

Factors associated with traffic accidents among drivers: findings from a population-based study

Polianna Alves Andrade Rios (<https://orcid.org/0000-0002-6318-2230>)¹
Eduardo Luiz Andrade Mota (<https://orcid.org/0000-0001-7819-0084>)²
Luciano Nery Ferreira (<https://orcid.org/0000-0002-9410-2467>)³
Jefferson Paixão Cardoso (<https://orcid.org/0000-0003-0128-5792>)¹
Vivian Mara Ribeiro (<https://orcid.org/0000-0002-8860-4428>)¹
Bruna Silva de Souza (<https://orcid.org/0000-0003-1608-8046>)⁴

Abstract *This study aimed to identify associated factors with drivers' involvement in traffic accidents (TA). Thus, in 2013, a household survey was conducted with 1,406 drivers in Jequié, Bahia, Brazil. A hierarchical conceptual model was established and consisted of four blocks of exposure factors, considering the proximal-distal relationships between them and the outcome. Multilevel logistic regression was applied to estimate the Odds Ratio (OR) and 95% Confidence Intervals (95%CI). Higher TA probability was observed among drivers aged 15-29 years (OR=3.15; 95%CI 1.24-8.02), with black or brown skin color (OR=1.56; 95%CI 1.03-2.35), motorcyclists (OR=1.73; 95%CI 1.15-2.60), with a history of traffic tickets (OR=1.75; 95%CI 1.04-2.94), who reported drinking and driving (OR=1.68; 95%CI 1.12-2.53) and used cell phone while driving (OR=1.63; 95%CI 1.09-2.43). Proximal factors changed the exposure association measures concerning higher levels of determination of the hierarchical model, mainly regarding the gender variable. The results emphasize the behavioral factors and reaffirm the TAs' preventable potential due to the occurrence of avoidable conditions associated with the outcome.*

Key words *Traffic Accidents, Health Surveys, Epidemiologic factors, Automobile driving*

¹ Departamento de Saúde II, Universidade Estadual do Sudoeste da Bahia. Av. José Moreira Sobrinho s/n, Jequiezinho. 45205-490 Jequié BA Brasil. polianauesb@yahoo.com.br

² Instituto de Saúde Coletiva, Universidade Federal da Bahia. Salvador BA Brasil.

³ Departamento de Saúde I, Universidade Estadual do Sudoeste da Bahia. Jequié BA Brasil.

⁴ Curso de Fisioterapia, Universidade Estadual do Sudoeste da Bahia. Jequié BA Brasil.

Introduction

The hallmark of road traffic accidents (TA) as a significant global public health issue is their increasing participation in the causes of morbimortality, taking the lives of more than one million people and producing up to 50 million people with disabilities in the world every year¹. In addition to the excessive human cost, these events also adversely affect the development of societies, with high health costs, social security assistance, material damages and productive loss^{2,3}.

This social and economic burden is primarily borne by developing countries, which account for more than 90% of traffic fatalities¹. Although they are preventable events, the trend for morbimortality related to road traffic in these places is growing, which may place TAs as the fifth most frequent cause of death in the world by 2030¹⁻⁴. This outlook made road safety gain space on the agenda of International Organizations, especially in the early twentieth century. Therefore, in 2010, the United Nations announced the Decade of Action for Road Safety (2011-2020) to stabilize and reduce road deaths from actions conducted at the national, regional and global levels⁵.

Brazil participates in this international initiative, denominated in the country as *Projeto Vida no Trânsito* (PVT, Life in Traffic Project)⁶. Although this project has committed to road safety, TAs still produce an alarming level of fatal and non-fatal victims in the country, casting doubt on its capacity to meet the targets set to address this problem⁷. According to the Ministry of Health, traffic accidents caused the death of 38,651 people⁸ in 2015 and generated approximately 158,000 hospitalizations in hospitals of the Unified Health System⁹. Although these numbers already show a worrying situation, it is known that part of the magnitude of the TAs remains little known. However, other sources of information have contributed to measure the accident issue, such as the VIVA Project (Violence and Accident Surveillance), which records care provided by urgent and emergency services. All of these sources reveal an increased number of accident victims among vehicle occupants, especially among motorcycle drivers^{10,11}.

Some national surveys conducted in 2008 (National Household Sample Survey – PNAD) and 2013 (National Health Survey – PNS) addressed the topic of TAs and estimated proportions of involvement in these events of approximately 2.5%¹² and 3.1%¹³, respectively, for the

Brazilian population. However, within the time interval of these two surveys, a change was noted in the accident profile concerning the category of victim, with a declining percentage of car occupants and elevation for motorcycle drivers, a group that accounted for more than 60% of all who suffered injuries by TA in the North and Northeast in 2013¹⁴.

