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Deaths preventable by actions of the Unified Health System in the population of the Brazilian Southeast Region

Rafaela Magalhães Fernandes Saltarelli [1]
Rogério Ruscitto do Prado [2]
Rosane Aparecida Monteiro [3]
Ísis Eloah Machado [2]
Bárbara de Sá Menezes Teixeira [2]
Deborah Carvalho Malta [2]

Abstract *This paper aims to analyze the mortality trend in the population aged 5-69 years residing in the Southeast and Federal Units (UF), using the "Brazilian List of Preventable Deaths Causes". An ecological study on time series of the standardized mortality rate from preventable and non-preventable causes, with adjustments for ill-defined causes and underreporting of notified deaths, from 2000 to 2013. A declining mortality rate from preventable (2.4% per year) and non-preventable causes (1.5% per year) was found in the population aged 5-69 years living in the Southeast in the period 2000-2013. A drop in all groups of preventable deaths causes and stability in the maternal death causes was observed. Deaths from noncommunicable diseases fell 2.7% annually and were higher in the age group of 60-69 years in 2013 (211.8/100,000 inhabitants for deaths from ischemic heart disease, 146.3/100,000 inhabitants for cerebrovascular diseases and 96.5/100,000 inhabitants for diabetes). The highest preventable death rates are from chronic noncommunicable diseases and external causes, both of which are sensitive to health promotion and intersectoral interventions, which reinforces the need for integrated health policies.*

Key words *Premature mortality, Cause of death, External causes, Chronic diseases, Unified Health System*

[1] Departamento de Medicina e Enfermagem, Universidade Federal de Viçosa. Av. P H Rolfs, Campus Universitário Centro. 36750-000 Viçosa MG Brasil. rafaelamagalhaes@yahoo.com.br
[2] Escola de Enfermagem, Universidade Federal de Minas Gerais. Belo Horizonte MG Brasil.
[3] Faculdade de Medicina de Ribeirão Preto, Universidade de São Paulo. Ribeirão Preto SP Brasil.

Introduction

Preventable or reducible deaths refer to those that can be prevented in whole or in part by actions of accessible and effective health services[1]. High rates of preventable deaths are related to shortcomings in the system of health care provided to the population and are "sentinel events" because they indicate that comprehensive health care may not be working well, indicating that the quality of care must be improved[1].

Since the precursor studies of Rutstein et al.[1], several proposals for the classification of preventable causes of death were carried out in developed countries[2-5], assuming that premature death can be prevented by avoiding the onset of the disease or treating it properly when it occurs[2,5]. The review by Nolte and McKee[5] elucidates the evolution of the studies produced on the subject, most of them from the 1980s and 1990s, when health care advanced considerably. Over time, the classification of preventable death included realms related to the economic-social development process, as well as the scientific knowledge in health consolidated and accessible to the population[5].

In Brazil, the growth of the scientific publication on preventability occurred in 2007, with the establishment of the "Brazilian List of Preventable Death Causes" by the Ministry of Health, from the perspective of the available technology in the Unified Health System (SUS)[6,7]. Since then, analyses of preventable deaths in Brazil, and in the Southeast, in particular, have shown a significant reduction of deaths[8-13]. However, studies that analyze mortality differences by different age groups are scarce, most of them for children under one year[9] or specific causes.[10-13]

This paper aimed to analyze the mortality trend of the population of the Southeast and Federal Units (UF), from 2000 to 2013, for the different age groups, using avoidability criteria.

Methods

This is an ecological time-series study on the trend of the mortality rate in the population aged 5 to 69 residing in the Southeast region, from 2000 to 2013. Death data were obtained from the Mortality Information System (SIM) and data on the population, by gender and age, were obtained from the Brazilian Institute of Geography and Statistics (IBGE), from the 2000 and 2010 censuses, as well as the projected population for the intercensal years conducted through the National Household Sample Survey (PNAD).

Concerning the classification of death causes, the codes 10th International Statistical Classification of Diseases and Related Health Problems (ICD-10) were gathered into two groups: avoidable and non-avoidable, according to the criteria adopted in the "Brazilian List of Preventable Death Causes" for the population aged 5 to 74 years[6,7]. The list of preventable death causes uses five subgroups, by type of health intervention based on the technology available through the SUS: reducible by vaccine-preventable actions (subgroup 1); reducible by health promotion actions, adequate prevention, control and care for diseases of infectious causes (subgroup 2); reducible by appropriate health promotion, prevention, control and care for noncommunicable diseases (subgroup 3); reducible by adequate action of prevention, control and care for the causes of maternal death (subgroup 4); reducible by intersectoral actions and actions of health promotion, prevention and adequate care for external causes (accidents and violence) (subgroup 5)[7].

