RESEARCH

TRIPLE BURDEN OF DISEASES IN BRAZIL, 1990-2921; CHANGES, INFLECTION POINTS AND THE COVID-19 FACTOR

TRIPLA CARGA DE DOENÇAS NO BRASIL, 1990-2021: MUDANÇAS, INFLEXÕES E O FATOR COVID-19

LA TRIPLE CARGA DE LAS ENFERMEDADES EN BRASIL, 1990-2021: CAMBIOS, INFLEXIONES Y EL FACTOR COVID-19

Adauto Martins Soares Filho[1]
Giovanny Vinícius Araújo de França[2]
Deborah Carvalho Malta[1]

[1]Universidade Federal de Minas Gerais - UFMG, Faculdade de Medicina, Programa de Pós-Graduação em Saúde Pública. Belo Horizonte, MG - Brazil.

[2]Ministério da Saúde - MS, Secretaria de Vigilância em Saúde. Brasília, DF - Brazil.

Corresponding author: Deborah Carvalho Malta
E-mail: dcmalta@uol.com.br

ABSTRACT

Objective: to describe the time evolution by the triple burden of diseases in Brazil, comparing the mortality data from the Mortality Information System (Sistema de Informação de Mortalidade, SIM) and from the Global Burden of Disease (GBD) study. **Method:** a descriptive and exploratory study on the time evolution of the rates and the proportional distribution of deaths for infectious diseases, chronic non-communicable diseases (CNCDs) and external causes, using two data sources and encompassing the period from 1990 to 2021. The SIM rates were adjusted by means of the direct method by age and smoothed by the mobile mean. The GBD estimates correct under-recording and garbage causes. **Results:** Brazil recorded 817,284 (1990) and 1,349,801 (2019) deaths in the SIM, corrected by 17.7% and 1.9% in the GBD for each year. During this period, the mortality rates decreased in both sources, respectively: CNCDs -16.8% (from 433.7 to 360.7) and -34% (from 720.5 to 474.6); infectious diseases -20.2% (from 86 to 68.6) and -57.2% (from 198.5 to 84.9); external causes -17.3% (from 77.4 to 64) and -27% (from 100.9 to 73.7). The SIM showed a 79.2% reduction (from 138.6 to 28.8) for the ill-defined causes (IDCs). The GBD correction factors were higher in the years before 2015. After 2019, the rates corresponding to infectious diseases and IDCs in the SIM were increased by 207% (from 68.6 to 210.7) and by 30.2% (from 28.8 to 37.5), respectively. **Conclusion:** the advances in the epidemiological transition of the burden of disease and improvement in the death data in Brazil were interrupted by COVID-19, thus increasing the burden of infectious diseases.

Keywords: Cost of Illness; Cause of Death; Coronavirus Infections; Mortality Registries; Information Systems; Public Health Surveillance.

RESUMO

Objetivo: descrever a evolução temporal pela tripla carga de doenças no Brasil, comparando a mortalidade do Sistema de Informação de Mortalidade (SIM) e do estudo de Carga Global de Doenças (GBD). Método: estudo descritivo e exploratório sobre a evolução temporal das taxas e a distribuição proporcional de óbitos para doenças infecciosas, crônicas não transmissíveis (DCNT) e causas externas, usando duas fontes de dados de 1990 a 2021. As taxas no SIM foram ajustadas pelo método direto por idade e suavizadas por média móvel. As estimativas do GBD corrigem sub registro e causas garbage. Resultados: o Brasil registrou 817.284 óbitos (1990) e 1.349.801 (2019) no SIM, corrigidos em 17,7% e 1,9% no GBD para os respectivos anos. Nesse período, as taxas de mortalidade diminuíram nas duas fontes, respectivamente: DCNT -16,8% (433,7 a 360,7) e -34% (720,5 a 474,6); infecciosas -20,2% (86 para 68,6) e -57,2% (198,5 para 84,9); causas externas -17,3% (77,4 para 64) e -27% (100,9 para 73,7). O SIM mostrou redução -79,2% (138,6 para 28,8) para as taxas de causas mal definidas (CMD). Os fatores de correção do GBD foram maiores nos anos anteriores a 2005. Após 2019, as taxas infecciosas e CMD no SIM aumentaram respectivamente 207% (68,6 para 210,7) e 30,2% (28,8 para 37,5). Conclusão: o avanço da transição epidemiológica da carga de doenças e a melhoria da qualidade do dado de óbito no Brasil foram interrompidos pela COVID-19, aumentando a carga das doenças infecciosas.

