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Road traffic accidents: Global Burden of Disease study, Brazil and f ederated units, 1990 and 2015

Acidentes de transporte terrestre: estudo Carga Global de Doenças, Brasil e unidades federadas, 1990 e 2015

Roberto Marini Ladeira[I], Deborah Carvalho Malta[II], Otaliba Libânio de Morais Neto[III], Marli de Mesquita Silva Montenegro[IV], Adauto Martins Soares Filho[IV], Cíntia Honório Vasconcelos[IV], Meghan Mooney[V], Mohsen Naghavi[V]

ABSTRACT: ***Objective:*** To describe the global burden of disease due to road traffic accidents in Brazil and federated units in 1990 and 2015. ***Methods:*** This is an analysis of secondary data from the 2015 Global Burden of Disease study estimates. The following estimates were used: standardized mortality rates and years of life lost by death or disability, potential years of life lost due to premature death, and years of unhealthy living conditions. The Mortality Information System was the main source of death data. Underreporting and redistribution of ill-defined causes and nonspecific codes were corrected. ***Results:*** Around 52,326 deaths due to road traffic accidents were estimated in Brazil in 2015. From 1990 to 2015, mortality rates decreased from 36.9 to 24.8/100 thousand people, a reduction of 32.8%. Tocantins and Piauí have the highest mortality risks among the federated units (FU), with 41.7/100 and 33.1/100 thousand people, respectively. They both present the highest rates of potential years of life lost due to premature deaths. ***Conclusion:*** Road traffic accidents are a public health problem. Using death- or disability-adjusted life years in studies of these causes is important because there are still no sources to know the magnitude of sequelae, as well as the weight of early deaths. Since its data are updated every year, the Global Burden of Disease study may provide evidence to formulate traffic security and health attention policies, which are guided to the needs of the federated units and of different groups of traffic users.

Keywords: Accidents, traffic. External causes. Violence. Mortality. Disability-adjusted life years.

[I]*Fundação Hospitalar do Estado de Minas Gerais* – Belo Horizonte (MG), Brazil.

[II]Department of Child and Mother Nursing and Public Health, School of Nursing, *Universidade Federal de Minas Gerais* – Belo Horizonte (MG), Brazil.

[III]Department of Collective Health, *Instituto de Patologia Tropical e Saúde Pública, Universidade Federal de Goiás* – Goiânia (GO), Brazil.

[IV]Department of Surveillance and Non-transmitted Diseases and Health Promotion, *Secretaria de Vigilância em Saúde*, Ministério da Saúde – Brasília (DF), Brazil.

[V]Institute for Health Metrics and Evaluation – Seattle, United States.

Corresponding author: Roberto Marini Ladeira. Alameda Álvaro Celso, 100, sala 231, CEP: 30150-260, Belo Horizonte, MG, Brasil. E-mail: robemarini@gmail.com

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RESUMO: ***Objetivo:*** Descrever a carga global dos acidentes de transporte terrestres no Brasil e Unidades Federadas, em 1990 e 2015. ***Métodos:*** Análise dos dados secundários das estimativas do estudo Carga Global de Doenças 2015. Utilizam-se as estimativas de taxas padronizadas de mortalidade e anos de vida perdidos por morte ou incapacidade, anos potenciais de vida perdidos por morte prematura, e anos de vida não saudáveis. O Sistema de Informações sobre Mortalidade foi a principal fonte de dados de óbitos. Houve a correção do sub-registro e ajustes por códigos *garbage*. ***Resultados:*** No ano de 2015 foram estimados 52.326 óbitos por acidentes de transportes terrestres no Brasil. De 1990 a 2015, as taxas de mortalidade diminuíram de 36,9 para 24,8/100 mil habitantes, redução de 32,8%. Tocantins e Piauí têm os maiores riscos de mortalidade entre as unidades federadas (UF), com 41,7 e 33,1/100 mil, respectivamente. Ambos também têm as maiores taxas de anos potenciais de vida perdidos por morte prematura. ***Conclusão:*** Os acidentes de transportes terrestres constituem um problema de saúde pública. Utilizar anos de vida perdidos ajustados por morte ou incapacidade nos estudos dessas causas é importante, pois não existem fontes para conhecer a magnitude da incapacidade nem o peso das mortes precoces. O estudo Carga Global de Doenças, ao atualizar os dados anualmente, poderá fornecer evidências para a formulação de políticas de segurança no trânsito e de atenção à saúde, orientadas para as necessidades das UF e de diferentes grupos de usuários do trânsito.

Palavras-chave: Acidentes de trânsito. Causas externas. Violência. Mortalidade. Anos de vida perdidos por incapacidade.

