

## Changes in health and disease in Brazil and its States in the 30 years since the Unified Healthcare System (SUS) was created

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**Abstract** *The Unified Healthcare System (SUS) was created to ensure the population's right to universal, free and comprehensive healthcare. This study compares the health indicators measured in 1990 to those measured in 2015 in Brazil and its states. The goal is to contribute to understanding the role SUS played in changing the nation's health profile. Analyses use estimates in the Global Burden of Disease (GBD) study for Brazil and its states, and compares 1990 and 2015. The main results are increased life expectancy, as well as an increase in the population's longevity measured in health-adjusted life expectancy. These in turn are due to a sharp decline in mortality due to transmissible diseases, in maternal and infant morbi-mortality, and avoidable causes of death. NTCDs are the leading cause of death, followed by violence. Poor diet is the leading risk factor, followed by metabolic issues. Tobacco use decreased over the period, as did infant malnutrition. In the thirty years since the SUS was created, health indicators in this country have improved, and major progress has been made to reduce inequality across the country's regions.*

**Key words** *Healthcare policies, Child mortality, Unified Healthcare System, Non-Transmissible, Chronic Diseases (NTCDs), Violence*

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## Introduction

Congress approved a democratic constitution in 1988, and health is included as a right. The Unified Healthcare System (SUS) was then created to ensure the population's right to free and comprehensive healthcare<sup>1</sup>.

Over the past 30 years, Brazil has undergone structural changes and become an emerging nation<sup>2</sup>. In terms of the SUS, we point to structuring measures and programs such as the Family Health Strategy (FHS), created in 1994 to guide the healthcare model to a more comprehensive approach, focusing on primary care and seeking to provide universal access to all Brazilians<sup>3</sup>. The Family Health Strategy has expanded greatly in the past decade, prioritizing vulnerable areas. According to the National Health Survey<sup>3</sup>, it now covers 53.4% of the population. The Brazilian National Vaccination plan, created in 1973, is an efficient provider of vaccines against numerous transmissible diseases. In fact, vaccine coverage in this country has helped reduce the number of immune preventable diseases<sup>4</sup>. The SUS also created a national policy to provide free and universal access to essential drugs<sup>5</sup>. In the past decade, the government decided that drugs to treat Non-Communicable Diseases would be provided to the population free of cost<sup>6,7</sup>, and created a program of Budget drugstores known as *Aqui Tem Farmácia Popular*. The Ministry of Health has ensured free and universal anti-retroviral treatment to those living with HIV/AIDS, and has taken numerous disease-prevention and health-promotion measures<sup>8,9</sup>. In 2006, the National Health Promotion Policy prioritized intersectoral measures as well as certain health determinants and conditionants<sup>10</sup>. Although Brazil is the world's 2<sup>nd</sup> largest tobacco producer, it has played a key role in tobacco control, implementing regulatory measures that range from prohibiting tobacco advertising to the Tobacco-Free Environments Law signed in 2014. These measures have helped reduce smoking around the world<sup>11,12</sup>. In 2004, Brazil signed the World Health Organization's Global Treaty on Diet, Physical Activity and Health to prevent obesity and Non-Communicable diseases<sup>13</sup>. In the past decade a pre-hospital service was created to care for the growing number of cardiovascular diseases, external causes among the population, etc.<sup>14</sup>.

Population ageing, decreasing fertility rates and other transformations in Brazilian society have brought with them new challenges for the healthcare system<sup>15</sup>. Demographic and epide-

miological transitions have resulted in different health and disease patterns in different regions and states<sup>15</sup>. Studies show that the expansion of the SUS system over the past 30 years helped reduce the burden of disease in the population, and the inequalities across regions in this country<sup>15</sup>. Thus, it is important to analyze how the disease scenario has changed in Brazil over the past decades.

The current study compared the health indicators prevalent in 1990 and 2015 in Brazil and its states. The goal was to help understand the role SUS plays in changing the nation's health profile.

## Methods

To analyze how the health of the Brazilian population has changed over time, this study used estimates published in the 2015 GBD (Global Burden of Disease) covering the country and the individual states<sup>16</sup>. In 2015, a GBD study by the University of Washington Institute for Health Metrics and Evaluation (IHME) analyzed 249 causes of death, 310 diseases and injuries, 2,619 unique sequelae and 70 risk factors using standardized methodology and different sources of data in 195 countries and territories<sup>16-18</sup>.

The first element of the GBD study's analytical approach is an estimate of overall mortality to correct under notified deaths. This includes estimating the probability of death among those younger than 5 years of age (5q0), adult mortality (45q15), specific mortality by age and the inclusion of the possible effects of epidemics such as HIV/Aids, natural disasters and other fatal discontinuities<sup>17</sup>. The main sources of data on mortality among those younger than five in Brazil were the death records in the Mortality Information System, demographic censuses, household surveys - PNAD, the Sample-Based Household Survey, and PNDS, the National Survey of Demographics and Health, as well as the complete (PNDS) and abbreviated (censuses and PNAD) birth records. The estimating process used statistical models to adjust the different sources and address any possible inconsistencies between them<sup>19,20</sup>.

The second key component of GBD methodology is cause of death, and for this the main source of information was the Ministry of Health SIM or mortality information database. SIM entries with diagnoses that should not be considered the main cause of death, poorly defined or

incomplete diagnoses, and entered as garbage<sup>19-21</sup>, were reassigned to non-garbage codes for each age-gender-year using specific redistribution algorithms. Causes of death were modeled using CODEm (*Cause of Death Ensemble Model*)<sup>19,20</sup>

The main sources of data for risk factor analyses were surveys such as the National Health Survey (PNS), Vigitel (telephone chronic disease risk factor surveillance and protection), the National Household Sample Survey (PNAD), and the National Student Health Survey (PeNSE), among others<sup>22</sup>.

