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Traffic accidents in Brazil from 1998 to 2010: many changes and few effects

ABSTRACT

The paper describes the situation of road traffic accidents in Brazil since 1998, when a new Brazilian traffic law was approved, up to the year 2010. A review of both academic and non-academic literature was carried out, including journals (both indexed and non-indexed), technical reports, author searches, searches in paper reference lists and direct contact with researchers. The main problems related to road traffic accidents in Brazil identified were the increase in the absolute number of deaths and in the mortality rates, a rapid increase in the number of motorcycles, and drink & driving. Influential authors in the field and centers of expertise were identified. Some potential solutions are presented by the authors, who suggest that the public offices related to traffic regulation and control are not taking suitable measures for control and reduction of road traffic accidents.

DESCRIPTORS: Accidents, Traffic, trends. External Causes. Accident Prevention. Review. Mortality. Pedestrian. Motorcyclists. Motor Vehicles.

INTRODUCTION

Around 1.2 million people die worldwide from road traffic accidents (RTA) every year and more than 90% of these deaths occur in low- and middle-income countries.^a In addition to people's suffering from deaths and physical disabilities, RTA also pose a heavy economic burden on health systems. The World Health Organization (WHO) estimates that annual losses due to RTA exceed \$500 billion.^b In Brazil, the annual number of killed and severely injured people exceeds 150,000^c and the Brazilian Institute of Applied Economic Research (IPEA) has estimated that total RTA costs amount to R\$ 28 billion per year.^{d,e}

Brazil ranks high among countries with the world's most dangerous roads and it has sought to reduce the high number of accidents in recent years. After the implementation of the new Brazilian Vehicle Code (BVC)^f in 1998 RTA mortality rate has remained stable (around 20 deaths per 100,000 inhabitants),

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^a World Health Organization - WHO. Global Status Report on Road Safety – Time for action. Geneva; 2009.

^b World Health Organization - WHO. The Global Burden of Disease: 2004 update. Geneva: 2008.

^c Ministério da Saúde. Departamento de Informática do SUS – DATASUS Informações em saúde. Brasília (DF); 2008 [cited 2010 Feb 21]. Available from: <http://www2.datasus.gov.br/DATASUS/index.php?area=02>

^d Instituto de Pesquisa Econômica Aplicada; Associação Nacional dos Transportes Públicos. Impacto social e econômico dos acidentes de trânsito nas aglomerações urbanas brasileiras: relatório executivo. Brasília (DF): IPEA; São Paulo: ANTP; 2003.

^e 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.

^f Ministério das Cidades Departamento Nacional de Trânsito. Código de Trânsito Brasileiro. Brasília (DF): DENATRAN; Conselho Nacional de Trânsito; 2008.

which is higher than the rates reported in Japan, Sweden and Canada (five to eight deaths per 100,000).^a New laws, local traffic control, improved vehicle safety and increased electronic traffic monitoring has all failed to significantly reduce deaths and disabilities.

This article aimed to present a panorama of road traffic since the implementation of the new BVC.

METHODS

In light of the small number of scientific publications on RTA and low interaction between areas such of knowledge such as epidemiology, engineering, psychology, medicine and others, a descriptive review was conducted with extensive literature search. This review study included scientific articles and publications in Portuguese, English and Spanish published between 1998 and 2010 with data collected in Brazil and that evaluated RTA as a primary or secondary outcome. There was conducted a search of indexed journals in electronic databases, non-indexed journals, technical reports, search by specific authors, reference lists of articles and communications with researchers. The electronic search was conducted in MEDLINE (National Library of Medicine), LILACS (Latin American and Caribbean Health Sciences), SciELO (Scientific Electronic Library Online) and Google Scholar databases. It included the following descriptors: “traffic accidents”, “road accidents”, “epidemiology” and “external causes”. The descriptor “Brazil” was added to restrict the search to publications in Brazil. There was no restriction on demographic and socioeconomic factors and types of studies. The search for articles was carried out between February and October 2010. Publications were pre-selected based on their titles and abstracts. The full text of the publications selected was obtained and examined. Brazilian websites such as the National Traffic Department (Denatran), National Department of Transport and Infrastructure (DNIT), Brazilian Federal Highway Authority (DPRF) and Brazilian Ministry of Health Mortality Database (Datusus) were searched. Manual search for non-indexed journals was also carried out at the Universidade Federal de Pelotas (UFPEL) and Universidade Católica de Pelotas (UCPEL) libraries.

The data here presented follow the WHO 10th Revision of the International Classification of Diseases and Related Health Problems (ICD-10).^g Data on mortality and morbidity (hospital admission) between 1998 and

2005 was obtained from the “Traffic Accidents in Brazil – An Atlas of their Distribution,” a publication of the Brazilian Traffic Medicine Association (ABRAMET).^h Data on mortality and morbidity between 2006 and 2008 was obtained from Datusus database.ⁱ The 2008 mortality data are preliminary and morbidity data include the year of 2009. The DENATRAN^j provided information on the motor vehicle fleet.

DATA AND TRENDS FROM 1998 TO 2008

Law No. 9503 established in 1998—the first year of this review study—the new BVC.^f The new BVC was regarded as a promising action to reduce the growing number of RTA and address this issue. It included stringent laws, higher fines and chapters on traffic education in traffic. However, RTA mortality and hospital admission rates remained the same or even increased.

By the end of 1998, a total of 30,890 people died from RTA. It increased by 19% in 2008 (36,666 deaths) while the Brazilian population increased 17%. From 1998 to 2000 there was a decrease in the fatality rate (28,995 deaths) but it increased steadily in the following years, amounting to 37,407 deaths in 2007. The number of hospital admissions resulting from RTA increased by 9%, from 108,988 in 1998 to 123,168 in 2009. It increased until 2000 (119,585), then fell from 2000 to 2003 (109,696), increased from 2003 to 2006 (120,997) and then fell again in 2007. A peak and a dip were seen during 2008 and 2009: a decline in 2008 (~95,000 hospital admissions), followed by an increase by more than 30% (123,168) in 2009. This variation may be explained by the impact of the National Prohibition Act (Law No. 11.705/08) or errors in the database.

Figure 1 shows mortality rates from RTA with denominators commonly used in the Brazilian scientific literature (deaths per 100,000 inhabitants and per 10,000 vehicles).