INTRODUCTION

A total of 1.2 million deaths due to road traffic accidents (RTA) occurred all over the world in 2012, mainly affecting male individuals aged 15–29 years[1]. According to the Global Burden of Disease (GBD) study, there was a decrease in the rates of death- or disability-adjusted life years (DALYs), between 1990 and 2013, due to injuries from traffic accidents worldwide (-15.7%). However, this reduction occurred mainly in high-income countries, whereas an increase in low- and medium-income countries was observed[2].

In Brazil, two population studies showed that 2.5 and 3.1% of the population older than 18 years suffered traffic accident injuries during a 12-month period, in the years of 2008 and 2013, respectively[3,4], with important regional inequalities. With regard to the number of deaths, the Brazilian Mortality Information System (SIM, acronym in Portuguese) registered an increase from 28,885 to 42,844 deaths due to RTA between 2000 and 2010, which corresponds to a 32.3% increase. This increase was observed among automobile occupants and motorcycle riders. There has been a decrease of pedestrian deaths since 2007[5]. In 2013, there were 42,266 deaths with a mortality rate of 21/100 thousand people and 1.3 million of potential years of life lost due to injuries in younger age ranges[6].

In addition to the high mortality rate, RTA have a strong impact on health services and on the society in general. Cost estimates of RTA for the Brazilian society, which were calculated by the Institute for Applied Economic Research (IPEA, acronym in Portuguese) have revealed a value of BRL 40 billion of road accidents and BRL 10 billion in urban areas[7]. In a study carried out in emergency services from Brazilian capitals, 25% of the attendance for external causes were due to traffic accidents[8]. Approximately 15% of hospitalizations for external causes in Brazilian public hospitals during the 2002–2011 period presented the diagnosis of injuries by RTA[9]. In addition, with regard to hospitalizations due to RTA in the Brazilian Unified Health System (SUS) during 2000–2013, 410.448 people (23.5%) were identified with diagnosis suggestive of physical sequelae and predominance of young men aged 20–29 years, mainly pedestrians and motorcycle riders[10]. However, few studies have analyzed both the burden of mortality and sequelae and disability due to RTA in the Brazilian population during the last few decades.

The GBD study provided a wider view by comparing the incidence and prevalence estimates of these damages and impacts on mortality and occurrence of disabilities for all countries and regions in the world, through the disability-adjusted life years indicator (DALY)[11]. The first studies to use this methodology were published in 1996 and identified accidents and violence among the main causes of morbidity and mortality in the world[11-14]. The 2010 GBD study extended the analysis to 291 diseases and injuries, including 187 countries in 21 regions in the world[15]. In 2015, a specific analysis on accidents and violence that used 2013 GBD data was published[2]. The 2015 GBD study updated the estimates and analysis of trend in the period from 1980 to 2015, due to the inclusion of new data and revision of methods. For the first time, sub-national data of several countries, including Brazil, were added. Therefore, data from 27 federated units (FU) are available, thus allowing the comparison with other countries[16].

The aim of this study was to analyze the indicators of mortality and DALY due to RTA, between 1990 and 2015, in Brazil and in the FU, using the estimates produced in the 2015 GBD study.

METHODS

This is a study based on secondary data estimated for the Brazilian population through the 2015 GBD study, upon partnership between Institute for Health Metrics and Evaluation (IHME), from Washington University, the Brazilian Department of Health and GBD Brasil[17]. Considering that the conceptual principles and procedures of the GBD methodology have been updated since its first publication[15], the burden of disease was estimated according to the methodology developed by the IHME in 2015. The results can be accessed in their webpage[17].

The GBD uses several sources in each country, such as vital record, verbal autopsy, mortality surveillance, censuses, population researches, and data from hospitals and institutes of legal medicine[2,17]. As to external causes, registrations of the police and of transportation agencies are also used in the three spheres, such as traffic accident event reports. Studies from Brazilian agencies and institutional research have been used, such as the Crime Trends survey from the United Nations (UN)[18] and the World Health Organization (WHO) report about the global status of road safety[1,19]. The GBD discloses the sources used in each country, state, or other subnational geographic unit, which were used in the respective years[20,21]. In countries with a good quality of vital record, police records are only used if the reported number of deaths due to injuries exceeds that of the vital record. In Brazil, the main source of information used for mortality analysis was the SIM database from the Department of Health[22].

In the calculation of GBD estimates of external causes, first all data sources for diseases and injuries are mapped. Next, garbage code adjustments are performed, which are then redistributed into other defined causes. Details on the grouping of causes using ICD-9 and ICD-10 reviews and also the classification errors have already been described[20]. Finally, statistical models and modeling are applied to estimate data by age, sex, country, year, and cause. The DisMod-MR 2.1, which is a meta-regression tool to calculate simultaneous estimates of incidence, prevalence, remission, incapacity, and mortality, was also used[16,23].

