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INCLUSIVITY IN PEOPLE, METHODS, AND OUTCOMES

RESEARCH ARTICLE

Burden and Regional Disparities in the Firearm Mortality Profiles in Brazil: A Systematic Analysis of Findings From the Global Burden of Disease 2019



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Introduction: Owing to legislative changes and regional disparities, knowledge of firearm death profile in Brazil is limited, creating a complex situation that requires data to improve the strategies to reduce the burden of this health problem. The aim of this study was to describe the burden of firearm injuries and regional disparities in Brazil, including the characterization of mortality profiles specifically in the year 2019.

Method: The researchers extracted secondary data from the Institute of Health Metrics and Evaluation, from Global Burden of Disease study, including information on new cases and deaths caused by firearms. They also examined metrics such as incidence, mortality, years of life lost owing to disability, years of life living with disability, and years of life lost owing to premature death. Descriptive statistics (number of deaths and proportion) were performed.

Results: The findings reveal that nearly 50,000 firearm-related deaths occurred in Brazil in 2019, corresponding to a rate of 21.6 deaths per 100,000 inhabitants. These deaths collectively contributed to around 3 million years of life lost when adjusted for disability. Notably, there are significant regional disparities, with the Northeast region of Brazil bearing a higher burden of firearm injuries. The study further differentiates mortality profiles on the basis of the type of firearm-related death. Young individuals and young adults experience a higher mortality rate due to homicides. On the other hand, individuals aged ≥ 70 years are more prone to firearm-related suicides.

Conclusions: Firearm injuries in Brazil have distinct mortality profiles. Acknowledging these different profiles is crucial when devising effective public policies to address this issue.

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INTRODUCTION

Globally, Brazil stands out in terms of the burden of firearm injuries. This is because together with 5 other countries (U.S., Mexico, Colombia, Venezuela, and Guatemala), firearms accounted for >50% of injuries worldwide in 2016.¹ In addition, according to data from the Global Burden of Disease (GBD) in 2019, Brazil is the country with the highest number

of cases of unintentional injuries caused by firearms and the highest number of deaths and disability-

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adjusted life-years (DALYs) inflicted injuries with firearms.²

Studies on the burden of injuries caused by firearms still have a low impact, despite the advancement of scientific discussions in this area and its relationship with the global disease burden.³ A study carried out by Malta et al.⁴ analyzed firearm injury data in Brazil between 2000 and 2017 and observed a reduction in firearm-related deaths following a law instituted by the Brazilian government in 2004.

Despite the progress in firearm-related injury research and its significance for public health, there remains a lack of comprehensive knowledge regarding the extent of the burden of such injuries, including their specific attributes and variations across different regions. This information is crucial for shaping effective evidence-based policies in the country.

Consequently, the objective of this study was to address these gaps by providing a thorough description of the epidemiologic impact of firearm-related injuries. This includes examining how these injuries are distributed across various regions and understanding the disparities that may exist in Brazil and at the subnational level for year 2019, according to sex and age groups. In addition, the study aimed to delve into the distinct characteristics of firearm-related deaths on the basis of the intentions behind them, namely self-inflicted injuries (suicides), intentional harm (homicides), and unintentional incidents.

METHODS

Study Population

This ecologic study utilized secondary data obtained from the year 2019. The data were extracted from the Institute for Health Metrics and Evaluation (IHME) data visualization platform, which can be accessed on the web.⁵

The IHME recognized globally for its significant contributions to understanding diseases and health conditions through its estimations is responsible for generating and upkeeping data from the GBD study.² This influential platform compiles information from more than 200 countries, drawing from official government sources, collaborations, research studies, and diverse databases.⁶ The breadth of data available on this platform spans from administrative records to vital statistics.⁷

All available data used in this study were extracted from the Institute of Health Metrics and Evaluation from the GBD study. The sources of this platform include the Brazilian Census, the Brazilian Department of Health Informatics (DATASUS), and others that

encompass the entire Brazilian population. Information regarding the methods for estimating the studied variables were extensively validated on international literature.²

The study focused on data pertaining to Brazil and its 27 federative units, encompassing 26 states and the Federal District. The country was further divided into its administrative regions: North, Northeast, South, Midwest, and Southeast. The year 2019 stands as the most recent year available on the platform. The data extraction occurred in February 2023, ensuring that the investigation was based on the latest available information.