While the country has several sources of information, there is scarce data on traffic accidents from population-based primary sources that can identify victims not captured by the usual information systems, and referring to municipalities that are not located in large urban centers, where participation of external causes in local morbimortality^{15,16} has shown a progressive upward trend. Thus, it is crucial to carry out population surveys to contribute to the knowledge on the size of TAs and their determining factors.

In this respect, the scientific literature shows that traffic accidents have a complex and multifaceted determination. The ecological framework proposed by Haddon has been widely used in health research on the subject and establishes causes related to people, the vehicle and the physical (road) and sociocultural environments that interact in the occurrence of TAs¹⁷. Among these causes, the human factor is an element of greater participation in the generation of accidents¹⁸. However, it should be made clear that, although this factor is an individual manifestation of traffic conduct, it is determined by a complex network that includes psychological features¹⁸ and gender issues, and cultural and socioeconomic determinants¹⁷. In this regard, the PVT chose two behavioral risk factors as priority interventions in Brazil: drinking and driving behavior, and excessive or inadequate speed⁶.

Thus, considering the problem of land transportation accidents in the country and the importance of producing information on the determinants of these events based on population-based surveys, this study was carried out in order to identify factors associated with vehicle drivers' involvement in TAs in the municipality of Jequié, Bahia, Brazil.

Methods

This is a cross-sectional, population-based study that is the baseline stage of a longitudinal survey on traffic accidents, their determinants and repercussions on the lives of the people involved conducted in the municipality of Jequié, Bahia,

from 2013 to 2015. Data from this paper refer to 2013 when the cohort was set through a household survey.

The municipality of Jequié is part of the Southwest region of Bahia and is located 365 km from the state capital¹⁹, outside the metropolitan axis. In 2013, its population was estimated at 161,391 inhabitants²⁰ and had 30.8 vehicles per 100 residents, with a higher motorcycle than car per capita ratio (15.5 bikes and 10.4 cars per 100 inhabitants, respectively)^{20,21}.

The study participants were motor vehicles drivers (automobiles, pickup trucks, motorcycles, scooters, mopeds, van, buses, and trucks) living in a private household in the urban area of the municipality. The minimum age cutoff point for inclusion in the survey was 14 years because of the possibility of finding teenagers driving vehicles, especially mopeds. Residents of temporary domiciles were excluded due to the need to follow-up planned in the longitudinal research in which this study is inserted.

The sample was calculated in the EPI-Info program (Version 6.0), based on the following parameters: proportion of involvement in TA = 9.0% (proportion established from the findings of a Health and Nutrition Survey, in which 7.8% of the adults reported involvement in TAs in the last 12 months, as any public roadway user²². As this study addressed the population of vehicle drivers, a projected frequency of 9.0% was considered relevant); $\alpha = 5.0\%$; precision = 2.0%; and design effect = 2; which resulted in a sample size of 1,572 drivers.

A single-stage cluster sampling was used to select the participants, with a draw of 35 Census Tracts (CT) from the 169 urban CTs of the municipality²³. This number was established taking into account some criteria attributed by the researchers. After conducting a pilot study in a CT, we found that the fraction of access to the research population was approximately one-third of all households in the sector. Thus, considering this fraction in the average number of households by CT (241 households/CT²³); the mean density of two adults per household, one of which could be a likely driver; and the possibility of finding households without drivers, due to the socioeconomic status of some regions of the municipality, we found that, on average, 60 households per CT could be included in the study. Thus, 26 CTs would be required for the sample. However, some sectors that were randomly selected had a lower number of households than the municipal average, which led us to increase the number to 35 sectors.

Survey data were collected from July to October 2013. The interviewers walked through all the blocks of the selected CTs, with maps made available through the Internet by the IBGE, and visited all households to check the presence of drivers. For those residences where it was not possible to interview all those eligible, who were absent or unable to participate in the first attempt, visits were rescheduled at a convenient time for the participants. The maximum number of three attempts at scheduling or returning to the closed house at different times was established to consider the driver/address as lack of response in the case of failure. The average number of drivers interviewed per participating household was 1.2 for the 35 CTs, ranging from 1.0 to 1.4 driver/household.

Data were produced through interviews with a structured form and search in the IBGE Census 2010 database to obtain information on the income of the census tracts.

