Burden of disease in Brazil and its regions, 2008

Carga de doença no Brasil e suas regiões, 2008

Carga de enfermedad en Brasil y sus regiones, 2008

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Abstract

The current study estimated DALY (disability-adjusted life years), an indicator of burden of disease, for Brazil in 2008. The North and Northeast regions showed higher burden of disease. Chronic noncommunicable diseases predominated in all regions of the country, especially cardiovascular diseases, mental disorders (particularly depression), diabetes, and chronic obstructive pulmonary disease. The study also showed a high burden of homicides and traffic accidents. Brazil's epidemiological profile appears even more complex when one considers the non-negligible burden of communicable diseases, maternal and perinatal conditions, and nutritional deficiencies. The analyses allowed a more detailed understanding of the Brazilian's population's health status, underscoring the need for crosscutting actions beyond specific health sector policies and greater attention to the quality of information on morbidity and mortality.

Disability-Adjusted Life Years; DALY; Mortality

Resumo

No presente estudo, o DALY (anos de vida perdidos ajustados por incapacidade), indicador de estudos de carga de doença, foi estimado para o Brasil em 2008. Entre os principais resultados, observam-se maior carga de doença no Norte e Nordeste e preponderância das doenças crônicas não transmissíveis em todas as regiões do país, em particular as doenças cardiovasculares, os transtornos mentais, com destaque para a depressão, o diabetes e a doença pulmonar obstrutiva crônica. Também chama a atenção a elevada carga dos homicídios e dos acidentes de trânsito. O perfil epidemiológico apresenta-se ainda mais complexo quando se considera a carga não desprezível das doenças transmissíveis, das condições maternas, das condições perinatais e das deficiências nutricionais. As análises empreendidas ao longo do estudo possibilitaram conhecer de forma mais detalhada o status de saúde da população, evidenciando a demanda por ações transversais, que vão além de políticas específicas circunscritas à área de saúde, bem como a necessidade de ampliar o escopo de preocupação com a qualidade das informações sobre morbimortalidade no Brasil.

Anos de Vida Perdidos por Incapacidade; DALY; Mortalidade

Introduction

In the second half of the 20th century, population aging, previously considered a phenomenon of developed countries, became apparent in various developing countries. The trend is for population aging to consolidate in the 21st century, fueled by both the rapid decline in fertility (the principal component in this process) and the decline in mortality [1,2]. The estimated proportion of elderly – individuals 65 years or older – will double between 2010 and 2050, from 8% to 16% of the world population. This growth will be far more intense in the developing countries, on the order of 250%, when compared to the developed ones, where the elderly contingent is expected to grow by 70% [1,2].

Population aging poses a major challenge for developing countries to elaborate adequate social security and health policies. As people live longer, various social benefits like retirement and pensions tend to last longer, thus requiring changes in the social security system [3]. Even more intense pressures are expected on the health system due to the greater prevalence of chronic diseases, which require long follow-up and more complex and costly interventions [4,5,6]. This pressure is aggravated by the fact that developing countries face important and persistent challenges for achieving adequate health conditions in the pediatric and adolescent population. Thus, in order to compare the health status of different populations and better understand the challenges raised by aging, summary indicators are needed evaluating the health status of different population groups and their changes over time [7,8].

The health status of populations has traditionally been measured by mortality indicators. However, in a context of increasing life expectancy and high prevalence of chronic diseases, it is also necessary to investigate the loss of health due to the time lived with these diseases [8]. Strong evidence indicates that the years gained from increasing life expectancy have not necessarily been translated as years lived with health [9,10]. In a study of 187 countries, Salomon et al. [11] observed that increasing life expectancy is accompanied by more years lived with disability.

Various summary indicators have been proposed to simultaneously measure the impact of mortality and morbidity on the health status of populations [7,11,12], the most popular of which proposed by Sullivan [7], called healthy or active life expectancy. The method basically predicts how many years an individual would expect to live in good health, and is frequently used to monitor a population's health status. Still, the method provides little policy input, since it fails to incorporate data on the etiologies associated with loss of health.

In the late 20th century, Murray & Lopez [13] proposed a new summary measurement called DALY (disability-adjusted life years), an indicator for studying burden of disease that combines information on both mortality and morbidity, originally calculated for a list of more than 100 diseases and health conditions. DALY allows measuring the impact of each disease or health condition on the population's health status, serving as a fundamental tool for policies to reduce burden of disease [14]. The importance of DALY as a summary health indicator extends beyond the identification of the principal conditions and diseases that affect the populations' health, including applications to cost-effectiveness studies that compare the benefits obtained from different interventions [8]. DALY has also been widely used to identify socio-environmental factors that increase the risk of diseases and health conditions [15].

The World Health Organization (WHO) adopted DALY as one of the most important elements in the evaluation of populations' health status [16]. Initially used to estimate burden of disease in major world regions [13], DALY has been employed to estimate burden of disease of countries [14,17,18], regions of countries [19], and cities [20], and even to evaluate the burden of specific diseases [21]. In addition, since DALY is quite sensitive for measuring health inequalities, it can also be used to identify the population's most vulnerable groups [22].