The following metrics were used to describe the burden of disease in 1990 and 2015: absolute number of deaths, infant deaths per 1,000 live births at the country and state level, mortality for standardized causes by age (for the overall populations), death and disability adjusted life years (DALY), life expectancy and health-adjusted life expectancy (HALE), as well as ranked lists of the main causes of death and risk factors in 1990 and 2015. Greater details about the metrics are available in other publications<sup>16-20</sup>.

Metrics are shown with their uncertainty intervals (UI), which reflect the uncertainty in the parameter estimates for each state and period of study. Greater details are available in other publications.

## Results

Table 1 shows an estimate of deaths and mortality rates for those under the age of 5 at the country and state level in 1990 and 2015. Mortality in Brazil was 52.5/1,000 live births in 1990, and 17.0/1,000 live births in 2015, a 67.6% drop. In 1990, 9 of the 11 states with the highest mortality rates for those under 5 are in the Northeast, all with rates over 60/1,000 live births. There was a 4.9-fold difference between the state with the highest mortality (Alagoas, 114.1/1,000 LB) and the state with the lowest mortality (Rio Grande do Sul, 23.2/1,000 LB), a difference of 91 deaths per 1,000 live births. By 2015 this had dropped to 2.3-fold between the state with the highest mortality (Acre, 27.0/1,000 LB) and the one with the lowest (Rio Grande do Sul, 12.0/1,000 LB), a difference of 15 deaths per 1,000 LB. In 2015, four of the ten states with the highest mortality rates were in the North.

Between 1990 and 2015, life expectancy at birth in Brazil increased 6.5 years, from 67.9 to 74.4, and health adjusted life expectancy (HALE) increased 5.4 years, from 59.4 to 64.8. The fact

and overall life expectancy and HALE show a similar increase in the number of years lived in good health. (Table 2)

Age-standardized mortality rates for both genders dropped 28.7% (UI: 26.1-31.1) between 1990 and 2015, from 1,102.2 (UI: 1,085,9-1,118,6) to 786.2 per 100,000 inhabitants (UI: 761.2-810.3). (Table 2) Age-standardized mortality rates dropped across Brazil, however at different rates depending on the region. The largest decreases were recorded in the more developed regions - the South (30%) and Southeast (32%), while the smallest ones were in the North (20%) and Northeast (21%). (Table 2)

The Federal District performed better in all health metrics. In 2015, the state of São Paulo - the wealthiest in the nation - came in second and third in terms of life expectancy and HALE at birth respectively. In 2015, the lowest life expectancy at birth was in states of the northeast: Maranhão, Alagoas and Pernambuco at 71.5 years (UI=69.1-73.6), 72.3 years (70.7-73.8) and 72.5 years (70.9-74.1) respectively. However, these states also had the largest increase in life expectancy compared to 1990 - 12.6% for Maranhão, 15.1% for Alagoas and 12.1 for Pernambuco (Table 2).

Table 3 shows the number of deaths and age-standardized rates for selected causes of death in both genders in Brazil in 1990 and 2015. In 2015, there were some 1.3 million deaths in Brazil, a 28.7% reduction in the overall mortality rate. Non-Communicable diseases are the leading cause of death - 75% or 1 million. However, NCD as a cause of death dropped 25% in this same period, from 816.6 to 611.3/100,000 inhabitants. There was a significant drop in cardiovascular (40.5%) and chronic respiratory diseases (29.9%). Cancers remained stable within the UI. Deaths due to diabetes increased 12.6% and mental disorders and substance abuse increased in absolute number, but again within the UI. Violence and accidents accounted for some 168 thousand deaths in 2015, a 22.8% drop in the period. Deaths due to traffic accidents dropped 30.9% and those due non-intentional accidents 33.2%. Deaths due to interpersonal violence remained essentially unchanged. Transmissible, infant/child and maternal diseases, along with nutritional disorders, were the cause of some 159 thousand deaths in 2015, a 31% drop compared to 1990, and a 47.1% reduction in the rate. We call attention to the mortality rate due to diarrhea (86.8%), meningitis (70.7%) and immune preventable diseases. Maternal causes dropped

**Table 1.** Mortality of children under 5 per 1,000 live births. Brazil and its states, 1990 and 2015.

State	1990		2015		Percent change
	n	Rate/1,000	n	Rate/1,000	
Acre	993	67.7	482	27.0	-60.1
Alagoas	8409	114.1	1104	18.5	-83.8
Amapá	411	38.0	350	21.4	-43.8
Amazonas	3581	54.0	146	17.5	-67.6
Bahia	2405	75.2	5449	23.0	-69.4
Ceará	17627	95.5	3068	21.8	-77.2
Federal District	1057	26.3	606	14.5	-44.7
Espírito Santo	2551	39.8	816	14.8	-62.8
Goiás	3332	34.9	1556	16.5	-52.7
Maranhão	14222	86.3	3434	24.2	-71.9
Mato Grosso	2307	41.8	734	13.8	-67.1
Mato Grosso do Sul	1497	32.1	639	15.0	-53.3
Minas Gerais	15146	40.9	4271	15.3	-62.7
Pará	10323	63.1	2941	18.4	-70.9
Paraíba	5875	68.9	1069	16.6	-75.9
Paraná	6529	32.1	2105	13.8	-56.9
Pernambuco	16797	88.2	3065	20.7	-76.5
Piauí	4726	64.0	1197	23.0	-64.1
Rio de Janeiro	9655	37.9	2995	14.4	-62.0
Rio Grande do Norte	4907	74.3	790	14.9	-80.0
Rio Grande do Sul	458	23.2	1658	12.0	-48.3
Rondônia	1573	48.5	428	14.8	-69.5
Roraima	351	58.2	265	25.0	-56.9
Santa Catarina	3639	33.6	1392	15.9	-52.8
São Paulo	2276	33.1	8055	13.7	-58.5
Sergipe	3027	70.1	748	20.8	-70.4
Tocantins	1583	59.2	550	20.3	-65.8
<b>Brazil</b>	<b>191505</b>	<b>52.5</b>	<b>51226</b>	<b>17.0</b>	<b>-67.7</b>

Source: França *et al.*<sup>23</sup>.