The study's dependent variable was self-reported involvement in traffic accidents in the 12 months before the interview as a driver at the time of the TA (yes, no). The definition of TA adopted in the survey was: "every vehicle accident occurred on the public highway, which includes any trampling, collision between vehicles, bicycle and motorcycle accidents and falls inside or outside a bus, trucks or motorcycles falls that occur on streets or roads, which may or may not cause injury to people" (definition adapted from the concepts of the International Classification of Diseases, 10th Revision²⁴ and the study by Magalhães et al.²⁵).

The independent variables were organized into blocks for multivariate analysis, namely:

- Block 1 – Neighborhood variable: CT average income (represented by the monthly income of people aged 10 and over, with and without income, categorized as less than R\$500.00, R\$500.00 to R\$724.00, and greater than R\$724.00).

- Block 2 – Sociodemographic: gender (male, female), age group (15-29 years, 30-44 years, 45-59 years, 60 years and over), skin color (black or white, white), common-law marriage (yes, no), schooling (higher education, secondary school, primary school).

- Block 3 – Experiences in traffic: has a National Driver's License (CNH) (yes, no), a traffic tickets in the last 12 months (yes, no), favorable opinion regarding the "new" Prohibition Law (Law N° 12.760/2012) (yes, no), and type of driver (motorcyclist, driver). This last variable was derived from the questioning of the type of vehicle that the par-

participant referred to drive more frequently and was categorized as “driver”, for those who referred to motor vehicles or other vehicles with four or more wheels, and “motorcyclist”, for those who referred to motorcycle, scooter or moped.

- Block 4 – Behavior in traffic: drinking and driving (ingesting any amount of alcohol) (yes, no), using a cell phone while driving (yes, no), referring to liking to speed when driving (yes, no), and adopting unsafe speed in urban road (yes: > 50 km/h, no: ≤ 50 km/h), a variable categorized from the question about the usual maximum driving speed.

The cut-off criterion for the definition of unsafe speed in this research was based on World Health Organization (WHO) reports that consider 50 km/h as the best practice for urban area limits, since both reduce the odds of TAs and minimize injuries and deaths^{1,4}.

Stata[®] software, version 12.0 was used for data analysis. Frequencies of the variables were estimated to describe the characteristics of the participants, and the Rao-Scott chi-square test ($p \leq 0.05$) was used for comparison between TA proportions; a version that is adapted to data with dependency structure due to the sampling design used.

The analysis of associated factors was based on a hierarchical conceptual model (Figure 1), elaborated according to the proximal-distal relations of the exposures and the outcome. The hierarchical analysis strategy has some advantages compared to the traditional multivariate analysis, since it is adequate for situations in which a large number of variables are involved, besides considering possible mediation relationships in the determination of the phenomena under study²⁶.

The Multilevel Logistic Regression model was used to estimate the ORs and 95% Confidence Intervals (95%CI), using Stata's *xtlogit* Syntax. The choice of the multilevel regression model also takes into account the dependency structure of the data; therefore, the estimates considered the study's design effect. Values of $p \leq 0.20$ in the bivariate stage and $p \leq 0.10$ in the multivariate-intra-blocks stage were established to select the variables in the modeling. In the hierarchical stage, $p \leq 0.05$ was considered statistically significant. The maximum likelihood ratio test was used to evaluate the permanence of the variables in the model.

All ethical precepts were followed in the study. The Research Ethics Committee of the Institute of Collective Health, Federal University of Bahia approved the project.

Results

From a sample of 1,572 drivers, 1,407 were interviewed, and 165 people were not found at home in all attempts to conduct the interview. One participant was excluded from the analysis because of the missing data on the interview form. Thus, the percentage of sample loss was set at 10.6%, and the paper's results refer to 1,406 people. Involvement in traffic accidents as a vehicle driver in the last 12 months was reported by 10.4% (147) of the participants.

Table 1 shows that the frequencies of TA involvement varied by categories of exposure factors, with statistically significant results for a higher proportion of TAs in black or brown young single people driving motorcycles without a driving license, with a history of traffic tickets, who did not agree with the “new” Prohibition Law and reported unsafe and illegal traffic behaviors.

The bivariate regression model revealed that the CT's mean income and schooling were not associated with the outcome. The other variables followed to the multivariate model (intra-blocks). Although the CT's income did not show a value of $p < 0.20$, it was maintained in the other stages of the analysis because it was a contextual variable. In Block 2, we observed that the outcome maintained its association with gender, age group, skin color and common-law marriage. In Block 3, it was associated with the type of driver, history of traffic tickets, not agreeing with the “new” Prohibition Law. In Block 4, it was just not associated with “adopting unsafe speed in urban roads” (Table 2).

