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Probability of premature death for chronic non-communicable diseases, Brazil and Regions, projections to 2025

Probabilidade de morte prematura por doenças crônicas não transmissíveis, Brasil e regiões, projeções para 2025

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ABSTRACT: ***Objective*:** Objective: To analyze the mortality trends for Chronic Noncommunicable Diseases (NCDs) in the period 2000–2013 and its probability of death until 2025. ***Method*:** time series analysis of mortality from cardiovascular diseases, cancer, diabetes and chronic respiratory disease, with correction for ill-defined causes and underreporting of deaths and calculation of probability of death. ***Results*:** There was an average decline of 2.5% per year in all four major NCDs in Brazil. There was a decline in all regions and federal units. The reduced likelihood of death by 30% in 2000 to 26.1% in 2013 and expected decline to 20.5% in 2025. ***Conclusion*:** From the trend of reduction is expected to reach Brazil reducing overall goal 25% by 2025.

Keywords: Chronic disease. Neoplasm. Diabetes mellitus. Respiratory tract diseases. Mortality, premature. Time series studies.

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RESUMO: ***Objetivo*:** Analisar as tendências de mortalidade por doenças crônicas não transmissíveis (DCNT) no período de 2000 a 2013 e a probabilidade de morte até 2025. ***Método*:** Análise de série temporal de mortalidade das DCNT (doenças cardiovasculares, câncer, diabetes e doenças respiratórias crônicas), com correções para causas mal definidas e sub-registro de óbitos, e a probabilidade de morte por essas doenças. ***Resultados*:** Houve declínio médio de 2,5% ao ano no conjunto das quatro principais DCNT no Brasil entre 2000 e 2013, em todas as regiões e unidades federativas. A probabilidade de morte foi reduzida de 30% em 2000 para 26,1% em 2013, e estima-se que caia para 20,5% em 2025. **Conclusões:** Dada a tendência de queda, prevê-se que o Brasil atinja a meta global de redução de 25% até 2025.

Palavras-chave: Doença crônica. Neoplasias. Diabetes mellitus. Doenças respiratórias. Mortalidade prematura. Estudos de séries temporais.

INTRODUCTION

Chronic non-communicable diseases (NCDs) include diseases of the circulatory system, diabetes, neoplasms and chronic respiratory diseases, accounting for the largest morbidity and mortality burden in the world and for 63% of global deaths[1]. These diseases lead to loss of quality of life, limitations and disabilities[1,2]. Deaths from NCDs affect predominantly developing countries, where about one-third of deaths occur in people under 60 years of age, while in developed countries premature mortality (age range 30-69 years) is less than 13% of cases[1,3].

NCDs involve individuals from all socioeconomic strata, especially the most vulnerable ones, such as low schooling and income groups[4,5], further increasing the poverty among people affected by disabilities and limitations, and reducing the productive force[6].

In Brazil, NCDs correspond to 72% of causes of death. Data from the National Health Survey PNS (2013) showed that more than 45% of the adult population, i.e., 54 million individuals, reported having at least one NCD[2,7-9].

In 2011, a High Level Declaration was signed at the United Nations with the mission of reducing the rates of mortality by NCDs[10]. In 2013, the World Health Assembly approved the Global NCD Action Plan, establishing a commitment for the member countries to reduce the probability of death by NCDs by 25% between 2015 and 2025[3,11].

Brazil has already acted on this global mobilization by launching, in 2011, its Strategic Action Plan for Tackle NCDs, 2011-2022, with measures and goals for the reduction of premature mortality rates (30 to 69 years) by these diseases by 2% per year, and also of the prevalence of their risk factors[4,12].

It is essential to continuously monitor the goal of reducing premature mortality, enabling a debate on progress and limits with society. The objective of this study was to analyze the trends of premature mortality by NCDs in the period from 2000 to 2013, as well as

the probability of death by these diseases projected for 2025, the year of conclusion of the Global NCD Action Plan.

METHOD

We conducted a time-series analysis of premature mortality (30 to 69 years) due to NCDs on the basis ofthe records of the Mortality Information System (SIM), made available online by the Department of Informatics of the Brazilian Unified Public Health System (DATASUS) [13].