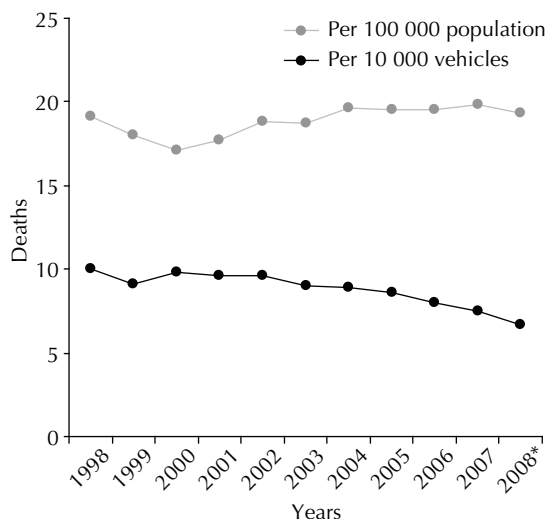
The mortality rate from RTA declined during the first two years of follow-up (from 19.1 deaths per 100,000 in 1998 to 17.1 in 2000). There was a steady increase between 2001 and 2004, reaching 19.6 deaths per 100,000, which remained stable and close to 20 deaths per 100,000 in subsequent years. The RTA mortality rate per vehicles remained stable (around 10 deaths per 100,000 vehicles) until 2002. From 2003 to 2008 there was a slow decrease, 6.7 deaths per 100,000. This decrease may be explained by an 85% increase of the

^g Organização Mundial da Saúde. Classificação estatística internacional doenças e problemas relacionados à saúde: CID 10 [cited 2010 Oct 28]. Available from: <http://cid10.datusus.gov.br/>

^h Mello Jorge MHP, Koizumi MS. Acidentes de trânsito no Brasil. Um atlas de sua distribuição. São Paulo: Associação Brasileira de Medicina de Tráfego; 2007. [cited 2010 Mar 10]. Available from: http://www.abramet.org.br/Site/Pagina.aspx?ID=399&MenuID=73&lang=pt_BR

ⁱ Ministério da Saúde, Departamento de Informática do SUS – DATASUS. Informações em saúde. Brasília (DF); 2008 [cited 2010 Feb 21]. Available from: <http://www2.datusus.gov.br/DATASUS/index.php?area=02>

^j Ministério das Cidades, Departamento Nacional de Trânsito – DENATRAN. Frota de veículos. [cited 2010 Feb 22]. Available from: <http://www.denatran.gov.br/frota.htm>



*Preliminary data

Sources: Acidentes de trânsito no Brasil – Um Atlas de sua distribuição – ABRAMET (Data until 2005). Brazilian Ministry of Health/Secretaria de Vigilância em Saúde/Departamento de Análise de Situação de Saúde – Sistema de Informações sobre Mortalidade - SIM (Data from 2006).

Figure 1. Mortality rate from traffic accidents per 100,000 population and 10,000 vehicles. Brazil, 1998-2008.

Brazilian vehicle fleet, from 29.5 million vehicles to over 54 million.

Figure 2 shows RTA according to categories of victims. “Other” included occupants of three-wheeled motor vehicle, heavy vehicles (trucks), and buses, other road

accidents and unspecified road accidents. The category “Car occupants” included occupants of vans.

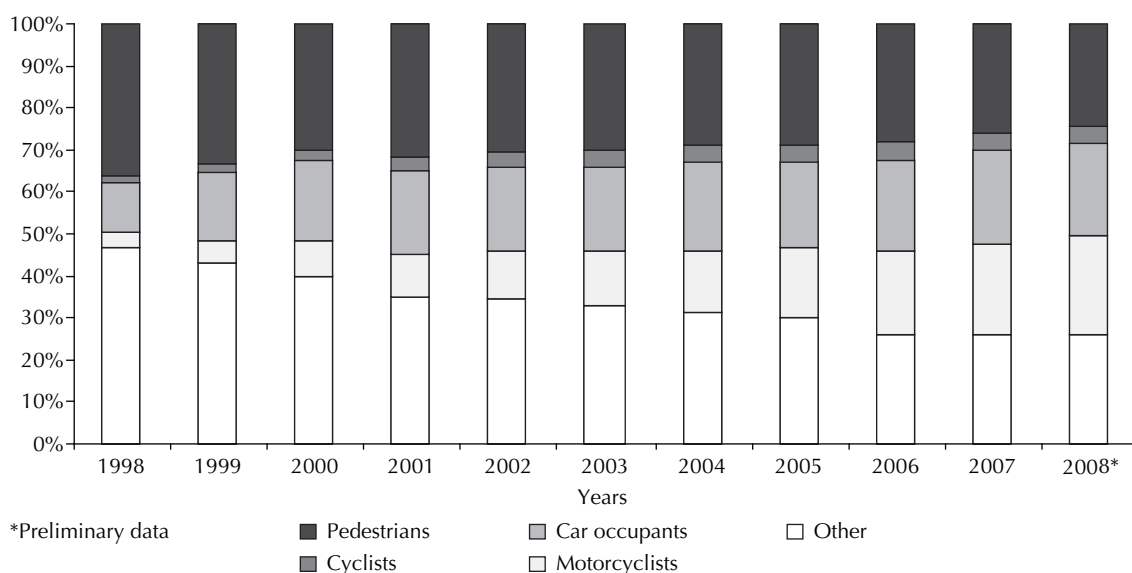
In “Other” category there were approximately 14,500 deaths in the beginning of the study period, accounting for 45% of all deaths. After a steady decline, there were seen 9,603 deaths in 2008, just over 26%. This decrease may be resulting from improved data quality as it also included unspecified road accidents.

There was a 12% reduction in relative pedestrian deaths (36% in 1998 to 24% in 2008). However, the number of deaths remained quite constant (from 9,000 to 10,000 deaths/year).

Deaths of car occupants accounted for 22% of total deaths in 2008 compared to 12% in 1998. The number of fatalities increased by 121% (from 3,736 to 8,093 deaths), being higher in 2007 (8,273 deaths).

Fatalities among motorcycle drivers and passengers increased over 700% during 1998–2008 (from 1,028 to 8,529 deaths). Motorcyclist deaths rose from 3% to 23% of all deaths and cyclist fatalities increased from 1% (396 deaths) to 4% (1,556 deaths), being higher in 2006 (1,668 deaths).

