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Motorcycle accident mortality time trends in Brazil, 1996-2009

ABSTRACT

OBJECTIVE: To analyze motorcycle accidents mortality trends in Brazil.

METHODS: A descriptive time series study of mortality from motorcycle accidents in Brazil between 1996 and 2009 according to state and age group. The data on mortality were obtained from the National Mortality Information System of Ministry of Health and the population data from the Brazilian Institute of Geography and Statistics. Standardized mortality rates were calculated for the entire period for the country as a whole and for each state. Annual variability in mortality rates was estimated using Prais-Winsten generalized linear correlation.

RESULTS: Between 1996 and 2009 the mortality rate increased from 0.5 to 4.5 per 100.000 habitants (an increase of 800.0% in mortality rates during the period studied and an average annual increase of 19.0%). High mortality rates in 2009 were observed in the states of Piauí, Sergipe and Mato Grosso. The largest increases were observed in states in the North, Northeast and Midwest of Brazil.

CONCLUSIONS: There was a significant increase in motorcycle accident mortality rates for the country as a whole during the studied period, mainly in states in the Northeast.

DESCRIPTORS: Motorcycles. Accidents, Traffic, mortality. Mortality Registries. Time Series Studies.

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INTRODUCTION

Worldwide, traffic accidents are one of the largest public health problems. They affect all age groups and affect the productivity of the population, with huge economic, social and emotional repercussions.[15,a]

According to the World Health Organization, in 2010, traffic accidents accounted for more than 1.2 million deaths and injured between 20 and 50 million individuals.[15] Traffic accidents are the 11th highest cause of death and the 9th highest cause of permanent injury in the general population, and the biggest cause of death in the population aged five to 44 years old. This trend is worrying, as it is estimated that it by 2030 it will have become the 5th largest cause of mortality.[15] The most vulnerable groups are pedestrians, cyclists and motorcyclists, and more than 90.0% of deaths from traffic accidents occur in countries with low to medium indices of development, totaling 48.0% of the world's vehicles and 2/3 of its population.[9]

The rate of traffic accidents in Brazil is among the highest in the world.15,a In the first decade of the 21st century, the country experienced a period of economic development, with a stabilized economy, greater availability of credit and increases in per capita income, which led to a huge increase in the number of motor vehicles,[b,c] especially motorcycles.[d]

Table 1. Mortality rates for motorcycle accidents per 100,000 inhabitants, standardized for the Brazilian population of the year 2000. Brazil and states, 1996 to 2009.

State	Year of death													
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Rondônia	0.5	0.8	0.6	0.8	1.4	3.1	3.9	2.8	4.4	4.3	7.3	5.5	7.3	7.1
Acre	0.5	–	0.3	3.0	2.6	2.1	1.9	1.1	1.0	1.3	1.2	0.7	1.7	0.8
Amazonas	0.3	–	–	0.8	2.0	1.7	1.4	1.3	1.8	2.8	2.1	2.6	2.8	2.8
Roraima	–	10.1	10.4	15.7	9.2	10.7	10.4	3.6	3.6	9.2	8.6	13.5	13.7	6.8
Pará	–	0.1	0.2	0.7	1.1	1.5	1.5	2.4	2.5	3.2	3.2	3.7	3.8	3.8
Amapá	0.2	0.6	–	–	0.4	0.3	0.5	0.6	1.5	0.4	2.2	0.8	0.6	1.8
Tocantins	–	0.5	2.2	2.7	3.8	5.1	5.7	6.7	8.0	9.2	8.0	10.4	12	10.8
Maranhão	0.1	0.2	0.3	0.5	0.9	1.0	1.8	2.2	2.3	4.1	3.9	4.9	5.3	5.1
Piauí	0.2	0.3	0.2	0.9	2.1	2.5	3.8	3.8	5.5	7.0	8.6	9.0	11.4	12.2
Ceará	1.3	1.8	2.1	2.5	3.2	4.4	4.7	5.3	5.7	6.6	7.7	7.4	6.9	6.1
Rio Grande do Norte	0.9	1.3	1.3	1.8	2.9	3.1	2.9	3.6	3.0	4.2	5.3	5.6	5.8	6.9
Paraíba	–	0.2	1.0	0.4	0.7	0.8	2.0	1.0	2.3	3.9	3.0	5.0	6.8	5.5
Pernambuco	0.4	0.8	0.9	1.7	2.1	1.9	2.5	3.0	3.0	3.7	4.2	4.2	4.6	5.1
Alagoas	0.6	1.3	0.8	0.7	1.1	1.1	2.0	2.3	2.7	3.6	3.9	4.5	4.0	5.0
Sergipe	0.2	0.3	0.1	0.4	1.8	2.5	3.3	4.7	5.4	5.4	6.9	8.1	9.2	11.4
Bahia	0.1	0.1	0.2	0.4	0.7	0.7	1.2	1.3	1.2	2.1	1.9	2.3	2.0	2.3
Minas Gerais	0.3	0.1	0.2	0.4	0.8	0.9	1.3	1.4	1.8	2.2	2.6	3.1	3.8	3.2
Espírito Santo	0.2	0.6	0.2	1.3	2.1	2.4	3.5	3.0	3.7	4.8	6.2	8.2	9.0	7.2
Rio de Janeiro	0.2	0.2	0.3	0.6	0.8	1.0	1.5	1.9	2.1	2.8	3.6	3.6	4.0	2.5
Sao Paulo	0.2	0.2	0.2	0.4	0.6	1.0	0.8	1.1	1.4	1.9	3.2	3.5	4.1	3.3
Paraná	1.1	1.6	1.6	1.7	2.3	2.6	2.5	3.0	3.9	5.3	5.8	7.2	7.2	5.8
Santa Catarina	3.0	2.6	2.2	2.6	3.0	3.9	4.2	5.3	6.0	7.4	8.9	8.9	8.9	8.5
Rio Grande do Sul	0.3	0.4	0.4	0.4	1.0	1.2	1.6	1.7	2.3	2.5	2.7	2.9	2.9	3.0
Mato Grosso do Sul	1.0	0.2	1.6	0.6	1.5	1.6	3.0	3.0	3.2	7.4	7.8	8.6	9.4	8.4
Mato Grosso	1.3	1.0	2.2	1.3	4.2	4.7	5.1	5.3	6.1	7.9	8.5	10.4	11.7	11.7
Goiás	0.7	0.6	0.4	1.4	3.1	3.3	4.0	1.7	5.0	6.5	6.7	7.2	8.2	6.6
Distrito Federal	1.6	0.6	0.1	0.5	0.5	0.3	1.7	1.2	1.4	3.1	3.0	4.8	4.3	3.4
Brazil	0.5	0.6	0.6	1.0	1.5	1.5	2.1	2.4	2.8	3.2	3.8	4.1	4.5	4.5