Table 3 shows the results of the hierarchical analysis from models A (Blocks 1 and 2), B (Blocks 1, 2 and 3) and C (Blocks 1, 2, 3 and 4). In model A, we observed the direct effect of the association between involvement in TAs and gender, age group and common-law marriage, adjusted for CT income. Men's involvement in TAs was 52% more likely than women's, adjusted for the other variables. Regarding the age group, greater odds ratios were observed among people aged 15-29 years and 30-44 years.

In model B, after the introduction of Block 3, we identified a direct effect of the history of traffic tickets and type of driver variables, adjusted by the variables of Blocks 1 and 2. The inclusion of Block 3 promoted reduced likelihood of involvement in TAs for the age group and gender variables, with emphasis on the latter, which was no longer associated in Model B (OR = 1.40 and 95%CI 0.94-2.08) (Table 3).

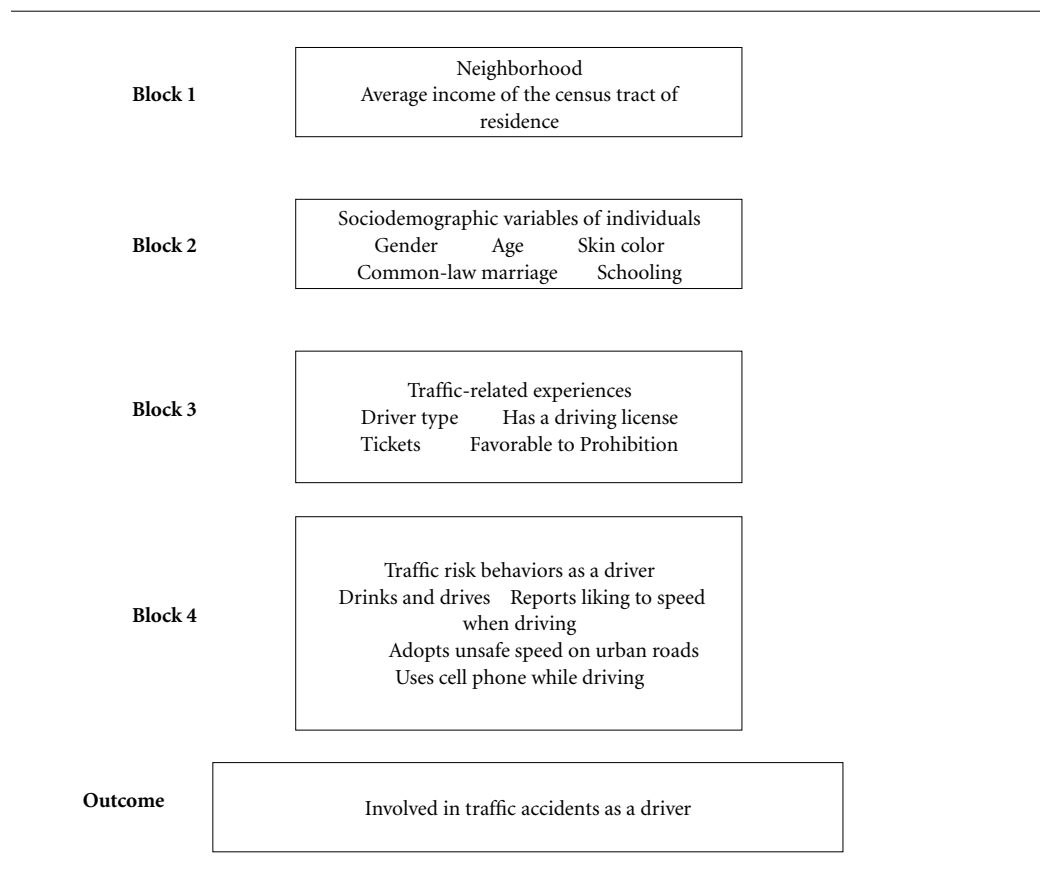


Figure 1. Hierarchical conceptual model for the analysis of factors associated with involvement in traffic accidents among vehicle drivers.

With the introduction of Block 4, Model C was adjusted and established the final model of associated factors. Thus, the direct effect of drinking and driving behavior (OR = 1.68; 95%CI 1.12-2.53) and cell phone use during driving (OR = 1.63; 95%CI 1.09-2.43) on the involvement in accidents, adjusted by the other variables. This model evidenced increased odds ratios for some variables (type of driver and skin color) and declining odds ratios for others (history of traffic tickets, age group and gender). Thus, the following factors were associated with involvement in TAs: age group, with odds ratio of 3.15 for drivers aged 15-29 years (95%CI, 1.24-8.02); skin color, with a 56% greater probability of involvement among those who self-declared as browns or blacks (95%CI 1.03-2.35); type of driver, and motorcyclists were 73% more likely to be involved than drivers (95%CI 1.15-2.60);

common-law marriage; history of traffic tickets; drinking and driving behaviors and using cell phones while driving (Table 3).