Palavras-chave: Efeitos Psicossociais da Doença; Causas de Morte; Infecções por Coronavírus; Registros de Mortalidade; Sistemas de Informação; Vigilância em Saúde Pública.

RESUMEN

Objetivo: describir la evolución temporal de la triple carga de las enfermedades en Brasil, comparando la mortalidad del Sistema de Información de Mortalidad (SIM) y del estudio de la Carga Global de las Enfermedades (GBD). Método: estudio descriptivo y exploratorio sobre la evolución temporal de las tasas y la distribución proporcional de las defunciones por enfermedades infecciosas, enfermedades crónicas no transmisibles (ECNT) y causas externas, utilizando dos fuentes de datos, de 1990 a 2021. Las tasas en el SIM se ajustaron por el método directo por edad y se suavizaron por media móvil. Las estimaciones de la GBD corregían el subregistro y las causas de la basura. Resultados: Brasil registró 817.284 muertes (1990) y 1.349.801 (2019) en el SIM, corregidas en 17,7% y 1,9% en el GBD para los respectivos años. En este periodo, las tasas de mortalidad disminuyeron en las dos fuentes, respectivamente: ECNT -16,8% (433,7 a 360,7) y -34% (720,5 a 474,6); infecciosas -20,2% (86 a 68,6) y -57,2% (198,5 a 84,9); causas externas -17,3% (77,4 a 64) y -27% (100,9 a 73,7). El SIM mostró una reducción del 79,2% (de 138,6 a 28,8) en las tasas de causas mal definidas (CMD). Los factores de corrección de la GBD fueron mayores en los años anteriores a 2005. Después de 2019, las tasas de infecciosas y de CMD en el SIM aumentaron respectivamente un 207% (68,6 a 210,7) y un 30,2% (28,8 a 37,5). Conclusión: el progreso de la transición epidemiológica de la carga de la enfermedad y la mejora de la calidad de los datos de mortalidad en Brasil fueron interrumpidos por COVID-19, aumentando la carga de las enfermedades infecciosas.

Palabras clave: Costo de Enfermedad; Causas de Muerte; Infecciones por Coronavirus; Registros de Mortalidad; Sistemas de Información; Vigilancia en Salud Pública.

INTRODUCTION

The distribution and extension of specific health problems of a given population is a development indicator for the promotion of better life conditions in the territory. Disease burden data are substantial for informing organized prevention and health care responses based on the best available evidence.[1] Mortality statistics are one of the leading and most reliable health information bases, allowing monitoring processes such as epidemiological transition.[2]

In most countries, epidemiological transition results from the progressive reduction in mortality due to infectious diseases, the predominance of deaths from chronic diseases and violent deaths.[3] However, this process has occurred differently in countries. In Brazil, the persistence of some communicable diseases results in an incomplete transition, due to regional inequalities and heterogeneous local realities.[4] The demographic and epidemiological transition has placed chronic diseases as the main cause of morbidity and mortality in the country.[5] However, in certain regions of the country, the burden attributed to communicable diseases and maternal and child diseases remains high.[4]

The advent of the COVID-19 pandemic, a highly transmissible and lethal disease,[6] has changed this scenario and worsened the panorama of the triple burden of diseases. COVID-19 is a global health challenge, requiring a rapid and coordinated public health response for prevention, treatment, control and availability of adequate information for health surveillance.[6] Therefore, information enhancement is a constant demand to support the decision-making process and inform evidence-based policies and responses. This article aims at describing the time evolution due to the triple burden of diseases in Brazil, comparing the mortality estimates of the Mortality Information System (SIM) and the Global Burden of Disease (GBD) study.