[a] Instituto de Pesquisa Econômica Aplicada; Departamento Nacional de Trânsito. Impactos sociais e econômicos dos acidentes de trânsito nas rodovias brasileiras: relatório executivo. Brasília (DF): IPEA; DENATRAN; 2006.rodovias brasileiras: relatório executivo. Brasília (DF): IPEA; DENATRAN; 2006.

[b] Ministério da Saúde, Secretaria de Vigilância em Saúde, Departamento de Análise de Situação em Saúde. Mortalidade por acidentes de transporte terrestre no Brasil. Brasília (DF); 2007. (Série G. Estatística e Informação em Saúde).

[c] Instituto de Pesquisa Econômica Aplicada. Mobilidade urbana e posse de veículos: análise da PNAD 2009. Brasília (DF); 2010. (Comunicados do IPEA, 73).

[d] Associação Brasileira dos Fabricantes de Motocicletas, Ciclomotores, Motonetas, Bicicletas e Similares. Dados do setor de motocicletas no ano de 2010. São Paulo; 2011 [cited 2011 Oct 2]. Available from: http://abraciclo.com.br

Increasing mobility in both urban and rural areas, linked to the low coverage and poor quality of public transport, made the motorcycle the most flexible means of transport. Moreover, compared to the car it costs less to buy and to run and is increasingly used in work-related activities.[1,4,5,7,11-14]

The number of motorcycles in Brazil rocketed from approximately 2,800,000 in 1998 to 16,500,000 in 2010, an increase of 490.0%, which meant motorcycles jumped from 11.5% of all motor vehicles in Brazil to 26.1%. The overall number of vehicles increased by 160.0% in the same period, from approximately 25,000,000 to 63,000,000.[d]

Despite the epidemiological relevance of the problem and the availability of data from official sources, there are no studies that analyze the evolution of deaths from motorcycle accidents in Brazil.

The aim of this study was to analyze motorcycle accident mortality trends in Brazil.

METHODS

This is a descriptive time series study of mortality from motorcycle accidents in Brazil according to state and age group between 1996 and 2009. From 1996 onwards the *Sistema de Informação sobre Mortalidade*[e] (SIM – National Mortality Information System) began to record deaths according to the tenth revision of the International Classification of Diseases (ICD-10). In this study, it was decided to use 1996 as the initial period of analysis, due to the aforementioned change in recording data.

Data on mortality were obtained from the SIM. Deaths from traffic accidents were considered to be those of a driver or passenger (ICD-10 codes V200–V29). Population data were gathered from the Brazilian Institute of Geography and Statistics (IBGE).[f]

In order to perform appropriate analysis and comparison between states and years, the total mortality rates for accidents involving motorcycles per 100,000 inhabitants were standardized using the direct method, considering the year 2000 as a benchmark for the population of Brazil. The unstandardized mortality rates were assessed according to age group: zero to 19 years old (children and adolescents), 20 to 59 years old (adults) and ≥ 60 (the elderly).

A database was constructed using the Stata 9.0 software, in which the analyses were undertaken. Prais-Winsten[3] linear regression models were used to quantify annual variations in the mortality rates with the respective 95% confidence intervals allowing trend analysis from 1996 to 2009. The rates were deemed to be stable when the coefficient of regression was not significantly different from zero ($p > 0.05$), to be increasing when the coefficient was positive and decreasing when it was negative.

Table 2. Trend of mortality from motorcycle accidents. Brazil and states, 1996 to 2009.

UF	Mean annual variation (%)	CI95%	Conclusion
Rondônia	21.82	15.06;28.97	Increase
Acre	-0.91	-13.13;13.02	Stable
Amazonas	14.09	6.32;22.43	Increase
Roraima	-6.43	-14.18;2.02	Decrease
Pará	33.94	11.68;60.64	Increase
Amapá	6.51	2.64;10.52	Increase
Tocantins	20.97	9.96;33.09	Increase
Maranhao	30.12	19.88;41.23	Increase
Piauí	34.14	21.15;48.52	Increase
Ceará	10.87	4.04;18.15	Increase
Rio Grande do Norte	14.09	9.46;18.93	Increase
Paraíba	25.90	22.14;29.77	Increase
Pernambuco	18.71	11.06;26.89	Increase
Alagoas	16.21	11.57;21.05	Increase
Sergipe	38.40	20.88;58.46	Increase
Bahia	27.38	13.46;43.00	Increase
Minas Gerais	26.71	17.51;36.62	Increase
Espírito Santo	29.77	19.94;40.40	Increase
Rio de Janeiro	22.77	12.57;33.90	Increase
Sao Paulo	25.44	22.41;28.54	Increase
Paraná	14.20	11.84;16.60	Increase
Santa Catarina	10.48	7.08;14.00	Increase
Rio Grande do Sul	20.24	13.51;27.38	Increase
Mato Grosso do Sul	29.43	19.58;40.09	Increase
Mato Grosso	24.19	15.65;33.36	Increase
Goiás	23.81	12.24;36.57	Increase
Distrito Federal	19.00	9.02;29.91	Increase
Total	19.23	14.18;24.50	Increase