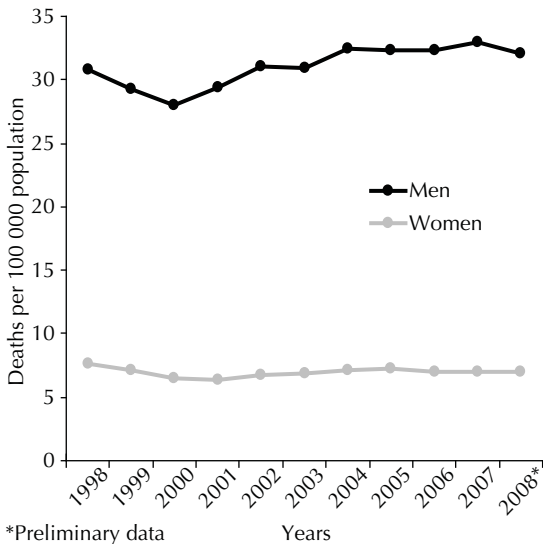
Similar to other countries, Brazilian males died more from RTA than females (approximately 4.5 male: female). There was a reduction of RTA mortality rate among males from 1998 to 2000, reaching the lowest rate of the study period (28 deaths per 100,000 males) (Figure 3). After a steady rise, it reached 33 deaths per 100,000 in 2007. Among females, after a decline



*Preliminary data

Sources: Acidentes de trânsito no Brasil – Um Atlas de sua distribuição – ABRAMET (Data until 2005). Brazilian Ministry of Health/Secretaria de Vigilância em Saúde/Departamento de Análise de Situação de Saúde – Sistema de Informações sobre Mortalidade - SIM (Data from 2006).

Figure 2. Proportion of deaths from traffic accidents according to the categories of victims. Brazil, 1998-2008.



*Preliminary data

Sources: Acidentes de trânsito no Brasil – Um Atlas de sua distribuição – ABRAMET (Data until 2005). Brazilian Ministry of Health/Secretaria de Vigilância em Saúde/Departamento de Análise de Situação de Saúde – Sistema de Informações sobre Mortalidade - SIM (Data from 2006).

Figure 3. Proportion of deaths from traffic accidents per 100,000 population stratified by sex. Brazil, 1998-2008.

between 1998 and 2000, it remained stable at seven deaths per 100,000.

MOTORCYCLES

Motorcycles have taken up urban spaces as an efficient means of transportation and work to avoid traffic congestion in large cities. Deficient public transport, the growing delivery service industry, the possibility of generating income for unskilled young people and ease of purchasing a motorcycle have all lead to a 5-fold increase in motorcycle fleet compared to car fleet. There are more than 14 million circulating motorcycles, accounting for 25% of the national fleet.¹ The motorcycle has become the most popular single means of transportation in Brazil.³⁶ But careless riding and increased vulnerability of the driver and passenger have led to an increase in the number of accidents involving motorcyclists, especially young males,^{2,9,42,61} and their main victims, pedestrians.^{9,61,k} Motorcycle drivers are a priority group in prevention programs^{9,11,59} because they are seven times more at risk of dying, four times more likely of being injured and two times more likely to hit a pedestrian compared to car drivers.⁹ Pedestrians were historically the main victims of road accidents but now they involve mainly motorcyclists.^{2,9,11,59} In four large urban centers (Belém in the northern state of Pará, Recife in the northeastern state of Pernambuco, São Paulo in the southeastern state of São Paulo and Porto

Alegre in the southern state of Rio Grande do Sul), 7% of all car accidents involved victims while this proportion ranged from 61% to 82% in motorcycle accidents.^d The cost of RTA involving motorcyclists was estimated at R\$ 5.3 billions between 1998 and 2006, R\$ 1,400.00 per circulating motorcycle.^k

Motorcycle courier and motorcycle taxi driver have become regulated professions under Law No. 12,009 of 29 July 2009 requiring a minimum age of 21 years, a two-year driver's license in this category and specialized training. Most drivers are young adult males.^{32,64} The motorcycle as a means of work is regarded as a potential factor for increased motorcycle casualties,^{2,9,11,59} and motorcycle couriers are at high risk of RTA due to their job demands.^{19,36,64,73} In São Paulo^k and Porto Alegre⁷⁴ 37% of deaths and 28% of emergency hospital admissions of motorcyclists were among motorcycle couriers. Pressure from customers and employers for fast deliveries,^{19,73} pay on the basis of productivity and daily work shifts exceeding 10 hours^{19,64} have been identified as determinants of inappropriate driving. Increased productivity is a justification for their disrespect for traffic laws.^{19,32,65,73} Typical behaviors of young males including boldness, immaturity, a sense of invulnerability, a tendency to overestimate their abilities and driving inexperience allied to the need to become part of a group make them push the limits and transgress them,¹ which makes it more complex the issue of RTA. The executive veto of BVC Article 56 that prohibited driving between the lanes of traffic on the grounds of offering “greater flexibility of movement” further jeopardizes the safety of road users.

The expanding market of delivery services and motorcycle taxis indicates that these workers' job is demanded in our society. A qualitative study conducted in Porto Alegre showed the social dichotomy involving motorcycle couriers: while they are discriminated as drivers, their services are needed for fast deliveries.⁷³ This pressure—recognizably a causing factor for traffic accidents—is key to secure their jobs and is encouraged by employers and clients.⁶⁵

Diniz et al¹⁹ have suggested the work reality of these workers outgrows the thrill of riding a motorcycle. They often have to cope with poor work conditions, lack of formal contracts, long working hours, stress, psychological pressure for greater productivity, low income and high risk of accidents. Motorcycle couriers live with the dialectic of risk-need as described by Veronese & Oliveira:⁷³ “To work at risk of an RTA or not to work, that's the question. All that motorcycle couriers can do is to manage the risk.”

The phenomenon of motorcycle couriers is a major issue for traffic authorities in Brazil.¹⁴ Some actions

^k Vasconcellos EA. O custo social da motocicleta no Brasil. *Rev Transp Públicos* 2008;Ano30/31;3º/4ºtrimestres:127-42.

have been pointed as critical for reducing RTA. Employers and clients have to take part of this responsibility, reducing their demands for deliveries that involve unsafe behaviors and extenuating working hours.^{32,73} Companies must be required to hire professional motorcycle couriers who have been trained on defensive driving and use of safety equipment, in addition to greater motorcycle inspection and use of speed control devices.^{32,73} However, a new debate on BVC Article 56¹⁴ and targeted actions to promote motorcycle courier behavior change⁷³ are unlikely to be effective. Vasconcellos said the motorcycle-related deaths have cancelled out the gains achieved with BVC in reducing RTA by other vehicles.^k

The motorcycle has definitely a social role, either at work, for commuting or during leisure time, and occupies 82% less public space than cars.⁶³ Its new status is part of an irreversible change of the motor vehicle fleet composition.³⁶ The challenge is to ensure safety of road users.

