regions exhibit very similar trends for females, with a decrease in the role of infant mortality in mortality improvement, shifting from a predominance of IPD to diseases related to the perinatal period. Decline in cardiovascular diseases has been the main driver for the mortality decline at older ages, so that the share of mortality attributable to cancer has gained importance in the last decade. Respiratory diseases have also contributed to increasing life expectancy, especially in the oldest old group.

The same general trends described for women can also be observed for males. However, some important differences help to explain the process of convergence/divergence between the two regions in the last 30 years for this group. From 1980 to 1991, there was an important increase in mortality among males at ages 15 to 45 years in the Southeast, which contributed negatively to decline in life expectancy at birth. Most of the decline was due to mortality from external causes, especially for ages 15 to 29 years. In addition, negative contributions from "other causes" emerged at ages 25-39, mostly due to mortality from HIV/AIDS[5]. It is well known that from the beginning of the HIV/AIDS epidemic, the Southeast region showed the highest concentration of cases and also stood out for its higher mortality from this disease (Dhalia, Barreira, and Castilho 2000; Reis, Santos, and da Cruz 2007).

However, in the last decade, the Southeast Region presented an amazing decline in mortality from external causes. São Paulo and Rio de Janeiro were the two States that had the largest decline in mortality from external causes in Brazil during this period, mostly because of a decline in homicide rates, resulting from the impact of disarmament strategies and policies addressing violence (Waiselfisz 2013).

[5] In ICD-9, HIV-AIDS was classified in category 279 (Disorders involving the immune mechanism), within Chapter 4 (Endocrine, nutritional and metabolic diseases, and immunity disorders). Almost 80% of the deaths in Chapter 4 among young adult males in Southeast Region in 1991 were classified in category 279.

The main difference between the Central-West Region and the national average is the mortality from IPD among adults, which had an important contribution to the increase in life expectancy. Most of the adult mortality decline from IPD in the Central-West region was due to trypanosomiasis, or Chagas' disease. This was a particularly important cause of death in the states of Goiás and Distrito Federal, where, in 1980, more than 70% of the deaths from IPD had trypanosomiasis as the main cause.

Due to the high proportion of ill-defined causes, changes in life expectancy in North and Northeast Regions were decomposed only into age groups. Even though some bias could result from the large proportion of under-registered deaths and the inability of indirect techniques to correct for the lack of information, inferences about general mortality trends for these regions are possible.

The decline in infant mortality has been responsible for an increase of life expectancy of more than 1.5 years per decade in the Northeast Region.