Discussion

The factors associated with involvement in traffic accidents among vehicle drivers were investigated using approaches that were unusual in the country, such as the population-based survey and the application of a hierarchical model.

We observed that the study, while restricted to the driver population, found results that followed the sociodemographic pattern of morbimortality due to TAs in the country and in the world, with a higher proportion of accidents for males, with a higher proportion of accidents for males and young people, corroborating national^{14,25,27} and international^{28,29} findings, as well as

Table 1. Characteristics of the study population and absolute and relative frequencies of traffic accidents (TA) among vehicle drivers, according to sociodemographic and traffic-related categories. Jequié, Bahia, Brazil 2013 (n = 1,406).

Variables	Study population		Involved in TA		p-value ^a
	N	%	N	%	
Gender					0.230
Male	934	66.4	106	11.3	
Female	472	33.6	41	8.7	
Age group (in years)					<0.001
15-29	367	26.1	62	16.9	
30-44	517	36.8	57	11.0	
45-59	336	23.9	22	6.5	
60 and over	186	13.2	6	3.2	
Skin color ^b					0.031
Black or brown	949	67.5	111	11.7	
White	457	32.5	36	7.9	
Common-law marriage					<0.001
No	550	39.1	79	14.4	
Yes	856	60.9	68	7.9	
Schooling					0.237
Higher education	298	21.2	37	12.4	
Secondary school	720	51.2	70	9.7	
Primary school	388	27.6	40	10.3	
Census Tract average income					0.985
Less than 500,00 reais	413	29.4	44	10.6	
500,00 to 724,00 reais	454	32.3	48	10.6	
More than 724,00 reais	539	38.3	55	10.2	
Driver type					<0.001
Motorcyclist	549	39.1	81	14.8	
Driver	857	60.9	66	7.7	
Driver's license					0.002
No	243	17.3	36	14.8	
Yes	1,163	82.7	111	9.5	
Traffic tickets history					0.014
Yes	129	9.2	23	17.8	
No	1,277	90.8	124	9.7	
Favorable to Prohibition					0.113
No	79	5.6	14	17.7	
Yes	1,327	94.4	133	10.0	
Drinks and drives					0.003
Yes	286	20.3	50	17.5	
No	1,120	79.7	97	8.7	
Adopts unsafe speed on urban roads					0.025
Yes (> 50 km/h)	631	44.9	80	12.7	
No (≤ 50 km/h)	775	55.1	67	8.7	
Reports liking to speed when driving					<0.001
Yes	264	18.8	46	17.4	
No	1,142	81.2	101	8.8	
Uses cell phone while driving					<0.001
Yes	382	27.2	60	15.7	
No	1,024	72.8	87	8.5	

^a Chi-square test with Rao & Scott adjustment. ^b Self-declared skin color; white: includes white and yellow.

Table 2. Odds Ratio (OR) values of bivariate and multivariate intra-block regression analyses for traffic accident (TA) factors among vehicle drivers. Jequié, Bahia, Brazil, 2013 (n = 1,406).

Variables	Bivariate		Multivariate intra-block	
	OR	p-value ^b	OR	p-value ^c
Contextual level				
Block 1: neighborhood				
Census Tract average income				
Less than 500,00 reais	1.06	0.808	1.06	0.808
500,00 to 724,00 reais	1.05	0.837	1.05	0.837
Individual level				
Block 2: sociodemographic				
Gender				
Male	1.35	0.120	1.49	0.044
Age group (in years)				
15-29	6.22	<0.001	5.42	<0.001
30-44	3.73	0.003	3.81	0.002
45-59	2.12	0.110	2.26	0.084
Skin color				
Black or brown	1.54	0.032	1.47	0.061
Common-law marriage				
No	1.97	<0.001	1.50	0.038
Schooling				
Higher education	1.22	0.399	-	-
Secondary school	0.93	0.767	-	-
Block 3: Traffic-related experiences				
Driver type				
Motorcyclist	2.08	<0.001	2.02	<0.001
Driver's license				
No	1.66	0.015	1.31	0.215
Tickets history				
Yes	2.04	0.004	2.18	0.002
Favorable to Prohibition				
No	1.92	0.035	1.77	0.069
Block 4: Traffic behaviors				
Drinks and drives				
Yes	2.23	<0.001	1.76	0.005
Adopts unsafe speed on urban roads				
Yes (> 50 km/h)	1.53	0.015	1.25	0.211
Reports liking to speed when driving				
Yes	2.20	<0.001	1.69	0.011
Uses cell phone while driving				
Yes	2.00	<0.001	1.51	0.035