DRINKING AND DRIVING

The association of alcohol and RTA has been well documented in the literature. It is a major cause of morbidity and mortality affecting mostly young males.¹ The First Household Survey on Patterns of Alcohol Consumption conducted in 143 Brazilian cities in 2009 showed a 35% prevalence of drinking and driving (43% among men and 9% among women).⁵⁴ Studies carried out in São Paulo, the Federal District, and Porto Alegre between 2005 and 2009 on the association between alcohol use and related deaths found blood alcohol contents (BAC) in 45%, 43% and 32% of cases, respectively.^{30,49,m} Among non-fatal injuries treated at trauma care centers and emergency rooms in São Paulo and Uberlândia (southeastern state of Minas Gerais), the prevalence of alcohol use was 24% and 29%, respectively.^{24,27} Alcohol use was suspected in nearly 17% of RTA cases seen at emergency services in the cities covered by the Sentinel Surveillance System on Violence and Injuries.³⁷

Under the 1998 BVC driving under the influence of alcohol (BAC ≥ 0.6 grams of alcohol per liter of blood) is a criminal offense. Law No. 11,705 that went into effect on June 20, 2008 changed blood alcohol limit for drivers to zero (with a tolerance of up to 0.2 g/L) punishable with more strict penalties up to imprisonment in *flagrante delicto* if BAC >0.6 g/L. Few studies have assessed the effectiveness of the Prohibition Act or Zero

Tolerance law. Mello Jorge & Koizumi⁴⁷ found 28% reduction in hospital admissions between the two halves of 2008, as well as significantly reduced hospital stay (42%), hospital costs (39.2%) and mortality (13.6%). In the city of São Paulo, there was a 48% to 36% reduction in BAC in fatal injuries when compared data from the second half of 2007 and 2008.²⁸ Despite not having been based on a time series that could support or refute the findings, the results suggest that the new law was effective.

Moura et al⁵⁰ monitored through phone calls the frequency adults drove after using alcohol in 27 Brazilian cities. They found a decrease in the months immediately following the enactment of the law but further increase was seen in the following months. These studies, together with morbidity data from the Brazilian National Health System Database (SIH-SUS), suggest that the Zero Tolerance law of 2008 was effective in reducing alcohol-related RTA for a limited period.

The city of Porto Alegre passed a law against alcohol consumption at gas stations in 2006. De Boni et al¹⁷ showed no difference in BAC among groups of young patrons pre- and post-law enforcement. Studies using breathalyzers to estimate BAC at sobriety checkpoints on weekends showed very high prevalences in other two cities. In the city of Belo Horizonte BAC was detected in 38% of drivers and was above the legal limit in 20%.¹³ In the city of Diadema, state of São Paulo, the proportions were 24% and 19%, respectively, which are up to six times higher than those reported in international studies.²¹ A study conducted post-law enforcement with individuals potentially at risk for alcohol-related RTA found 51% with BAC and they intended to drive.ⁿ Studies^{13,17,21,n} pointed deficient oversight as a factor for failed law enforcement, in addition to high prevalence of BAC. Pinsky et al⁵⁶ showed that 85% of young people applying for a driver's license did not know anyone who has been legally punished for drinking and driving, 74% believed that no offender would receive the statutory penalty and 64% said it was very unlikely they would be stopped by police or subject to penalties. A study conducted post-enforcement of the Zero Tolerance law found that, while 86% of respondents said they had drunk and driven in the last year, 9% were stopped and asked to perform a breathalyzer test.ⁿ Twenty percent of professional drivers working in Brazilian federal highways said they had been asked to take the breathalyzer test while 9% and 8% of car and motorcycle drivers were asked to do so, respectively.

¹ Pinsky I, Laranjeira R. O fenômeno de dirigir alcoolizado no Brasil e no mundo. *Rev ABP-APAL*. 1998;20(4):160-5.

^m Stampe MZ, Silva HH, Schroeter D, De Boni R, Pechansky F, Camargo J et al. Acidentes de trânsito com vítimas fatais necropsiadas no Departamento Médico Legal de Porto Alegre. In: Pechanski F, Duarte PCAV, De Boni RV, organizadores. *Uso de bebidas alcoólicas e outras drogas nas rodovias brasileiras e outros estudos*. Porto Alegre: Secretaria Nacional de Políticas sobre Drogas; 2010. p. 78-83.

ⁿ De Boni R, Vasconcellos M, Holmer BP, Robin R, Bastos FI, Pechansky F, Beber e dirigir em uma amostra de condutores que frequentam bares de Porto Alegre. In: Pechanski F, Duarte PCAV, De Boni RV, organizadores *Uso de bebidas alcoólicas e outras drogas nas rodovias brasileiras e outros estudos*. Porto Alegre: Secretaria Nacional de Políticas sobre Drogas; 2010. p. 90-5.

BAC was detected in 1% of bus drivers to up to 5% of truck drivers.⁹

Souza et al⁹ reported that 47% of RTA cost is related to excess alcohol use in Porto Alegre. Mello Jorge & Koizumi⁴⁷ showed 28% reduction in hospital admissions and 36% cost reduction with a public saving of more than R\$ 23 million after the enforcement of Zero Tolerance law. They stressed this law has saved lives since it came into force.

The negligence of state authorities with inadequate oversight can kill thousands of people each year.^{13,17,21,6} The Zero Tolerance law would not be required if there were effective oversight and enforcement of the previous law. Countries with low RTA mortality rates (<8 deaths per 100,000) enforce BAC limits close to that provided in the 1998 BVC such as 0.3 g/L in Japan, 0.5 g/L in France, 0.5 g/L in Germany, 0.5 g/L in the Netherlands, 0.8 g/L in England, and 0.8 g/L in Canada.^a They all have strict enforcement of alcohol laws.

The Global Road Safety Partnership (GRSP)^q recommends actions to reduce alcohol-related accidents such as political commitment to reduce drinking and driving, clear laws for alcohol limits and penalties for offenders, mass campaigns and dissemination of law enforcement, education to change behavior and strict penalties for offenders.

WHO recommends the implementation of sobriety checkpoints with breathalyzer tests, which is a cost-effective action than can reduce accidents by 20%.^a They should be operated primarily on weekend nights when most alcohol-related RTA occur.^{24,28,49}

According to the Brazilian Consensus on Public Policies on Alcohol²⁹ (2004), evidence-based measures are an approach with great potential for success in preventing alcohol-related RTA and should include low BAC tolerance, evident and frequent oversight, suspension of offenders' driver's license and increasing the certainty of punishment through spot checks (oversight of checkpoints).