56%, neonatal causes 56.7% and nutritional causes 50.2% (Table 3).

Figure 1 compares the main causes of mortality in 1990 and 2015. Ischemic heart diseases were the leading cause of death in 1990 and 2015, followed by cerebrovascular disorders. Alzheimer's dropped from 5<sup>th</sup> to 6<sup>th</sup> place. Lower respiratory tract infections came in third in 2015, while COPD dropped from 3<sup>rd</sup> to 4<sup>th</sup> place. Diabetes went from 7<sup>th</sup> to 5<sup>th</sup> and interpersonal violence from 9<sup>th</sup> to 7<sup>th</sup>. In 2015, traffic accidents were the 8<sup>th</sup> leading cause of death, followed by chronic kidney disease (9<sup>th</sup>) and lung cancer (10<sup>th</sup>). Diarrhea as a cause of death dropped significantly - from 8<sup>th</sup> in 1990 to 36<sup>th</sup> place in 2015, as did malnutrition (18<sup>th</sup> to 31<sup>st</sup>), and premature labor (19<sup>th</sup> to 30<sup>th</sup>).

Figure 2 shows the changes in the main risk factors for all-cause DALY by gender between

1990 and 2015. In 1990, inadequate diet, smoking, high blood-pressure and maternal-infant malnutrition were the main risk factors for DALY among men and women. Inadequate diet topped the list throughout, with high blood pressure moving from 2<sup>nd</sup> to 3<sup>rd</sup> place among both men and women. Infant and child malnutrition dropped significantly, from 4<sup>th</sup> to 11<sup>th</sup> place among boys, and from 2<sup>nd</sup> to 6<sup>th</sup> place among girls. Smoking went from 2<sup>nd</sup> to 4<sup>th</sup> place among men, and from 4<sup>th</sup> to 5<sup>th</sup> among women (Figure 2).

Over this period, BMI went from 8<sup>th</sup> to 5<sup>th</sup> among men, and from 5<sup>th</sup> to 3<sup>rd</sup> among women. Drug and alcohol use went from 5<sup>th</sup> to 4<sup>th</sup> among men, and high fasting glucose levels from 6<sup>th</sup> to 4<sup>th</sup> among women. Other behavioral factors also contributed to worsening DALY, such as insufficient physical activity, unsafe sex and all metabolic risks. Environmental risk factors, including

**Table 2.** Comparison of the Standardized Mortality Rate (per 100,000, Life Expectancy at Birth (years), Health-Adjusted Life Expectancy (years) by state, 1990 and 2017.