The study adopted methodological changes to improve the database. Thus, the two techniques used in the preparation of this database were detailed as shown below.

The first consisted of revising the list in the item of deaths by ill-defined causes, proceeding to the proportional redistribution of these causes among all other defined causes. We followed the assumption that the distribution of death causes among the ill-defined is similar to the distribution of deaths by defined causes[12,13]. The redistribution of ill-defined causes also included external causes, as it was based on a study by França et al.[14], which evidenced findings of violence and accidents among the ill-defined causes investigated. Thus, in the redistribution of deaths, we decided to consider the total number of ill-defined deaths, including external causes.

The second methodological procedure adopted was regarding underreported deaths. We adopted the adjustment of unrecorded deaths, as recommended by the study "Active search for deaths and births in the Northeast and the Legal Amazon: estimated coverage of SIM and SINASC in Brazilian municipalities", developed by Szwarcwald et al.[15], whose adjustment proposes to characterize the adequacy of information on deaths in each municipality, based on the calculation of the general mortality coefficient standardized by age. Adaptive standards are estimated and mortality correction factors calculated as per the level of adequacy of information and population size. Routines for redistribution by gender and age group were prepared among individuals aged

1 and over, which are available on the DATASUS website of the Ministry of Health, for the period 2000 to 2013 (http://tabnet.datasus.gov.br/cgi/deftohtm.exe?obitocorr/cnv/obitocorr.def). All adjustments were made for year strata (2000 to 2013), age range (5-9, 10-14, 15-19, 20-29, 30-39, 40-49, 50-59 and 60-69 years) and Federative Units (UFs) (MG, ES, RJ and SP).

The definition of the age limit at 69 years is another methodological change, since the previous list provided for 74 years[6,7]. The conceptual basis is to maintain comparability with goals of the World Health Organization[16], the Plan to Combat Chronic Noncommunicable Diseases (DCNT)[17] and the Sustainable Development Goals[18], which establish the age range of 30-69 years as premature death by NCDs.

The adjusted final mortality rate was standardized by the direct method, by gender and age, using the WHO standard world population[19]. Data were processed by building spreadsheets to calculate the adjusted rate of mortality due to non-preventable and preventable deaths, by main specific causes of death for each group of preventable diseases and the percentage of annual mean variation and the period (2000-2013). The tables showed data for 2000, 2007 and 2013, but the regression analysis was calculated with all the years of the series (2000 to 2013).

The Simple Linear Regression method was used to analyze the trend of mortality rates due to preventable causes and their subgroups and non-preventable causes. The residue analysis was used to evaluate the model fit. The software used was SPSS (Statistics Base), version 17. A level of statistical significance of 5% was accepted. The mean annual percentage reduction in mortality rate was calculated by the difference between consecutive year rates and dividing it by the rate in the baseline year of the calculation (multiplied by 100). The mean of values found was defined as the annual reduction for the period. The percentage of total reduction for the period was calculated by subtracting the mortality rate for the year 2013 from the year 2000 mortality rate and dividing it by the year 2000 rate (multiplied by 100). The values of the mean annual and total percent reduction for the period were shown in the tables, and the negative value represented the declining mortality rate and the positive value represented the increasing mortality rate.

The Research Ethics Committee (CEP) approved the study, on February 25, 2016. We used secondary and clustered data available on the official website of the Ministry of Health, in which no information was available to identify individuals.

Results

In 2013, 588,675 deaths were registered in all SIMs in the population aged 5-69 years residing in Brazil, of which 263,735 (44.8%) occurred in the Southeast region. The mortality rate from preventable causes in the Southeast declined in the period 2000-2013, from 390.1/100,000 inhabitants in 2000 to 282.7/100,000 inhabitants in 2013, with a mean annual decline of 2.4% and a total decline of 27.5% for the period (Table 1).

Table 1 shows the mortality rate per 100,000 inhabitants, standardized and adjusted for underreporting and ill-defined causes, for each group of preventable causes in the age group 5-69 years of the Southeast region and its UFs in the period 2000-2013 and the mean annual period-wise reduction percentage.

Reduced causes by vaccine-preventable actions in the Southeast showed a reduced mortality rate between 2000 and 2013, down from 0.7 to 0.3 deaths per 100,000 inhabitants ($p < 0.001$), with a mean annual decline of 5.9% and 59.7% for the period. All the UFs in the Southeast showed a declining mortality rate in this group, except for Espírito Santo, which remained stable for the period ($p = 0.263$). The highest annual and period-wise reduction was observed in Minas Gerais (6.8% and 68.7%), followed by São Paulo (4.1% and 67.1%) and Rio de Janeiro (1% and 40%) (Table 1).