To describe the mortality trends, corrections were made for ill-defined causes and underreporting of deaths by the method developed by Duncan et al.[14]. Per this method, the correction of underreporting deaths and the redistribution of ill-defined causes were done for strata of year, sex (male or female), age group (0 to 4, 5 to 9, 10 to 14, 15 to 19, 20 to 29, 30 to 39, 40 to 49, 50 to 59, 60 to 69, 70 to 79 and ≥80 years of age) and State of domicile[14]. Ill-defined causes were proportionally redistributed among all causes, except those addressed in Chapter XX (external causes).

Correction of number of deaths reported was estimated by the SIM coverage in Brazilian municipalities, using data from the study "Active search for deaths and births in the Northeast and in the Legal Amazon: estimation of the coverage of SIM and the Information System on Live Births (SINASC) in Brazilian municipalities", by Szwarcwald et al.[15]. In this study, the general mortality rate standardized by age (GMRS) in 2008 was calculated to characterize the level of adequacy of information about deaths in each municipality, considering the population of Brazil in the corresponding year as standard. The GMRS was divided into categories (<2; ≥2 and <3; ≥3 and <4; ≥4 and <5; ≥5 and <5.5; and ≥5.5 per 1,000 inhabitants).

When calculating factors of correction of deaths, the municipalities were grouped by strata according to region (North and Mato Grosso, Northeast, Minas Gerais, Goiás, and other States with adequate information), population size (<20,000; ≥20,000 and <50,000; ≥50,000 and <400,000; and ≥400,000 inhabitants) and level of adequacy of information, according to the GMRS. More details can be found in specific publications[15].

To distribute the deaths added according to this method by sex and age range, among individuals of one year of age or more, we compared age and sex distribution of deaths not reported to SIM, but found in the active search process in 2008, with deaths reported to SIM in the same year[15].

NCDs were classified, according to the 10th International Statistical Classification of Diseases and Related Health Problems (ICD), with the following codes: cardiovascular diseases (I00 - I99); respiratory diseases (J30 - J98); malignant neoplasms (C00-C97); diabetes mellitus (E10-E14); and other chronic diseases, grouped according to the World Health Organization's (WHO) criteria [3,14] (Table 1).

Estimates of the resident population by sex, age group and geographic region were obtained from the Brazilian Institute of Geography and Statistics (IBGE)[16]. Premature mortality was determined by the method proposed by WHO[3] that considers the deaths of people aged 30 years or more in 10-year intervals up to 69 years of age. Mortality data by observed NCDs were also presented, as well as corrected data for ill-defined causes, with adoption of proportional redistribution by the other groups of known causes[13] and correction for underreported cases[15]. The standardized rate of mortality by NCD per 100,000 inhabitants was calculated by sex, region and State by means of WHO standard world population[1,14], and by the direct method of standardization.

Aiming at international and regional comparability, this study has already used methodological aspects such as the adoption of standardized rates based on the world population and the correction of underreported and ill-defined causes[8,14,15]. These corrections are essential for intra-country comparisons even, depending on the predominant age groups between States and the difference in quality of the country's databases.

To determine the percent rate reduction in the period, the annual rate reduction was initially calculated by taking the difference between consecutive year rates and dividing it by the rate in the initial year of the calculation (multiplied by 100). The mean value was defined as the annual decrease in the period, where the average decrease in annual rates was calculated by subtracting the rates of consecutive years and dividing by the rate in the initial year of the calculation.

Death probability was measured per WHO standards, and age-specific mortality rate for each 10-year age group between 30 and 70 years was initially calculated as: (rate × 10)/(1 + rate × 5). Unconditional probability of death by NCD in the age range between 30 and 70 years was calculated as: 1 - product (1 - $rate_y$). The mean annual rate of decline for the country was determined by regression of the logarithm of the probability of death in a given year by means of ordinary least squares regression: ln(prob) = b x year + a. The change in mean annual rate was calculated using the formula: $1 - e^{b}$ [3].

The probabilities of death from 2013 to 2025 were then projected, considering the goal of a 25% reduction by 2025 compared to the current trend of decline.

The present study was conducted with aggregated secondary data related to deaths and populations from the databases of the Ministry of Health published online. These did not include confidential information, such as name and address, so there was no need for approval of the study project by a research ethics committee.