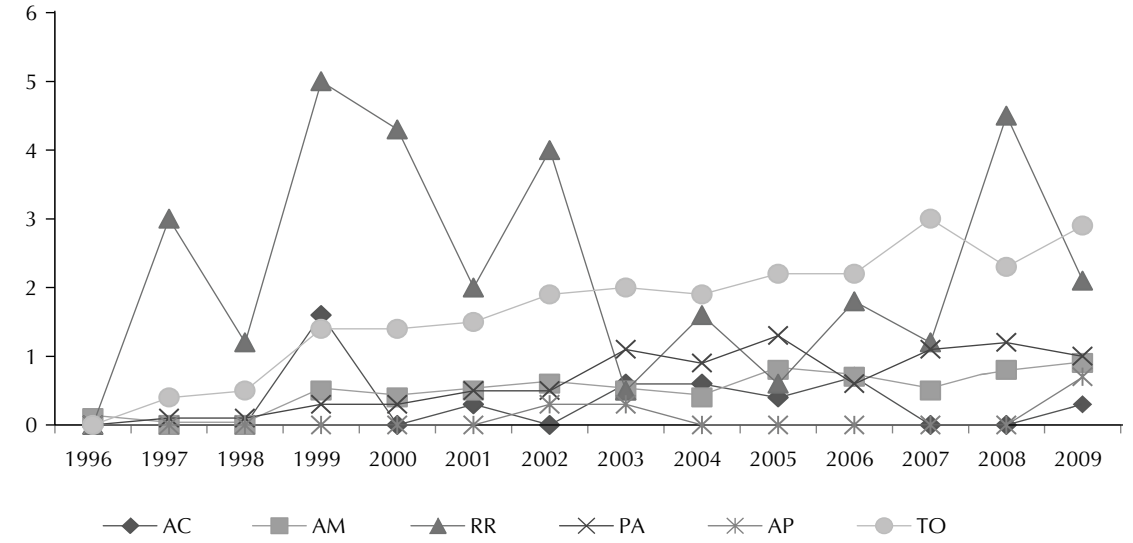
RESULTS

The mortality rate from motorcycle accidents in Brazil increased by 800.0%, going from 0.5 to 4.5/100,000 inhabitants between 1996 and 2009, a mean increment of 19.0% per year.

Piauí (12.2/100,000 inhabitants) and Sergipe (11.4/100,000 inhabitants), in the Northeast, had the highest mortality rates in 2009, with a mean annual increase of over 30.0%. The state of Bahia had one of the lowest mortality rates (2.3) although it had one of the

[e] Ministério da Saúde. DATASUS. Informações de Saúde [base de dados na Internet]. Brasília (DF): 2009 [cited 2010 Jun 17]. Available from: http://www2.datasus.gov.br/DATASUS/index.php