The mortality rate for the causes that could be reduced by adequate actions to promote health, prevention, control and care for diseases of infectious causes in the Southeast region was 40.2 and 36.7 deaths per 100,000 inhabitants in 2000 and 2013, respectively, with a mean annual and period-wise decline of 0.7% and 8.6%, respectively ($p = 0.001$). Minas Gerais and São Paulo showed a significant mean annual reduction of 1.2% and 1.1%, respectively ($p < 0.001$). Espírito Santo was stable for the period ($p = 0.167$). On the other hand, Rio de Janeiro showed an annual and period-wise increase of 0.9% and 12.4%, respectively, with an increased mortality rate of 43.9 deaths in 2000 to 49.3 deaths per 100,000 inhabitants in 2013 ($p = 0.009$) (Table 1).

Deaths from causes preventable by adequate health promotion, prevention, control, and care for noncommunicable diseases ranked first in the causes of death in the Southeast throughout

Table 1. Standardized and corrected mortality rate, percentages of mean annual reduction and reduction percentage for the period (2000-2013), per 100 thousand inhabitants, in the population aged 5 to 69 years, by preventable causes by the SUS, main preventable groups and non-preventable causes. Southeast and UFs, 2000, 2007 and 2013.

Preventable Causes	UF	2000	2007	2013	% Mean annual reduction	% Reduction for the period	p
Immunopreventive actions	MG	0.6	0.4	0.2	6.8	68.7	< 0.001
	ES	0.6	0.5	0.6	-13.7	-10.3	0.263
	RJ	0.5	0.3	0.3	1.0	40	0.003
	SP	0.8	0.4	0.3	4.1	67.1	0.005
	Southeast	0.7	0.4	0.3	5.9	59.7	< 0.001
Appropriate actions of health promotion, prevention, control and care for diseases due to infectious causes	MG	36.4	32.0	30.8	1.2	15.3	< 0.001
	ES	27.1	24.0	24.0	0.6	11.2	0.167
	RJ	43.9	44.0	49.3	-0.9	-12.4	0.009
	SP	41.4	36.0	35.6	1.1	14.1	< 0.001
	Southeast	40.2	36.2	36.7	0.7	8.6	0.001
Appropriate actions of health promotion, prevention, control and care for noncommunicable diseases	MG	248.1	212.8	179.3	2.5	27.8	< 0.001
	ES	237.9	204.3	165.1	2.8	30.6	< 0.001
	RJ	286.7	238.5	200.8	2.7	30	< 0.001
	SP	250.7	201.4	172.9	2.8	31	< 0.001
	Southeast	257.5	212.1	179.9	2.7	30.1	< 0.001
Appropriate actions of prevention, control and care for causes of maternal deaths	MG	1.1	0.6	0.8	0.4	22.2	0.027
	ES	1.0	0.8	1.1	-4.5	-2.9	0.049
	RJ	1.7	1.4	1.5	0.5	14.4	0.908
	SP	0.7	0.7	0.7	-0.2	8.5	0.598
	Southeast	1.0	0.8	0.9	0.6	13.9	0.752
Appropriate intersectoral actions of health promotion, prevention and care for external causes	MG	66.1	79.4	80.3	-1.5	-21.5	0.001
	ES	111.2	111.5	96.4	1.0	13.2	0.020
	RJ	106.2	96.6	74.7	2.6	29.7	< 0.001
	SP	94.7	58.1	51.6	4.5	45.5	< 0.001
	Southeast	90.8	73.0	65.0	2.5	28.3	< 0.001
Total – Preventable causes	Southeast	390.1	322.4	282.7	2.4	27.5	< 0.001
Total – Non-preventable causes	Southeast	77.5	67.3	63.6	1.5	17.9	< 0.001

the period, down from 257.5 deaths in 2000 to 179.9 deaths per 100,000 inhabitants in 2013. A mean annual and period-wise decline of 2.7% and 30.1% was recorded, respectively ($p < 0.001$). This declining trend was significant and similar in all Southeastern UFs, with the highest mean annual reduction recorded in São Paulo and Espírito Santo (2.8% in both), and the lowest in Minas Gerais (2.5%) ($p < 0.001$). In 2000, the highest standardized mortality rate for these preventable causes was in Rio de Janeiro (286.7/100,000 inhabitants) and the lowest in Espírito Santo (237.9/100,000 inhabitants). In 2013, rates were very close in all UFs, the highest in Rio de Janeiro (200.8/100,000 inhabitants), followed by Minas Gerais (179.3/100,000 inhabitants), São Paulo (172.9/100,000 inhabitants) and Espírito Santo (165.1/100,000 inhabitants) (Table 1).

