Do speed cameras reduce speeding in urban areas?

Os radares fixos modificam o comportamento relacionado à velocidade excessiva dos condutores em áreas urbanas?

¿Los radares modifican comportamientos de velocidad excesiva en áreas urbanas?

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Abstract

This observational study aimed to estimate the prevalence of speeding on urban roadways and to analyze associated factors. The sample consisted of 8,565 vehicles circulating in areas with and without fixed speed cameras in operation. We found that 40% of vehicles 200 meters after the fixed cameras and 33.6% of vehicles observed on roadways without speed cameras were moving over the speed limit (p < 0.001). Motorcycles showed the highest recorded speed (126km/h). Most drivers were men (87.6%), 3.3% of all drivers were using their cell phones, and 74.6% of drivers (not counting motorcyclists) were wearing their seatbelts. On roadway stretches without fixed speed cameras, more women drivers were talking on their cell phones and wearing seatbelts when compared to men (p < 0.05 for both comparisons), independently of speed limits. The results suggest that compliance with speed limits requires more than structural interventions.

Traffic Accidents; Accident Prevention; Velocity Measurement; Urban Health

Resumo

Este estudo observacional teve como objetivo estimar a prevalência de condutores que transitam com excesso de velocidade em vias urbanas e estudar fatores relacionados a este comportamento. A amostra consistiu de 8.565 veículos que circulavam em áreas com e sem radares fixos em operação. Verificamos que 40% dos veículos observados em locais a 200m de radar fixo e 33,6% daqueles observados nos locais sem radar excedem os limites legais (p < 0,001). Motocicletas tiveram maior velocidade máxima registrada (126km/h). Os homens mostraram ser maioria entre os condutores (87,6%), o uso do celular durante a direção foi verificado em 3,3% de todas as observações e 74,6% dos condutores, exceto motociclistas, faziam uso do cinto de segurança. Nos locais onde não havia a presença do radar fixo, maior proporção de mulheres foi observada utilizando mais o celular e o cinto de segurança em relação aos homens (p < 0,05, para ambas comparações), independente dos limites de velocidade. Sugere-se que adesão ao cumprimento dos limites de velocidade vai além de intervenções estruturais.

Acidentes de Trânsito; Prevenção de Acidentes; Medição de Velocidade; Saúde Urbana

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Introduction

Road traffic accidents are among the leading causes of mortality and disability worldwide, and according to forecasts they will account for increasing public health expenditures in the coming decades. By 2020, traffic accidents are estimated to shift from 9th to 3rd place in the international ranking of global burden of disease, measured in disability-adjusted life years [1].

An estimated 50 million persons a year suffer road traffic accidents, resulting in 1.3 million deaths, 62% of which are concentrated in ten countries. Brazil ranks fifth, after China, India, Russia, and the United States. The traffic mortality rate in Brazil varied from 18 to 22.5 deaths/100,000 inhabitants from 2000 to 2010. The number of deaths and serious injuries currently exceeds 150,000 per year, and annual expenditures related to road traffic accidents total some 15 billion dollars [2,3].

This serious scenario led the Brazilian Ministry of Health to implement various strategies since 2001, aimed at monitoring the morbidity and mortality attributable to road traffic accidents [4,5].

The Ministry of Health has currently linked integrated measures with efforts launched by the United Nations, which proclaimed 2011-2020 as the Decade of Action for Road Safety through the *Road Safety in 10 Countries Project* (RS10). The Project includes various multi-sector traffic safety interventions such as the impact of speed control as a target [6,7]. This project, launched nationwide in Brazil in 2011, is called "Vida no Trânsito" (Life in the Traffic).

Speeding, defined in this article as driving a vehicle over the legal speed limit [8], is a serious traffic safety problem in many countries, contributing to at least a third of all traffic injuries, in addition to representing an aggravating factor in these events. Higher vehicle speed is directly associated with increased risk of crashes and likelihood of severe injuries [9].