[f] Instituto Brasileiro de Geografia e Estatística. População estimada por idade: revisão 2009. Rio de Janeiro; 2009.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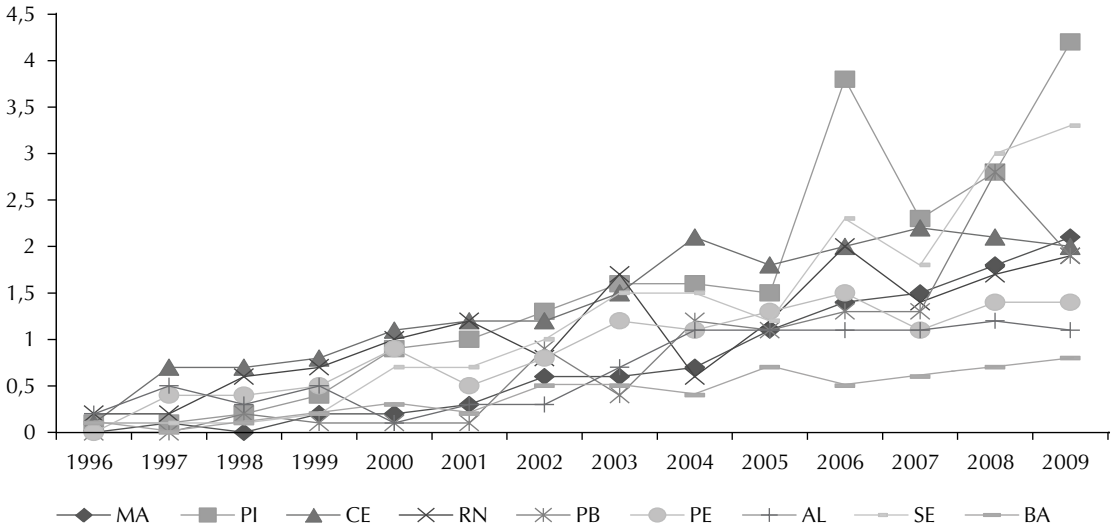
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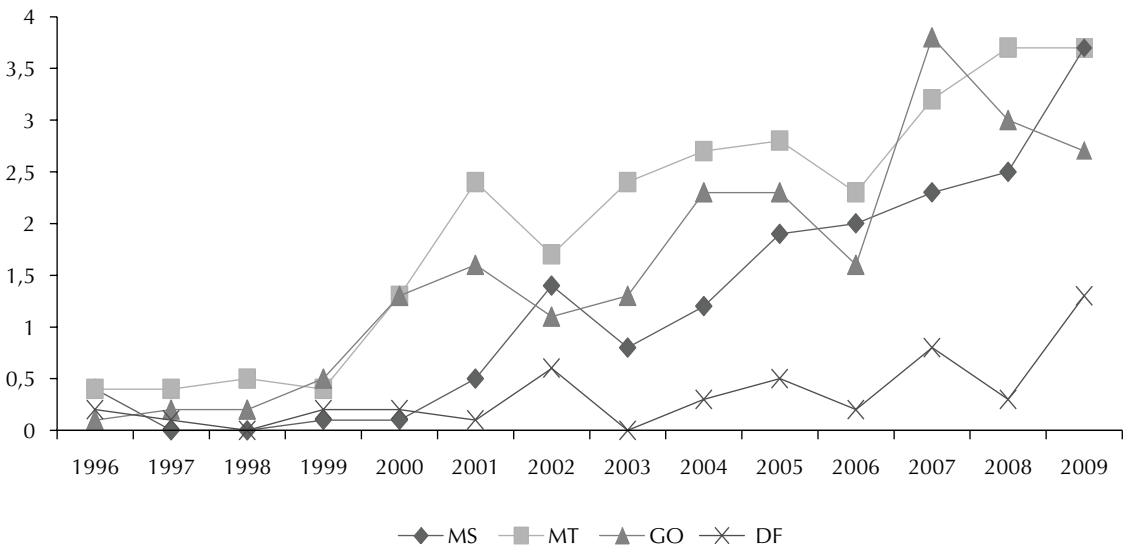
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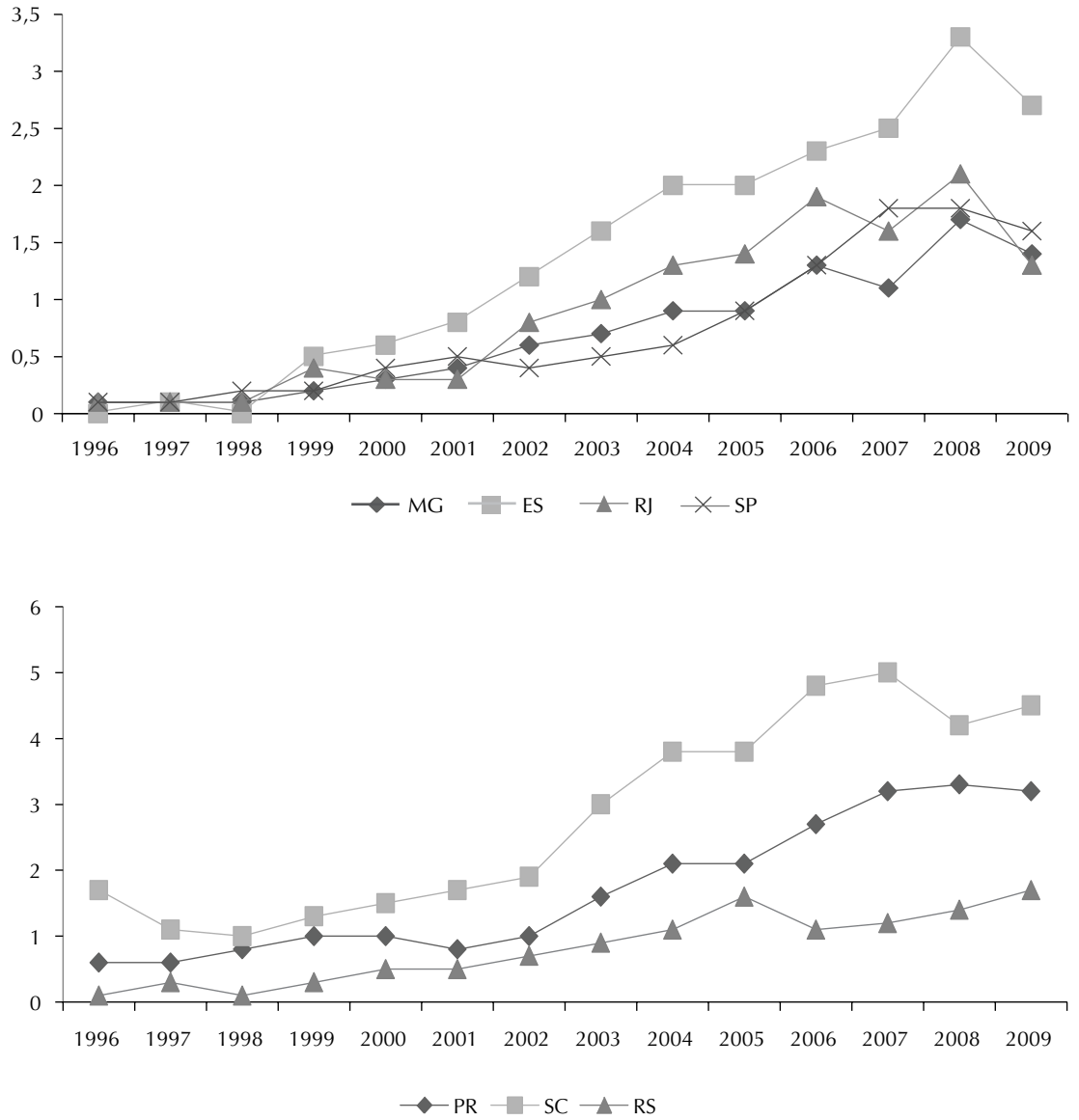


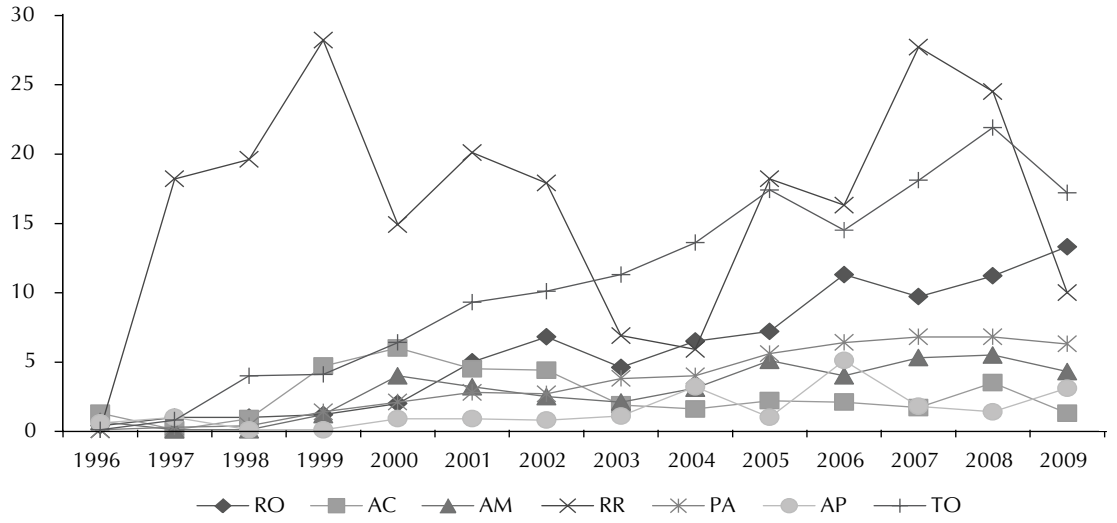
RO: Rondonia; AC: Acre; AM: Amazonas; RR: Roraima; PA: Pará; AP: Amapá; TO: Tocantins; MA: Maranhao; PI: Piauí; CE: Ceará; RN: Rio Grande do Norte; PB: Paraíba; PE: Pernambuco; AL: Alagoas; SE: Sergipe; BA: Bahia; MG: Minas Gerais; ES: Espírito Santo; RJ: Rio de Janeiro; SP: Sao Paulo; PR: Paraná; SC: Santa Catarina; RS: Rio Grande do Sul; MS: Mato Grosso do Sul; MT: Mato Grosso; GO: Goiás; DF: Distrito Federal