METHOD

This is a descriptive study that resorted to secondary databases on the triple burden of mortality in Brazil between 1990 and 2021, coming from two different sources:

a) The death-related data from the Mortality Information System (SIM) belonging to the Ministry of health can be found in the Datasus website, from 1990 to 2020. Other more recent data (2021) are available in: http://svs.aids.gov.br/dantps/cgiae/sim/. SIM is the main source of data on deaths in Brazil and follows a set of standardized procedures, from collection to improvement of the quality of the information that leads to selecting the underlying cause of death.

b) The GBD study estimated for Brazil from 1990 to 2021 are available in: https://ghdx.healthdata.org/gbd-results-tool.

GBD 2019 estimates diverse information about mortality due to 369 diseases and injuries for 204 countries and territories, whose methodology has already been described and published.[7,8] For Brazil, the input data were extracted from the SIM, with adjustment by other national and international sources. Deaths attributed in the SIM were adjusted for under-recording and redistribution of inadequately specified causes (for example, unassisted death and other ill-defined and nonspecific causes), called garbage codes (GCs).

The GBD data were analyzed in three major groups that characterize the "Triple burden of diseases": a) Group I – communicable diseases, maternal diseases, neonatal diseases and nutritional diseases; b) Group II – chronic non-communicable disease; and c) Group III – external causes. The data referring to the historical series made available by GBD from GBD 1990 to 2019 were analyzed.[7]

The SIM data included the 1990-2021 period, aiming to achieve possible changes as a result of the COVID-19 pandemic period. In the ICD-9 and ICD-10 codes, they are matched to the following GBD groups of causes:

Group I: communicable diseases (Chapters 1 from ICD-9 and ICD-10), maternal diseases (Chapter 11 from ICD-9 and Chapter 15 from ICD-10), neonatal diseases (Chapter 15 from ICD-9 and Chapter 16 of ICD-10) and nutritional diseases (260-269 from ICD-9, and E40-E64 from ICD-10); in addition to acute upper airway infection (460-465 ICD9 and J00-J06 from ICD-10), pneumonia and influenza (480-487 ICD9 and J09-J18 from ICD-10), other acute lower airway infections (466 ICD9 and J20-J22 from ICD-10) and otitis media (381-382 from ICD-9 and H65-H67 from ICD-10);

Group II: non-communicable diseases (other chapters from ICD-9 and ICD-10 not classified in groups I and III, excluding specified causes belong to the scope of group I);

Group III: external causes (Chapter 17 from ICD-9 and Chapter 20 from ICD-10).

The GBD data use the GC redistribution. The SIM data herein presented do not use this methodology and showed the group of ill-defined causes (IDCs) (Chapter 16 from ICD-9 and Chapter 18 from ICD-10), which comprise part of the GCs. Consequently, it also allows verifying the general quality of the death cause. For 2020 and 2021, COVID-19 is considered in codes B34.2 from ICD-10, with the U07.1, U07.2 and U92.1 markers.[9]

The metrics used to examine and measure changes in the magnitude of the triple burden of diseases over time were evolution of the rates and the mortality proportion in the large groups of causes, comparing SIM and GBD in the study period. The proportional distribution was compared for three years in the SIM (1990, 2019 and 2021) and for two in GBD (1990 and 2019). The respective standardized

rates per 100,000 inhabitants incorporate the period from the historical series for each of these sources.

For SIM, the direct standardization method is used, adjusted by age, and with data from the last Brazilian census (2010) as standard population, available in the Datasus website: https://datasus.saude.gov.br/populacao-residente. The mortality rates with SIM data were submitted to a smoothing process, with the mobile mean technique.

GBD employs redistribution algorithms for the death causes with GCs,[7] in addition to using standardization of the rates, resorting to the GBD global population as a reference to allow for a comparison between the countries. In order to estimate the mortality rates, GBD applies Cause of Death Ensemble modeling (CODEm), a tool that combines results from a set of different modeling approaches.[7]

The study worked with secondary data records in the public domain and a non-nominal basis, in accordance with Decree No. 7,724 of May 16th, 2012, and Resolution No. 466/2012 of the National Health Council.