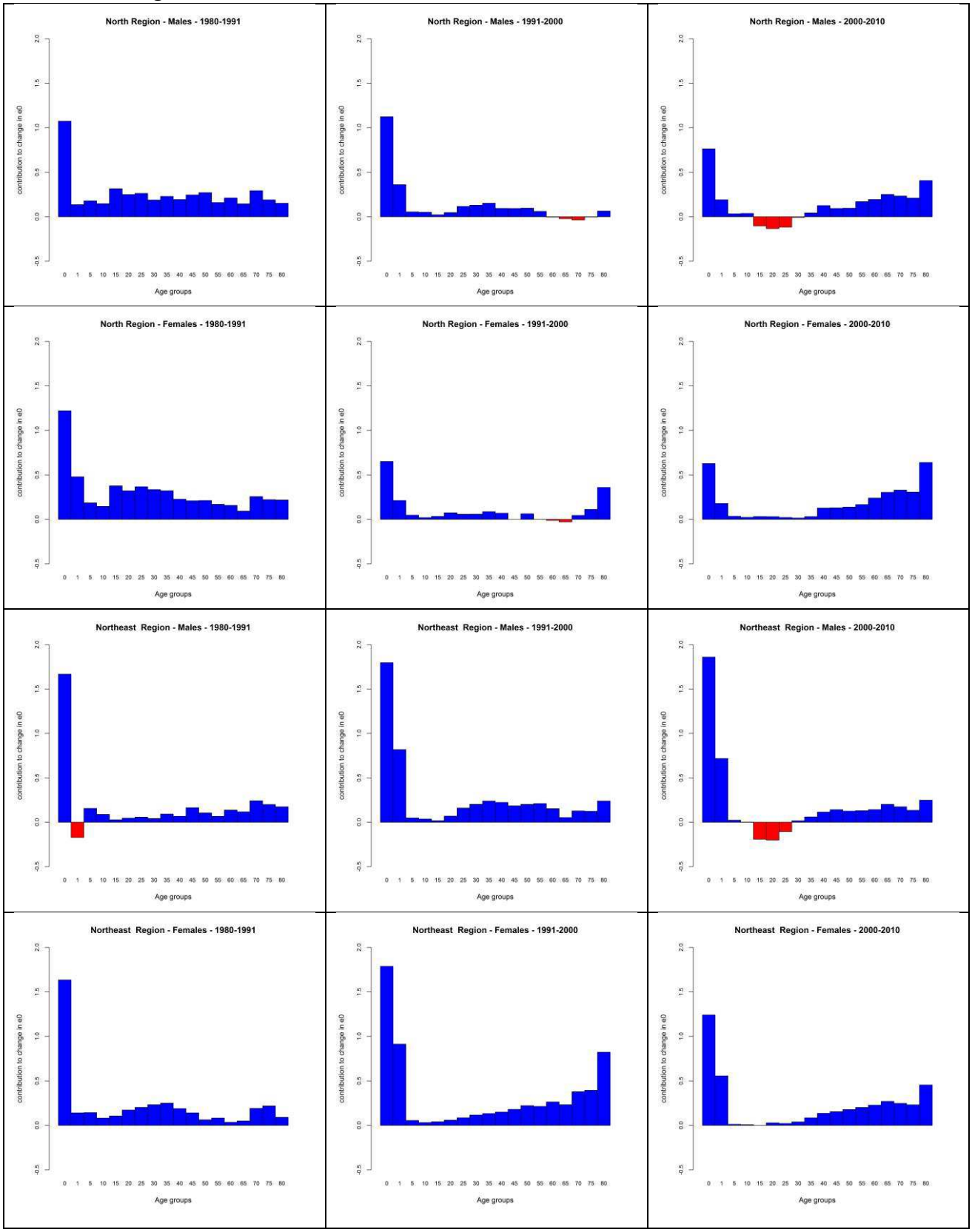
Females have exhibited larger gains in life expectancy than males, increasing the sex gap in mortality, from 5.9 years in 1980 to 8.3 years in 2010. This is the largest difference between the two sexes in 2010. Most of this difference is due to higher young adult male mortality from external causes. Almost all the states in the Northeast Region presented an important increase in homicide rates in the last decade (Waiselfisz 2013). In addition, this gender gap in life expectancy reflects differences in mortality due to chronic diseases at older ages.

Increase in life expectancy in the North Region is also largely attributable to infant mortality decline, though not to the same extent as in the Northeast Region.

Mortality decline among women of reproductive age also contributed significantly to increasing female life expectancy from 1980 to 1991. An important share of this decline is due to improvements in maternal mortality. In 1980, 22% of deaths registered among women from 15 to 39 years old were due to "Complications of Pregnancy, Childbirth, and Puerperium", down to 8.3% in 1991.

The negative contribution to life expectancy of mortality in young adult males in the period 2000-2010 is also worth noting, while advanced ages contributed positively.

Figure 6 - Contribution to change in e_0 by age group, sex and cause of death – Brazil, North and Northeast Regions – 1980, 1991, 2000, 2010



Source: Albuquerque and Senna (2005), IBGE (2013), SIM (1979/2011)

5. Discussion and Conclusions

Brazil mortality changes have follow the epidemiologic transition theory to some extent during the period since 1980: the sharp decline in infant mortality in all regions (first from IPD and then from causes associates to the perinatal period); maternal mortality decline in the 1980's in the North Region; reduction in mortality from Chagas' disease in the Central-West; increase in the participation of chronic and degenerative diseases as the main cause of death.