The estimates made by DALY and its use to compare a population's different health-related aspects are even more important and complex for developing countries like Brazil, where population aging is occurring at a rapid pace. In the last 50 years, life expectancy in Brazil increased by 25 years, reaching 73.4 in 2010 [23]. According to United Nations forecasts, the proportion of elderly in the country will increase from 7% to 14% between 2010 and 2030, a change that took more than a century in developed countries like France [24]. Brazil thus needs public policies that adapt rapidly to this new reality, an essential component for interpreting the demands on the health sector.

The current study aims to identify the main diseases and health conditions affecting the Brazilian population, according to the country's major geographic regions, based on the methodology used in burden of disease studies, with 2008 as the reference year. The epidemiological profile depicted here is expected to provide relevant input for new health policies in Brazil.

Global burden of disease methodology

DALY simultaneously measures the impacts of mortality and morbidity on a given population's health status, using time as the common metric [13]. One DALY represents a year of healthy life lost, and is calculated as the sum of two components: mortality, represented by the years of life lost due to premature death (YLL), and morbidity, the years lost due to disability (YLD).

DALY = YLL + YLD

In its simplest form, YLL from a given cause of death is calculated as the product of the number of deaths related to this cause and the estimated life expectancy for the age at which the death occurred. Considering the differences in mortality by gender, the calculation of YLL for cause c, age a, and sex s can be expressed as follows:

YLL(c,a,s) = N(c,a,s) x E(a,s)

Where: N(c,a,s) is the number of deaths due to cause c for age a and sex s; while E(a,s) is life expectancy for age a and sex s.

YLL is calculated based on the life expectancies for levels 25 and 26 of the model life tables developed by Coale & Guo [25], corresponding to 80 years for men and 82.5 years for women. This standard was conceived as the highest attainable life expectancy when DALY was proposed, and its use allows comparing the results.

Since mortality is an incident event, calculation of YLD is based on incidence, that is, new cases of a given disease/health condition in a specific year [13,26]. In order to add the two components of DALY, Murray & Lopez [13] estimated a set of weights to quantify the loss of health during the time lived with the disease/health condition, varying from 0, considered full health status, to 1, defined as the worst degree, equivalent to death. Calculation of YLD for a cause c, age a, and sex s can be expressed simply as follows:

YLD(c,a,s) = I(c,a,s) x D(c,a,s) x W(c,a,s)

Where: I(c,a,s) is the number of incident cases due to cause c, for age a and sex s; D(c,a,s) refers to the mean duration of disability from for cause c, for age a and sex s; and W(c,a,s) expresses the weight of disability from for cause c, for age a and sex s.

The current study basically used the weights proposed by Murray & Lopez [13], but for some diseases or health conditions we used weights elaborated for the burden of disease study in Australia [27]. Calculation of DALY in our study also incorporated a 3% discount rate, such that the first year of life is lost entirely, while the others correspond to 97% of the previous one. Thus, in ten years, one year of healthy life gained due to health interventions in the current year is 24% less than the gain in the first year, thus decreasing the differences between years of life lost by young people and elderly [26,28]. The age-weight function, sometimes used in burden of disease studies, was not employed here, because it introduces greater complexity into the method when compared to its impact on the estimation of DALY [29].

Classification of diseases or health conditions

The causes of diseases or health conditions were classified in three main groups: group I – infectious and parasitic diseases, maternal and perinatal conditions, and nutritional deficiencies; group II – noncommunicable diseases; and group III – external causes [13].

The main groups were subdivided into 21 subgroups of diseases and health conditions (Table 1), which in turn were subdivided into 107 specific causes [13]. The current study considered 22 subgroups by separating neurological and psychiatric diseases. The list of causes was adjusted to Brazil's epidemiological profile, with inclusions and exclusions that resulted in 100 specific diseases and health conditions.

Methodological aspects

Mortality

- **Data source**

The data source for estimating YLL was the Mortality Information System (SIM), available on the website of the Brazilian Health Informatics Department (DATASUS; http://www.datasus.gov.br). Since the reference year for burden of disease in Brazil was 2008, the study used the mean number of deaths in 2007-2009, disaggregated by State, sex, age group, and cause of death coded according to the 10th revision of the International Classification of Diseases (ICD-10).

- **Underreporting of deaths**

The degree of coverage of death reporting was corrected for Brazil as a whole, regions and States, sex, and age group (< 1 year, ≥ 1 year). The degree of coverage of deaths from external causes was assumed to be close to 100%, so only the so-called natural deaths were corrected. This process was conducted such that the sum of the number of deaths estimated by State was equal to the estimated number of deaths in each region, which when summed would reproduce the total deaths in Brazil. To ensure more reliable estimates, the correction factors for both the infant age group (< l year of age) and individuals 1 year

Table 1

Major groups and subgroups of diseases evaluated in the global burden of diseases study.