The mortality trend for the causes that could be reduced by appropriate actions of prevention, control and care for diseases caused by maternal deaths in the Southeast region was stationary for the period ($p = 0.752$), with 1.0 deaths and 0.6 deaths per 100,000 inhabitants in 2000 and 2013, respectively. The same stability was found in Rio de Janeiro ($p = 0.908$) and São Paulo ($p = 0.598$). Minas Gerais showed an annual decline of 0.4% ($p = 0.027$) and Espírito Santo an annual increase of 4.5% ($p = 0.049$) (Table 1).

The group of causes reducible by appropriate intersectoral actions of health promotion, prevention and care for external causes showed a

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decline (2.5%) in the mortality rate in the Southeast, from 90.8/100,000 inhabitants in 2000 to 65.0/100,000 inhabitants in 2013 ($p < 0.001$), ranking second in magnitude. Minas Gerais had a significant average annual and period-wise increase of 1.5% and 21.5%, respectively, up from 66.1 deaths/100,000 inhabitants in 2000 to 80.3/100,000 inhabitants in 2013 ($p = 0.001$). In the other UFs, a significant mean annual reduction in the mortality rate was observed, with 4.5% in São Paulo (94.7 to 51.6/100,000 inhabitants), 2.6% in Rio de Janeiro (106.2 to 74.7/100,000 inhabitants) and 1% in Espírito Santo (111.2 to 96.4/100,000 inhabitants) (Table 1).

Figure 1 and Table 1 show the decline of the preventable and non-preventable mortality rate for the population aged 5-69 years in the Southeast region from 2000 to 2013. Avoidable causes fell 2.4% per year and 27.5% for the period ($p < 0.001$), while the non-preventable causes fell 1.5% per year and 17.9% for the period ($p < 0.001$).

Figures 2 A and B show the trend of mortality by UF of the Southeastern region during the period 2000-2013 for the population aged 5-69 years, according to a group of preventable causes, by selected causes. We found that the declining trend was homogeneous among the UFs in the group of preventable causes through care provided to noncommunicable diseases. Mortality was higher throughout the period in Rio de Janeiro, and the values were very close in the other UFs (Figure 2-A). A marked reduction is observed in the group of preventable causes by care for external causes in Rio de Janeiro and São Paulo. On the other hand, Minas Gerais showed an increasing trend; it had the lowest rates in 2000 and climbed to second place in 2011. Despite reduced mortality, Espírito Santo showed the highest rates in the whole period, except 2003 (Figure 2-B). Swings were noted in the other groups of causes in the period, but the trend is generally a decline, except for the causes of maternal death, which were stationary in Rio de Janeiro and São Paulo, besides increased mortality in Espírito Santo and reduced mortality in Minas Gerais (data not shown).

The standardized mortality rates for the leading causes of specific deaths in each group of preventable ones for the age range of 5-69 years are shown in Table 2. The behavior was decreasing for all of them, except for pneumonia and in-