RESULTS

There were 1,210,474 deaths registered in SIM in 2013, of which 829,916 (68.6%) were NCDs. After correction for underreporting and redistribution of ill-defined causes, this percentage increased to 72.6%. Cardiovascular diseases were the leading cause of death (29.7%

of corrected deaths), followed by cancer (16.8%), chronic respiratory diseases (5.9%) and diabetes (5.1%). Altogether, these four diseases accounted for 85% of deaths from NCDs. "Other chronic diseases", which included chronic kidney diseases, autoimmune diseases and others, made up 15% of the total (Table 1).

In the period from 2000 to 2013, there was a decline in the rate of premature mortality by NCD (2.5% per year), varying according to the disease: 4.1% in chronic respiratory diseases, 3.4% in cardiovascular diseases, 2.1% in diabetes and 0.87% in cancer (Figure 1). Table 2 shows the crude rates observed, uncorrected, which still indicated an increase in the North and Northeast regions from 2000 to 2013. However, when corrections were applied for underreporting and ill-defined causes, this effect disappeared and there were reductions in mortality rates in all regions. In 2000, the highest standardized rate of premature

Table 1. Number (N) and proportion (%) of deaths due to basic causes. Brazil, 2013.

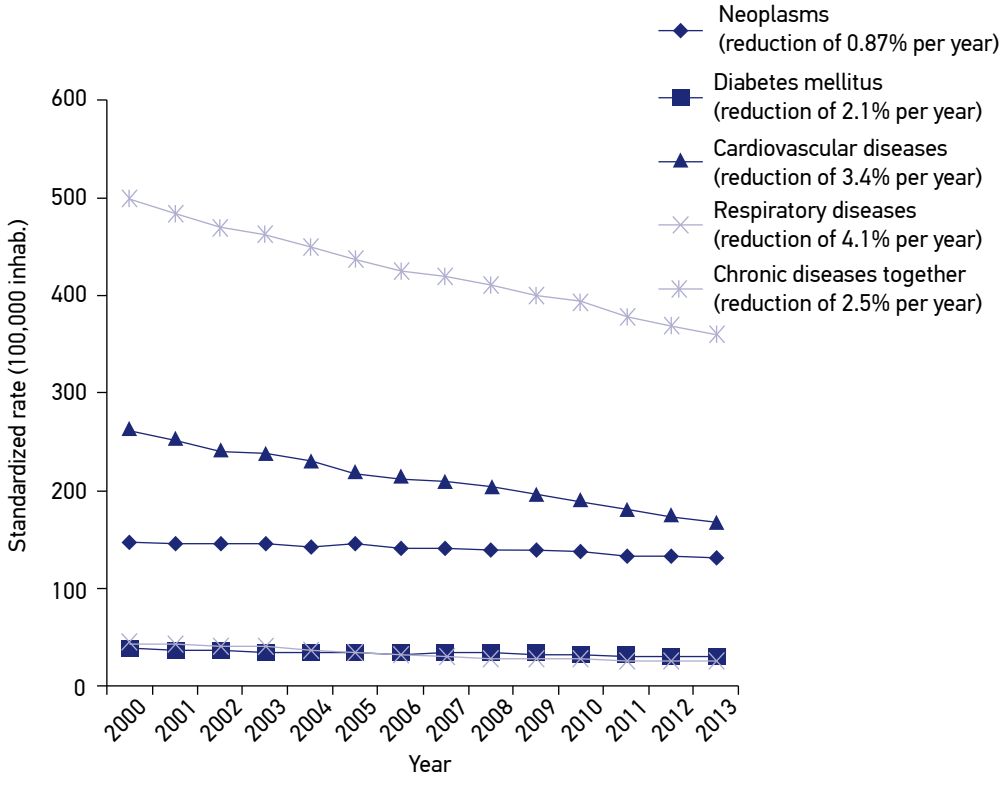
Cause	ICD-10 codes	Deaths		
		Crude		Corrected*
		N	%	%
Chronic non-communicable diseases		829.616	68,6	72.6
Cardiovascular diseases	I00-I99	339,672	28.1	29.7
Cancer	C00-C97	193,173	16	16.8
Respiratory diseases	J30-J98	67,880	5.6	5.9
Diabetes mellitus	E10-E14	58,017	4.8	5.1
Other chronic diseases	D00-D48, D55-D64 (less D64.9), D65-D89, E03-E07, E15-E16, E20-E34, E65-E88, F01-F99, G06-G98, H00-H61, H68-H93, K00-K92, N00-N64, N75-N98, L00-L98, M00-M99, Q00-Q99	170,874	14.1	15.0
Maternal, child and communicable	A00-B99, G00-G04, N70-N73, J00-J06, J10-J18, J20-J22, H65-H66, O00-O99, P00-P96, E00-E02, E40-E46, E50, D50-D53, D64.9, E51-64	157,371	13	14.0
External causes	V01-Y89	151,683	12.5	13.4
Ill-defined	R00-R99	71,804	5.9	---
Total		1,210,474	100	