Major groups	Subgroups
Group I	I.A. Infectious and parasitic
	I.B. Respiratory infections
	I.C. Maternal conditions
	I.D. Conditions of the perinatal period
	I.E. Nutritional deficiencies
Group II	II.A. Cancer
	II.B. Benign neoplasms
	II.C. Diabetes mellitus
	II.D. Other endocrine and metabolic diseases
	II.E. Neuropsychiatric diseases
	II.F. Disorders of the sensory organs
	II.G. Cardiovascular diseases
	II.H. Chronic respiratory diseases
	II.I. Diseases of the digestive system
	II.J. Genitourinary diseases
	II.K. Diseases of the skin
	II.L. Musculoskeletal diseases
	II.M. Congenital anomalies
	II.N. Oral conditions
Group III	III.A. Unintentional external causes
	III.B. Intentional external causes

Source: Murray & Lopez [13].

or older were estimated independently by two researchers. In case of disagreement, the estimates were evaluated by a third researcher.

For infants (< l year), the factors were estimated with a variant of the Brass child-surviving method proposed by Trussell, with the corresponding temporal allocation [30]. The coverage rate for deaths in individuals one year of age or older was estimated using a variety of demographic methods: Brass growth balance equation [31]; Bennett & Horiuchi [32]; Hill general growth balance equation [33]; and adjusted synthetic extinct generation [34] (Table 2).

• **Ill-defined causes and garbage codes**

Ill-defined causes, referring to ICD-10 Chapter XVIII (symptoms, signs, and abnormal findings of clinical and laboratory findings, not elsewhere classified), and septicemias were distributed proportionally in all causes of death, except for external causes, according to State, sex, age group, and cause of death.

According to the Global Burden of Disease methodology, some ICD-10 codes, called "garbage codes", should also be distributed, corresponding to ICD-10 categories that do not furnish sufficient information on the underlying disease or cause of the lesion, for example "malignant neoplasm without specification of site", or "heart failure". A study by Mathers et al. [35] to evaluate the quality of mortality databases highlighted six categories of garbage codes: cardiovascular diseases, cancers, and external causes. In this study, another three categories of garbage codes were identified and distributed proportionally in a set of specific causes of deaths: diseases of the digestive system (K920, K921, K922); diseases of the respiratory system (J961, J98); leishmaniasis (B559); hepatitis (B559, B189, B19); meningitis (G038, G039); malignant neoplasm of the uterus, unspecified (C55).

Morbidity

• **Data source**

Calculation of YLD depends on information on incidence and duration of the diseases, which is usually not available, so that it is necessary to estimate them based on other clinical and epidemiological parameters. This estimation uses

Table 2

Correction factors for underreporting of deaths in infants (< 1 year) and individuals 1 year and older. Regions of Brazil, 2008.

Regions	Correction factors					
	< 1 year			≥ 1 year		
	Men	Women	Total	Men	Women	Total
North	1.42	1.37	1.40	1.22	1.30	1.25
Northeast	1.56	1.55	1.55	1.36	1.47	1.40
Southeast	1.04	1.04	1.04	1.02	1.03	1.02
South	1.03	1.03	1.03	1.00	1.02	1.01
Central	1.17	1.19	1.19	1.06	1.07	1.07
Brazil	1.28	1.27	1.27	1.11	1.15	1.13

Source: Research Center for Applied Methods in Global Burden of Disease studies, National School of Public Health, Oswaldo Cruz Foundation.

the Dismod II software package, based on three clinical epidemiological parameters to estimate incidence and duration of diseases, evaluating their internal consistency [36]. Thus, through analyses of national databases and a literature review, for each disease or health condition considered in the study, the available data were collected on incidence, prevalence, mortality, case-fatality, relative risk of death, remission, and duration.

In order to produce estimates that reflected regional characteristics, the preferred information sources on morbidity were national databases and surveys, with data disaggregated by region. When these sources were not available, information was obtained from surveys conducted in one or more cities of Brazil. Data from the international literature were employed when there were no Brazilian national data on the given parameters. Expert consensus meetings were convened for some diseases with scarce information.

For the literature review, we elaborated quality criteria for article selection, prioritizing population-based studies that used methods to guarantee the estimates' internal validity and minimize the risk of bias.

• **Estimation of residual categories of YLD**

In the estimation of burden of disease, YLL – the mortality component – can be calculated for all causes of death. However, given the complexity of the morbidity estimation process, YLD is only measured for the set of diseases considered most important for the burden of morbidity and mortality. The other diseases or health conditions are classified, according to the groups to which they belong, in so-called residual categories.

Based on the above, the residual morbidity categories were estimated in three stages. In the first, the residual burden of morbidity for each major group was obtained by applying to the residual YLL the YLD/YLL ratio for the set of diseases from the same group whose YLD was estimated [13,26]. Next, we applied this same ratio to the groups with relevant burden of mortality. In the third stage, the difference between these two estimates was distributed among the diseases with low mortality, proportionally to the burden of YLL from each.