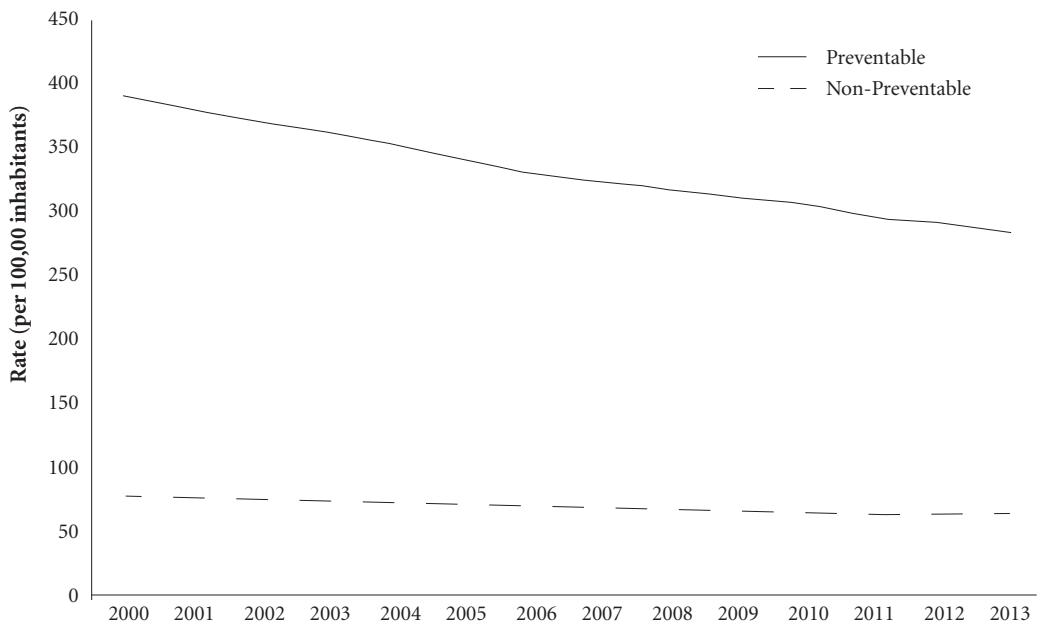

Figure 1. Trend of the standardized and adjusted mortality rate per 100,000 inhabitants in the population aged 5 to 69 years, by preventable and non-preventable causes by the SUS. Southeast, 2000 to 2013.

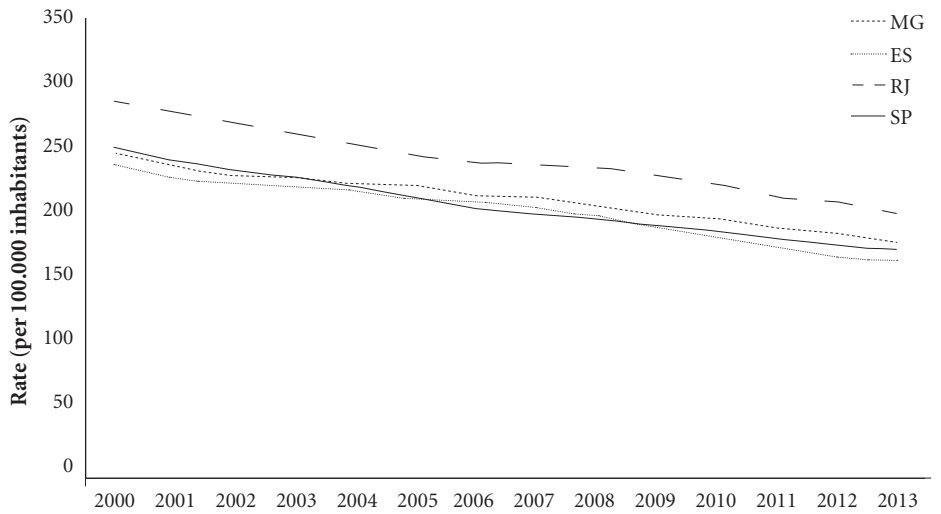

Figure 2 A. Trend of standardized and adjusted mortality rate by group of death causes preventable by the SUS that may be reduced by actions in noncommunicable diseases, per 100,000 inhabitants, in the population aged 5 to 69 years. Southeast and UFs, fr.

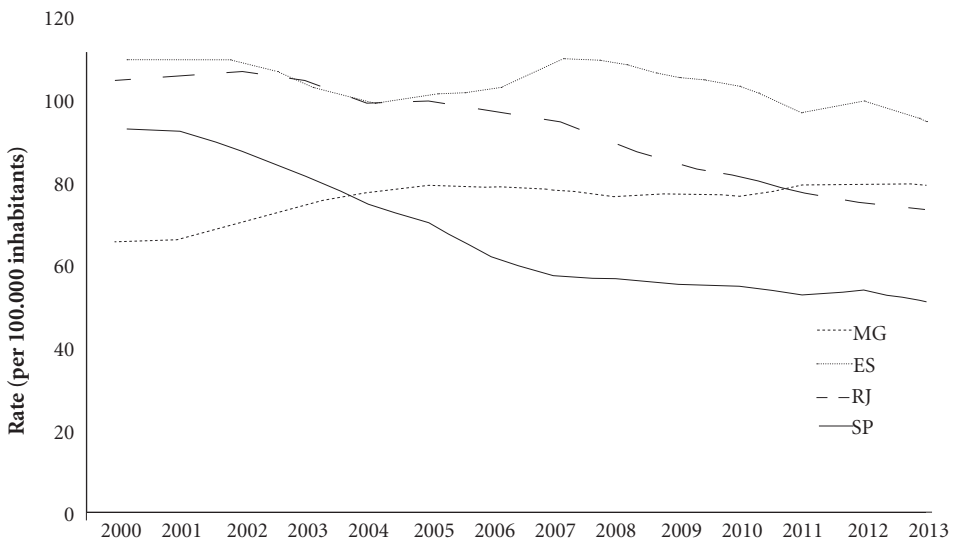

Figure 2 B . Trend of standardized and adjusted mortality rate by group of death causes preventable by the SUS that may be reduced by actions in external causes, per 100,000 inhabitants, in the population aged 5 to 69 years. Southeast and UFs, from 2000 t.