Measures

The study focused on examining variables related to firearm-related injuries, utilizing data available on the platform. These cases were categorized into 3 groups:

1. Self-inflicted injuries by firearms (suicides): Found using ICD-10 codes X72–X74.
2. Injuries to others with firearms (homicides): Referred to as physical violence by firearms and classified with ICD-10 codes X93–X95.
3. Injuries by unintentional firearms: Cases involving unintentional firearm-related injuries, classified with ICD-10 codes V01–Y98.

The analysis considered 7 factors, including the following:

- Age groups: The study classified individuals into 3 age groups: <5 years, 5–14 years, 15–19 years, 20–24 years, 25–29 years, 30–34 years, 35–39 years, 40–44 years, 45–49 years, 50–54 years, 55–59 years, 60–79 years, ≥80 years.
- Sex: Data were stratified by male and female.
- Federative units: The state-level of analysis was the Brazilian federative units, which were 26 administrative units and the Federal District, presented according to respective Brazilian administrative regions.
- Year of data: The study considered 2019 because it is the last year for which data were available.
- Variables extracted: The study collected absolute numbers, new cases, and deaths as well as DALYs, years of life lost from mortality (YLLs), and years lived with disability. These metrics provide insights into the overall burden of diseases and health problems caused by firearm injuries.
- Cumulative mortality: This was calculated for each region, considering age-standardized mortality and the number of deaths within the region.
- Epidemiologic indicators: The rates of epidemiologic indicators (prevalence, incidence, mortality, DALY,

YLL, and years lived with disability) were extracted per 100,000 inhabitants.

Statistical Analysis

The study’s methodology involved extracting data from the GBD platform from IHME in comma-separated value format, which were then imported and managed using STATA software, Version 11.0. Descriptive analyses were conducted on the collected indicators, providing insights into the characteristics and impact of firearm-related injuries within the studied population. Binomial CIs of proportion of deaths were estimated by the immediate command using STATA according to the studied characteristics, considering the number of deaths of each group and the deaths total.

RESULTS

Table 1 provides an overview of the firearm injury burden in Brazil during 2019. The data indicate a total of 210,008 recorded cases, resulting in an incidence rate of 96.3 cases per 100,000 inhabitants. These cases led to 49,437 deaths, reflecting a mortality rate of 21.6 deaths per 100,000 inhabitants. The collective impact of these injuries amounted to nearly 3 million DALYs, specifically 2,866,956.0 DALYs, with a rate of 1,323.3 DALYs per 100,000 inhabitants.

Most deaths were among male individuals, accounting for 93.7% of the cases (95% CI=93.5, to 93.9). This corresponds to a rate of 41.1 deaths per 100,000 inhabitants. The age range with the highest mortality was between 20 and 24 years, constituting 20.9% of the cases (95% CI=20.5, 21.2). This translates to a rate of 19.7 deaths per 100,000 inhabitants and burden of 690,187.44 DALYs.

Residents of the Northeast Brazilian region experienced a significant proportion (41.1%) of these deaths (95% CI=40.7, 41.5). This corresponds to a rate of 31.3 deaths per 100,000 inhabitants and 1,179,059.42 DALYs. The primary cause of death was physical violence, specifically homicides, which accounted for 96.0% of cases (95% CI=95.8, 96.2). This results in a

rate of 20.8 deaths per 100,000 inhabitants and burden of 5,531,733.92 DALYs. This information can be observed in Table 2.

An analysis of firearm-related mortality across the federative units and the Federal District of Brazil reveals distinct patterns. Within the Northeast region, specific states exhibit elevated firearm-related mortality rates due to homicides. The state of Alagoas stands out with the highest firearm-related mortality rate at 43 deaths per 100,000 inhabitants due to firearms. This elevated rate is primarily attributed to homicides (42.53 deaths per 100,000 inhabitants). The state of Bahia experienced the highest rate of firearm-related deaths caused by unintentional injuries by firearms, at 0.94 deaths per 100,000 inhabitants. For firearm-related suicides, Rio Grande do Sul had the highest incidence with a rate of 1.25 deaths per 100,000 inhabitants, as indicated in Table 3.

Mortality was higher in males in all subtypes of firearm deaths, with 1 per 100,000 inhabitants by suicide, 39.5 per 100,000 homicides, and 0.3 per 100,000 by accident. The age group between 15 and 49 years had higher mortality from homicides (36.5 per 100,000) and accidents (0.43 per 100,000), whereas mortality from suicide with a firearm occurred more in the age group of ≥70 years (1.1 per 100 thousand) (Table 4).