The following indicators were used in this study: mortality rates and DALY — standardized by age. DALY is an index composed of the potential years of life lost due to premature death (years of life lost — YLL) and damage caused by the disease, sequelae, or disability, given the different levels of severity of one or several diseases at the same time (years lived with disability — YLD). By adding the years of life lost due to premature mortality and years of unhealthy living conditions, the DALY aims at revealing the global burden that health loss imposes on countries and populations[24,25].

In order to classify the RTA, the International Classification of Diseases (ICD) was used: codes 800-999 and E800-E849 from ICD-9 and Chapter XIX (codes S00 to T98) and Chapter XX (codes: V01-V89) from ICD-10[2].

The Research Ethics Committee from *Universidade Federal de Minas Gerais* (no. CAAE 62803316.7.0000.5149) approved the project.

RESULTS

A total of 134,931 deaths were registered due to external causes in 1990, whereas 168,018 were registered in 2015, with decrease of the mortality rate from 105.1 to 81.2/100 thousand people, a 22.8% decrease in the period. Deaths due to interpersonal violence were prevalent followed by RTA, accidents, or unintentional injuries, and suicides. The highest risk regarding RTA was seen for pedestrians and automobile occupants (Table 1).

The traffic accidents group had a decrease in its mortality rate of 30.6% between 1990 and 2015, and the RTA subgroup had a decrease of 32.8%. Among the victims categorized according to the type of transportation user, there was a higher decrease among pedestrians (47.5%) and automobile occupants (41.6%). Among motorcycle and bicycle riders, an increase of 49.9 and 33.9%, respectively, was observed. However, despite these alterations, in Brazil, between 1990 and 2015, the mortality rates of pedestrians (10.6/100 thousand) and automobile occupants (6.9/100 thousand) remain higher than the rates of motorcycle riders (5.9/100 thousand) and bicycle riders (1.0/100 thousand) (Table 1). The mortality rates due to RTA were four times higher in men. This risk is higher in all kinds of victims: 7.5 times in motorcycle riders and 3.4 times in automobile riders (data are not shown).

Table 1. Number of deaths and mortality rate per 100 thousand people due to external causes and road traffic accidents, with a 95% uncertainty interval, Brazil, 1990 and 2015.

Death causes	Number of deaths and 95% uncertainty interval			Mortality rate per 100 thousand people		
	1990	2015	Variation % 1990–2015	1990	2015	Variation % 1990–2015
External causes	134,931	168,018	24.5	105,1	81,2	-22.8
	(131,104 – 138,852)	(159,904 – 177,046)	(18.4 – 31.2)	(101.7 – 108.1)	(77.4 – 85.4)	(-26.5 – -18.6)
Traffic accidents	48,618	54,601	12.3	37,3	25,9	-30.6
	(46,835 – 50,494)	(51,381 – 60,111)	(5.5 – 27.2)	(36.0 – 38.6)	(24.4 – 28.4)	(-34.9 – -21.3)
Road traffic accidents	48,059	52,326	8.9	36,9	24,8	-32.8
	(46,231 – 49,893)	(49,298 – 57,696)	(2.3 – 24.0)	(35.6 – 38.2)	(23.4 – 27.3)	(-36.9 – -23.2)
Pedestrians	25,134	21,444	-14.7	20,1	10,6	-47.5
	(23,482 – 27,565)	(19,508 – 24,086)	(-23.6 – -3.0)	(18.7 – 21.9)	(9.7 – 11.8)	(-52.6 – -40.6)
Bicycle riders	1,011	2,148	112.3	0,8	1,0	33.9
	(934 – 1.175)	(1.932; 2.543)	(88.1 – 144.4)	(0.7 – 0.9)	(0.9 – 1.2)	(19.1 – 53.3)
Motorcycle rider	5,817	13,175	126.5	3,9	5.9	49.9
	(4,983 – 7,152)	(9,098 – 16,484)	(36.1 – 166.2)	(3.4 – 4.8)	(4.1 – 7.4)	(-9.0 – 77.4)
Automobile occupants	15,911	14,766	-7.2	11,9	6.9	-41.6
	(13,285 – 17,667)	(13,271 – 18,735)	(-17 – 17.0)	(10.0 – 13.3)	(6.2 – 8.8)	(-47.7 – -26.9)
Other road transportations	184	793	330.2	0,1	0.4	168.6
	(151 – 355)	(405 – 1.033)	(51.1 – 520.8)	(0.1 – 0.3)	(0.2 – 0.5)	(-5.7 – 288.9)
Other transportations	558	2,275	307.3	0,4	1.1	156.2
	(503 – 656)	(1.839 – 2.582)	(221.4 – 371.7)	(0.4 – 0.5)	(0.9 – 1.2)	(102.2 – 196.6)

The RTA mortality rate decreased in 26 of the 27 Brazilian FU, but it was very heterogeneous with a variation from 2.5 (Tocantins) to 52.3% (Federal District). The only exception was the state of Piauí in the northeastern region, which showed a growth of 9.7%. Nevertheless, after examining the uncertainty intervals, significant changes were only seen in 13 states (signaled with * in Table 2).