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tentional self-inflicted injuries (suicide), which achieved a mean annual increase of 1.6% in both causes ($p < 0.001$). Mortality remained stable in the period for transport accidents ($p = 0.687$) and other infections ($p = 0.057$) (except pneumonia, HIV disease, intestinal infectious diseases) (Table 2).

Table 3 shows the specific mortality rate in 2013 for the leading causes of preventable deaths in each age group of the population in the Southeast region.

The rates for causes avoidable by vaccine-preventable actions (miliary tuberculosis, acute hepatitis B and tetanus) are low. Among the causes of care for infectious diseases, pneumonia more affected the age groups 50-59 and 60-69 years, and HIV-related diseases occurred more between 40 and 49 years. The noncommunicable diseases were those of greater magnitude, growing during the life, reaching higher rates between 60 and 69 years: 211,8/100,000 inhabitants for ischemic heart diseases; 146.3/100,000 inhabitants for cerebrovascular diseases; and 96.5/100,000 inhabitants for diabetes. The causes preventable by actions of care for external causes also show high rates. Assaults predominated in the 15-19, 20-29 and 30-39 years' age groups. Transport accidents between 15 and 69 years and intentional self-inflicted injuries (suicide) were similar and higher in the 20-69 years' age group (Table 3).

Discussion

The study showed a declining mortality rate in the population aged 5-69 years residing in the Southeast region due to preventable and non-preventable causes in the period 2000-2013. There was a drop in all groups of causes of preventable deaths, except those reducible by actions of care for the maternal death causes that remained stable in the period.

The mortality profile has changed significantly in Brazil in the last decades, outlining a new scenario in which diseases from malnutrition, and infectious, parasitic and mother and child causes have been reduced over the decades, while an accelerated increase in NCD-related deaths has been observed[20]. Several factors have contributed to the changes, including aging, controlling or reducing the risk of death from various diseases (such as vaccine-preventable and intestinal infectious diseases) and the emergence of others (such as HIV/AIDS)[20,21]. However, these changes

Table 2. Standardized and adjusted mortality rate and percentage of mean annual reduction per 100 thousand inhabitants, in the population aged 5 to 69 years, according to the main specific root causes preventable by the SUS. Southeast and UFs, 2000, 2007 and 2013.

Preventable causes	2000	2007	2013	% Mean annual reduction	p
1. Immunopreventive actions					
Miliary tuberculosis	0.29	0.16	0.14	4.4	< **0.001**
Acute Hepatitis B	0.24	0.14	0.07	3.1	**0.019**
Tetanus	0.05	0.02	0.02	0.1	< **0.001**
2. Actions of care for diseases of infectious causes					
Pneumonia	12.6	13.4	15.2	-1.6	< **0.001**
Diseases caused by the HIV virus	11.6	8.7	7.4	3.4	< **0.001**
Intestinal infectious diseases	0.8	0.6	0.5	2.9	< **0.001**
Other infections	5.1	4.6	4.8	0.3	0.057
3. Actions of care for noncommunicable diseases					
Ischemic heart diseases	49.1	39.2	33.7	2.8	< **0.001**
Cerebrovascular diseases	44.5	30.6	23.2	4.9	< **0.001**
Diabetes mellitus	20.7	16.9	13.5	3.2	< **0.001**
4. Actions of care for maternal causes	1.0	0.8	0.9	0.6	0.752
5. Actions of care for external causes					
Assault and Battery	41	27.0	23.7	4.0	< **0.001**
Transportation Accidents	19.6	22.2	19.6	-0.1	0.687
Self-inflicted injuries	4.4	4.8	5.3	-1.6	< **0.001**

Table 3. Specific mortality rate for the main specific underlying causes preventable by the SUS, per 100 thousand inhabitants, by age group in the population of 5 to 69 years. Southeast Region, 2013. *