^a Multilevel Logistic Regression Analysis; ^b p-value < 0,20 to remain in the model and entry into the multivariate analysis stage;

^c p-value < 0,10 to remain in the model and entry into the hierarchical analysis. ^d Variable Census Tract average income was maintained in the steps of analysis since it is a contextual variable. ^e Self-declared skin color; white: includes drivers who self-declared as white or yellow. Categories of reference: Census Tract average income: more than 724,00; Gender: female; Age group: 60 years and over; Skin color: white; Common-law marriage: yes; Schooling: Primary school; Driver type: driver (car/van or other vehicle with more than four wheels); Has driver's license: yes; Tickets history: no; Favorable to Prohibition: yes; Drinks and drives: no; Maximum speed on urban roads: safe (\leq 50 km/h); Likes to speed while driving: no; Uses cell phone while driving: no.

among those with black or brown skin color¹¹, single³⁰ who use a motorcycle^{11,12} and who report

a history of traffic tickets and unsafe traffic behaviors^{27,31,32}.

Table 3. Odds Ratio (OR) and Confidence Intervals of 95% (95% CI) of the hierarchical analysis for factors associated with traffic accidents (TA) among vehicle drivers. Jequié, Bahia, Brazil, 2013 (n = 1,406).

Variables	Involvement in traffic accidents		
	Model A (Blocks 1 and 2)	Model B (Blocks 1, 2 and 3)	Model C (Blocks 1, 2, 3 and 4)
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Block 1: Neighborhood			
Census Tract average income ^b			
Less than 500,00 reais	0.80 (0.50-1.28)	0.73 (0.45-1.19)	0.77 (0.49-1.29)
500,00 to 724,00 reais	0.88 (0.55-1.40)	0.84 (0.52-1.35)	0.88 (0.55-1.41)
Block 2: Sociodemographic			
Gender			
Male	1.52 (1.03-2.24)	1.40 (0.94-2.08)	1.22 (0.81-1.83)
Age group (in years)			
15-29	5.61 (2.31-13.60)	4.28 (1.71-10.69)	3.15 (1.24-8.02)
30-44	3.91 (1.64-9.30)	3.18 (1.31-7.72)	2.42 (0.98-5.95)
45-59	2.30 (0.91-5.81)	2.02 (0.79-5.15)	1.78 (0.69-4.55)
Skin color ^c			
Brown or black	1.49 (0.99-2.23)	1.49 (0.99-2.24)	1.56 (1.03-2.35)
Common-law marriage			
No	1.50 (1.02-2.20)	1.47 (1.00-2.17)	1.49 (1.01-2.21)
Block 3: Traffic-related experiences			
Driver type			
Motorcyclist		1.51 (1.02-2.23)	1.73 (1.15-2.60)
Tickets history			
Yes		2.02 (1.21-3.37)	1.75 (1.04-2.94)
Block 4: Traffic behaviors			
Drinks and drives			
Yes			1.68 (1.12-2.53)
Uses cell phone while driving			
Yes			1.63 (1.09-2.43)

^a Multilevel Logistic Regression Analysis; ^b Variable Census Tract average income was maintained in the model since it is a contextual variable; ^c Self-declared skin color; white: includes drivers who self-declared as white or yellow. Block 1: contextual variable (refers to census tract); Block 2: sociodemographic variables of individuals; Block 3: traffic-related experiences variables; Block 4: Traffic risk behaviors variables. Categories of reference: Census Tract average income: more than 724.00 reais; Gender: female; Age group: 60 years and over; Skin color: white; Common-law marriage: yes; Driver type: driver; Tickets history: no; Drinks and drives: no; Uses cell phone while driving: no. The intraclass correlation coefficient of the final model (ρ): 0.0105443.

Despite the higher proportion of TA observed among males, gender was no longer associated with involvement in accidents since the inclusion of the variables on traffic experience. The odds ratio value became even lower when introducing risk behavior variables. The lack of association between gender and TA involvement in the final model may suggest that the effect of this exposure on the outcome is mediated by the variables that reflect experiences in traffic and risky behaviors, which is plausible since studies show gender differences in engaging in risk behavior and traffic violations³³. The literature on the subject points out a higher risk of TA for men

and, in this study, a higher frequency of accidents in male drivers was observed. In the final multivariate model, we noted that the odds ratio for men was 22% higher than for women, although this difference was not statistically significant. The final model data may indicate that men and women would be equally exposed to TA once adopting risk behaviors.