• **Interpretation of the results**

The results were interpreted as proportions, rates, and adjusted rates, the latter obtained by standardization using the Brazilian population for both sexes in 2008 as the standard. This adjustment aimed to eliminate the age structure effect.

Results

In 2008, the estimate for Brazil was 36,957,662 DALY, of which 18,260,990 YLL and 18,696,672 YLD, resulting in 195 DALY, 96 YLL, and 99 YLD per thousand inhabitants (Table 3). Higher adjusted rates were observed in the Northeast and North regions, with 218 and 206 DALY per thousand inhabitants, respectively.

In Brazil, the DALY rates were higher in men (208 DALY/1,000) than in women (183 DALY/1,000). Men showed higher YLL rates, while women recorded higher YLD, indicating higher mortality in the male population and longer

Table 3

Absolute numbers and crude and adjusted YLL, YLD, and DALY in men and women. Regions of Brazil, 2008.

Regions/Sex	YLL			YLD			DALY			YLL/DALY
	n (in 1,000)	Rates *		n (in 1,000)	Rates *		n (in 1,000)	Rates *		(%)
		Crude	Adjusted **		Crude	Adjusted **		Crude	Adjusted **	
North										
Men	834	109	125	617	80	92	1,450	189	217	57.5
Women	511	68	81	767	102	114	1,278	171	196	40.0
Total	1,345	89	103	1,384	91	103	2,728	180	206	49.3
Northeast										
Men	3,497	134	143	2,192	84	90	5,688	218	233	61.5
Women	2,381	88	88	3,073	114	115	5,454	202	204	43.7
Total	5,878	111	115	5,264	99	103	11,142	210	218	52.8
Central										
Men	726	107	114	540	80	84	1,266	187	198	57.3
Women	432	62	67	724	105	108	1,156	167	175	37.3
Total	1,157	85	90	1,265	92	96	2,422	177	186	47.8
Southeast										
Men	4,439	114	112	3,365	86	85	7,804	200	198	56.9
Women	2,980	73	65	4,703	114	109	7,683	187	173	38.8
Total	7,419	93	87	8,068	101	97	15,487	193	185	47.9
South										
Men	1,478	109	108	1,145	84	83	2,623	193	191	56.4
Women	984	71	63	1,571	113	107	2,555	183	170	38.5
Total	2,462	90	85	2,716	99	95	5,178	188	180	47.5
Brazil										
Men	10,973	118	122	7,859	84	86	18,832	202	208	58.3
Women	7,288	76	72	10,838	112	110	18,126	188	183	40.2
Total	18,261	96	96	18,697	99	99	36,958	195	195	49.4

DALY: disability-adjusted life years; YLD: years lost due to disability; YLL: years of life lost.

Source: Research Center for Applied Methods in Global Burden of Disease studies, National School of Public Health, Oswaldo Cruz Foundation.

* Per 1,000;

** Adjusted rates, with the Brazilian population as the standard, in both sexes, in 2008.

time lived with disability among women. Excess male mortality, present in all regions of Brazil, was higher in the Northeast, where mortality accounted for 61.5% of total DALY.

Table 4 shows the proportional distribution and crude and adjusted YLL, YLD, and DALY according to regions of the country and major groups of causes. Of the total DALY for Brazil, 13.2% were due to infectious and parasitic diseases, maternal and perinatal conditions, and nutritional deficiencies (group I); 77.2% to non-communicable health conditions (group II); and 9.5% to external causes (group III).

The rates for Brazil were 25.8, 150.6, and 18.6 DALY per 1,000 inhabitants for groups I, II, and III, respectively. The North and Northeast showed the highest adjusted rates in group I, with 31.4

and 31.8 DALY per 1,000 inhabitants, 22% and 23% higher than Brazil, respectively. These same two regions also showed higher rates in group II. The highest adjusted rates in group III (external causes) were in the South and Central, approximately 4% and 15% above the national mean, respectively (Table 4).

Adjusted YLL rates showed wider regional variation than YLD. The widest variation in YLL was in group I, and the adjusted rate in the North exceeded that of the South by 85%. The highest adjusted YLL rate in group II was in the Northeast, 35% higher than in the South (Table 4).

Table 5 lists the 15 leading specific causes of DALY in Brazil, accounting for more than 50% of the global burden of disease in men (52.8%) and women (51.9%).

Table 4:

Distribution and crude and adjusted rates, YLL, YLD, and DALY, according to major groups of causes. Regions of Brazil, 2008.