Preventable causes	2013							
	Age group (years)							
	05-09	10-14	15-19	20-29	30-39	40-49	50-59	60-69
Immunopreventive actions								
Miliary tuberculosis	0.0	0.0	0.0	0.1	0.2	0.1	0.4	0.3
Acute Hepatitis B	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.3
Tetanus	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Actions of care for diseases of infectious causes								
Pneumonia	1.0	1.1	2.1	3.2	7.1	16.8	34.6	84.0
Diseases caused by the HIV virus	0.1	0.1	0.9	4.9	11.5	16.8	11.7	7.2
Intestinal infectious diseases	0.1	0.1	0.1	0.1	0.2	0.5	1.4	2.6
Other infections	1.1	0.7	1.0	1.2	2.0	4.6	11.1	25.5
Actions of care for noncommunicable diseases								
Ischemic heart diseases	0.0	0.1	1.0	2.0	7.4	31.5	94.2	211.8
Cerebrovascular diseases	0.4	0.6	1.2	1.9	6.7	22.6	58.4	146.3
Diabetes mellitus	0.0	0.1	0.5	1.2	2.9	10.5	32.1	96.5
Actions of care for external causes								
Assault and Battery	0.5	3.5	44.4	45.8	30.9	19.8	12.4	8.0
Transportation Accidents	2.9	4.1	19.3	27.8	23.4	23.2	21.6	23.7
Self-inflicted injuries	0.0	0.5	2.8	6.6	7.6	7.5	7.2	6.1

* Maternal mortality rate is not included, since it is a specific rate for the female population.

did not occur homogeneously or with the same intensity in all countries, states and municipalities[20,21]. Considering that Brazil's mortality profile is complex and unequal, it is fundamental to analyze the composition of mortality by age groups, besides the causes of death. The analysis of geographical inequality is crucial to reorient the priorities of prevention and treatment of the most lethal diseases[20].

In Brazil, NCDs are the health problem with the most significant magnitude, accounting for 72% of all deaths in 2007, with a particular focus on the four groups of causes of death focused by the WHO: cardiovascular diseases (31.3%), neoplasms (16.3%), chronic respiratory diseases (5.8%) and diabetes (5.2%)[10,17].

Because of the severity of the NCD theme and its impact on health systems and society, the Global NCD Coping Plan agreed for 2015-2025 provides for a 25% reduced likelihood of premature death from these diseases in a decade and the "Strategic Actions Plan for Coping with Noncommunicable Chronic Diseases in Brazil, 2011-2022" reinforces the reduction of the premature mortality rate (< 70 years) by NCD at 2% per year[16,17] as one of its goals.

The study showed that the states of the Southeast had achieved this goal since the rate of premature mortality from noncommunicable diseases fell annually 2.7% in the region from 2000 to 2013. This is also confirmed in other studies because this indicator can be reduced since these are diseases that are sensitive to health promotion and care interventions[10-13].

Likewise, this study highlights the high mortality rates from avoidable causes due to NCDs compared to the other groups of causes, and in 2013, the highest rates were observed in Rio de Janeiro and Minas Gerais. Therefore, public health interventions that seek to reduce the prevalence of arterial hypertension, the main risk factor for cardiovascular diseases, are essential, as they directly influence the achievement of the goal of reducing the rate of premature mortality (< 70 years) due to NCDs.

In 2015, the United Nations Assembly endorsed the Sustainable Development Goals (SDG), including 17 targets, among which are: ensuring a healthy life and promoting well-being for all, at all ages[18]. The indicator "reducing by 30% the probability of premature death by NCDs between 30 and 69 years of age by 2030"

was included, continuing the commitment already assumed by the World Health Assembly by 2025[18]. Thus, the monitoring of this indicator will be a State action and the Southeast region and its four UFs already show their ability to achieve this goal.

On the other hand, vaccine-preventable diseases were the group with the lowest number of deaths and the lowest rate, showing the advances achieved in the past, due to the incorporation of numerous vaccines in the National Immunization Program (PNI) calendar[9,22]. A reduction in these deaths was observed in the Southeast and all UFs, except for Espírito Santo whose rates were stable in the period.

Regarding the mortality rate for the causes that could be reduced by care for the diseases of infectious causes, a significant annual reduction of 0.7% was observed in the Southeast region, but this behavior was not across-the-board in all the UFs. Rio de Janeiro recorded an annual increase of 0.9%, while Espírito Santo reported stable rates, for example. Brazilian data show that, while the proportion of total deaths caused by infectious diseases has dropped from 50% to 5% over the last 80 years, it still is a significant crucial public health problem[23].

This reduction has been sharper in some infectious diseases than in others, and we found some worrying data that evidence deaths from diseases that can be treated, such as the case of pneumonia that showed a yearly increase of 1.6% and other infections that were stable in the period. Poverty-related infectious diseases are a common set of diseases in populations living in poverty and marginalized, such as AIDS and tuberculosis[20]. This implies the need for better socioeconomic and health conditions and increased access to health services since poor living conditions are responsible for a significant number of diseases and death cases.