There is so far a consensus in the scientific literature that the greater involvement of men in accidents is due to gender differences, manifested by the more significant historical exposure of men to motorization, as well as by representations of virility when assuming aggressive be-

aviors while driving vehicles^{28,29,33}. However, with the intense contemporary motorization, women are increasingly participating as vehicle drivers and, more recently, as motorcycle drivers. This may contribute to lower differences in the intra-gender TA frequency, perhaps signaling a reduction in the “masculinized” profile of driver accidents.

Also, some international studies have found no differences for specific risk behaviors in traffic between men and women, such as the study by Wickens et al.³⁴, conducted in Canada on aggressive driving, and that of Lonczak et al.³⁵, who studied aspects of angry driving with drivers from the United States. It is necessary to point out that they are findings in different cultures, with advanced levels of motorization and road organization. Even so, they provide indications of a possible change, both in patterns of exposure and in the conduct of women in traffic. In Brazil, researchers point to the growing representation of women in accidents as drivers^{36,37}.

The hierarchical analysis showed that the involvement in TA was associated with factors that are parallel in the literature. A dose-response effect was observed among the age groups, with a higher frequency of accidents with decreasing age range. However, we found that this variable exerted a mediated effect on the outcome, since the measure of association fell in Models B and C, maintaining a higher proportion of involvement only among younger drivers, corroborating other studies^{12,14,25,29} and emphasizing the transcendence of the TA phenomenon, thus showing great potential for productive loss and early disability.

Skin color was another factor associated with involvement in accidents, and black or brown drivers had a higher proportion of the event. This result is consistent with the profile found, in general, for external causes in the country^{11,38,39}, expressing the social inequities of traffic accidents. One of the explanations for this inequality would be the condition of greater vulnerability to which black people are subjected in the road environment, since, due to the social exclusion of a significant number of these individuals, they end up being the majority of the vulnerable public highway⁴⁰ users.

Regarding motorcycle drivers, there was a higher frequency of accidents in this group, which reflects the contemporary national pattern for traffic occurrences, with motorcycle users predominating as TA victims. Data from the Ministry of Health indicate that motorcycle

occupants correspond to most of the victims in the records of SUS information systems, from ambulatory care, monitored by VIVA¹¹, to death statistics⁸. In the national scenario, the Northeast Region shows a worrying situation regarding the occurrences involving this category¹⁴. Studies have shown higher traffic violence involving motorcycles in this region, especially in small cities¹⁶ and outside the metropolitan axis⁴¹.

The genesis of accidents involving motorcyclists in Brazil is quite complicated, as it involves macro-determinants with political, economic and social elements, besides factors related to the style of driving and greater vulnerability in traffic, inherent to this type of vehicle. Some macro-determinants can be highlighted: i) the political option for individual transportation and tax incentives for vehicle assembling factories; ii) the unemployment situation for a large population, who saw in the use of the motorcycle a possibility of income; iii) the rise of occupations with motorcycle use, in which the logic of speed and per-productivity pay are found; and iv) acquisition facilities and lower vehicle maintenance costs^{42,43}.

This situation has contributed to a more significant presence of the motorcycle in traffic, assuming different roles in society, supplying demands for individual and sometimes family-related travel, in a context of poor urban mobility and congested public roads, and functioning as a working tool. Also, a low government investment in traffic, motorcycle-appropriate engineering measures, due to the historic privilege of automobiles in the road environment^{43,44}.

The characteristics of the municipality of Jequié meet the determinants pointed out in the literature for the production of accidents with motorcyclists. One of them is the city's large fleet of motorcycles, which, since 2007, has surpassed the fleet of automobiles and other vehicles. In 2006, motorcycles (motorcycles and scooters) accounted for 38.3% of the local fleet, reaching 50.3% in 2013, while the proportion of automobiles rose from 41.6% to 33.9% in the same period²¹. These data show a real “vehicular transition” in this location, with the massive presence of an inherently vulnerable vehicle.

Another factor that was shown to be associated with involvement in TA was having received traffic tickets. The study with young drivers by Marín-Leon and Vizzotto²⁷ found an association between a history of traffic tickets and involvement in accidents only for the men's group. The authors considered the “history of traffic tickets”

as a variable that carries, in itself, norm violations and, therefore, this would be an expression of inappropriate traffic behaviors, which contribute to the increased risk of accidents. This hypothesis is supported because following the inclusion of the variables of the last Block (on risk behaviors), the measure of association between history of traffic tickets and involvement in TA was reduced, which suggests an effect mediated by the behavioral variables studied.