State	Standardized Mortality Rate (per 100,000)		Life expectancy at birth (years)		HALE Health Adjusted Life Expectancy (years)	
	1990	2015	1990	2015	1990	2015
North						
Acre	1058.4 (994.2-1129.8)	852.9 (758.6-960.7)	67.8 (66.8 - 68.7)	72.8 (71.2 - 74.3)	59.2 (56.7 - 61.6)	63.5 (60.7 - 66.3)
Amapá	890.5 (822.7-971.1)	830.7 (697.8-984.1)	71.8 (70.7 - 72.8)	73.5 (71.1 - 75.7)	62.9 (60.2 - 65.3)	64.4 (61.3 - 67.3)
Amazonas	1027.4 (946.4 - 1100)	816.6 (720.5 - 928.4)	68.9 (67.9 - 70)	73.9 (72.1 - 75.4)	60.5 (58 - 62.9)	64.7 (61.8 - 67.4)
Pará	1022.2 (945.2 - 1108.5)	823.3 (712.1 - 962.2)	68.5 (67.3 - 69.6)	73.7 (71.7 - 75.5)	60 (57.5 - 62.4)	64.4 (61.2 - 67.3)
Rondônia	1207.1 (1123 - 1288.7)	814.4 (718.7 - 905)	66.7 (65.6 - 67.7)	74.1 (72.8 - 75.7)	58.8 (56.4 - 61)	65 (62.1 - 67.8)
Roraima	1096.9 (1040.3 - 1151.5)	802.5 (725.9 - 889.7)	67.5 (66.7 - 68.3)	73.8 (72.3 - 75.2)	59.4 (57 - 61.7)	64.6 (61.8 - 67.3)
Tocantins	1012.8 (908 - 1137.6)	881 (759.9 - 1017.6)	68.9 (67.1 - 70.5)	72.7 (70.7 - 74.6)	60.5 (57.6 - 63.1)	63.7 (60.8 - 66.5)
Northeast						
Alagoas	1253.5 (1179.3 - 1332.4)	880.6 (789 - 992.7)	62.8 (61.6 - 64)	72.3 (70.7 - 73.8)	55.1 (52.5 - 57.5)	63.2 (60.3 - 66.1)
Bahia	1059.2 (989 - 1129.5)	861.1 (767 - 964.8)	67.4 (66.4 - 68.4)	72.8 (71.2 - 74.3)	59.1 (56.6 - 61.5)	63.6 (60.7 - 66.1)
Ceará	991.6 (930.2 - 1046.9)	858.5 (766.4 - 962.7)	67.4 (66.4 - 68.4)	72.9 (71.3 - 74.4)	58.9 (56.3 - 61.3)	63.6 (60.7 - 66.5)
Maranhão	1290.2 (1184.7 - 1394)	936.9 (804.5 - 1108.4)	63.5 (62.2 - 65)	71.5 (69.1 - 73.6)	55.7 (53.2 - 58.2)	62.5 (59.4 - 65.6)
Paraíba	995.1 (930.2 - 1057.4)	876 (762.9 - 1009.1)	68.8 (67.9 - 69.7)	72.9 (70.9 - 74.6)	60.3 (57.7 - 62.7)	63.7 (60.7 - 66.7)
Pernambuco	1179.8 (1108.5 - 1257.5)	872 (777.9 - 979.8)	65 (63.8 - 66.2)	72.5 (70.9 - 74.1)	57.2 (54.6 - 59.5)	63.5 (60.7 - 66.2)
Piauí	971.2 (905.8 - 1031.7)	833.9 (732.9 - 939.2)	69.3 (68.3 - 70.3)	73.3 (71.6 - 74.9)	60.6 (57.9 - 63.1)	63.8 (60.8 - 66.6)
Rio Grande do Norte	912.3 (856.6 - 965)	752.7 (673.8 - 834.6)	69.7 (68.7 - 70.8)	75.1 (73.8 - 76.4)	61 (58.5 - 63.3)	65.6 (62.8 - 68.5)
Sergipe	1031 (968.8 - 1098)	827 (735 - 936.5)	68 (67.1 - 68.9)	73.4 (71.8 - 74.9)	59.6 (57.2 - 62)	64.2 (61.3 - 67.1)
Middle-West						
Goiás	1136.8 (1079.5 - 1193.3)	819.8 (741.3 - 909.9)	68.3 (67.6 - 69)	73.8 (72.5 - 75)	60.2 (57.7 - 62.4)	64.6 (61.7 - 67.2)
Mato Grosso	1085.7 (1005.5 - 1162.9)	837.7 (735.7 - 940.1)	68.7 (67.6 - 69.7)	73.7 (72.3 - 75.3)	60.3 (57.8 - 62.7)	64.4 (61.4 - 67.2)
Mato Grosso do Sul	1045.4 (976.7 - 1107.5)	811.7 (717.7 - 909.5)	69.8 (68.9 - 70.6)	74.1 (72.6 - 75.6)	61.1 (58.5 - 63.5)	64.7 (61.7 - 67.5)
Distrito Federal	943 (906.1 - 981)	614 (554 - 678.9)	71.5 (70.9 - 72)	78 (76.8 - 79.1)	62.6 (60.1 - 65)	67.9 (64.8 - 70.9)

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**Table 2.** Comparison of the Standardized Mortality Rate (per 100,000, Life Expectancy at Birth (years), Health-Adjusted Life Expectancy (years) by state, 1990 and 2017.

State	Standardized Mortality Rate (per 100,000)		Life expectancy at birth (years)		HALE Health Adjusted Life Expectancy (years)	
	1990	2015	1990	2015	1990	2015
Southeast						
Espírito Santo	1062.5	763.7	68.9	74.6	60.5	65.1
Minas Gerais	(1003.3 - 1129.3)	(677.1 - 853.8)	(68 - 69.8)	(73.2 - 76.1)	(57.8 - 63)	(62.1 - 67.9)
Rio de Janeiro	1107.5	758.8	68.5	74.9	60.1	65.5
São Paulo	(1049.9 - 1168.3)	(682.4 - 841.7)	(67.7 - 69.3)	(73.6 - 76.2)	(57.7 - 62.4)	(62.5 - 68.3)
	1205.5	798.1	66.6	74.2	58.6	64.9
	(1158.4 - 1252.4)	(729.7 - 869.9)	(66 - 67.3)	(73.1 - 75.3)	(56.4 - 60.8)	(62.1 - 67.4)
	1082.5	711.9	69	76.1	59.9	65.7
	(1040.4 - 1124.7)	(640.7 - 780)	(68.5 - 69.6)	(74.9 - 77.2)	(57.4 - 62.3)	(62.6 - 68.5)
South						
Paraná	1125	805.8	69.2	74.3	60.7	64.7
Rio Grande do Sul	(1067.7 - 1184)	(721.5 - 902.4)	(68.5 - 69.9)	(72.9 - 75.6)	(58.1 - 62.9)	(61.8 - 67.3)
Santa Catarina	1063.7	756.8	70.1	75.2	61.6	65.6
	(1001.3 - 1126.1)	(661.7 - 860.7)	(69.4 - 70.9)	(73.7 - 76.7)	(59 - 63.8)	(62.7 - 68.4)
	1087.3	735.1	69.6	75.6	61.3	66.1
	(1024.8 - 1151.5)	(650.9 - 826.4)	(68.8 - 70.4)	(74.1 - 77)	(58.9 - 63.5)	(63 - 68.9)
<b>Brazil</b>	<b>1.102.2</b>	<b>786.2</b>	<b>67.9</b>	<b>74.4</b>	<b>59.4</b>	<b>64.8</b>
	<b>(1,085.9-1,118.6)</b>	<b>(761.2-810.3)</b>	<b>(67.5-68.2)</b>	<b>(73.9-74.9)</b>	<b>(56.9-61.7)</b>	<b>(62.1-67.3)</b>

Source: Global Burden of Disease study.

air pollution, deceased, while occupational risks increased (Figure 2).

## Discussion

These findings show that in the 25-year period analyzed (1990 to 2015), which covers much of the SUS existence, there have been many changes in the health/disease profile of the Brazilian population, most of them positive. It also shows a decrease in the inequalities in health indicators across the states.