One possible explanation for the increased mortality rate due to pneumonia in the Southeast would be the expanded Brazilian health system that may have led to a higher number of hospitalization-acquired infections[23]. Although insufficient data are available for an adequate evaluation of the trends at the national level, they suggest that these infections are a problem of concern, which is likely to grow with greater access to the hospital system with the use of high technology and the increased frequency of invasive interventions[23].

This study also showed the stability of deaths by preventable causes due to adequate prevention, control and care for diseases caused by maternal deaths in the Southeast, Rio de Janeiro and São Paulo regions, as well as the mean annual reduction of 0.4 % in Minas Gerais and an increase of 4.5% in Espírito Santo.

Estimates of Brazilian maternal mortality ratios are affected by underreported deaths and maternal causes in recorded deaths[24]. A study of the profile of maternal mortality in Brazil from 2000 to 2009 showed that the leading causes of maternal deaths were: other maternal diseases, but that complicate pregnancy, childbirth and puerperium (17.1%); eclampsia (11.8%); gestational hypertension with significant proteinuria (6.2%); postpartum hemorrhage (5.8%); puerperal infection (5.1%) and early placental abruption (4.2%)[25].

The phenomenon of "obstetric transition", characterized by the transition from a pattern of predominant direct obstetric causes of maternal mortality to a growing proportion of indirect causes associated with chronic-degenerative diseases, aging of the maternal population, has been described[26-28]. This has led to a change in the natural history of pregnancy and childbirth to a pattern of institutionalization of care, increased rates of obstetric intervention, and possible over-medicalization[26-28].

Studies show that the high coverage of essential interventions in the pregnancy-puerperal cycle should be combined with comprehensive emergency care and improvements in the quality of maternal health care[29]. Also, strengthening health systems must go hand in hand with social development and equity, indispensable steps for the remission of preventable maternal deaths[27-29]. Thus, quality prenatal follow-up than can recognize early vulnerable groups and risk factors for morbidity and mortality could enable adequate interventions and correct delivery planning, with appropriate institutional care[25].

The same was the case, an international systematic review study from 1965 to 2011 identified three significant factors underlying maternal deaths in low- and middle-income countries: poor care, delayed care and problems with blood transfusions[30]. Responding to the latter requires significant investments in infrastructures, since health services technology is evidenced as the way to achieve the SDGs targets[31].

The current study also showed an annual reduction of 2.5% in the mortality rate from external causes, from 90.8 to 65.0 deaths per 100,000 inhabitants, and is the second group of preventable deaths with higher rates in the region. This

decline in the period was evidenced in the states of Espírito Santo, Rio de Janeiro and São Paulo. Conversely, in Minas Gerais, these deaths increased 1.5% per year. In Brazil, in the same period, a 10.5% hike was recorded in the crude mortality rate[32], evidencing advances in the Southeast compared to the other regions of the country.

Studies show that deaths from external causes predominantly affected brown male individuals aged 20-39 years[32-34]. This profile can be attributed to the greater exposure of young men to some higher-risk work activities, alcohol consumption, aggressive behavior and dangerous driving of motor vehicles[32].

The current study introduced methodological changes in the application of the "List of Preventable Deaths Causes" as it incorporated adjustment factors for underreporting and proposed the distribution of ill-defined causes. Although there are several methodologies for the redistribution of ill-defined causes as reported in studies by Soares et al.[12], Duncan et al.[13] and the Global Burden Disease (GBD)[35], we decided to redistribute all causes of death, including external causes, according to the findings of França et al.[14].

Among the limitations of this study, the use of preventability lists, which may vary according to the advances in knowledge and the use of new technologies, should be considered, as well as the need to respond whether the proposed causes can be affected by effective healthcare. Another limitation refers to the use of SIM data, which can still be subject to underreporting even after adjustment.

Conclusion

We can conclude that there is a more significant decline in preventable deaths than in non-preventable deaths. Thus, the interventions implemented within the scope of SUS show their potential for reducing preventable mortality, while the reduction of non-preventable deaths occurs slowly since they depend on external factors not modifiable by the health sector. The rates of preventable deaths are still high, especially for noncommunicable diseases and external causes. These causes of death are sensitive to health promotion interventions and, therefore, the study reinforces the need to remain focused on coping with these causes of illness and death, as well as their risk factors.

Collaborations

Saltarelli RMF and Malta DC: study concept and design, analysis and interpretation of results, drafting and approval of the final version of the manuscript. Prado RR: organized the databases, conducted the analyses, revised the scientific content of the manuscript and contributed to the drafting of the final version. Monteiro RA, Machado IE and Teixeira BSM revised the scientific content of the manuscript and contributed to the drafting of the final version. All authors have approved the final version of the manuscript and declare that they are responsible for all aspects of the work, ensuring its accuracy and integrity.

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