Source: Mortality Information System, Secretariat of Health Surveillance/Ministry of Health.
*Corrected for underreporting and ill-defined causes; ICD-10: International Classification of Diseases and Health-Related Problems.

mortality by NCDs was in the Southeast (525.9/100,000 inhabitants) and the lowest in the North (463.8/100,000 inhabitants). In 2013, rates were very close in all regions, with the highest rates in the Northeast (367.1/100,000 inhabitants) and Southeast (361.2/100,000 inhabitants) (Table 2).

The standardized rates of premature mortality by NCD according per State in 2013 were higher in Alagoas (415.4/100,000 inhabitants) and in Rio de Janeiro (415.4/100,000 inhabitants). In all States, there was a decline in premature mortality rates due to NCD, which varied from 0.62% per year in Paraíba to 2.7% per year in the Federal District (Table 3).

Figure 2 shows the decline in the probability of premature death due by NCD and the reduction of risk in the study period. In 2000, death probability was 30.3%, falling to 26.1% in 2013. In 2025, with the maintenance of current declining trends, the probability of premature death due to NCDs is projected to be 20.5%, coinciding with WHO's target of 25% reduction from baseline (2010).



Source: Mortality Information System, Secretariat of Health Surveillance/Ministry of Health.
*Standardized by age to the standard population of the World Health Organization, corrected for underreporting and with redistribution of ill-defined causes of death.

Figure 1. Mortality trends* of all chronic non-communicable diseases (cardiovascular diseases, cancer, respiratory diseases and diabetes mellitus) among adults 30–69 years old. Brazil, 2000–2013.

DISCUSSION

In the present study, a reduction of 2.5% per year in the rate of premature mortality due to NCDs in Brazil was observed, confirming the findings in other countries and showing that it is possible to reduce the rates of this indicator, since these are diseases sensitive to interventions of health promotion and health care[1,3]. Regarding the distribution of mortality by NCD according to magnitude, cardiovascular disease predominated, which is the leading cause of death in the world[1], and also in Brazil[2,8], causing about one-third of all deaths. All regions showed a tendency towards a decrease in mortality due to NCDs, and although the rates in the Northeast exceeded those in other regions, they all tended to approximate over the study decade, indicating that NCDs are widespread and are leading causes of death in all five Brazilian regions. With current trends maintained, Brazil could achieve the 25% reduction goal proposed in the Global NCD Action Plan.

Although all Brazilian States showed a decline in mortality rate, differences are still large, such as for Rio de Janeiro and Pernambuco. Local studies are needed to explain these regional differences.

Cardiovascular diseases and their complications have a high impact, as they result in loss of work productivity and reduction of family income; there was a deficit of US$ 4.18B in the Brazilian economy between 2006 and 2015[6]. Studies conducted in several countries have indicated a reduction in incidence and mortality from cardiovascular diseases since the 1960s[1,17]. In Brazil, this decline occurred later in the 1990s.

Neoplasms are the second cause of death in most countries and the tendency is to rise[1,19]. In some countries, such as the United States, there has been a reduction in

Table 2. Variation in mortality due to chronic non-communicable diseases* in adults 30–69 years old resulting from correction and standardization of rates**, according to region. Mortality Information System, Brazil, 2000, 2006 and 2013.