RESULTS

In 1990, Brazil had 817,284 deaths recorded in the SIM and, in 2019, the number was 1,349,801, respectively adjusted by 17.7% and 1.9% in GBD (Figures 1 and 2). Figure 1 (A, B, C) presents the proportional distribution of the triple burden of diseases and IDCs in Brazil in 1990, 2019 and 2021, with direct data from the SIM. Between 1990 and 2019, reductions are observed in all the groups, except for mortality due to CNCDs, which rose from 54.3% to 71.3%, expanding their frequency. IDCs presented a higher reduction, from 18.2% to 5.6% (Figures 1A and 1B). In 2021, there was an inflection point, an increase in the frequency of deaths in Group I (32.6%),

due to COVID-19 deaths and to IDCs (5.9%). In turn, there were reductions in the proportions of CNCDs (53.6%) and external causes (7.9%). Mortality due to COVID-19 represents 87% (n=418,000) of the deaths in Group1 and 24% of the total number of deaths in 2021 (data not presented).

Figures 2A and 2B present the GBD estimates for the three major groups of diseases and show the proportional increase in CNCDs, from 60% (1990) to 75.9% (2019), and reductions in transmissible, maternal, neonatal and nutritional diseases (Group I), from 26.3% to 12.1%, and in external causes, from 13.7 to 11.9% in the same period.

Figures 3 and 4 show the trends of declining mortality rates in all groups of causes in the period from 1990 to 2019, either with direct SIM data or with data estimated by GBD, although with different magnitudes. Between 1990 and 2019, the mortality rates in SIM varied in Group I -20.2% (from 86 to 68.6/100,000), in Group 2 (CNCDs) -16.8% (from 433.7 to 360.7/100,000 inhabitants) and in Group 3 (external causes) -17.3% (from 77.4 to 64/100,000). In this period, the SIM experienced the highest reduction for all the rates of ill-defined causes: -79.2% (from 138.6 to 28.8/100,000). In 2020 and 2021, the Group 1 rates presented a significant increase due to COVID-19, rising from 68.6 to 210.7/100,000 inhabitants between 2019 and 2021, as well as the IDCs, which rose from 28.8 to 37.5/100,000. In the same period, CNCDs decreased from 360.7 to 330.9/100,000 and external causes from 64 to 60.8/100,000 (Figure 3).

Between 1990 and 2019, the estimates corresponding to the GBD mortality rates were reduced for all three major cause groups: Group 1, -57.2% (from 198.5 to 84.9/100,000); Group 2 (CNCDs), -34% (from 720.5 to 474.6/100,000); and Group 3 (external causes), -27% (from 100.9 to 73.7/100,000). As GBD used corrected data for GCs and under-recording, the data by IDCs are not presented (Figure 4).

SIM: 1990	SIM: 2019	SIM: 2021

Figure A
(n=817.284)

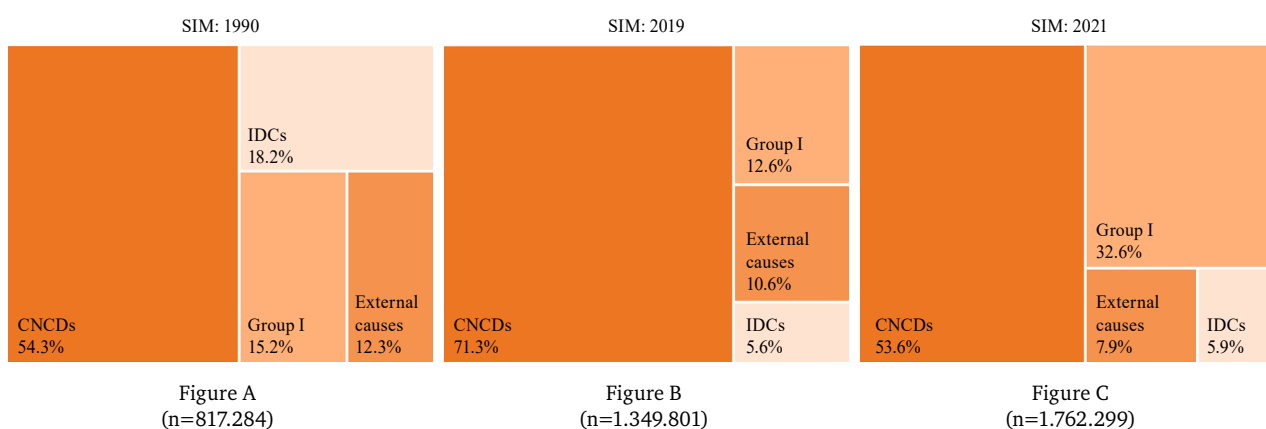Figure B
(n=1.349.801)