This difference in rates according to types of deaths due to firearm injuries was also seen among the Brazilian administrative regions, in which the highest mortality rates for homicides and accidents involving firearms occurred in the Northeast region (30.5 per 100 thousand and 0.37 per 100,000 inhabitants, respectively). In comparison, the highest mortality from suicide occurred in the South region (0.81 per 100,000 inhabitants) (Table 4).

DISCUSSION

When analyzing the GBD study, notable disparities in mortality rates appear between different causes and regions within a country. Specifically, differences seem to be

Table 1. The Burden of Injuries by Firearms in Brazil During 2019, According to the GBD Study

Variables	Total firearms		Suicides		Homicides		Accidents	
	n	Rate ^a	n	Rate ^a	n	Rate ^a	n	Rate ^a
Incidence	210,008	96.3	4,932	2.0	141,376	64.8	63,700	29.5
Mortality	49,437	21.6	1,259	0.5	47,510	20.8	668	0.3
DALYs	2,866,956.0	1,323.3	58,021.74	26.8	2,765,867.00	1,276.6	43,067.52	19.9
YLLs	2,836,998.7	43.3	57,230.70	26.4	2,743,181.63	1,266.1	36,586.40	16.9
YLDs	29,957.4	13.8	790.97	2.9	22,685.34	10.5	6,481.13	0.4

^aAge-standardized rates per 100,000 people.

DALY, disability-adjusted life-year; GBD, Global Burden of Disease; YLD, years lived with disability; YLL, years of life lost from mortality

Table 2. Epidemiology of Deaths by Firearms in Brazil During 2019

Variables	Deaths	Percentage (95% CI)	Mortality ^a	DALY
Brazil	49,437	100	21.6	2,866,956.0
Sex				
Male	46,333	93.7 (93.5, 93.9)	41.1	2,688,545.6
Female	3,104	6.3 (6.1, 6.5)	3.2	178,410.62
Age range ^b , years				
<5	176	0.4 (0.3, 0.5)	0.6	15,497.32
5–14	727	1.5 (1.4, 1.6)	0.8	56,524.35
15–19	7,223	14.6 (14.3, 14.9)	14.6	515,955.81
20–24	10,338	20.9 (20.5, 21.2)	19.7	690,187.44
25–29	8,078	16.3 (16.0, 16.6)	15.7	500,748.33
30–34	6,530	13.2 (12.9, 13.5)	12.4	373,195.94
35–39	5,161	10.4 (10.1, 10.7)	9.8	270,295.45
40–44	3,620	7.3 (7.0, 7.5)	7.7	172,608.31
45–49	2,513	5.1 (4.9, 5.3)	6.1	108,286.4
50–54	1,764	3.6 (3.4, 3.8)	4.6	68,365.11
55–59	1,228	2.5 (2.3, 2.6)	3.7	42,385.36
60–79	1,911	3.9 (3.7, 4.1)	2.5	50,438.95
≥80	168	0.3 (0.2, 0.4)	1.3	2,467.48
Region				
North	4,804	9.7 (9.4, 10.0)	19.0	277,854.55
Northeast	20,333	41.1 (40.7, 41.5)	31.3	1,179,059.42
Midwest	3,922	7.9 (7.7, 8.1)	19.9	229,658.2
Southeast	14,963	30.3 (29.9, 30.7)	22.2	870,280.98
South	5,415	11.0 (10.7, 11.3)	16.3	310,103.03
Type of injury				
Suicide	1,259	3.0 (2.8, 3.2)	0.53	116,043.48
Homicide	47,510	96.0 (95.8, 96.2)	20.8	5,531,733.92
Unintentional	668	1.0 (0.9, 1.1)	0.30	86,135.04

^aMortality per 100,000 inhabitants.

^bGross rates

DALY, disability-adjusted life-year.

observed in mortality due to homicides and unintentional firearm injuries compared with suicides involving firearms.

Approximately >2.8 million years of life were prematurely lost in Brazil due to the burden of firearm-related injuries, according to analysis by DALYS and YLLs extracted from GBD study, especially in the active working age group, which can have untold economic impact on the country, which is an important scientific gap to be filled owing to the lack of estimates.

According to this study's findings, which should be interpreted for regions and not for individuals, in the Northeast region of the country, the data show a higher mortality rate from homicides and unintentional firearm injuries among the younger population. On the other hand, these data show that suicides involving firearms are more prevalent among the older population residing in the Southern region.