However, our work has showed that epidemiologic transition in Brazil has not followed the linear and unidirectional pattern observed in developed countries, requiring a broader framework to understand the health transition in the country, with particular attention to social and regional inequalities.

The emergence of the HIV/AIDS epidemic, for example, is considered as the most important fact in questioning the basis of the epidemiological transition, which does not allow the establishment of the emerging and re-emerging infectious diseases. Even though the HIV-AIDS epidemic was never been as prevalent as some other countries, HIV/AIDS had significant negative effects on life expectancy at birth in Brazil, especially among males in the Southeast Region.

The persistence of relatively high levels of other infectious and parasitic diseases, even more than 70 years after the beginning of substantial mortality decline, is also a particularity of the Brazilian health transition. Despite important decline in mortality from IPD, morbidity has exhibited a different trend, with the percentage of hospitalizations from these causes presenting almost constant figures for the last three decades, around 8%[6], with some seasonal fluctuations. The persistence of these diseases involves economic and social burden, with direct and indirect costs to society. According to Luna (2002), the simplified view of the epidemiologic transition could even have contributed to unpreparedness of health services and workers, as well as the society as a whole, in facing the emergence and reemergence of infectious diseases.

Another piece not present in the epidemiologic transition theory is the unexpected improvement in mortality from cardiovascular diseases. Just as observed in many other developed countries (Vallin and Meslé 2004), improvements in mortality from this cause of death have been the main driver of mortality decline at older ages, although it has been unequal according to the different regions. This inequality could be attributable to differences

[6] Hospital Information System (SIH) of the Brazilian Unified National Health.

in adults' socioeconomic status and lifestyle, but also to early life conditions that might have affected differently childhood in different regions.

Mortality decline from cancer has also gained importance in the last decade in the more developed regions, while the increase in mortality from this disease in the less developed regions was lower.

Finally, the key factor contributing negatively to increase in life expectancy is mortality from external causes, especially among young adult males. This impact has varied significantly over time and across regions, being the most important cause of the historical convergence/divergence process among the Brazilian regions.

These findings have showed that the idea of convergence implicit in the demographic and epidemiologic transition might not apply to the Brazilian case during the period under study. Despite some long-term trends showing reducing regional inequalities, there have been some periods of divergence in life expectancy and life-span, for instance between the Southeast and the North and Northeast Regions.

A new mortality convergence process between the less and more developed regions in the future would be possible if the North and Northeast Regions could sustain important declines in infant mortality as observed in the last years, and if mortality among young adult males could be better controlled.

However, some differences in mortality among the elderly persist, for both males and females, mostly due to cardiovascular diseases. Thus, future trend in regional inequalities in mortality will also depend on the ability of each region to incorporate the benefits of new technologies to treatment and, most importantly, to improve prevention, especially against cardiovascular diseases. Controlling risk factors of these diseases is also a key point to mortality from chronic and degenerative diseases. In that sense, it is essential the use of data on biomarkers as health and disease predictors, for instance to monitor trends in risk factors for cardiovascular diseases.

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Appendix

Table 1 – ICD coding and reconciliation

Code	Chapter ICD-10	Chapter ICD-10	Chapter ICD-9	Chapter ICD-9
IPD	I	Certain Infectious and Parasitic Diseases	1	Infectious and Parasitic Diseases
NEO	II	Neoplasms	2	Neoplasms
DCC	IX	Diseases of the Circulatory System	7	Diseases of the Circulatory System
DRS	X	Diseases of the Respiratory System	8	Diseases of the Respiratory System
DDS	XI	Diseases of the Digestive System	9	Diseases of the Digestive System
PER	XVI	Certain Conditions Originating in the Perinatal Period	15	Certain conditions originating in the perinatal period
CON	XVII	Congenital Malformations, Deformations and Chromosomial Abnormalities	14	Congenital Anomalies
EXT	XX	External Causes of Morbidity	17	Injury and Poisoning
OTH		Other causes		Other causes