Regions/Major groups *	%	YLL Rates **		%	YLD Rates **		%	DALY Rates (2)		Rates ratio #
		Crude	Adjusted ***		Crude	Adjusted ***		Crude	Adjusted ***	
North										
I	26.2	23.2	22.2	10.6	9.7	9.2	18.3	33.0	31.4	122
II	55.2	49.0	64.0	87.3	79.7	91.9	71.5	128.7	155.9	104
III	18.6	16.5	16.8	2.1	1.9	2.0	10.2	18.4	18.8	101
Total	100.0	88.8	103.1	100.0	91.4	103.1	100.0	180.2	206.2	106
Northeast										
I	20.1	22.3	21.3	10.8	10.7	10.5	15.7	33.0	31.8	123
II	64.3	71.2	76.5	87.6	86.9	90.5	75.3	158.1	167.0	111
III	15.6	17.2	17.4	1.5	1.5	1.5	8.9	18.8	18.9	102
Total	100.0	110.7	115.1	100.0	99.2	102.6	100.0	209.9	217.7	112
Central										
I	17.0	14.4	14.7	8.3	7.7	7.5	12.5	22.1	22.3	86
II	60.2	50.9	56.5	89.2	82.4	86.0	75.4	133.3	142.5	95
III	22.7	19.2	19.0	2.5	2.3	2.3	12.2	21.5	21.3	115
Total	100.0	84.5	90.2	100.0	92.4	95.9	100.0	176.8	186.1	95
Southeast										
I	15.9	14.7	14.6	7.2	7.2	7.4	11.4	21.9	22.0	85
II	67.7	62.6	57.7	90.4	90.9	87.4	79.5	153.5	145.2	96
III	16.4	15.2	15.1	2.5	2.5	2.5	9.2	17.7	17.6	95
Total	100.0	92.5	87.5	100.0	100.6	97.3	100.0	193.1	184.7	95
South										
I	13.0	11.6	12.0	9.3	9.2	9.6	11.1	20.9	21.6	84
II	68.2	61.1	55.8	88.1	87.0	83.1	78.6	148.0	138.9	92
III	18.8	16.8	16.8	2.6	2.5	2.5	10.3	19.4	19.3	104
Total	100.0	89.5	84.6	100.0	98.8	95.3	100.0	188.3	179.9	92
Brazil										
I	17.7	17.1	17.1	8.8	8.7	8.7	13.2	25.8	25.8	100
II	65.3	62.8	62.8	89.0	87.7	87.7	77.2	150.6	150.6	100
III	17.0	16.4	16.4	2.2	2.2	2.2	9.5	18.6	18.6	100
Total	100.0	96.3	96.3	100.0	98.6	98.6	100.0	194.9	194.9	100

DALY: disability-adjusted life years; YLD: years lost due to disability; YLL: years of life lost.

Source: Research Center for Applied Methods in Global Burden of Disease studies, National School of Public Health, Oswaldo Cruz Foundation.

* Major groups: I – infectious and parasitic diseases, maternal and perinatal conditions, and nutritional deficiencies; II – noncommunicable diseases; III – external causes.

** Per 1,000;

*** Adjusted rates, with the Brazilian population as the standard, in both sexes, in 2008.

The national rates were used as the reference (100) for the adjusted rates ratio.

Ischemic heart disease was the leading cause in men, with an adjusted rate of 15.4 DALY per thousand, and the second leading cause in women, with 11.3 DALY per thousand. For men, the second leading cause was homicide/violence, with 13.4 DALY per thousand, but this cause did not even appear among the 15 leading causes in women. Alcohol abuse and dependence ranked third in men (10.1 DALY) and 13th in women (2.1 DALY). Stroke ranked third in both men and women. Fifth place was occupied by traffic accidents in men and chronic obstructive pulmonary disease in women. These two causes presented higher adjusted rates in the male population, and this difference was more striking for traffic accidents, whose adjusted rate was approximately four times higher than in women.

Table 5

Distribution and crude and adjusted DALY rates by sex and the 15 leading specific causes. Regions of Brazil, 2008.