The highest mortality rates were in the states of the north and northeastern regions, especially Tocantins (41.7 / 100 thousand), Piauí, and Maranhão (36.3 / 100 thousand) in 2015. Of the ten states with the highest mortality rates due to RTA, four belong to the northeastern region; three from the north; two from the middle-west; and one from the south region. The lowest rates were from São Paulo (18.3 / 100 thousand), Federal District (18.9 / 100 thousand), and Rio Grande do Sul (19.5 / 100 thousand) (Table 2).

The analysis of age-specific mortality rates showed a higher risk for 70-year-old people and for pedestrians, bicycle riders and automobile occupants. On the other side, for motorcycle riders, the highest death risk was seen in the 15- to 49-year-old group; however, in this age range, the risk is also high for automobile occupants (Figure 1). The death risk of

Table 2. Mortality rate by road traffic accident with 95% uncertainty interval in both sexes, per federated units and Brazil, between 1990 and 2015.

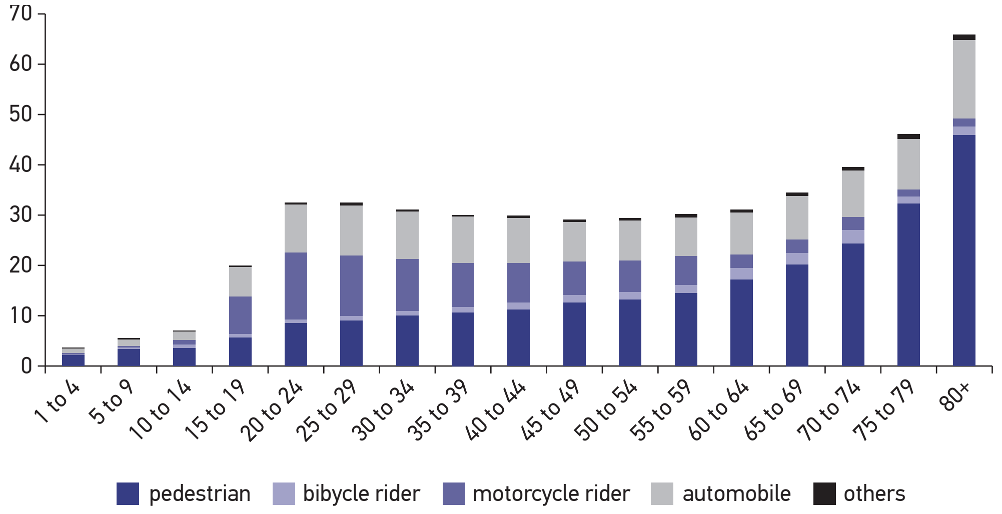
Federated units	Rates per 100 thousand people and 95% uncertainty interval				Variation (%)
	1990		2015		
Brazil	36.9	(35.6 – 38.2)	24.8	(23.4 – 27.3)	-32.8
Mid-West Region					
Mato Grosso	48.0	(40.4 – 54.3)	35.4	(28.9 – 42.7)	-26.3
Goiás*	50.7	(43.9 – 55.4)	32.7	(27.8 – 38.3)	-35.5
Mato Grosso do Sul	39.6	(34.7 – 44.0)	29.7	(24.1 – 35.8)	-25.0
Federal District*	39.7	(35.7 – 42.7)	18.9	(16 – 22.5)	-52.3
Northeast Region					
Piauí	33.1	(27.4 – 37.6)	36.3	(28.6 – 44.3)	9.7
Maranhão	53.6	(43.9 – 63.4)	36.3	(29.0 – 47.4)	-32.3
Ceará	36.0	(31.1 – 40.4)	33.1	(27.5 – 39.9)	-7.9
Sergipe	40.2	(35.3 – 44.6)	30.5	(25.4 – 37.1)	-24.0
Alagoas*	50.4	(44.4 – 56.3)	28.7	(23.6 – 36.8)	-43.1
Paraíba	36.1	(31.0 – 40.2)	28.6	(23.3 – 35.6)	-20.9
Pernambuco	35.4	(31.9 – 40.0)	26.1	(21.5 – 33.2)	-26.2
Bahia	32.4	(28.7 – 36.2)	25.2	(21 – 31.2)	-22.2
Rio Grande do Norte*	33.1	(28.4 – 36.8)	23.3	(19.5 – 28.3)	-29.7

Continue...