Figure C
(n=1.762.299)

Figure 1 - Proportional mortality according to the triple burden of diseases and ill-defined causes in the SIM, Brazil, 1990, 2019 and 2021 (direct data)
Source: SIM/CGIAE/MS
Note: Group I (communicable, maternal, neonatal and nutritional diseases), CNCDs (chronic non-communicable diseases) and IDC (ill-defined causes).

When comparing the SIM and GBD mortality rates during the period, the correction factors applied by the GBD study were higher between 1990 and 2005. In the 1990s, the estimates even corrected mortality rates by 2.4 times for Group I, 1.7 times for Group 2 (CNCDs) and 1.3 for Group 3 (external causes). In 2010, these rates were less adjusted, up to 1.5 times in Group I, by 1.3 for CNCDs and 1.1 for external causes (Figures 3 and 4).
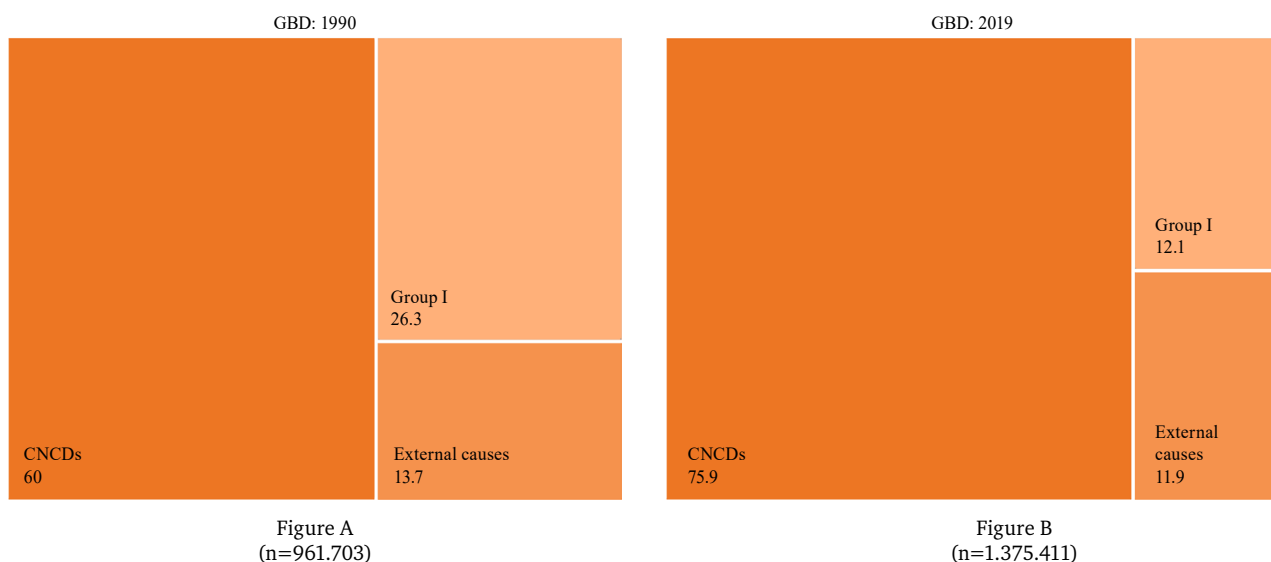
Figure 2 - Proportional mortality according to the triple burden of diseases, 1990 and 2019, with data estimated by GBD.
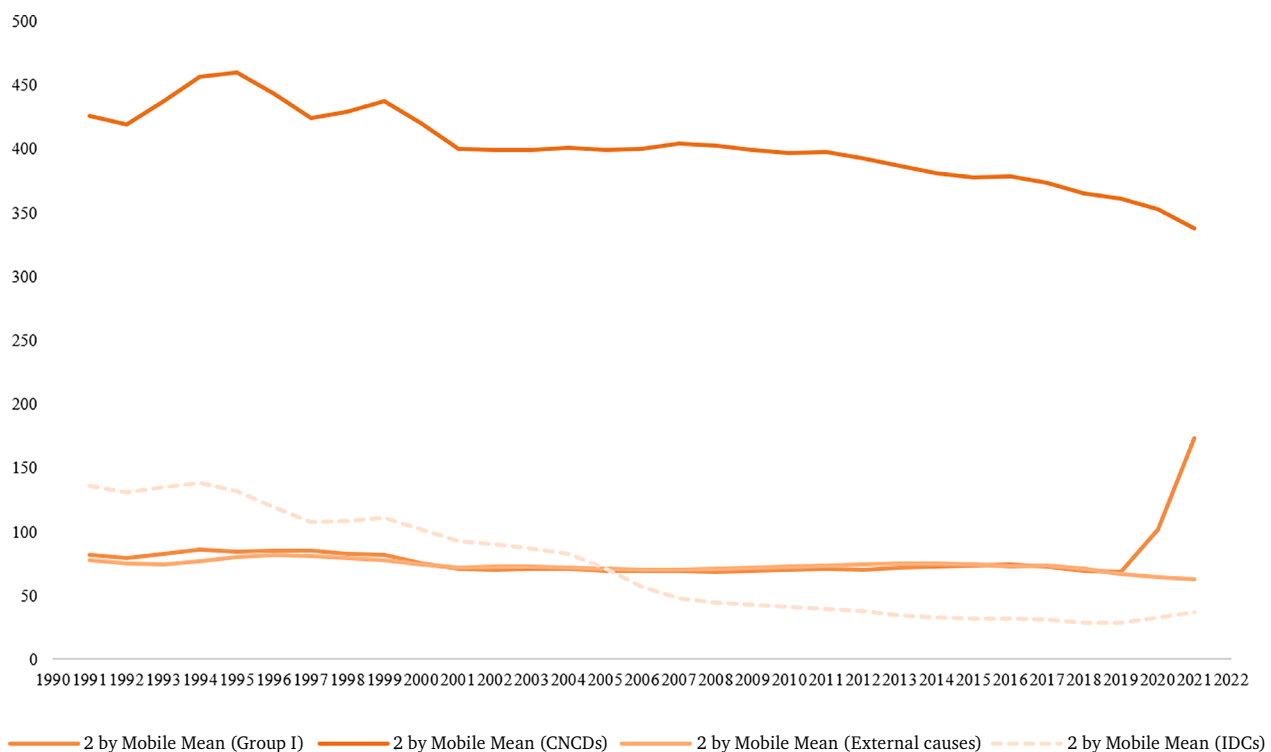