Sex and specific causes	Brazil				North				Northeast			
	Order	%	Rates *		Order	%	Rates *		Order	%	Rates *	
			Crude	Adjusted **			Crude	Adjusted **			Crude	Adjusted **
Men												
Ischemic heart disease	1	7.2	14.5	15.4	2	5.0	9.5	13.4	2	6.8	14.7	17.3
Homicide and violence	2	6.7	13.5	13.4	1	7.8	14.8	14.8	1	7.6	16.6	16.4
Alcohol abuse and dependence	3	5.0	10.0	10.1	3	4.9	9.3	9.7	3	5.2	11.4	11.8
Stroke	4	4.4	9.0	9.7	4	4.0	7.5	10.8	4	4.7	10.3	12.0
Traffic accidents	5	4.4	9.0	9.0	5	3.9	7.3	7.8	6	3.7	8.1	8.4
Diabetes mellitus	6	4.4	8.9	9.4	6	3.6	6.9	9.2	5	4.0	8.6	10.1
Depression	7	3.5	7.1	7.1	7	3.6	6.9	7.1	7	3.2	6.9	7.1
Chronic obstructive pulmonary disease	8	3.5	7.0	7.5	10	2.6	4.8	7.0	11	2.3	5.1	6.0
Infections of the lower respiratory tract	9	2.9	5.9	6.1	8	3.2	6.1	6.5	8	2.8	6.0	6.1
Bipolar affective disorder	10	2.7	5.4	5.3	9	3.0	5.6	5.3	9	2.6	5.6	5.3
Cirrhosis/Alcoholic and other	11	2.3	4.7	4.9	16	1.6	2.9	3.7	10	2.5	5.4	6.2
HIV/AIDS	12	1.7	3.4	3.4	12	2.0	3.9	4.2	15	1.3	2.9	3.1
Asthma	13	1.6	3.3	3.2	11	2.2	4.1	3.5	12	1.8	4.0	3.6
Hypertensive cardiac diseases	14	1.3	2.6	2.8	20	1.1	2.0	3.0	14	1.5	3.2	3.8
Alzheimer's and other dementias	15	1.3	2.6	2.9	19	1.1	2.0	3.3	18	1.2	2.7	3.1
Women												
Depression	1	13.4	25.1	25.1	1	14.5	24.7	25.1	1	12.3	24.8	25.2
Ischemic heart disease	2	6.4	12.0	11.3	3	4.3	7.3	10.0	2	6.4	13.0	13.5
Diabetes mellitus	3	5.0	9.5	9.0	2	4.4	7.5	10.1	4	5.3	10.6	11.0
Stroke	4	4.8	9.0	8.4	4	4.1	7.0	10.1	3	5.4	10.9	11.1
Chronic obstructive pulmonary disease	5	3.5	6.5	6.2	8	2.6	4.5	6.4	7	2.7	5.4	5.7
Alzheimer's and other dementias	6	3.1	5.8	5.3	9	2.2	3.7	5.8	6	2.8	5.6	5.6
Bipolar affective disorder	7	2.9	5.5	5.6	5	3.5	6.0	5.6	5	2.8	5.7	5.6
Infections of the lower respiratory tract	8	2.7	5.0	4.8	6	3.2	5.5	6.0	9	2.5	5.0	4.8
Asthma	9	2.3	4.3	4.3	7	3.0	5.2	4.6	8	2.5	5.1	4.9
Breast cancer	10	1.8	3.4	3.3	24	1.0	1.7	2.2	12	1.5	3.1	3.3
Osteoarthritis	11	1.5	2.9	2.8	15	1.2	2.0	2.8	16	1.1	2.1	2.3
Hypertensive cardiac diseases	12	1.4	2.6	2.4	23	1.0	1.7	2.5	10	1.6	3.2	3.3
Alcohol abuse and dependence	13	1.1	2.1	2.1	14	1.2	2.1	2.2	15	1.1	2.3	2.3
Epilepsy	14	1.0	2.0	1.9	16	1.2	2.0	2.6	19	1.0	2.0	2.0
Traffic accidents	15	1.0	2.0	1.9	21	1.1	1.9	1.9	26	0.8	1.6	1.6

(continues)

Importantly, depression was the leading cause of burden of disease in women, with 25.2 DALY per 1,000, and the seventh leading cause in men, with a much lower rate (7.1 DALY). Diabetes ranked third in the female population and sixth in the male population. Despite the difference in order, the DALY rate for diabetes was similar in men and women, with 9.0 and 9.4 DALY per 1,000, respectively.

As for regional variations in the five leading specific causes, the pattern was quite similar to that observed in Brazil as a whole. In the North, Northeast, and Central, for men there was a change in order between the two leading causes, with homicide and violence in first place and ischemic heart disease in second. The Northeast showed the highest adjusted rate from homicide and violence, with 16.4 DALY per thousand in-

Table 5 (continued)