A sharp decline in mortality due to transmissible diseases, in maternal-infant morbi-mortality and avoidable causes of death have increased life expectancy and increased the population's longevity measured in healthy life-years. NCD remain the leading cause of death, despite an overall reduction in mortality rates and in death due to cardiovascular and respiratory diseases. On the other hand, deaths due to diabetes increased in this period. Violence killed over 168 thousand Brazilians in 2015. As these can be fully avoided, a decrease in this rate is a major challenge for the coming decades. Poor diet is the leading risk factor, followed by metabolic factors. In the 25-

year period smoking decreased substantially, as did infant malnutrition. All of these changes coincided with re-democratization and significant economic growth. A number of social protection policies were instated at this time, along with the unified healthcare system (SUS), the definitive strategy to promote a society with a healthcare system suited to its needs. Along with economic and social advances, there is evidence that the SUS contributed to the changes observed, and in particular to reduce the inequality that prevails in this country.

The GBD study is innovative as it records the nation's health-disease burden using corrected estimates, new metrics such as DALY, and expected health-adjusted life expectancy, all of which provide new data on population health and new views for healthcare professionals and managers<sup>24</sup>.

Between 1990 and 2015 overall mortality in Brazil dropped and life expectancy at birth went up. Higher life expectancy at birth is the result of socioeconomic income distribution policies, programs such as *Bolsa Familia* (family stipend), increased employment in the past decade and other policies to reduce inequality<sup>15</sup>. Better coverage and access to healthcare services and a rapid change in the population age pyramid also con-



**Table 3.** Number of deaths and age-standardized rates for selected causes of death in both genders Brazil, 1990, 2015.

Cause of Death	Number of Deaths			Standardized rate of death (per 100,000)		
	1990	2015	% change 1990-2015	1990	2015	% change 1990-2015
All causes	911.317 (896.944-925.847)	1.357.434 (1.312.612-1.400.906)	49 (43,8-54,5)	1.102,2 (1085,9-1118,6)	786,2 (761,2-810,3)	-28,7 (-31,1--26,1)
A – Transmissible, maternal, neonatal and nutritional diseases	233.554 (222.998-240.244)	159.917 (139.858-170.945)	-31,1 (-38,7--26,5)	178,5 (168,3-183,4)	93,8 (81,4-100,7)	-47,1 (-52,7--43,6)
A.1 HIV/AIDS and tuberculosis	13.740 (11.664-15.402)	26.812 (23.412-31.197)	94,9 (62,5-140,2)	12,8 (10,7-14,8)	12,5 (10,9-14,6)	-2,6 (-19,2-20,3)
A.2 – Diarrhea, lower respiratory tract diseases and other infectious causes	119.418 (111.562-124.075)	85.657 (65.814-94.532)	-27,3 (-41,7--20,4)	101,6 (92,4-105,8)	52,9 (40,7-58,6)	-47,2 (-56,6--42,1)
A.2.1 – Diarrheic diseases	46.035	6.343 (5.942-6.732)	-86,2 (-87,3--85)	29,6 (28,3-31)	3,9 (3,6-4,2)	-86,8 (-87,8--85,7)
A.2.11 - Measles	8.027 (6.256-8.844)	2.785 (2.515-3.530)	-67,2 (-70,4--49,9)	4,8 (3,7-5,2)	1,5 (1,3-1,9)	-70,7 (-73,4--55,8)
A.2.11 - Sarampo	1.109 (806-1.492)	3 (2-5)	-99,7 (-99,8--99,6)	0,6 (0,4-0,7)	0 (0-0)	-99,7 (-99,7--99,5)
A.3 – Neglected tropical diseases and malaria	9.541 (9.121-9.962)	7.486 (6.918-8.049)	-21,4 (-27,9--14,9)	10,9 (10,4-11,4)	4,2 (3,9-4,5)	-61,7 (-65--58,4)
A.4 – Material disorders	3.081 (2.896-3.299)	1.972 (1.786-2.165)	-36 (-43,2--27,9)	2 (1,8-2,1)	0,9 (0,8-0,9)	-56 (-61--50,4)
A.5 – Neonatal disorders	69.532 (67.501-71.533)	25.137 (22.843-27.716)	-63,9 (-67,3--59,8)	35,8 (34,7-36,8)	15,5 (14,1-17,1)	-56,7 (-60,7--51,8)
A.6 – Nutritional disorders	13.570 (10.445-14.964)	9.568 (7.584-10.585)	-29,4 (-35,5--23,1)	12,2 (9,7-13,4)	6 (4,8-6,7)	-50,2 (-54,1--46,3)
A.7 – Other transmissible maternal, neonatal and nutritional diseases	4.672 (3.734-5.905)	3.285 (2.986-3.510)	-29,2 (-43,2--13,1)	3,3 (2,8-4)	1,7 (1,6-1,8)	-48,2 (-55,9--40,3)

it continues

tributed<sup>25,26</sup>. Life expectancy improved in Brazil more than in other Latin American countries such as Argentina, Chile, Colombia and Mexico<sup>17</sup>.

Successful aging, or increased health-adjusted life expectancy (HALE) are often used as indicators of quality of life<sup>27</sup>. HALE estimates the

expected number of “healthy years” for a population of a given age<sup>27</sup>. This indicator includes a dimension of quality of life<sup>3</sup>, as long-life may not be the same as healthy-life<sup>27</sup>.

Szwarcwald et al.<sup>27</sup> analyzed data from the National Health Survey and found significant

**Table 3.** Number of deaths and age-standardized rates for selected causes of death in both genders Brazil, 1990, 2015.