It is critical to improve control and oversight of alcohol sale and advertising. Beer must be categorized as an "alcoholic beverage" and subject to restrictions on advertising and broadcasting times since the greatest investment are made in alcohol products.^{34,57}

The First Household Survey on Patterns of Alcohol Consumption in the Brazilian population showed that

people support public policies that address the drinking and driving problem including increasing taxes on alcohol, restrictions on alcohol advertising and alcohol industry sponsorship of cultural and sports events and stricter penalties.^r Nascimento & Garcia⁵¹ have examined many public policies, emphasizing the need to definitely set the alcohol issue high in the Brazilian political agenda. Yet the power of the parties of interest including alcohol industry, retailers and consumers should not be underestimated. These policies must be implemented as the people's wish should prevail.

PEDESTRIANS AND CYCLISTS

Pedestrians account for almost one-third of deaths from RTA in Brazil (approximately 10,000 deaths per year) and an increasing number of deaths are seen among cyclists (over 1,500 in 2005).^h Pedestrians are the third largest group of victims, following motorcyclists and car occupants in southern Brazil, but they are the leading group in casualties (38% of deaths and 11% mortality rate).⁹ There is high underreporting of RTA in pedestrians and cyclists, 53% and 33%, respectively, with a corrected mortality rate of 5%, the highest for both groups. Among injured pedestrians 70% were children or elderly.⁹

In the city of Maringá, southern state of Paraná,⁶⁸ pedestrians and cyclists had a 119% and 65% higher risk of RTA hospital admission, respectively, compared to car occupants. In 1998, 47% of the deaths occurred in pedestrians and cyclists⁶² and almost 90% of deaths in elderly (65 years or more) were caused by run overs. Andrade & Mello Jorge² found that even if pedestrians are 12% of total RTA in Londrina, southern state of Paraná, they account for almost one-third of the deaths and have the highest rates of hospital admission (18%) and mortality (5%). Soares & Soares study⁶⁷ showed that children and elderly are the main groups of injured pedestrians, with high rates of RTA incidence and mortality among the elderly (256 and 44 per 100,000, respectively). Pedestrians accounted for 42% while cyclists accounted for 15% of RTA deaths in the city of Fortaleza, northeastern state of Ceará, in 2001–2002. These two groups accounted for 38% of all injuries.¹⁶

The elderly are the main injured group among pedestrians. Gawryszewski et al²⁶ pointed RTA as a leading cause of death from external causes in this group, half of them occurring by run overs. In the city of

⁹ Pechanski F, De Boni R, Duarte P, de Paula FC, Benzano D, von Diemen L et al. Consumo de álcool e drogas entre motoristas privados e profissionais do Brasil. In: Pechanski F, Duarte P, De Boni R, organizadores *Uso de bebidas alcoólicas e outras drogas nas rodovias brasileiras e outros estudos*. Porto Alegre: Secretaria Nacional de Políticas sobre Drogas; 2010. p. 54-63.

^h Souza TRV, Correa E, Stampe MZ, Porto Junior SS, De Boni R. Custos dos acidentes com vítimas associados ao uso de álcool em Porto Alegre. In: Pechanski F, Duarte P, De Boni R, organizadores *Uso de bebidas alcoólicas e outras drogas nas rodovias brasileiras e outros estudos*. Porto Alegre: Secretaria Nacional de Políticas sobre Drogas; 2010. p. 100-11.

^q Global Road Safety Partnership. *Drinking and driving: a road safety manual for decision-makers and practitioners*. Geneva; 2007.

^r Laranjeira R, Pinsky I, Zalesky M, Caetano R. *Levantamento nacional sobre os padrões de consumo de álcool na população brasileira*. Brasília (DF): Secretaria Nacional Antidrogas; 2007.

Ribeirão Preto, southeastern state of São Paulo, 41% of RTA in individuals over 60 were in pedestrians, of which 60% had sequelae due to their injuries, and 12% were cyclists.⁶⁶ About 52% of the elderly injured were pedestrians and 13% were cyclists.⁷¹ They were all able to perform daily activities before but RTA have prevented them from their activities causing serious financial difficulties. The authors noted the importance of the elderly in society: many work in the community, care for relatives, support their families, work and consume goods and services. In the city of Londrina, of 121 elderly who were injured and treated in hospitals, 9% died and the main underlying cause was run over. According to the families, the elderly were totally independent before they were injured.¹²

Similar to the elderly, child pedestrians are frequently injured. There were more than 1,000 deaths per year due to run overs in children under 15 years between 2000 and 2005 (2.2 deaths per 100,000 inhabitants).¹⁵ The male-to-female ratio was 1.8:1 and the most affected age group was five to nine. Because of poor data quality or run away from the accident scene 83% of reports did not specify the causing vehicle in 2000, decreasing to 70% in 2005. Among the vehicles specified, there was a higher proportion of passenger vehicles, and the highest number of deaths occurred in pedestrians under 15 when compared to other RTA in this age group (64% in 2000 and 67% in 2005). In the city of Uberlândia, 46% of injured victims from zero to 14 years of age²⁵ were cyclists and 31% pedestrians. Among the most severely injured (admission to an intensive care unit), 81% were pedestrians and 7% cyclists. Two-thirds of deaths occurred in pedestrians. The large proportion of RTA involving bikes can be possibly explained by the fact that they are commonly used for recreation in the flat, sunny streets of Uberlândia. In Londrina, most injured people were cyclists (66%) and pedestrians (20%) and the rates of hospital admission were 38% and 35%, respectively. Of eight deaths reported, five were pedestrians and two cyclists.³⁵

With an estimated fleet of 75 million units, bikes are the main means of transportation among workers in Brazil.⁵ In the city of Pelotas, southern state of Rio Grande do Sul, 17% of the working population use bikes for daily commute. It is the main means of transportation among men (27%).⁶ Over a 12-month period, 6% of cyclists have suffered some RTA during work commute, a proportion that is higher than that reported in official local data. In Maringá, cyclists accounted for 18% of deaths from RTA in 1992. The

use of bikes as a means of transportation is common in Brazilian inner cities with mild temperatures and flat topography, and is an economic means especially among lower income population.⁶²

Most studies have recommended measures to reduce RTA in pedestrians and cyclists, from the reassessment of public policies that encourage one-person-per-car commute² to the design of more friendly public spaces to pedestrians especially children and elderly.^{2,15,68} The main recommendations include creating safe spaces for recreation,³⁵ educational programs for drivers^{15,66} children, parents¹⁵ and the elderly.⁶⁶ Faria & Braga²² (1999) proposed a program of actions to reduce the risk of RTA involving children and adolescents, especially pedestrians. These recommendations included assessment of routes of circulation, traffic engineering and educational activities at pedestrian crossings, improved monitoring and a new proposal for traffic education.