Figure 3 - Standardized rate (by 100,000 inhabitants) corresponding to the triple burden of diseases and ill-defined causes in the SIM, Brazil, from 1990 to 2021
Source: SIM/CGIAE/MS
Note: Group I (communicable, maternal, neonatal and nutritional diseases), CNCDs (chronic non-communicable diseases) and IDC (ill-defined causes).
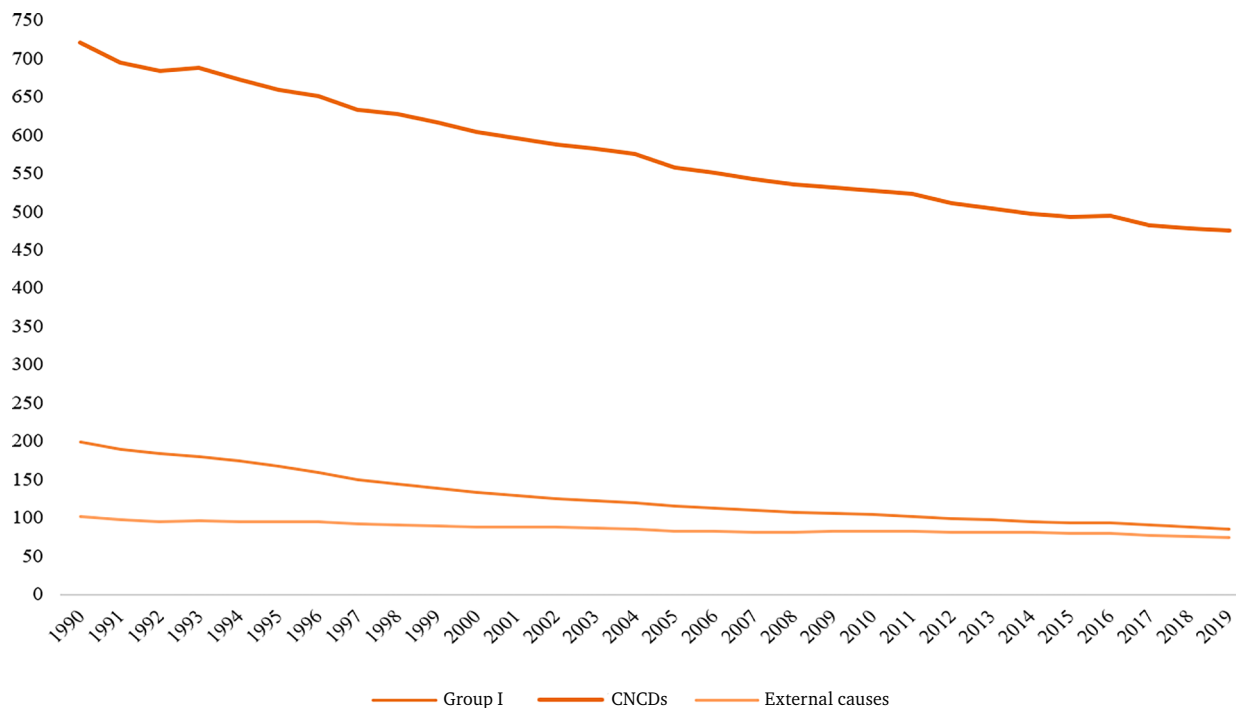
Figure 4 - Standardized rate (by 100,000 inhabitants) corresponding to the triple burden of diseases in GBD, Brazil, from 1990 to 2019.
Source: GBD 2019/IHME (https://ghdx.heslthdata.org/gbd-resultes-tool
Note: Group I (communicable, maternal, neonatal and nutritional diseases) and CNCDs (chronic non-communicable disease).