According to the GBD data, the burden of disease, as measured by DALYs, resulting from firearm injuries in

Brazil surpasses that of several prominent diseases. Notably, firearm injuries have a greater impact in terms of DALYs than diseases such as type 2 diabetes, lung diseases, breast diseases, stomach diseases, depression, and even ischemic stroke.⁷ These findings emphasize the significance of firearm injuries in the overall health landscape, calling for thoughtful consideration in the formulation of public policies.

The association between socioeconomic factors and firearm mortality in Brazil has been examined in previous research, showing an association between higher mortality rates and areas with lower socioeconomic development.^{4,8} Similar scenarios have been observed worldwide,¹ suggesting that this problem is still inadequately addressed despite its significant public health impact.³ Importantly, this does not mean that these individuals living in less developed areas are at high risk of death.

Moreover, this concern is not confined to developing countries such as Brazil. A study conducted by Kennedy

Table 3. Age-Standardized Mortality Rates by Firearms and Subtypes in Brazilian Federative Units During 2019

Region/federative units	Homicide ^a	Suicide ^a	Unintentional ^a	Total firearms ^a
North				
Acre	18.03	0.8	0.41	19.2
Amapá	16.78	0.36	0.24	17.4
Amazonas	18.7	0.35	0.20	19.3
Pará	26.84	0.37	0.51	27.7
Rondônia	23.54	0.68	0.46	24.7
Roraima	11.47	0.55	0.36	12.4
Tocantins	11.4	0.77	0.34	12.5
Northeast				
Alagoas	42.53	0.28	0.15	43.0
Bahia	27.62	0.55	0.94	29.1
Ceará	36.31	0.46	0.25	37.0
Maranhão	18.84	0.49	0.63	20.0
Paraíba	28.22	0.33	0.17	28.7
Pernambuco	39.17	0.42	0.15	39.7
Piauí	10.13	0.56	0.29	11.0
Rio Grande do Norte	35.58	0.66	0.63	36.9
Sergipe	36.07	0.52	0.20	36.8
Midwest				
Distrito Federal	16.4	0.40	0.06	16.9
Goiás	27.92	0.72	0.24	28.9
Mato Grosso	18.74	0.56	0.59	19.9
Mato Grosso do Sul	12.99	0.83	0.26	14.1
Southeast				
Espírito Santo	33.02	0.43	0.17	33.6
Minas Gerais	16.29	0.51	0.2	17.0
Rio de Janeiro	27.68	0.52	0.25	28.5
São Paulo	8.85	0.4	0.19	9.4
South				
Paraná	18.43	0.61	0.17	19.2
Rio Grande do Sul	19.24	1.25	0.17	20.7
Santa Catarina	8.2	0.58	0.12	8.9

^aMortality per 100,000 inhabitants

in 1998 highlighted a robust correlation between income inequality, as assessed by hygiene index, and firearm-related mortality. This relationship was further influenced by measures of social capital.⁹

In a study conducted in 2021, researchers aimed to assess the correlation between firearm possession and homicide rates across different regions of Brazil. The study revealed distinct findings for the Northeast and South regions of the country. Specifically, in the Northeast region, an increase in the number of firearm possessions was directly associated with a rise in the number of homicides, but this does not imply that all gun owners in the Northeast region are at increased risk of committing homicides. This suggests that a higher prevalence of gun ownership in the Northeast coincided with an increase in homicides. In contrast, this correlation was not observed in the South region of the country.¹⁰

In Brazil, data sourced from the Social Vulnerability Atlas of the Institute of Economic and Applied Research in 2019 underscore the significant socioeconomic disparities between different regions of the country. Specifically, the Northeast region exhibited lower socioeconomic indicators than other regions, such as the lowest human development index at 0.72, indicating a lower level of overall development. A higher social vulnerability index of 0.30 signifies increased vulnerability in terms of factors such as income, education, and housing. Greater income inequality, as measured by the Gini index, stood at 0.57 in the northeast region.¹¹

In contrast, Brazil's Southern region consistently maintains an association with higher socioeconomic development and improved living conditions, among other positive factors.¹¹ This regional contrast highlights the disparities in terms of economic well-being, social