Figure 1. Time series of mortality rates for motorcycle accidents (100,000 inhabitants) in the population up to 19 years of age, for the Brazilian regions, 1996 to 2009.

highest annual growth rates (27.4%). In the North, the mortality rates for Tocantins (10.8) and Rondônia (7.1) per 100,000 inhabitants stood out. Roraima was the only state in which there was a decrease (-6.4%) in the mortality rate, although the rate remained high (6.8). The rates for Mato Grosso (11.7) and Mato Grosso do Sul (8.4) stood out in the Midwest region. Espírito Santo had the highest mortality rate (7.2) and the highest annual growth rate (29.8%) in the Southeast, with Sao Paulo (3.3), Minas Gerais (3.2) and Rio de Janeiro (2.5) showing the lowest rates (Tables 1 and 2, Figure 1).

In the South, Santa Catarina had high mortality rates (8.5), despite a low growth rate (10.5%) compared to those observed in the states in the Northeast. On the other hand, it had one of the highest mortality rates (4.5) for the zero to 19 year old age group (Tables 1 and 2 and Figures 1 and 2). The state of Rio Grande do Sul (3.0) had the lowest rate in the South.

Amazonas (2.8), Amapá (1.8), Acre (0.8) and Rio de Janeiro (2.5) had the lowest mortality rates. Sergipe (19.1), Mato Grosso (19.1), Piauí (18.8), Tocantins (17.1) and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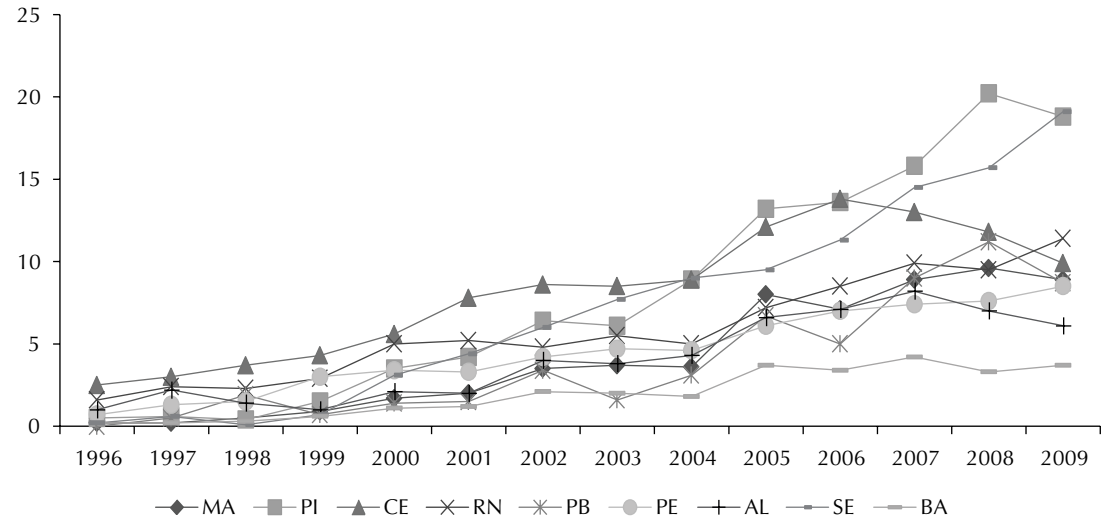
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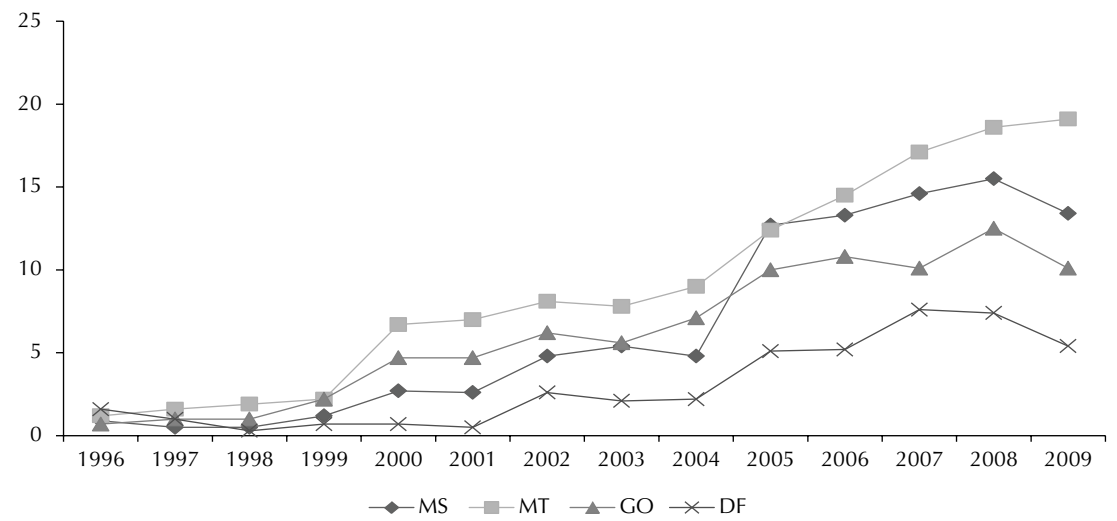
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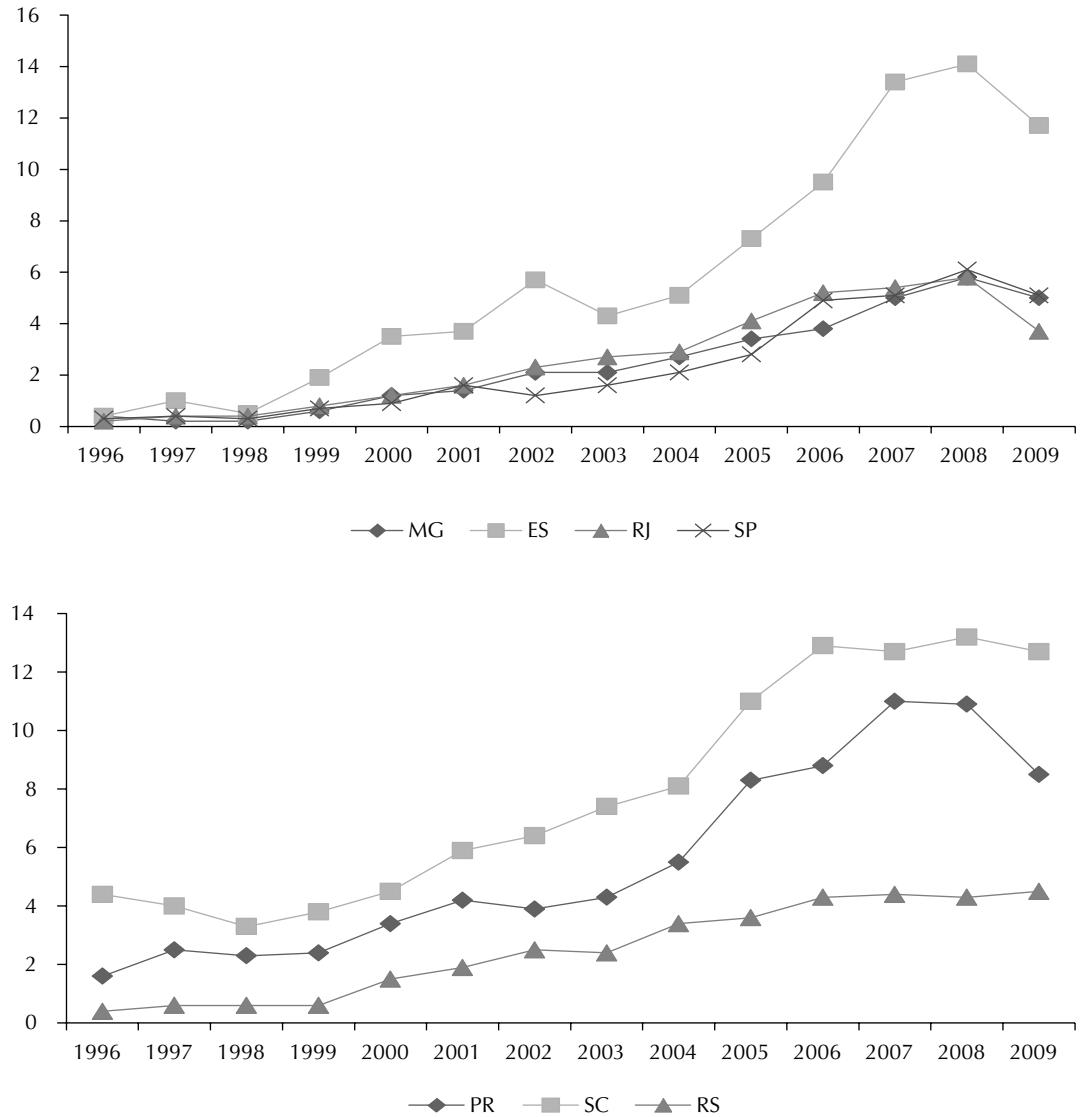