Specific causes	Central				Southeast				South			
	Order	%	Rates *		Order	%	Rates *		Order	%	Rates *	
			Crude	Adjusted **			Crude	Adjusted **			Crude	Adjusted **
Men												
Ischemic heart disease	2	6.6	12.3	14.0	1	7.8	15.7	15.3	1	7.5	14.4	13.8
Homicide and violence	1	7.9	14.8	15.4	2	5.8	11.6	11.6	2	5.9	11.4	11.4
Alcohol abuse and dependence	4	5.6	10.5	10.5	3	4.8	9.6	9.5	6	4.6	8.8	8.6
Stroke	8	3.7	7.0	8.2	5	4.5	8.9	8.8	7	4.4	8.5	8.3
Traffic accidents	3	6.1	11.3	11.3	6	4.5	8.9	8.8	4	5.4	10.5	10.3
Diabetes mellitus	5	4.4	8.1	8.8	4	4.7	9.3	9.0	5	5.2	10.1	9.6
Depression	6	3.8	7.2	7.1	8	3.6	7.2	7.0	8	3.7	7.2	7.1
Chronic obstructive pulmonary disease	7	3.8	7.1	8.3	7	3.7	7.4	7.2	3	5.7	11.0	10.6
Infections of the lower respiratory tract	10	2.8	5.1	5.5	9	3.2	6.5	6.5	11	2.3	4.5	4.5
Bipolar affective disorder	9	3.0	5.5	5.3	10	2.6	5.3	5.3	9	2.7	5.3	5.3
Cirrhosis/Alcoholic and other	11	2.0	3.6	3.8	11	2.4	4.8	4.6	10	2.4	4.7	4.4
HIV/AIDS	13	1.4	2.7	2.6	12	1.7	3.5	3.3	12	2.2	4.3	4.2
Asthma	12	1.8	3.4	3.3	14	1.4	2.8	2.9	16	1.4	2.7	2.9
Hypertensive cardiac diseases	17	1.2	2.3	2.7	17	1.3	2.6	2.5	23	0.9	1.8	1.8
Alzheimer's and other dementias	15	1.3	2.5	3.2	15	1.3	2.6	2.7	15	1.4	2.7	2.8
Women												
Depression	1	15.2	25.5	25.1	1	13.5	25.3	25.1	1	13.9	25.4	25.2
Ischemic heart disease	2	5.7	9.5	10.3	2	6.7	12.5	10.7	2	6.7	12.4	10.5
Diabetes mellitus	3	4.6	7.7	8.1	3	5.0	9.3	8.1	4	5.3	9.7	8.4
Stroke	5	3.9	6.5	7.2	4	4.6	8.5	7.2	5	4.7	8.6	7.2
Chronic obstructive pulmonary disease	4	4.3	7.2	7.9	5	3.4	6.3	5.4	3	5.4	9.8	8.3
Alzheimer and other dementias	7	3.0	5.0	6.0	6	3.3	6.2	5.0	6	3.5	6.4	5.1
Bipolar affective disorder	6	3.5	5.8	5.6	7	2.9	5.4	5.6	7	2.9	5.3	5.6
Infections of the lower respiratory tract	9	2.6	4.3	4.6	8	2.9	5.3	4.8	8	2.3	4.2	3.9
Asthma	8	2.6	4.4	4.4	10	2.0	3.8	4.0	10	2.0	3.6	3.9
Breast cancer	12	1.5	2.6	2.7	9	2.1	3.9	3.4	9	2.0	3.7	3.2
Osteoarthritis	11	1.6	2.7	2.8	11	1.9	3.5	3.0	11	1.8	3.3	2.8
Hypertensive cardiac diseases	14	1.2	2.0	2.3	12	1.3	2.5	2.1	15	1.2	2.1	1.8
Alcohol abuse and dependence	13	1.4	2.3	2.3	13	1.1	2.1	2.1	17	1.0	1.9	1.9
Epilepsy	16	1.1	1.9	2.1	15	1.0	1.9	1.7	16	1.1	2.0	1.8
Traffic accidents	100	1.7	2.8	2.8	14	1.0	1.9	1.9	13	1.3	2.4	2.4

DALY: disability-adjusted life years.

Source: Research Center for Applied Methods in Global Burden of Disease studies, National School of Public Health, Oswaldo Cruz Foundation.

* Per 1,000;

** Adjusted rates, with the Brazilian population as the standard, in both sexes, in 2008.

habitants, exceeding the estimated rates for the Southeast and South by 40%. Diabetes ranked from fourth to sixth among the different regions.

Interregional variations in the ranking of specific causes were wider in women. The principal difference compared to the national pattern for the five leading causes in women was the pres-

ence of bipolar affective disorder in fifth place in the North and Northeast, where it outstripped chronic obstructive pulmonary disease and dementias, although with DALY rates similar to other regions of the country.

Discussion

The current study used DALY, a summary indicator for burden of disease studies, to estimate the magnitude of the Brazilian population's leading health problems.

Studies have criticized the lack of standardized application of the methodology in burden of disease studies and the absence of information on the correction of underreporting on mortality [37]. To minimize these problems, despite some adaptations of the analysis to Brazil's reality, the current study aimed to follow precisely the methodology described by Murray & Lopez [13]. In addition, underreporting of mortality was corrected and the garbage codes were distributed proportionally in a set of specific causes of mortality.

The main results feature the preponderance of chronic noncommunicable diseases in all regions of the country, particularly cardiovascular diseases, mental disorders, diabetes, and chronic obstructive pulmonary disease. The high burden of external causes also called attention, especially homicides and traffic accidents, with men as the main victims, accounting for a considerable share of the excess male mortality. The epidemiological profile is even more complex when one considers the non-negligible burden of communicable diseases, maternal and perinatal conditions, and nutritional deficiencies, especially in the North and Northeast. Corroborating other research [8,26,27], the current study showed higher burden of mortality in men and higher morbidity in women. In this sense, there was a particularly high burden of psychiatric disorders in Brazilian women.

The comparison between regions indicates a higher global burden in the North and Northeast, reflecting earlier deaths and higher burden of disability due to health problems. The highest burden is due not only to the health conditions in group I, but also to chronic diseases. The high burden from this group of diseases may reflect worse living conditions and worse access to health services to control risk factors (such as hypertension) and treat the diseases that lead to higher incidence of disability and earlier deaths. The higher homicide rates in the North and Northeast also called attention, reflecting the increase in violence in these two regions in the last decade [38].