DISCUSSION

Between 1990 and 2019, the burden of disease in Brazil advanced in its epidemiological transition process, with reductions in mortality due to infectious diseases and external causes and an increase in CNCDs. At the same time, there was an improvement in quality of the recording of the underlying cause of death, with a reduction of IDCs by the SIM. In the years of the coronavirus pandemic, there is a shift in the magnitude and intensification of infectious diseases and IDCs, highlighting the role of the triple burden of diseases in the country.

According to other studies,[4,5,10,11] the results presented in this paper indicated that the change in mortality in Brazil followed, to some degree, the theory of epidemiological transition. However, the Brazilian transition process proved to be more complex than the linear and unidirectional pattern proposed by this theory. The persistence of relatively high levels of some infectious diseases, such as HIV/AIDS, and the sharp increase in violent deaths in the composition of the country's health profile draw the attention. In addition, there were regional differences in the improvement of mortality rates due to cardiovascular diseases.[10,12]

The demographic and epidemiological transition processes have placed CNCDs as the main burden of diseases in Brazil, especially after the implementation of the Unified Health System (Sistema Único de Saúde, SUS).[5,11] Expansion of access to health care services and prevention and promotion actions - including the improvement of surveillance on diseases and health risks - have contributed to reducing the burden of diseases and complications in the Brazilian population, as well as the regional differences - although inequalities persist.[4,13] Therefore, evolution of mortality is a result of the interaction of several interdependent factors resulting from economic development, sociocultural factors and public health interventions, such as treatments, immunization and sanitation.[12,14]

When reviewing the theory of demographic transition, GBD 2019 classified Brazil into a group of countries, as well as China and the USA, which are in the late transition stage, with mortality rates stabilizing, while birth rates continue to decrease.[15] This process assumed another meaning when COVID-19 emerged as a public health emergency in 2020 in Brazil, resulting in excess mortality due to natural causes[16]. In such a public health crisis scenario, there may be a temporary reduction in the number of births, followed by an increase in fertility as a response to a subsequent improvement in the situation.[17]

Introduction of the concepts of emerging and reemerging infectious diseases is postulated to better understand the characteristics of the Brazilian epidemiological transition, sometimes reported as incomplete; in particular, due to possible limitations of this theory in explaining the morbidity and mortality trends, especially the emergence of the HIV/AIDS epidemic and the reemergence of diseases such as dengue, malaria and yellow fever.[12] As a new health problem, this concept can be useful to understand the effects of the coronavirus disease on mortality and the progress of the epidemiological transition in Brazil.