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Figure 2. Time series of mortality rates for motorcycle accidents (100,000 inhabitants) in the population 20 to 59 years of age, for the Brazilian regions, 1996 and 2009.

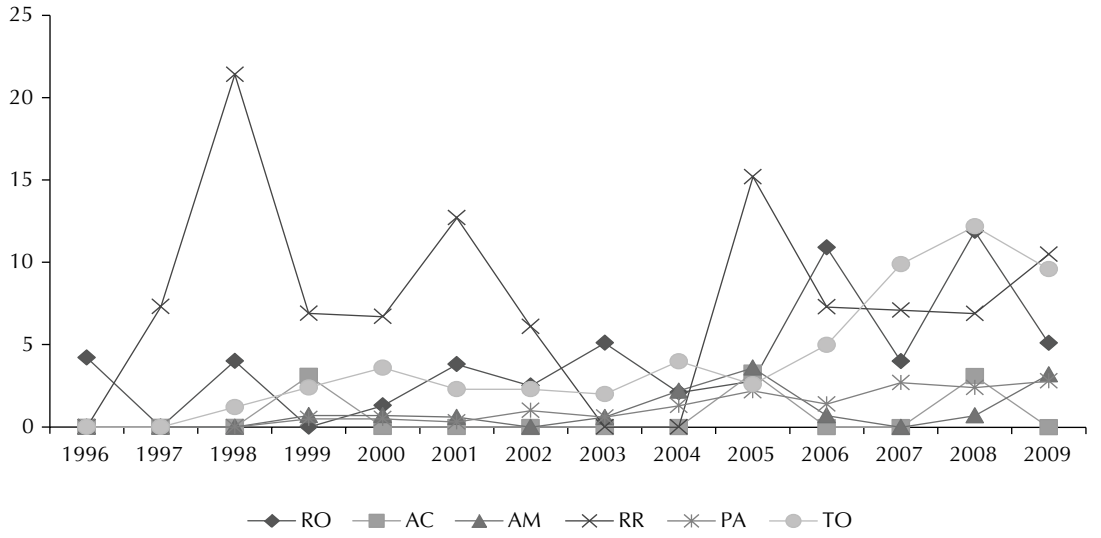
Mato Grosso do Sul (13.4) stood out for mortality among adults and the elderly (Figures 2 and 3).