Cause of Death	Number of Deaths			Standardized rate of death (per 100,000)		
	1990	2015	% change 1990-2015	1990	2015	% change 1990-2015
B – Non-communicable diseases	542.832 (532.149-554.906)	1.029.499 (992.362-1.068.244)	89,7 (82,4-97,2)	818,6 (803,9-834,7)	611,3 (589,8-633,9)	-25,3 (-28--22,6)
B.1 – Cancers	105.275 (102.761-109.195)	236.345 (226.265-248.290)	124,5 (115,4-134,9)	142,7 (139,2-149,1)	133,5 (127,9-140,4)	-6,5 (-10,1--2,3)
B.2 – Cardiovascular diseases	267.634 (262.150-273.226)	424.058 (407.250-444.686)	58,2 (51,7-66,3)	429,5 (421,1-438,1)	256 (246,3-268,3)	-40,5 (-42,9--37,5)
B.3 – Chronic respiratory diseases	41.272 (40.138-42.445)	79.651 (76.015-83.698)	92,8 (83,3-103,1)	69,9 (67,8-71,9)	49,7 (47,3-52,3)	-28,9 (-32,6--25,1)
B.4 – Cirrhosis and other chronic liver diseases	22.783 (21.290-23.771)	36.607 (34.172-39.284)	60,5 (50-72,7)	25,7 (24,1-26,9)	18,9 (17,6-20,3)	-26,7 (-31,2--21,3)
B.5 - Digestive Diseases	17.711 (16.770-18.591)	33.267 (28.455-35.152)	88,9 (62,3-99,3)	25,3 (24,1-26,5)	19,5 (16,6-20,7)	-22,4 (-33,6--18,2)
B.6 – Neurological disorders	19.714 (16.924-22.399)	63.396 (53.548-73.278)	221,4 (205,7-237,5)	43,2 (36-50,3)	42,2 (35,3-49,1)	-2,5 (-6-1,4)
B.7 – Mental disorders and substance abuse	5.079 (4.837-5.385)	11.037 (10.308-11.828)	117,7 (100,2-133,5)	4,6 (4,4-4,9)	5,3 (4,9-5,6)	14,4 (5,4-22,5)
B.8 – Diabetes, urogenital, blood and endocrine disorders	45.922 (44.606-48.180)	124.066 (117.671-130.022)	170,8 (155,6-182,7)	65,9 (63,9-69,2)	73,9 (70-77,4)	12,6 (6,2-17,3)
B.9 – Musculoskeletal disorders	1.454 (1.264-1.544)	3.553 (3.277-4.182)	142,4 (125,6-180)	1,6 (1,4-1,7)	1,9 (1,8-2,3)	19 (10,5-38,9)
B.10 – Other non-communicable diseases	15.988 (13.668-22.657)	17.519 (13.174-19.780)	17,3 (-36,9-37,6)	10 (8,7-13,8)	10,4 (7,8-11,8)	7,3 (-39,1-29,1)
C – Injuries	134.931 (131.104-138.852)	168.018 (159.904-177.046)	24,5 (18,4-31,2)	105,1 (101,7-108,1)	81,2 (77,4-85,4)	-22,8 (-26,5--18,6)
C.1 – Traffic injuries	48.618 (46.835-50.494)	54.601 (51.381-60.111)	11,8 (5,5-27,2)	37,3 (36-38,6)	25,9 (24,4-28,4)	-30,9 (-34,9--21,3)
C.3 – Self-aggression and interpersonal violence	51.048 (48.599-55.573)	75.273 (69.169-80.229)	48,2 (30-57,5)	36,4 (34,8-39,8)	34,3 (31,7-36,6)	-5,1 (-16,9-0,8)
C.2 Accidents	34.975 (32.391-36.301)	38.144 (35.781-40.384)	8,8 (3,1-17,3)	31,2 (28,3-32,5)	20,9 (19,6-22,2)	-33,2 (-36,8--27)
C.4 - Forças da natureza guerra e intervenção legal	290 (85-648)	NA (NA-NA)	-100 (-100--100)	0,2 (0,1-0,5)	NA (NA-NA)	-100 (-100--100)



1990		2015	
1 – Ischemic heart disease	209.4	1 – Ischemic heart disease	117.6
2 – Cerebrovascular disease	162.9	2 – Cerebrovascular disease	88.0
3 – COPD	64.5	3 – Lower respiratory tract infections	47.0
4 – Lower respiratory tract infections	63.5	4 – COPD	44.5
5 – Alzheimer's	39.4	5 – Diabetes	37.5
6 – Traffic accidents	36.9	6 – Alzheimer's	37.1
7 – Diabetes	35.9	7 – Interpersonal violence	27.8
8 – Diarrheic diseases	29.6	8 – Traffic accidents	24.8
9 – Interpersonal violence	28.3	9 – Chronic renal disease	21.4
10 – Neonatal complications of premature delivery	21.3	10 – Lung cancer	18.3
11 – Chronic renal disease	20.6	11 – Hypertensive heart disease	20.6
12 – Stomach cancer	19.8	12 – Prostate cancer	13.4
13 – Lung cancer	18.7	13 – Chronic renal disease	12.4
14 – Hypertensive heart disease	18.2	14 – Stomach cancer	12.3
15 – Cardiomyopathy	14.0	15 – Cardiomyopathy	11.3
16 – Other cardiovascular diseases	12.7	16 – Other cardiovascular diseases	11.1
17 – Prostate cancer	11.8	17 – HIV/AIDS	9.5
18 – Hepatitis C cirrhosis	11.4	18 – Hepatitis C cirrhosis	9.5
19 – Protein-calorie malnutrition	11.4	19 – Falls	9.3
20 – Colorectal cancer	10.3	20 – Breast cancer	9.2
21 – Falls	9.8	21 – Neonatal complications of premature delivery	5.9
22 – Breast cancer	9.1	30 – Protein-calorie malnutrition	5.6
42 – HIV/AIDS	4.5	36 – Diarrheic diseases	3.9

**Figure 1.** Standardized mortality rates (100,000 deaths) for the main causes of death, Level 3, GBD 2015. Brazil, 1990 and 2015.