The creation of exclusive spaces for bicycle travel (bicycle paths and lanes) is the main recommendation for increasing the safety of cyclists,^{6,8,35,62} besides increasing public awareness about traffic rules.⁶ Studies conducted in Pelotas have shown that behavior change of cyclists and educational interventions will not have a significant impact on reducing RTA in the city.^{7,8}

Although it makes no reference to RTA, it is worth mentioning the publication of the Brazilian Program for Bike Mobility – Bike Brazil by the Brazilian Ministry of Cities.⁵

FREIGHT AND PASSENGER TRANSPORTATION

Sixty-two percent of freight and 96% of passengers are transported in the Brazilian highway system,[†] with a fleet estimated at more than two million trucks and about 700,000 buses and minibuses.[‡] Between 2004 and 2007 road traffic accidents involving trucks and freight vehicles on federal highways increased 14%, from 40,107 to 45,833 with 3,124 deaths and more than 20,000 injured.[‡] In the United States 25 truck drivers per 10,000 die in road accidents every year compared to 281 per 10,000 in Brazil.¹⁴ Truck drivers fall into two categories: employees of truckload services companies with better work conditions and safety, and self-employed.¹⁴ In addition to their stressful job, self-employed truck drivers have to deal with low pay, little or no training, great pressure to deliver their freight on time, and excess workload.¹⁴ However, the association with RTA cannot be verified due to a lack of scientific publications on these workers working on the Brazilian

⁵ Ministério das Cidades, Secretaria Nacional de Transporte e da Mobilidade Humana, Programa Bicicleta Brasil. Programa Brasileiro de Mobilidade por Bicicleta. Caderno de referência. Brasília (DF); 2007.

[†] Confederação Nacional do Transporte. Atlas do transporte 2006 [cited 2011 Jun 18]. Available from: <http://www.sistemacnt.org.br/informacoes/pesquisas/atlas/2006/index.htm>

[‡] Rodrigues JN. Drama no asfalto: uma análise sobre acidentes de trânsito com caminhões nas rodovias federais no ano de 2004. SOS Estradas - Programa Segurança nas Estradas [cited 2010 Sep 17]. Available from: http://www.estradas.com.br/sosestradas/articulas/nivaldino/acid_veic_carga.asp

highway system. However, there few studies on sleep disorders, use of amphetamines and alcohol among professional truck drivers.

Studies with truck drivers at gas stations and roadside restaurants showed that two-thirds would drive nine hours or more per day, 50% of them over 12 hours a day.⁵² Another study showed 43% of truck drivers would drive more than 16 hours a day.⁷⁰ This work routine is associated with high prevalences of excessive daytime sleepiness (32%⁷⁰ to 46%⁵⁵) and RTA. Many truck drivers use amphetamines to reduce their fatigue on long journeys. Nascimento et al⁵² reported that two-thirds of truck drivers use amphetamines: 27% reported daily use and 60% reported using it two to three times a week. Most (76%) reported using it to get to their destination in less time and 27% reported road accidents associated to its use. Amphetamines are purchased at gas stations (58%), drugstores (38%), and in their truck companies (8%). Nearly half of truck companies in the southern state of Santa Catarina reported drug use by drivers in 2004; 65% of them reported amphetamine use. Most reported RTA causing deaths or permanent disabilities.⁷⁷

A study showed that 91% of truck drivers interviewed reported alcohol use during working hours, 24% of them reported daily use. Forty-three percent of drivers reported gas stations as their preferred place of consumption, and 17% who reported alcohol use were involved in road traffic accidents.⁵² Seventy-one percent of truck drivers working in the metropolitan areas of 26 Brazilian capitals reported at least one episode of binge drinking in the last year. About 10% had used alcohol on the day of the interview and 9% reported drinking and driving.⁹

There were found no studies on RTA associated with passenger transportation. Data from the Federal Highway Authority, *apud* Correa,¹⁴ showed that 4% of more than 177,000 RTA occurring on federal highways involved buses and minibuses in 2004. These accidents kill at least 2,000 people every year.¹⁴ A study found that 42% of bus drivers were involved in interstate road accidents and in 8% they were associated with excessive sleepiness.⁷⁵ Excessive daytime sleepiness was found in 28% of drivers, 48% reported sleepiness while driving and 12% took daily medication to help them stay awake. It should be noted that these proportions may be underestimated since these interviews were conducted in the transportation company. Another study found that 16% of the drivers interviewed reported having fallen asleep at the wheel of the bus while on duty.⁴⁸

Researchers have recommended prevention programs, increased oversight of roads on the sale of alcohol and amphetamines,^{52,70} and implementation of education programs, specific treatments⁵⁵ and management of sleep disorders.⁷⁵

DATA QUALITY

Mello Jorge & Koizumi⁴³ have asserted that knowledge, research and understanding of these issues would allow the implementation of actions aimed at changing the current panorama of road traffic in Brazil.

RTA data come from three main data sources: police reports, SIH-SUS and Mortality Database (SIM). Data from these sources are not fully complete and accurate and are neither complementary nor interconnected.⁴³

The police report is a record of RTA filed at civil police and civil-military federal highway authority stations. This is not a standard record systematized at the national level.⁴³ Studies with police reports have demonstrated significant underreporting of RTA and deaths. Barros et al⁹ verified that 39% of RTA in Pelotas were underreported, varying according to the category of the victim, type of injury and time of occurrence. Andrade & Mello Jorge³ reported only 33% of police reports compared to records of emergency room and hospital admissions and death certificates in Londrina. Police report coverage was 72% of accidents involving car occupants and 8% and 25% of those involving cyclists and pedestrians, respectively. These authors have argued that police reports can provide major information on RTA that is crucial for the development of prevention actions.

Although SIH-SUS includes only data from hospital admissions paid by the Brazilian National Health System (SUS), these data are regularly updated and readily available.⁵⁸ All information is collected from hospital admission authorizations (AIH). The AIH form has been modified in 1998 to include a required specific field to code "secondary diagnosis" or injury morbidity data from external causes. A 2008 study assessed the quality of AIH data by comparing the coding of primary and secondary diagnoses in SIH-SUS and medical records.⁴¹ RTA accounted for 32% of hospital admissions showing an optimal level of agreement ($\kappa = 0.90$). But hospital admissions due to external causes coded as natural causes in the database were not included in the study. Tomimatsu et al⁷² assessed coverage and quality of hospital admission information in Londrina and Maringá based on AIH medical reports. In Londrina there was high underreporting of RTA with an increase in the number of hospital admissions to 988 from 492 after reclassification. They also found underreporting of hospital admissions due to external causes (41% in Londrina and 25% in Maringá). Researchers have argued that low appreciation and use of epidemiological information in the medical curricula could explain data underreporting. It is being implemented an intervention study that proposes awareness-raising actions and training of doctors and hospital coders on the importance of proper reporting of information in SUS-affiliated hospitals.⁴