DISCUSSION

In Brazil, there was a significant increase in mortality from motorcycle accidents between 1996 and 2009. This period was characterized by millions of individuals moving out of poverty and moving upwards socially and economically, acquiring their first vehicle, often a motorcycle. This situation was more conspicuous in the North, Northeast and Midwest regions.[9,15,a,b,c]

The increase in the number of motor vehicles is a worldwide phenomenon, as is the increase in the number of motorcycles.a Mortality rates from motorcycle accidents have increased worldwide, especially in low and middle income countries.[9,15] Even in high-income countries such as the United States, the mortality rates increased 55.0% between 2001 and 2008, from 1.12 to 1.74/100,000 inhabitants.[2,10,g]

[g] National Research Council, National Highway Traffic Safety Administration. Countermeasures that work: a highway safety countermeasures guide for state highway safety offices. 5.ed. Washington (DC): NHTSA; 2010.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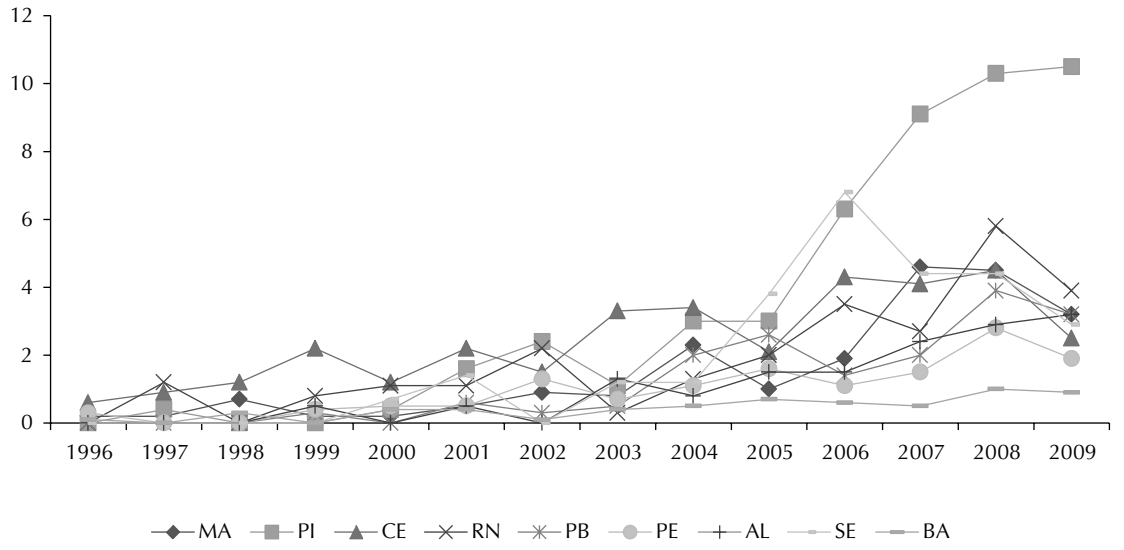
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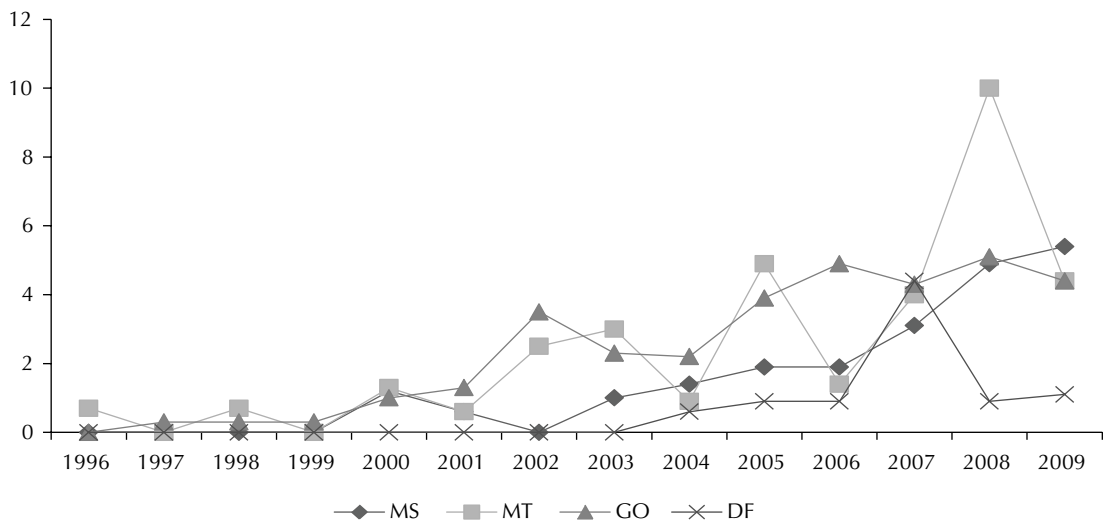
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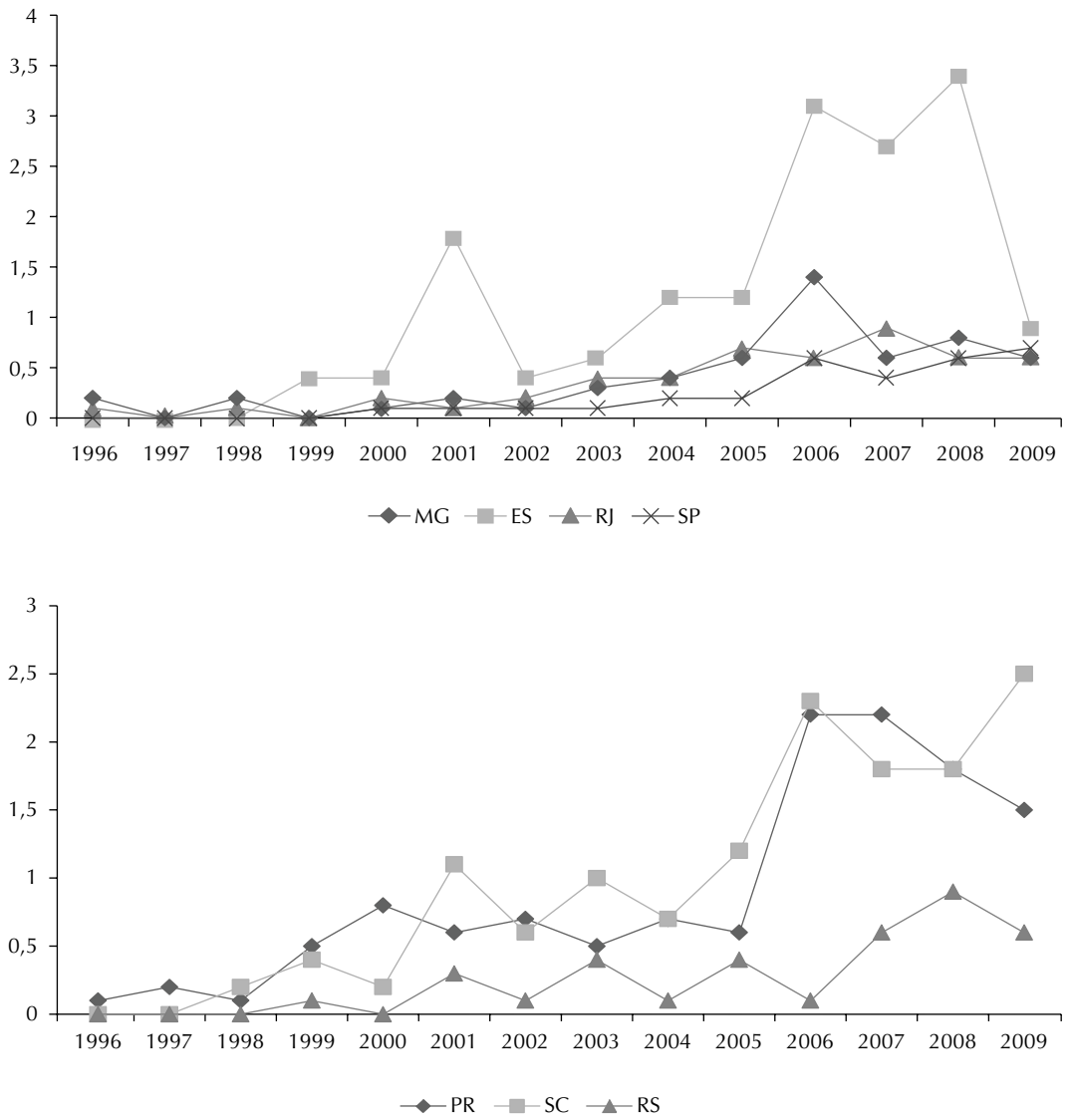