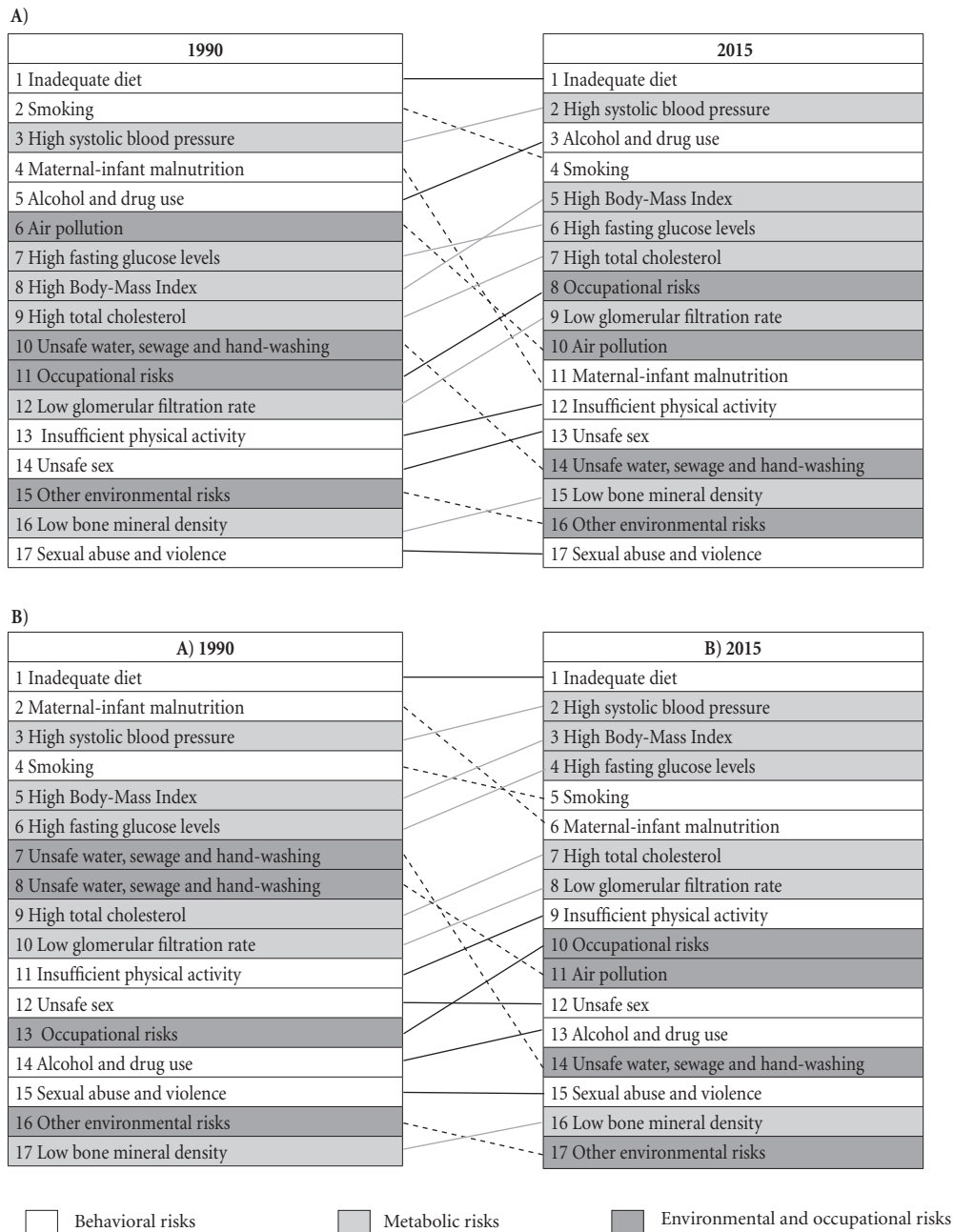
Source: Global Burden of Disease Study. <https://vizhub.healthdata.org/gbd-compare/>

differences in HALE by state – as much as seven years –, and by socioeconomic class. The current study found that HALE had increased significantly between 1990 and 2015, but also found differences by state. The highest HALE was found in the Federal District and Santa Catarina, although both within the UI.

This study shows that between 1990 and 2015, Child Mortality dropped significantly in all states, and there was also a major decline in the differences between states. Mortality dropped more significantly in the northeast states<sup>23,28</sup>. A 2013 UN Report<sup>29</sup> pointed to the decline in Child Mortality in Brazil, highlighting intersectoral measures and the Unified Healthcare System (SUS) offering things such as pre-natal, delivery and infant (first-year of life) care. The Family Health Strategy also had a positive impact on reducing Child Mortality<sup>29</sup>, especially neonatal mortality. Measures to address malnutrition and diarrhea, and campaigns to foster breastfeed-

ing helped keep down Child Mortality rates in the period<sup>28</sup>. Other measures, such as increasing the number of high-risk beds and easier access to care during delivery helped reduce neonatal death<sup>23,28</sup>. The report also highlights social service policies such as the *Bolsa Família* (Family Stipend) income transfer program<sup>29</sup>, and a number of improvements in living conditions and infant and child healthcare<sup>23</sup>.