Regarding the risk behaviors, only adopting unsafe speed in urban roads was not associated with the outcome. Drivers who reported driving after consuming alcohol were 68% more likely to be involved in TAs than those who did not, which shows a worrying but consistent result with findings from studies conducted in the country²⁷ and even in other contexts such as New Zealand⁴⁵ and France⁴⁶.

The alcohol-driving association is one of the main risk factors for traffic accidents in the world⁴ and, thus, several countries have established maximum levels of blood alcohol tolerance in their legislation. Despite the legal “zero tolerance” apparatus for alcohol abuse in Brazil, established by Law N° 11.705/2008 (“Prohibition Law”), drinking and driving behavior is still very much alive in the daily life of Brazilian society, since 24.3% of the adults participating in the PNS reported driving a vehicle after intake of any amount of alcohol⁴⁷. In fact, due to the relevance of this behavior in the generation of accidents, it was selected as one of the national targets for the actions of the Life in Traffic Project, implemented in Brazil between 2010 and 2011, consonant with the Decade of Road Safety⁶.

Another behavioral order factor with an association with involvement in TA was cell phone use. While few Brazilian studies have addressed this behavior in the occurrence of accidents⁴⁸, other countries evidenced^{32,46} the danger of using a cell phone while driving, such as the longitudinal study carried out in France, which found a relative risk for TAs with injuries of 1.88 (95%CI: 1.35-2.61) among those who always used it while driving⁴⁶.

The WHO points out that the risk of suffering traffic accidents between people using cell phones while driving can vary from twice to nine times the risk of those who do not use this device and, therefore, launched in 2011 the document “Mobile phone use: a growing problem of driver distraction”, with which it hopes to raise awareness around the risks of such behavior. It also encourages the production of knowledge about

the subject, which is relatively recent and remains unknown in many countries³¹.

Mobile phone use while driving vehicles is a contemporary behavior, which shares some determinants to other associated factors that we already addressed, such as weak enforcement, feelings of impunity and issues related to work processes, such as occupations that have both vehicles and cell phones as work tools. Besides these determinants, there are also other more recent factors, such as the intense use of this device by society in recent years. The underlying process of the relationship between cell phone use and TAs is the shift of attention from primary tasks (driving vehicle cognitive processes) to secondary tasks (use of the device). This deviation is known as cognitive distraction and is said to be as damaging to the driver’s performance as alcohol’s effects³¹.

Regarding the limitations of this research, survival bias and operational difficulties are mentioned in order to reach the final sample size, because it was not possible to find some drivers in all attempts to perform the interview until the end of the collection period. Even so, we found essential associations that were coherent and consistent with the findings of the national and international literature on the subject. Some results may have been underestimated, both because of the sample issue and the nature of some subjects, which are socially reprehensible and legally prohibited and, therefore, likely to be omitted by respondents. However, the observed high level of frequency of risk behaviors and measures of association of these factors with the involvement in TA expresses the severity of contemporary road unsafety.

In conclusion, we observed important socio-demographic and behavioral factors associated with involvement in traffic accidents, with a higher proportion of this event in the group of young, brown or black people not in common-law marriage, who were motorcyclists, with a history of traffic tickets and adopting risk behaviors in this environment, such as drinking and driving and using the cell phone while driving. An interesting finding, which differs from most of the evidence on the subject, was the lack of association between TA and gender when other variables were included in the model. This result can be explained in part by the mediation effect of other exposure factors introduced later, as well as by the influence of sample power. On the other hand, it may also indicate reduced gender inequalities in traffic events. We observed that the proximal factors modified the measures of association of the

exposures of the higher levels of determination of the hierarchical model, which suggests some effect mediated by these behavioral factors that trigger the event.

Thus, the results of this study ratify both the prevention potential of traffic accidents, due to the avoidable factors associated with the outcome, and the urgency for investments in education and traffic control interventions and, above all, safe mobility policies that prioritize collective travel.

Collaborations

PAA Rios participated in the conception of the project; collection, analysis and interpretation of the data; writing of all versions of the article; and approval of the final writing. ELA Mota participated in the conception of the project; analysis and interpretation of the data; review of all versions of the article; and approval of the final writing. LN Ferreira and JP Cardoso participated in the collection, analysis and interpretation of the data; critical review and approval of the final writing. VM Ribeiro and BS Souza participated in the collection and interpretation of the data; critical review and approval of the final writing. All authors contributed to the final version of the article.

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