Death certificates are SIM core data form. For deaths from external causes, a death certificate is completed by medical examiners at Institutes of Forensic Medicine (IMLs) who is ethically and legally responsible for providing complete death certificates according to the Brazilian Ministry of Health.^v Unlike police reports, deaths are recorded in the SIM regardless of the time between the RTA and death, resulting in inconsistent data.⁴³ ICD-10 allows to include information on RTA victim category (pedestrian, cyclist, motorcyclist, and others) and characteristics. A study with death certificate data collected in 1996 following the implementation of ICD-10 in Brazil showed that RTA was not reported as a cause of death in about 35% of deaths and 20% of death certificates did not include information on the category of victim.³ Limited knowledge and/or low motivation of health providers could explain inadequate quality of data. Also in 1996, Drumond Jr. et al²⁰ found that the type of accident could be identified in 53% of deaths from police reports sent with the bodies, and 33% were RTA suggesting that IMLs do not use information available at their own institute. A study carried out in 15 Brazilian cities based on data from IMLs, police stations and victim's homes showed an increase by 90% of RTA deaths compared to that reported in death certificates only.⁴⁴ The authors argued that IMLs have data that allow to identify the cause of death but they are not included in death certificates. Jorge Mello et al have suggested there is a need to focus on the search for information, which is usually available but have to be retrieved.⁴⁶ Matos et al³⁸ identified 83% of the 70 deaths classified as "unspecified injury" by combining IML and SIM data from the Municipal Health Department of Belo Horizonte, and 41% were RTA-related. The cause of death was identified in 71% of events of undetermined intent, and RTA were the most common cause, resulting in a 6% increase in deaths from run overs and 33% from car accidents. This study suggests the need to improve coding and selection of underlying cause, death certificate completion and quality of police and medical information. In the city of São Jose dos Campos, southeastern state of São Paulo, missing information on death certificates prevented the estimate of mortality rates by type of victim. Unspecified RTA was recorded in 57% to 70% of death certificates.³⁹ A study in the state Paraná using SIM data showed a reduction in the proportion of deaths due to events of undetermined intent, 22% in 1980 to 2% in 2005.³³ The reduction of 15 deaths per 100,000 during the triennium 1979–1981 to two deaths in 2003–2005 suggests improved quality of records as a result of local data processing (1993) and systematic training of technical coders. According to Jorge Mello et

al,⁴⁶ SIM has greatly improved coverage and quality of data and is expected to have a coverage close to 100%. There is a need to encourage, raise awareness and guide managers, conduct research and learn from successful experiences to improve quality of data.

ROAD TRAFFIC ACCIDENT COSTS

Deslandes et al¹⁸ estimated emergency room costs due for violence-related injuries in the city of Rio de Janeiro in 1996 in two local public hospitals, Miguel Couto Hospital (HMMC) and Salgado Filho Hospital (HMSF). RTA accounted for 67% and 46% of the costs in HMMC and HMSF, respectively, from R\$ 78.00 to 236.00 for run overs and R\$ 74.00 to 119.00 for other RTA, with an annual expenditure close to R\$ 1 million.

The financial impact on injured patients was assessed based on AIH records obtained from a university hospital in the city of Curitiba, southern state of Paraná.⁷⁶ Between September 2000 and February 2001 RTA accounted for 54% of hospital admissions amounting to over US\$ 110,000. The cost of each hospital admission was on average US\$ 600, ranging from US\$ 21 to 2,722.

Mello Jorge & Koizumi⁴⁵ estimated costs of hospital admissions due to external causes based on SIH data in the state of São Paulo in 2000. Because of costly procedures, external causes incurred in higher average cost and daily cost (about 4% and 50%, respectively) compared to patients admitted due to natural causes. RTA accounted for 17% of hospital admissions due to external causes and 26% of deaths post-admission. The average hospital stay was 5.7 days and hospital mortality rate was 4.7%, both above the average rates from other external causes. The average cost was R\$ 721.15 for discharged patients, R\$ 1,500.79 for deceased patients and the daily cost was R\$ 132.18. The Technical Advisory Group for Injury and Violence Prevention of the Health Department of the State São Paulo reported that during 2005 RTA accounted for 17% of hospital admissions and 22% of all costs from external causes amounting to nearly R\$ 34 million.^x

Melione & Mello Jorge estimated direct costs of SUS with hospital admissions due to external causes in the city of São José dos Campos, southeastern state of São Paulo.⁴⁰ RTA were the leading cause of hospital admissions (33%) and costs (41%), totaling almost R\$ 200,000 during the first half of 2003. The highest average cost per hospital admission was for injuries (R\$ 614.63), with an average hospital stay of 7.7 days and daily cost of R\$ 80.21.

^v Ministério da Saúde. Declaração de óbito: documento necessário e importante. Brasília (DF): MS; Conselho Federal de Medicina; Centro Brasileiro de Classificação de Doenças; 2007. (Série A. Normas e Manuais Técnicos).

^x Secretaria de Estado da Saúde de São Paulo, Centro de Vigilância Epidemiológica "Prof. Alexandre Vranjac". Grupo Técnico de Prevenção de Acidentes e Violências. O impacto dos acidentes e violências nos gastos da saúde. *Rev Saude Publica*. 2006;40(3):553-6. DOI:10.1590/S0034-89102006000300028

Rodrigues et al⁶⁰ in 2009 proposed a methodology for estimating the cost of accidents and violence based on SUS databases, state and municipal budgets and estimates of demand for outpatient care (urgent and emergency) from the National Household Survey. They found that the cost of RTA treatment was 4.3 times higher than that recorded in 2004 increasing from R\$ 106.5 million to R\$ 453 million.

The Brazilian Institute of Applied Economic Research (IPEA) and the National Association of Public Transportation (ANTP) estimated the economic and social costs of RTA by the sum of direct costs (medical and hospital costs, rescue services, vehicle damage, police assistance, [actual] loss of productivity, among others) and indirect costs ([potential] loss of productivity and traffic congestion) in 2003.^d The total cost was estimated at R\$ 3.6 billion in 49 large urban areas and R\$ 5.3 billion for all urban areas in Brazil. Loss of productivity accounted for 43% of the total cost of RTA, followed by property damage (30%), medical and hospital costs (16%), and other costs (11%) such as legal proceedings, removal of vehicles, police assistance, among others. Cars, which are 74% of the motor vehicle fleet, accounted for 56% of all costs. Motorcycles, urban buses and trucks, which are a lower percentage of the fleet, accounted for a high proportion of costs (11% to 19%, 1% to 13%, and 4% to 11%, respectively). A RTA had an average cost of R\$ 8,782.49; a RTA without injured victims cost on average R\$ 3,262.00; with injured victims more than R\$ 17,000; and with deaths R\$ 144,478.00. Although accidents with victims (injured or dead) represented 14% of all accidents, they accounted for 69% of the total cost (almost R\$ 2.5 billion).