Table 2. Continuation.

Federated units	Rates per 100 thousand people and 95% uncertainty interval				Variation (%)
	1990		2015		
North Region					
Tocantins	42.8	(34 – 51.5)	41.7	(32.1 – 52)	-2.5
Rondônia*	49.9	(43.6 – 56.1)	35.0	(28.5 – 41.5)	-29.9
Roraima*	49.7	(42.5 – 54.8)	32.6	(27.1 – 38.4)	-34.3
Amapá	29.9	(26.0 – 34.2)	25.9	(20.2 – 33.5)	-13.6
Pará	34.4	(30.0 – 39.2)	24.8	(19.8 – 31)	-28.0
Acre	31.6	(28.2 – 35.6)	24.6	(20.5 – 30.2)	-22.0
Amazonas*	31.3	(27.4 – 35)	20.5	(16.5 – 26.3)	-34.6
Southeast Region					
Espírito Santo*	42.7	(37.9 – 47.1)	29.2	(24.1 – 35.4)	-31.6
Minas Gerais*	32.5	(29.5 – 35.5)	24.6	(20.8 – 29.0)	-24.4
Rio de Janeiro*	36.3	(33.1 – 44.5)	21.1	(17.8 – 27.0)	-41.9
São Paulo*	36.0	(32.9 – 39.7)	18.3	(15.4 – 21.5)	-49.2
South Region					
Paraná	40.9	(35.6 – 44.8)	30.3	(25.3 – 35.8)	-26.1
Santa Catarina*	46.5	(37.2 – 51.5)	30.2	(24.4 – 36.1)	-35.1
Rio Grande do Sul*	27.1	(24.3 – 29.8)	19.5	(15.7 – 24.2)	-27.8

*Significant variation of rates.



*Rates are standardized by sex and age, using the world population.

Figure 1. Mortality rate* specific by age, based on the types of road traffic accidents, Brazil, 2015.

pedestrians increases with age, whereas the motorcycle riders' decreases in the age groups of individuals older than 35 years old.

With regard to DALY per 100 thousand people, Table 3 presents the distribution of its components: YLL and YLD due to RTA, for Brazil and FU. For Brazil, the DALY rate was 1,175.5 / 100 thousand. Sixteen FU presented higher rates than the country's rate. The states of Tocantins, Piauí, and Maranhão had the highest rates, whereas the lowest ones were found in Amazonas, Federal District, São Paulo, and Rio Grande do Sul. The main components of the DALY were the YLL, which accounted for 90% of the total amount, being less than 94% in FU such as São Paulo, Roraima, Rio de Janeiro, and Federal District, and higher than 96% in FU such as Paraná, Piauí, Pará, Bahia, Alagoas, Sergipe, Amazonas, Pernambuco, and Tocantins.

The DALY rates by the main external causes (Chart 1) had pedestrian accidents in the first position in 1990, which moved to the second position in 2015 — 51.4% decrease, being replaced by assaults with firearm, which occupied the second position in 1990. In addition, automobile occupants changed from the third position to the fourth — a 40.7% decrease. With an opposed trend, the DALY rates in motorcycle riders, which occupied the ninth position in 1990, occupied the fifth position in 2015 — a 53.7% increase.

DISCUSSION

When comparing Brazil with other South America countries, Brazil has the second highest rate of DALY due to RTA (1,230 / 100 thousand people) after Paraguay (1,270 / 100 thousand people) and also has higher rates than countries with worst socioeconomic indicators, such as Ecuador and Bolivia. In such region, Peru, Chile, Colombia, and Argentina have the lowest DALY rates — between 615 and 700 / 100 thousand people[17]. When Brazilian data are compared with data from the countries of the group called BRICS — Brazil, Russia, India, China, and South Africa — a relative similarity of the DALY rates due to traffic accidents between the countries is observed — between 1,010 and 1,230 / 100 thousand people — with the exception of South Africa, which rate reaches 1,914 / 100 thousand people[17]. The main component of DALY due to RTA in Brazil, China and India is pedestrians' injuries. In Russia and in South Africa, the highest DALY rates are due to injuries in automobile occupants. In this group of countries, Brazil has the highest DALY rate among motorcycle rider — 358,2 / 100 thousand people.