Table 2 - Contribution to change in e_0 by age group according to the Major Region, sex and period

Region	Sex	Period	Age group																	
			0	1-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80+	Total
BR	M	1980-1991	1.6	0.1	0.1	0.0	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.2	0.2	**2.9**
BR	M	1991-2000	1.2	0.4	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	**3.5**
BR	M	2000-2010	1.0	0.3	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.2	0.4	**4.2**
BR	F	1980-1991	1.6	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.3	0.3	0.2	**4.3**
BR	F	1991-2000	1.0	0.4	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.5	**3.9**
BR	F	2000-2010	0.7	0.3	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.3	0.7	**3.7**
NO	M	1980-1991	1.1	0.1	0.2	0.1	0.3	0.2	0.3	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.1	0.3	0.2	0.2	**4.6**
NO	M	1991-2000	1.1	0.4	0.1	0.1	0.0	0.0	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	**2.4**
NO	M	2000-2010	0.8	0.2	0.0	0.0	-0.1	-0.1	-0.1	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.2	0.2	0.4	**2.5**
NO	F	1980-1991	1.2	0.5	0.2	0.1	0.4	0.3	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.1	0.3	0.2	0.2	**5.5**
NO	F	1991-2000	0.7	0.2	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.4	**1.8**
NO	F	2000-2010	0.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.6	**3.4**
NE	M	1980-1991	1.7	-0.2	0.2	0.1	0.0	0.0	0.1	0.0	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.2	**3.3**
NE	M	1991-2000	1.8	0.8	0.0	0.0	0.0	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.2	**4.9**
NE	M	2000-2010	1.9	0.7	0.0	0.0	-0.2	-0.2	-0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.2	**3.6**
NE	F	1980-1991	1.6	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.2	0.1	0.1	0.1	0.0	0.0	0.2	0.2	0.1	**4.0**
NE	F	1991-2000	1.8	0.9	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.2	0.4	0.4	0.8	**6.1**
NE	F	2000-2010	1.2	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.5	**4.1**
SE	M	1980-1991	1.8	0.2	0.0	0.0	-0.2	-0.2	-0.2	-0.2	-0.1	0.0	0.1	0.0	0.1	0.2	0.2	0.3	0.2	0.2	**2.5**
SE	M	1991-2000	1.0	0.2	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.0	**2.8**
SE	M	2000-2010	0.6	0.1	0.0	0.0	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.4	0.4	0.3	0.2	0.4	**5.1**
SE	F	1980-1991	1.8	0.3	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.4	0.4	0.4	**4.6**
SE	F	1991-2000	0.6	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.2	0.1	**2.7**
SE	F	2000-2010	0.5	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.2	0.2	0.7	**3.4**

Region	Sex	Period	Age group																	
			0	1-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80+	Total
SU	M	1980-1991	1.3	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.2	0.2	**2.8**
SU	M	1991-2000	0.9	0.2	0.0	0.0	0.1	0.1	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	-0.1	**2.4**
SU	M	2000-2010	0.4	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.5	0.4	0.4	0.3	0.5	**4.0**
SU	F	1980-1991	1.3	0.4	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3	**4.1**
SU	F	1991-2000	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.3	0.2	0.1	**2.3**
SU	F	2000-2010	0.4	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.4	0.3	0.4	0.4	0.9	**3.8**
CO	M	1980-1991	0.9	0.2	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.3	0.1	0.1	**2.8**
CO	M	1991-2000	0.9	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.1	0.2	**4.1**
CO	M	2000-2010	0.4	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.2	**2.7**
CO	F	1980-1991	0.9	0.4	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.1	0.4	0.3	0.1	**4.3**
CO	F	1991-2000	0.5	0.2	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.4	0.3	0.4	**4.1**
CO	F	2000-2010	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4	**2.9**

Source: Albuquerque and Senna (2005), IBGE (2013), SIM (1979/2011)
BR (Brazil); NO (North); NE (Northeast); Southeast (SE); SU (South); CO (Central-West)