In the coronavirus pandemic period (2020 and 2021), the time evolution of mortality rates due to the triple burden of diseases showed a reversal of trends in rates for IDCs and Group I diseases, mostly due to COVID-19. This inflection in the weight of the distribution of causes and trend of mortality rates in the burden of diseases highlights the direct effect of COVID-19 for the excess of deaths and radical change in the evolution in the context of epidemiological transition, along with a deterioration in the quality of the recording of the underlying cause of death in the SIM.

The emergence of COVID-19 raises the magnitude of communicable diseases, elevating this group of causes to a very intense level of mortality and public health concern. In a proportion more equivalent to external causes in recent years, communicable diseases significantly shorten the percentage and risk differences in relation to CNCDs in pandemic years. However, the impacts of mortality due to COVID-19 are neither linear nor homogeneous in the population due to socioeconomic and sociodemographic disparities in Brazil.[16] A number of studies indicate that the mortality rates were higher in poorer populations, living in vulnerable areas[18] and of black race/skin color.[16]

The impact of the pandemic on the recording quality of the underlying cause of death undid a long sequence of gradual decrease in IDCs in the SIM, which resulted from advances in the reduction of regional inequalities in the notification of the country's records.[19,20] The COVID-19 pandemic presented an adverse scenario to the production of death data, which proved challenging to maintaining achievements such as the recommendation to avoid autopsies in events with the disease.[21] Potentially, this resulted in the increase in deaths due to undiagnosed or nonspecific natural and violent causes.[22]

Another possible implication of COVID-19 would have been a greater reduction in mortality due to CNCDs and external causes, but for various reasons. The impact on external causes can be related to social restriction measures and, therefore, by reduction to exposure factors. In CNCDs, it can be related to the effect of comorbidity in the clinical-epidemiological course of COVID-19, that is, it would be affected by a risk factor concurrent or competitive with COVID-19, as it is an associated factor for higher risk of death by the new coronavirus. However, the rates still need to be reanalyzed, as a significant percentage of CNCDs and external causes may be concealed between IDCs or nonspecific.[23]

This study presents limitations in the comparison between the estimated GBD data and the direct SIM data. In these two sources, the standard population for the production of standardized mortality rates was different, and the GBD study has not yet published estimates for 2020 and 2021. In addition, the 2021 SIM data are still preliminary, and may undergo reclassification of causes after due investigation. The comparative analysis of corrected data from the GBD and uncorrected data from the SIM could be a limitation; however, it was important to identify the correction factors for the triple burden of diseases and the period of time in which the corrections were more intense. In addition, as the study only resorted to aggregated data at the national level, it was not possible to explore locoregional differences.

CONCLUSION

GBD estimates use corrections by under-recording and GCs, allowing to adjust the estimates and, thus, to better support health planning.[7,11] Corrections in the SIM data were especially relevant for a more reliable monitoring of the time evolution of the burden of diseases. Progress of the epidemiological transition process of the triple burden of diseases and improvement of the quality of death data in Brazil were interrupted by the public health crisis caused by the emergence of COVID-19, increasing the burden of infectious diseases.

In a scenario of public health crisis caused by COVID-19, measures to cope with the disease call for fast and organized health responses, based on the best available data. At this juncture, one cannot, therefore, dispense with anticipated actions that contribute to the improvement of information and to monitoring effects on the burden of diseases. The mortality surveillance network should be better prepared for potentially lethal epidemics such as COVID-19.[24] Continuity of substantial and consistent progress of the SIM[25] should aim at an integrated plan for the contingency of outbreak deaths and modernization in data availability and transmissibility, strengthening rapid surveillance and the health system, as well as advancing death investigations and GC redistribution methodologies.

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