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Figure 3. Time series of mortality rates for motorcycle accidents (100,000 inhabitants) in the population aged over 60, for the Brazilian regions, 1996 to 2009.

Ownership of vehicles and motorcycles differs between the states, varying from up to 70.0% of households, as in Santa Catarina, to 26.0%, in Alagoas.[c] States that have larger public transport systems – such as Sao Paulo, Rio de Janeiro, Minas Gerais and Rio Grande do Sul, where a significant number of the population use public transport such as buses, trains and metro – have lower mortality rates.

This study showed the growing public health problem of motorcycle accidents and death resulting from motorcycle accidents. With the rapid expansion in the number of motorcycles came a significant increase in the mortality rates in all regions and states, especially in the North, Northeast and Midwest of the country. This increase accompanied the growing number of vehicles and the increasing proportion of the population who moved out of poverty, although this study does not allow for inferences on causal relationships.[c]

The growth in mortality rates in the North, Northeast and Midwest may be related to economic development, which stems from the appearance of new agricultural frontiers and agri-business in Maranhão, Tocantins, Piauí and Bahia. In addition, it could be due to the development

of economic activities connected to petroleum and mining in Espírito Santo and Sergipe. Over the last decade, there has been an important cycle of economic development and improvements in income distribution in Brazil, which provided access to consumer goods for a considerable part of the population. The number of motorcycle accident victims overtook the number of car accident victims in 2007, and the number of pedestrian victims in 2009, a trend that is likely to continue in coming years. The motorcycle is one of the most dangerous means of transport. Means of prevention in which the authorities are the main protagonist need to be intensified.[2,10,g]

The deficient road infrastructure, the difficulty of monitoring driving licenses, use of protective equipment such as helmets, drinking and driving and the lack of medical attention in these regions contribute to the high mortality rates and need to be faced up to by the public. There was a fall in the rates in the Southeast after 2008, which could be due to more rigorous enforcement of the *Lei Seca* (Dry Law) there than in other regions.[6,h]

The variation in the quality of SIM records may have influenced the results observed. Data are better recorded in the South and Southeast of the country and there was a substantial decrease in the quantity of deaths classified as from unknown causes during the period.[8] It is expected that, with the quality of information improving over the years, there would be increases in deaths classified under different ICD-10 codes, including motorcycle accidents, which could mean an artificial increase in mortality rates. However, the increase was on such a scale that this reason alone is not enough to explain it.

This study emphasizes the importance of using the increasingly reliable SIM data to monitor mortality rates for external causes in the different regions and states of Brazil, for scientific purposes and for health policies. Continuous and intense use will lead to even better qualification of its records.

This study showed that there has been a huge increase in motorcycle accident mortality rates in Brazil, especially in states in the Northeast. The findings suggest that policy makers may not have satisfactorily taken responsibility for controlling and reducing traffic accidents and mortality from traffic accidents, above all those involving motorcycles. The need to prevent injury and death from motorcycle accidents is a significant and growing public health problem in Brazil.

[h] Brasil. Lei nº 11.705. de 19 de junho de 2008. Altera a Lei nº 9.503, de 23 de setembro de 1997, que 'institui o Código de Trânsito Brasileiro', e a Lei nº 9.294, de 15 de julho de 1996, que dispõe sobre as restrições ao uso e à propaganda de produtos fumígeros, bebidas alcoólicas, medicamentos, terapias e defensivos agrícolas, nos termos do § 4º do art. 220 da Constituição Federal, para inibir o consumo de bebida alcoólica por condutor de veículo automotor, e dá outras providências. Brasília (DF); 2008 [cited 2013 Oct 30]. Available from: http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2008/lei/l11705.htm

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