Chronic noncommunicable diseases are now the leading cause of death in the world, with increasing the Brazilian population prevalence, especially in low and middle-income countries, due to aging and changes in behavioral, occupational, and environmental risk factors [1,39]. The importance of increasing access to cost-effective interventions to reduce morbidity and mortality from these diseases was documented in a recent proposal by the WHO, emphasizing a health system based on primary care to guarantee equity in the continual and sustainable supply of care [40]. In Brazil, upgrading primary care and organizing a services network that guarantees the continuity of care at levels of higher complexity remain as challenges for administration of the Brazilian Unified National Health System (SUS) [41].

The high burden of psychiatric disorders, especially depression and alcohol dependence, poses a major challenge for health services, since only a small proportion of individuals with these disorders seek care, and these diseases are frequently diagnosed when a patient seeks treatment for another comorbidity [42,43]. Primary health care services could thus play an important role in the identification and treatment of these disorders [44]. However, such a strategy requires the development of treatment protocols as well as training and follow-up of the services provided by general practitioners, since evidence shows that such professionals lack the necessary knowledge to determine the most adequate treatment for these patients [43,45].

The presence of homicides/violence as the second leading cause of death in men calls attention to this serious public health problem, the pattern of which differs from what is observed in the low and middle-income country group, where it is not among the ten leading causes of DALY [26]. To overcome this problem requires long-term health, public security, educational, and economic policies, including those focused on increasing income levels and reducing inequalities [46,47].

In relation to the Brazilian national databases that served as the principal source of information in this study, it is important to increase coverage, improve standardization of information, with the use of the same categories in the different systems, increase data completeness, and facilitate access to the databases and to the results of nationwide health surveys, all essential measures to allow better estimates of the Brazilian population's health conditions, with greater efficiency and at lower costs. Important measures in this area feature investments to improve the coverage of the Information System for Notifiable Diseases (SINAN), access to data from the Brazilian National Agency for Supplementary Health or ANS (for private health plans, including services outsourced by the SUS), and ICD-10 classification of the information collected on injuries and their causes in the survey entitled *Surveillance System for Violence and Accidents* (Viva) [48]. Given the scarcity of epidemiological data on psychi-

atric disorders, which represent a high burden of disease, nationwide studies to investigate its prevalence by geographical areas of the country should be conducted.

The estimation of diseases is a highly dynamic process, and thus the strategies to evaluate diseases and health conditions are constantly undergoing improvement, so that evaluations of burden of disease over time should be conducted with caution. In a recent study on global burden of disease by Murray et al. [8] with the year 2010 as the reference, various methodological changes were proposed in comparison to that performed in 1990 [13]: the number of target diseases and health conditions that were evaluated, and the respective disabilities, more than doubled; a new reference life table was used; there was a change in the weights of diseases and disabilities; and YLD was expressed as prevalence rather than incidence.

Chan [49] calls attention to the need for cooperation between different research groups on burden of disease in order to establish standards for documenting estimation strategies, data-sharing, and greater transparency of methods. Such information-sharing is highly important for assessing the proposed methodological changes in the estimation of DALY and for the development of new burden of disease studies in Brazil.

The analyses conducted over the course of this study allow at least two relevant considerations, given the study's primary objective of identifying the Brazilian population's main diseases and health conditions. The first is the clear contribution by this type of study to the knowledge on the population's health status, revealing the demand for crosscutting measures that go beyond specific health sector policies. The second, no less important and complementary to the first, is the clear evidence of the need to expand the scope of concern with the quality of morbidity and mortality data in Brazil. Finally, the regional differences identified here emphasize the need for policies adapted to each region's realities, with the aim of minimizing the inequalities that remain as a striking trait of Brazilian society.

Resumen

En este estudio, se estimó DALY (años de vida ajustados por discapacidad), un indicador de estudios de carga de enfermedad, para Brasil durante 2008. Entre los principales resultados se observan la mayor carga de enfermedad en las regiones Norte y Noreste y la preponderancia de las enfermedades crónicas no transmisibles en todas las regiones del país; en particular, las enfermedades cardiovasculares, los trastornos mentales, destacándose la depresión, la diabetes y la enfermedad pulmonar obstructiva crónica. Llama también la atención la elevada carga de homicidios y accidentes de tráfico. El perfil epidemiológico se revela más complejo cuando se considera la no despreciable carga de enfermedades transmisibles, condiciones maternas, perinatales y deficiencias nutricionales. Los análisis efectuados hicieron posible conocer el status de salud de la población, lo que pone en evidencia la demanda de acciones que van más allá de políticas específicas para el área de la salud, así como la necesidad de ampliar la preocupación con la calidad de las informaciones sobre morbimortalidad en Brasil.

Años de Vida Perdidos por Incapacidad; DALY; Mortalidad

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