The BRICS present a quite high DALY rate, which had a significant decrease in Brazil and Russia during 1990 to 2013, whereas the rates of South Africa, India, and China did not change significantly[2]. However, the mortality rates due to traffic accidents among the BRICS are even higher than in low-income countries[26]. The BRICS have experienced a fast economic growth during the last years, with increase of automobile traffic; however, they did not invest enough in systems to increase safety of the roads, and therefore it had an increase of injuries and deaths[26].

Table 3. Years of life lost, years lived with disability and disability-adjusted life year rates* per 100 thousand people by road traffic accidents for both sexes, with a 95% uncertainty interval, Brazil and federated units, 2015.

Federated units	Rates* and 95% uncertainty interval		
	YLL	YLD	DALY
Brazil	1114.6 (1047.9 – 1247.8)	61.0 (42.6 – 82.6)	1175.5 (1105.0 – 1313.4)
Tocantins	1828.6 (1413.2 – 2286.0)	6.8 (4.7 – 9.3)	1835.4 (1420.1 – 2292.9)
Piauí	1677 (1307.6 – 2039.5)	66.8 (46.9 – 91.2)	1743.8 (1374.5 – 2105.6)
Maranhão	1618.6 (1224.6 – 2098.6)	74.1 (51.6 – 100.8)	1692.7 (1293.9 – 2168.3)
Mato Grosso	1525.8 (1251.8 – 1835.0)	83.3 (58.2 – 113.9)	1609.1 (1335.6 – 1920.4)
Rondônia	1474.4 (1188.5 – 1756.5)	76.3 (53.1 – 103.6)	1550.7 (1278.6 – 1836.2)
Ceará	1456.8 (1205.9 – 1757.7)	77.4 (53.4 – 104.8)	1534.2 (1287.3 – 1835.8)
Goiás	1426.6 (1213.0 – 1685.1)	75.2 (52.3 – 102.0)	1501.8 (1284.2 – 1757.1)
Roraima	1398.0 (1162.9 – 1653.4)	101.1 (70.6 – 137.1)	1499.1 (1261.4 – 1759.2)
Santa Catarina	1400.0 (1096.8 – 1692.7)	61.7 (42.8 – 83.9)	1461.8 (1162.1 – 1753.1)
Paraná	1373.5 (1153.5 – 1634.0)	56.7 (39.7 – 77.2)	1430.2 (1212.7 – 1685.3)
Sergipe	1376.8 (1142.2;1678.7)	32.1 (22.4 – 43.7)	1409.0 (1171.3 – 1711.9)
Espírito Santo	1322.0 (1088.4 – 1648.7)	63.7 (44.1 – 86.7)	1385.7 (1148.5 – 1719.3)
Mato Grosso do Sul	1307.0 (1063.0 – 1579.4)	62.6 (43.9 – 85.2)	1369.6 (1126.0 – 1643.8)
Paraíba	1276.1 (1037.4 – 1597.2)	71.06 (49.6 – 96.2)	1347.1 (1103.8 – 1675.4)
Alagoas	1284.8 (1048.6 – 1717.6)	42.4 (29.4 – 57.5)	1327.2 (1093.5 – 1763.1)
Pernambuco	1193.8 (979.6 – 1558.1)	12.5 (86.7 – 16.9)	1206.3 (990.5 – 1573.1)
Minas Gerais	1097.6 (925.7 – 1294.6)	57.8 (40.3 – 78.7)	1155.4 (983.5 – 1356.4)
Bahia	1111.8 (926.1 – 1395.0)	42.6 (29.7 – 58.0)	1154.4 (965.6 – 1438.9)
Acre	1092.7 (902.0 – 1344.9)	56.4 (39.2 – 76.5)	1149.0 (959.3 – 1401.7)
Amapá	1086.2 (841.4 – 1417.4)	60.3 (42.1 – 81.9)	1146.5 (903.2 – 1482.6)
Pará	1071.2 (857.1 – 1341.9)	42.3 (29.7 – 57.5)	1113.5 (903.0 – 1386.4)
Rio Grande do Norte	1034.7 (864.7 – 1262.4)	54.7 (38.1 – 74.5)	1089.5 (915.8 – 1314.9)
Rio de Janeiro	930.7 (777.4 – 1215.8)	66.9 (46.8 – 91.0)	997.6 (843.7 – 1288.4)
Rio Grande do Sul	885.3 (712.2 – 1112.8)	45.9 (31.5 – 62.2)	931.2 (758.7 – 1161.0)
São Paulo	827.6 (686.7 – 971.2)	80.8 (56.0 – 109.4)	908.4 (771.1 – 1052.2)
Federal District	815.2 (687.1 – 990.0)	57.0 (39.8 – 77.4)	872.2 (7402.2 – 1037.5)
Amazonas	856.1 (684.6 – 1147.5)	9.7 (6.8 – 13.3)	865.8 (693.7 – 1155.3)

*Rates are standardized by sex and age, using the world population. YLL: years of life lost; YLD: years lived with disability; DALY: disability-adjusted life year.