	2000			2006			2013		
	Crude	Crude corrected	Standardized corrected	Crude	Crude corrected	Standardized corrected	Crude	Crude corrected	Standardized corrected
North	198.4	358.2	458.1	210.8	318.5	403.2	225.1	277.1	342.6
Northeast	239.3	412.4	463.8	286.4	378.1	422.4	279.9	331.4	367.1
Southeast	388.1	459.4	526.9	348.2	394.8	433.9	329.4	356.9	361.2
South	412.0	436.6	502.7	360.8	385.8	417.0	346.3	360.0	353.7
Central-West	307.1	377.3	476.6	301.6	345.9	421.9	285.0	307.8	349.0
Brazil	338.0	432.4	499.9	322.5	380.8	425.8	308.7	341.6	359.5

Source: Mortality Information System, Secretariat of Health Surveillance/Ministry of Health.
*The four main groups of causes; **correction for underreporting and redistribution of ill-defined causes death; standardization by reference to the standard population of the World Health Organization.

mortality trends by neoplasms since the 1990s due to early diagnosis and treatment[20,21]. In Brazil, as with other NCDs, albeit to a lesser extent, mortality rate related to cancer has been declining. It should be noted that there are large variations according

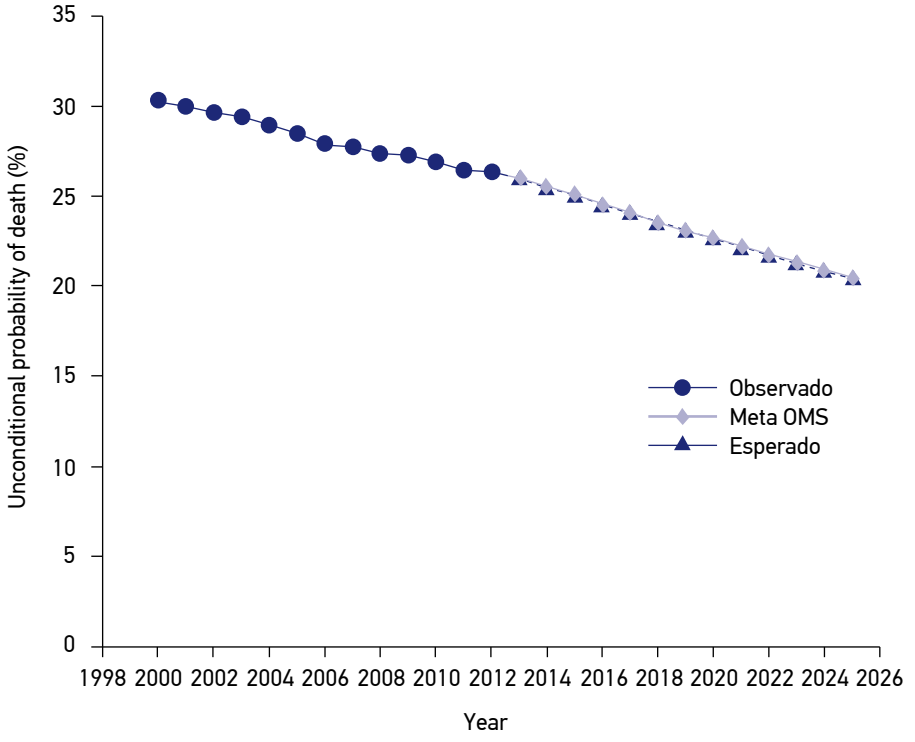
Table 3. Variation in mortality due to chronic non-communicable diseases* in adults aged 30-69 due to correction and standardization of rates**, according to region. Mortality Information System, States, Brazil, 2000–2013.