In 2006 the IPEA and the ANTP conducted a new study on the costs of RTA on Brazilian highways.^e More than 100,000 RTA on federal highways had an estimated total cost of R\$ 6.5 billion in 2005. Victim costs accounted for 68%. Loss of productivity and health care were the main components of cost while vehicle costs represented 31%. Accidents involving fatalities had an average cost of R\$ 418,000 while accidents with injured victims and without victims had an average cost of R\$ 86,000 and R\$ 17,000, respectively. RTA costs in state highways, as determined by adjustment models, were estimated at R\$ 14.1 billion and R\$ 1.4 billion in local highways. RTA on Brazilian highways cost about R\$ 22 billion every year. The annual RTA costs in Brazil exceed R\$ 27.2 billion.^{d,e}

ROAD TRAFFIC ACCIDENT MORBIDITY AND MORTALITY REDUCTION PROGRAM

The 2001 Brazilian Ministry of Health Decree 737 established the National Policy for the Reduction of

Morbidity and Mortality from Violence and Injuries. The Program for Road Traffic Accident Morbidity and Mortality Reduction: Mobilizing Society and Promoting Health (PRMMAT)^w was launched to put into practice the new public policy. Its starting point was the Brazilian Vehicle Code. The program aimed to implement health promotion activities in partnership with government, non-government organizations and society in large urban areas with extensive road systems and high rate of accidents. It was coordinated by the Brazilian Ministry of Health and implemented at state and local levels and its priority was intersectoral actions with involvement of civil society. The areas of actions were defined based on the magnitude, risk and relevance of RTA in overall mortality. There were selected 26 urban areas, covering 84 municipalities in 14 states, totaling over 46 million people.

Between 2003 and 2006 the Latin American Center for Studies on Violence and Health, the National School of Public Health, Fundação Instituto Oswaldo Cruz and the Brazilian Ministry of Health evaluated the implementation of PRMMAT in five cities: Recife, Belo Horizonte, Goiânia (central-west Brazil), São Paulo and Curitiba.⁶⁹ This study evaluated mainly the effectiveness and impact of this intervention using a quantitative approach to outline the epidemiological scenario of RTA and a qualitative approach (interviews with managers, program implementation staff, users, among others, and field observations). PRMMAT implementation in the five cities studied occurred at different time points from October 2003 to August 2004. The authors pointed out weaknesses including lack of familiarity with intersectoral work; poor visibility of RTA as a problem; frequent changes in coordination; and political interference in the program projects. The strengths included the experience of local departments in dealing with RTA; the process of intersectoral coordination; raising public awareness on RTA; and the production of a set of indicators and methods for program evaluation.

There is no assessment of the effectiveness of PRMMAT based on RTA mortality and morbidity reduction data. PRMMAT reduction goals to be achieved and their terms have not been reported.

CONCLUSIONS

Although scientific production on RTA is still modest in Brazil, there was a 450% growth in publications during the review period, from 22 until 1997 to 100 from 1998 to 2010 (using the descriptor "traffic accidents" in the SciELO database). It is of note focal points of knowledge production and leading authors in the areas studied, particularly the production of an atlas of RTA

^w Ministério da Saúde, Secretaria de Políticas de Saúde, Projeto Promoção da Saúde. Programa de Redução da Morbimortalidade por Acidentes de Trânsito: mobilizando a sociedade e promovendo a saúde. *Rev Saude Publica* 2002;36(1):114-7. DOI:10.1590/S0034-89102002000100018

distribution in Brazil.¹³ However, there are gaps in RTA research in Brazil including ongoing studies on accidents and traffic flow on highways, use of more reliable denominators for risk comparison (e.g., per mileage traveled) and assessment of intervention effectiveness.

Brazil is off track in the fight against RTA which is evidenced by a growing number of deaths and sustained high mortality and hospital admission rates. The BVC had at its implementation the required legal framework to produce an effective reduction of RTA. Over the years factors including modern electronic data systems, improved technologies (breathalyzers, radars, and electronic speed control devices), improved vehicle safety, and development of traffic engineering and pre-hospital emergency services have all contributed to increase its effectiveness. In addition, several cities have invested in traffic safety, highways were privatized and properly maintained and the media has given due visibility to the problem helping to raise public awareness.

The process of reducing RTA has been hindered by several actions, or lack of actions, including the requirement to warn the public on the location of traffic control devices, veto of a law prohibiting motorcycles to ride between lanes of traffic, reduced penalties and payment of fines in installments, non-implementation of a traffic education and mild restrictions on advertising related to drinking and driving, among others.

Marin & Queiroz (2000)³⁴ stressed that state authorities shall have the responsibility for the implementation of effective public policies and law enforcement. The original BVC and most recently Law No. 11,705/08 have constituted legal advancements. Yet, public policies and

law enforcement lacked strength with minor actions or actions limited to short periods after their implementation. Studies on the implementation of the new BVC have emphasized that strict law enforcement and punitive measures may be effective in reducing traffic accidents^{10,23} and increasing traffic safety practices.³¹ Andrade et al⁵ demonstrated that the greatest impact on RTA mortality reduction observed from 1994 to 2005 was a result of the implementation of the new BVC. But there were no major advances in reducing mortality after 1999, possibly due to loosening law enforcement and penalties provided for under the new code.

Studies that have shown RTA reduction after implementation of BVC and Law No. 11,705/08 suggest that state authorities have the power to reduce a great deal of accidents and save lives. It is key to have ongoing vigorous actions. Educational actions are also important and should be widely implemented, but they are not effective as a single measure.⁵³ Improvements in public transport, investment in alternative healthier means of transport such as bikes and promotion of rational use of private cars are essential to improve quality of life in cities and reduce traffic accidents.

The significant increase in the car and motorcycle fleet fueled by low interest loans and economic growth and coupled with the rapid population aging are enormous challenges to the current national traffic policy. In 2004 RTAs were the ninth major cause of death worldwide with 1.2 million victims. The WHO estimates that RTA will be the fifth leading cause of death in 2030, killing more than 2 million people.⁸ The way Brazil will address this issue can either help reduce this burden or confirm this prediction.

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