Chart 1. Disability-adjusted life year rates per 100 thousand people based on the main external causes, both sexes, with a 95% uncertainty interval, Brazil, 1990 and 2015.

1990		2015		
Rate (95% uncertainty interval)	Classification of causes	Classification of causes	Rate (95% uncertainty interval)	Variation (%)
884.6 (826.5;969.7)	1 Pedestrian accidents	1 Assault by firearms	1050.0 (827.3;1135.4)	29.6
810.0 (747.8;981.8)	2 Assault by firearms	2 Pedestrian accidents	430.1 (388.0 ;482.9)	-51.4
579.7 (487.4;642.8)	3 Automobile accidents	3 Falls	359.6 (300.2;434.1)	-17.2
434.5 (373.9;506.5)	4 Falls	4 Automobile accidents	343.7 (309.5;428.2)	-40.7
392.7 (251.8;434.2)	5 Aggression — other means	5 Accidents — motorcycle riders	334.1 (238.9;410.8)	53.7
376.8 (358.1;408.2)	6 Drowning	6 Self harm	282.8 (261.2;339.2)	-16.8
339.9 (318.4;363.1)	7 Self harm	7 Assaults by sharp objects	249.2 (225.0;276.3)	-5.0
262.3 (244.0;327.7)	8 Assaults by sharp objects	8 Drowning	178.6 (166.8;195.4)	-52.6
217.4 (187.3;264.3)	9 Motorcycle rider accidents	9 Aggression — other means	175.4 (146.5;207.3)	-55.3
167.2 (145.9;193.0)	10 Other accidents	10 Other accidents	114.5 (97.3;134.5)	-31.5
135.6 (108.8;151.3)	11 Fire and heat	11 Risks — breathing accidents	75.5 (50.6;90.2)	-41.6
129.2 (86.5;145.0)	12 Risks — breathing accidents	12 Medical complications	53.4 (44.1;65.5)	-42.2
104.8 (78.0;135.0)	13 Extreme temperatures	13 Other traffic accidents	51.6 (42.6;58.2)	138.7
92.4 (72.4;114.8)	14 Medical complications	14 Other mechanic strengths	50.1 (42.6;59.4)	-45.2
91.5 (80.3;109.0)	15 Other mechanic strengths	15 Accidents — bicycle riders	49.2 (44.5;57.1)	26.6
54.7 (32.1;60.2)	16 Accidents — weapon	16 Extreme temperatures	48.9 (35.2;66.2)	-53.3
38.9 (35.8;44.7)	17 Accidents — bicycle riders	17 Fire and heat	47.9 (41.9;60.0)	-64.7
29.6 (22.7;32.8)	18 Accidental choking	18 Accidents — weapon	21.6 (17.1;28.1)	-60.5
28.2 (21.8;31.3)	19 Poisoning	19 Other road traffic accidents	18.5 (10.6;23.6)	140.1
21.6 (19.6;25.1)	20 Other traffic accidents	20 Poisoning	11.7 (10.2;15.1)	-58.5
19.6 (17.2;21.3)	21 Poisonous animals	21 Accidental choking	11.6 (9.8;16.5)	-60.8
16.0 (10.0;17.3)	22 Foreign body	22 Poisonous animals	8.3 (7.4;11.0)	-58.0
11.9 (4.4;25.1)	23 Natural disasters	23 Foreign body	6.8 (5.8;7.7)	-57.5
7.7 (6.4;13.7)	24 Other road traffic accidents	24 Non-poisonous animals	4.6 (4;7.1.0)	-25.8
6.2 (5.7;7.4)	25 Non-poisonous animals	25 Natural disasters	1.1 (0.6;2.4)	-90.7

Brazil had an important decrease in the mortality rate due to RTA between 1990 and 2015. However, the decrease did not occur homogeneously among the main traffic user groups. If, on one hand, there was a decrease of pedestrians and automobile occupants' death; on the other hand, there was an increase of deaths of motorcycle riders and less of bicycle riders.

The morbidity and mortality increase of motorcycle riders have been reported in several studies carried out in Brazil[27-30]. Among the main explanations for this death raise is the increasing use of this type of vehicle for different activities, both in the urban area and also in rural areas. Therefore, there has been a strong fleet growth, which was remarkably observed in the middle of the 1990s[31,32], with a 1,400% increase in the annual sale of motorcycles between 1991 and 2008[31]. The acquisition of motorcycles could be associated with a period of the country's economic scenario, from 2004 to 2013, when millions left the poverty line, with social and economic ascension; thus, people were able to acquire their first own vehicle, which was generally a motorcycle[30]. With regard to the mortality rate per 10 thousand vehicles, between 2003 and 2008, there was a gradual decrease to 6.7/10 thousand people, which is possibly due to an increase of 85% in the fleet size[32].