UF	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	%*
RO	483.7	481.1	459.1	446.2	456.3	423.1	412.8	402.4	385.6	394.6	380.5	365.1	340.9	327.4	2.92
AC	439.1	392.4	385.4	421.7	366.4	397.6	402.9	424.0	393.0	410.1	376.4	391.0	362.4	381.2	0.80
AM	468.6	448.5	428.2	433.9	430.3	421.4	416.8	417.4	404.5	394.5	382.1	379.6	361.5	355.0	2.10
RR	426.7	448.6	436.3	422.7	458.2	392.8	394.6	359.3	346.0	346.3	370.6	357.9	324.1	338.0	1.56
PA	459.8	452.3	431.1	430.7	419.6	404.9	400.1	401.8	397.3	396.0	380.5	376.3	352.9	340.7	2.26
AP	448.7	422.5	416.5	413.6	381.1	390.9	374.2	352.5	363.1	337.4	324.2	330.0	352.1	334.2	2.15
TO	420.5	422.2	445.0	430.1	423.2	411.5	396.7	392.7	403.9	393.7	393.5	377.8	353.3	333.1	1.72
MA	494.3	472.4	479.6	466.6	469.6	452.4	449.4	447.2	442.9	426.6	438.4	414.2	403.6	392.2	1.74
PI	413.1	427.4	406.0	406.4	409.5	412.2	391.8	390.9	382.6	376.2	376.9	375.4	364.7	354.6	1.14
CE	401.4	401.7	411.0	408.6	398.0	392.2	372.3	377.1	364.1	360.1	342.1	329.8	329.3	320.6	1.69
RN	415.2	407.3	403.9	394.6	388.7	380.8	377.6	375.6	361.5	352.5	348.9	346.5	345.0	335.5	1.62
PB	420.5	432.0	426.9	416.5	408.4	405.0	400.8	413.9	412.4	409.0	401.1	393.0	391.7	383.9	0.68
PE	514.0	499.8	484.0	490.9	491.3	480.3	466.4	458.4	453.0	441.1	442.8	421.8	418.0	415.4	1.61
AL	496.4	501.8	488.5	498.9	476.1	472.0	452.9	441.4	446.1	437.5	437.4	429.2	414.6	411.5	1.41
SE	459.0	454.2	442.7	443.2	431.4	428.2	416.7	417.2	416.7	396.7	388.3	373.2	367.3	359.4	1.85
BA	484.1	477.4	448.7	445.8	440.0	430.4	430.6	422.1	408.2	401.9	385.1	372.5	357.6	352.0	2.41
MG	520.4	494.0	480.2	468.9	459.4	449.3	433.6	426.5	412.6	400.1	393.1	375.9	361.0	348.6	3.03
ES	486.5	471.6	447.7	432.8	428.8	416.4	400.5	385.3	382.2	375.6	350.0	334.4	328.5	314.2	3.29
RJ	602.4	579.0	561.7	549.4	520.7	509.4	497.9	490.5	481.1	472.7	461.0	440.0	429.5	414.5	2.83
SP	500.6	479.5	464.6	456.1	442.2	424.9	410.2	402.6	397.4	384.7	379.0	365.3	357.9	349.4	2.72
PR	502.9	490.6	475.8	467.3	450.0	437.5	421.7	420.3	407.3	402.5	392.5	375.1	365.0	356.5	2.61
SC	476.3	456.4	435.9	435.3	415.9	402.9	383.5	372.9	374.0	360.3	355.8	340.1	334.4	319.0	3.02
RS	514.7	495.8	477.7	470.4	455.7	443.4	429.0	419.0	407.0	393.4	388.9	373.7	367.8	369.5	2.51
MS	479.5	462.4	446.0	442.9	441.4	446.7	430.5	411.5	408.1	396.9	388.5	368.6	368.3	369.6	1.96
MT	474.3	481.4	475.4	465.7	453.0	444.4	420.2	418.5	398.5	401.9	387.8	388.5	368.4	353.8	2.20
GO	488.2	470.2	465.4	474.9	457.2	447.2	438.4	432.2	419.1	415.1	402.5	383.3	381.7	367.8	2.14
DF	445.4	446.5	424.8	419.0	406.6	390.9	370.8	355.6	335.6	327.3	314.9	289.1	290.9	276.9	3.56
Brasil	499.9	484.1	469.6	463.2	450.6	438.6	425.8	419.6	410.9	401.2	393.0	378.0	368.7	359.5	2.50

Source: Mortality Information System, Secretariat of Health Surveillance/Ministry of Health.
FU: federative unit; * mean annual reduction.

to the type of cancer, age and sex. Among women, mortality rates for breast, lung and colorectal cancer have increased in recent decades, while rates for cervical and stomach cancer have dropped[2]. Among men, mortality rates for prostate and colorectal cancer rose, while rates for gastric and lung cancer declined. The decline in death rate from lung cancer in people aging less than 60 years is probably due to a decrease in smoking[2,20].