Table 4. Epidemiology of Deaths by Type of Injury in Brazil, 2019

Variable	Suicide		Homicide		Unintentional	
	Deaths	Mortality	Deaths	Mortality	Deaths	Mortality
Sex						
Male	1,125	1.00	44,607	39.52	601	0.54
Female	134	0.11	2,903	3.00	67	0.06
Age, range, ^a years						
<5	—	—	164	1.06	12	0.08
5–14	9	0.03	681	2.11	37	0.12
15–19	87	0.53	7,059	42.9	77	0.47
20–24	119	0.68	10,113	57.89	106	0.61
25–29	125	0.73	7,871	45.9	82	0.48
30–34	128	0.73	6,326	36.09	76	0.43
35–39	124	0.71	4,969	28.36	68	0.39
40–44	111	0.71	3,458	22.02	51	0.33
45–49	101	0.74	2,372	17.36	40	0.29
50–54	93	0.73	1,641	12.94	30	0.24
55–59	80	0.72	1,126	10.03	22	0.2
60–79	225	0.89	1,639	6.48	47	0.19
≥80	57	1.34	92	2.17	19	0.44
Region						
North	87	0.55	4,636	18.10	81	0.36
Northeast	310	0.47	19,721	30.50	302	0.37
Midwest	114	0.62	3,759	19.00	49	0.29
Southeast	453	0.47	14,322	21.50	188	0.20
South	294	0.81	5,072	15.30	49	0.15

^aGross rates.

vulnerability, and income equality between the northeast and southern parts of the country. Another crucial aspect to highlight is the prevailing issue of criminality in Brazil, which is intrinsically intertwined with social disparities, inadequate educational levels, and a higher incidence of individuals possessing illicit firearms.¹²

At present, the legal framework concerning firearms in Brazil is defined by Decree Number 11,366, enacted on January 1, 2023.¹³ This decree brings amendments to Law Number 10,826, also known as the Disarmament Statute, which was established in December 2003.¹⁴ Discussions surrounding Law Number 10,826 highlight that the measures set in this legislation have yielded minimal success in terms of decreasing the incidence of homicides.¹⁵ Paradoxically, the law appears to have introduced a heightened ease in obtaining firearms.¹⁶ This shift in policy seems to correspond with a notable increase in the proportion of firearms among individuals engaged in hunting and collecting, juxtaposed with a decrease in the same proportion among private firearms owned by military personnel over the period spanning from 2019 to 2022.¹⁷

Indeed, the findings from various studies^{4,8} conducted with Brazilian data consistently point to a greater burden of firearm injuries specifically among young male

Brazilian population; however, this does not mean that all young Brazilian men are at greater risk. This trend is further supported by the outcomes of this study, which utilized data from the year 2019. The consistency of this pattern across different studies suggests a consensus within the literature regarding this issue.

In the year 2019, homicides emerged as the primary cause of firearm-related injuries in Brazil. This distinction was evident through various epidemiologic indicators, all of which pointed to a more significant burden associated with homicides than with other causes of firearm-related injuries. This trend is believed to have arisen partly owing to Brazilian public policies that aimed to ease restrictions on firearm access. These policies contributed to a decline in the rate of voluntary return of firearms, particularly in the years leading up to 2017.⁴

Firearm-related homicides are influenced by a range of interconnected factors that encompass various aspects of lifestyles and societal dynamics. Notably, factors such as alcohol and drug use, along with socioeconomic inequalities, have been linked to higher rates of homicides.¹² Furthermore, certain determinants, including race, ethnicity, and low educational levels, appear to significantly influence the observed profile of firearm-related homicides.¹⁸

Limitations

Some limitations of this study were known, but the study team did not consider them owing to missing data. Analysis of other socioeconomic variables helps to understand these profiles, as does the presence of characteristics that increase access to firearms, such as military veteran status.

CONCLUSIONS

The insights gained from the data analysis of firearm-related injuries in Brazil for the studied year shed light on the gravity of the issue and the complexities surrounding it. The findings not only quantify the extent of firearm-related injuries but also highlight distinct patterns in the mortality populational profiles on the basis of the types of deaths attributed to firearms. The age-specific trends are where homicides are prevalent among young adults, and suicides are more common among population aged ≥ 70 years.

The links established between criminality, socioeconomic vulnerabilities, and illegal firearm possession underscore the intricate relationship between societal factors and firearm-related incidents, even though not all individuals in these socioeconomic conditions engage in criminal activities or possess illegal weapons. Continued research and analysis will undoubtedly play a critical role in refining the understanding of these patterns and their underlying causes.

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CREDIT AUTHOR STATEMENT

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