Despite the increase of mortality rates among motorcycle riders, the rates of pedestrians and automobile occupants still remained as the highest. This finding is not in agreement with other studies[5,30], considering that the number of deaths and the mortality rate of motorcycle riders during the last years surpassed the other victims[33]. The study of Morais Neto et al.[5] identified that, in the 2000–2010 period, the mortality rates of motorcycle riders had overcome those of automobile occupants and pedestrians. In addition, a high growth in the mortality rate of motorcycle riders was observed in the study of Chandran et al.[28]. In the end of the analysis period (2008), the rates were similar (4.7/100 thousand people) to the mortality rates of pedestrians (5.4/100 thousand people). Andrade and Mello-Jorge[6] found that the mortality rates per 100 thousand residents, from 2011 on, among motorcycle riders had already overcome those of pedestrians and automobile occupants, which remained unchanged in 2012 and 2013. This discrepancy in the mortality rates of motorcycle riders, pedestrians, and automobile occupants, if we compare GBD data with those from the SIM, can be due to the process of death codes redistribution and adjustments of garbage codes used in the GBD. This procedure, which is carried out by means of regression equations, redistributes to the other groups of victims those deaths due to traffic accidents in which the victim has not been identified, which may also attributes a larger weight to pedestrians. As the percentage of deaths with unspecified victims is approximately 20% of the total RTA[33], it may be the cause of the discrepancy. Another finding was that the rates showed variations among the states within the Brazilian regions. Although there has been a decrease in the mortality rate in almost all FU — with the exception of Piauí, in the northeastern region — the magnitude of decrease had a wide variation, with more emphasis in the FU of the south and southeastern regions. However, the Federal District had the largest decrease, which is equal to the result found in a study on RTA mortality trends in this FU[5].

Several studies indicated an increase of the mortality per RTA in the states of the north and northeastern regions, especially in the risk among motorcycle riders, with emphasis on the northeastern region[5,34]. In 2011, in these same regions, motorcycles were already the main vehicles in the total fleet[35]. Morais Neto et al.[4], using data from the Brazilian Health Research, found a prevalence of RTA in the states of the north and northeastern regions higher than those of the south region, with high percentages of motorcycle riders. The southeast region showed the lowest mortality rates, which are similar to those found in the study of Andrade and Mello-Jorge[6].

The limitations of this study refer to data source and to corrections used, such as redistribution of garbage codes. In Brazil, the SIM increased registration collection and improved their quality; however, in previous years and in some states, there are some non-collected deaths, incomplete records, raised proportion of garbage codes[36-38]. Therefore, it is important to compare GBD data with Brazilian information to improve the estimates.

CONCLUSION

The efforts developed in the three government spheres, the improvement of information, and the establishment of a national legal framework — the Brazilian Traffic Code, which came into force in 1998 –, with continued improvement, are fundamental elements for Brazil's progress in decreasing the social impact of traffic accidents. The laws promoted a series of interventions directed to the institutionalization of the Traffic National System and to the promotion of road safety.

In the health sector, after publication of the National Policy for the Reduction of Morbidity and Mortality by Accidents and Violences[39] and of the Project on Reduction of Morbidity and Mortality by Traffic Accidents[40], the main guideline for health promotion was established within a complex view of the situations that need to be faced.

The implementation of the *Projeto Vida no Trânsito* in 2010, which was inserted in the international context of mobilization for reaching the goal of the Decade of Actions for Road Safety 2011–2020 of the UN, also represented an advance by seeking to build partnerships, qualify information, and execute articulated, inter-sectorial and integrated interventions[41].

According to the WHO global status report on road safety 2015[1], Brazil is in a better position compared with other densely populated countries in the world in terms of best legislative practices. Brazil has implemented legislation on the use of helmet, seat belt, and adequacy of children's vehicular transportation, and has the most restricted laws of the world on driving after drinking alcoholic beverages.

Despite the advances achieved in the last few years, with decrease of the mortality rates and DALY, there is still a significant challenge ahead in addressing the RTA in the country due to the magnitude of the negative impacts on the population's health.

Finally, it is important to highlight that the GBD results are valuable for a better understanding of the health problems in our country, and GBD is a tool to analyze and prioritize groups of victims, FU, and age ranges as targets for public policies which aim at road safety interventions and the necessary monitoring of results.

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