Diabetes accounted for 4.9 million deaths worldwide in 2014 and was linked to 11% of total adult health expenditures, estimated at US$ 612B[22]. The increase in the prevalence of diabetes is a result of an increase in the elderly population and an increase in the prevalence of obesity[1]. Diabetes can still have acute complications, which in 2010 were responsible for 3,741 deaths in Brazil (2.45 deaths/100,000 inhabitants and 0.29 among those under 40)[23]. Diabetes is, moreover, associated with increased mortality from cardiovascular diseases and



WHO: World Health Organization.
Source: Mortality Information System, Secretariat of Health Surveillance/Ministry of Health.
*Standardized by age to the standard population of the World Health Organization, corrected for underreporting and with redistribution of ill-defined causes of death.

Figure 2. Trends and projections of the probability of mortality* for chronic non-communicable diseases among adults 30–69 years old. Brazil, 2000–2013 and projection up to 2025.

its effects are systemic, compromising the cardiovascular system, the great arteries, the heart and the kidneys[24]. Recent data from PNS, a household survey conducted in Brazil in 2013, among adults aged 18 years and over, found about 9.1 million people reporting previous medical diagnosis of diabetes (prevalence of 6.2% of all adults) [25].

Similarly to the present study, other authors have also pointed out a reduction in chronic respiratory diseases, which has been attributed to better access to health care and medication and to a decrease in smoking[2]. In Brazil, data from PNS (2013) showed prevalence of smoking of 14.7% in the adult population, having decreased about 20% in the last years. In addition, attempts to quit smoking were reported by 51% of current smokers[26].

Decline in premature mortality from chronic respiratory diseases was observed in all five regions of the country and in both sexes. Factors associated with this process may be improvements in living conditions, access to health services, smoking cessation, and improvement in eating habits and physical activity practice[2,8,12,13].

The Global NCD Action Plan predicts a 25% reduction in the probability of premature death from these diseases in a decade[3], a projection that Brazil could achieve if it maintains current trends. In 2000, the probability of premature death due to NCDs in Brazil was 30%, corresponding to a third of the population in the range of 30 to 69 years. The decline in this probability was constant, and a 20.5% probability is projected for 2025, that is, one in five people would be at risk of premature death due to NCDs.

In 2015, the United Nations Assembly approved the Sustainable Development Goals, including 17 objectives such as ensuring a healthy life and promoting well-being for all, at all ages. The indicator "30% reduction in the probability of premature death by NCDs by 2030" was included, continuing the commitment already assumed by the World Health Assembly until 2025. Thus, the monitoring of this indicator will be a State action, and Brazil has already demonstrated the ability to achieve this goal.

The method of active search for deaths has improved the identification of underreporting[15] and has already been used in other studies[8]. These corrections are essential for the appropriate interpretation of trends in different regions of the country.

Among the limitations of this study, we point out that, even using methods for the correction of underreporting, unidentified events may still occur. Mortality coverage has progressed, reducing the percentage of underreporting to less than 5% in the country. There was also a significant reduction in the percentage of ill-defined causes[27], which were proportionally distributed. Studies already point out differences in this distribution, which could lead to changes in calculations.

CONCLUSION

The present study demonstrated a decline in premature mortality rates due to NCDs nationwide up to 2013. Rates between regions tended to remain close, reducing regional

differences. There was also a reduction in all groups of causes, with a greater decrease for chronic respiratory diseases, followed by cardiovascular diseases, and a lower reduction for diabetes and cancer.

The trends towards a decline in premature mortality due to NCDs in Brazil are on track, but there is still a long way to go. Achieving the goals of reducing NCDs is a global challenge[3,11]. WHO published a set of evidence pointing out the importance of health promotion measures, implementing public policies within and between sectors that facilitate healthy practices, such as adequate nutrition, reduced salt in foods, public spaces to support physical activity, smoke-free environments, regulation of alcohol advertising and others[1,28]. In addition, it is worth investing in basic care and access to medium- and high-complexity technologies, when necessary, aiming at the integral care of patients with NCDs. These diseases have a prolonged course and require a longitudinal, integral approach with investment in self-care and bonding[29]. Essentially, we must take measures to reduce inequalities in health and guarantee access to care for the entire population, especially the most vulnerable groups, given the greater concentration of NCDs and their risk factors in the population with low income and little schooling[1].

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