The thirty years since the SUS has existed have seen major progress in coverage and access to primary care, now available to more than half the population. Access to medicines, vaccines, disease prevention and health promotion measures have also improved<sup>30</sup>. These measures, better/expanded sanitation and social protection programs have all helped cut down the number of infectious diseases such as diarrhea, respiratory infections, TB, immune preventable diseases and infant and maternal mortality<sup>4,15,30,31</sup>. Diarrhea for example, dropped to 39<sup>th</sup> in the ranking



**Figure 2.** 17 main level 2 risk factors for all-cause DALYs for (A) men and (B) women, 1990 and 2015 GBD Brazil, 2015.

Source: Malta *et al.*<sup>22</sup>.

of causes of death. The past 25 years in Brazil have also seen major changes in the nation's demographics. As the population ages, the country is also experiencing a transition in epidemiology,

leading to important changes in the morbi-mortality profile. NCD account for about 75% of all deaths and for loss of quality of life<sup>32</sup>. However, the study also shows that rates are declining as a re-

sult of different measures, among them increased healthcare for adults<sup>33</sup>, and the nation's commitment to the theme, defining targets to control NCD<sup>32</sup>. In 2011, the government launched a plan to address NCD that includes health promotion, disease prevention and care<sup>6</sup>. In 2011, voluntary agreements with the food industry reduced the amount of salt in ultra-processed foods, and eliminated trans-fats<sup>6,7</sup>. In 2014, the government launched the Healthy Nutrition Guide<sup>34</sup>, and in 2011 the *Academia da Saúde* (Health Gym) created incentives for physical activity and other health promotion measures<sup>35</sup>. Universal access to all three levels of healthcare (primary, secondary and tertiary)<sup>36,37</sup> is another important measure. In the case of cardiovascular diseases this includes access to drugs such as blood pressure drugs, beta-blockers, statins, etc.<sup>36</sup>.

Patients with diabetes have access to oral hypoglycemics and insulin. National Health Survey data shows that more than 80% of those with diabetes and/or hypertension in Brazil have access to healthcare services and medicines and, when required, to experts, tests and hospitalization<sup>38</sup>.

The study shows that inadequate diet is the main contributor to the burden of disease, measured by DALYs, and particularly Non-Communicable Diseases (NCD)<sup>39</sup>. It is essential to invest in measures to deter the increase in obesity, such as regulatory measures to tax unhealthy foods such as soft-drinks and other ultra-processed foods<sup>6,7,22,33</sup>.

Smoking has fallen in the ranking of risk factors, as the number of smokers in Brazil has declined sharply<sup>11,12,39</sup>. In 1989 36.4% of the population smoked, while in 2013 this was down to 15%, one of the lowest rates in the world<sup>12</sup>. Regulatory measures such as forbidding advertising and health warnings, among others, explain this drop<sup>11,12,40</sup>. The Tobacco Free Environment Law, signed in 2011 and regulated by Presidential Decree in 2014, prohibits smoking in closed public environments, prohibits cigarette advertising and promotions, and expanded the warning messages on tobacco packaging. Taxes on tobacco products also increased<sup>12,40</sup>.

Over the past decade, the Ministry of Health created a broad system to monitor NCD, which includes health surveys and Health Information Systems to monitor trends, risk factors and protection against NCD<sup>7,41</sup>.

Finally, the results point to external causes of death, which did drop over the period, but are still quite prevalent, especially interpersonal violence and traffic accidents. These are particularly

prevalent among young people and contribute to premature mortality during the productive years<sup>16</sup>. Also worth noting are premature deaths due to HIV and its rising importance as a cause of early death in recent decades, and SUS actions to ensure access to diagnosis and treatment. Brazil led global measures to break patents to manufacture generic drugs, especially those used to treat HIV, offering ample access to medication to those with the disease<sup>8,9</sup>.

## Conclusion

The SUS faces many challenges, among them new epidemics, neglected diseases, vector control, the magnitude of NCD and violence. Understanding the pattern of health and the associated trends over the past decades allows us to take a critical look at healthcare policies and the SUS, and to assess progress made and limitations in addressing health issues. This study is innovative as it contributes new metrics to monitor the health of the population, such as Health-Adjusted Life Expectancy (HALE), and Disability-Adjusted Life Years (DALY), among others.

In terms of SUS activities, we highlight the expansion of the Family Health Strategy, emergency and pre-hospital care, expanded treatment of cancer and cardiovascular diseases, a more extensive vaccine calendar and health promotion and disease prevention measures. Other contributions are regulatory measures to reduce tobacco use, programs to encourage physical activities, and intersectoral violence-prevention programs, all of which helped improve the indicators analyzed in this paper. These positive findings are directly related to implementing highly cost-effective interventions by the Unified Healthcare System, such as expanding primary care, drug distribution to those at high risk of developing cardiovascular diseases, and measures to control tobacco use<sup>39</sup>. Addressing ischemic heart disease is a dual challenge for the Brazilian healthcare system, as it includes health promotion measures and better specialized care to deliver better results in managing cardiovascular diseases<sup>37</sup>.

We also point to the rapidly growing elderly population, as life expectancy increases and regional differences decrease. This will demand a new healthcare system and social security policies. Healthy aging is a challenge of our times and will require an innovative healthcare policy that promotes health and reduces the burden of disease. However, approval of Constitutional

amendment 95, which makes it impossible to grow the resources available for healthcare and other social policies, is a serious threat to these new demands<sup>42</sup>. Budget cuts will have an impact on population health indicators<sup>43</sup>, so studies to monitor trends such as those presented here are essential to measure the health and living conditions of the Brazilian population.

In short, advances made by the Unified Healthcare System and better economic planning, such as real increases in the minimum wage, progress made in housing and basic sanitation policies and other distributive social protection measures, such as the family stipend, have created a positive scenario for important improvements in health conditions and an increase in health-adjusted life expectancy among the population of this nation<sup>44,45</sup>.

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