Speed limits are used to regulate traffic speed by establishing maximum limits and contribute to decreasing the variation of vehicles' speed. In Brazil, speed limits vary from 30 to 110km/h. In urban areas they vary from 80km/h in rapid thoroughfares to 60km/h on arterial roads, 40km/h on collector roads, and 30km/h on local streets. These limits are regulated by the Brazilian Traffic Code [10] and complement other speed management measures such as instruments or equipment that record average speed, classified as fixed, static, mobile, and portable [11]. Despite all efforts to prevent one of the known risk factors for the occurrence and severity of traffic accidents, little research has been done on the population's compliance with speed control.

In a recent systematic review, Wilson et al. [12] evaluated the impact of speed cameras on speeding, traffic accidents, and the number of injuries and deaths. Despite some methodological limitations, the authors showed that speed cameras are a useful intervention for reducing traffic accidents and deaths. However, although the level of evidence points clearly in a positive direction in this effect, the authors identify various gaps in this area of knowledge and recommend more studies, especially in developing countries, where no articles were found [12].

The current study was thus designed to assess the prevalence of vehicles and their drivers that fail to circulate within the prevailing speed limits on urban arterial roads in a Brazilian state capital, 200 meter after fixed and visible speed cameras and 200 meters after points not covered by this type of speed control equipment (considered the comparator group). The study also intended to study characteristics of drivers related to the use of safety devices and cell phones, gender, and type of vehicle. Our main question was the prevalence of drivers that obey or disobey the speed limits monitored by fixed speed control equipment, referred to in this study as fixed cameras. This study is part of the evaluation of the "Vida no Trânsito" project in the city of Belo Horizonte, Minas Gerais State, Brazil.

The study's theoretical reference includes the integration of Susser's theoretical model for public health with Bronfenbrenner's socio-ecological model (Bronfenbrenner, 1979, *apud* Runyan [13]) and the Urban Health model [14], in addition to Haddon's logical framework [15]. The models and framework have similar characteristics: systemic approaches, valuing prevention, and taking into account the multi-factor causes of traffic accidents, including both the physical and social space, highlighting the need for multi-sector efforts and actions that extend beyond the health sector to deal with this problem.

Methods

The study adopted a cross-sectional, observational, roadside-type design, by direct observation of vehicles, drivers, and road conditions in the city of Belo Horizonte from October 24 to November 6, 2012.

Belo Horizonte is the capital of Minas Gerais State, located in Southeast Brazil. The city's population is 2,258,096, the sixth largest in the country [16]. The city has a total of 1,596,081 motor vehicles [17].

Sample design and calculation

The sample design drew on data furnished by the Belo Horizonte Urban Transport and Transit Company (BHTRANS), including: (1) a complete list of all the city's arterial roads containing routes with and without fixed cameras; (2) studies of daily traffic flows according to types of vehicles (automobiles, buses, trucks, and motorcycles); (3) information on days of the week and shifts for accidents attributed to speeding [18].

Using cluster grouping (Ward) [19], the city's 50 speed cameras were grouped into four strata according to daily vehicle flow studies. To calculate the total sample size [20] with optimal allocation and fixed and equal data collection cost for all the strata, confidence level was set at 95%, margin of error 1%, and 20% losses, according to the following expressions:

$$n = \frac{\left[\sum_{i=1}^{L} W_i \hat{\sigma}_i\right]^2}{\left(\frac{d}{z_{\alpha/2}}\right)^2 + \frac{1}{N}\sum_{i=1}^{L} W_i \hat{\sigma}_i^2}$$, (total sample size)

$$n_i = n \frac{W_i \hat{\sigma}_i}{\sum_{i=1}^{L} W_i \hat{\sigma}_i}$$, (sample size in each stratum i)

Where $L = 4$ strata, n the sample size (i.e., the total number of vehicles to be sampled), n_i the sample size in each stratum i, oi, σ_i^2 the sampling variance, N the population size, N_i the size of the population stratum i, $W_i = N_i/N$ the stratum's weight i, $i = 1,2,..., L$; d the deviation, $Z_{\alpha/2}$ the value corresponding to level of significance $\alpha = 0.05$ in normal standard distribution.

The minimum required sample was 2,220 vehicles on roadway stretches preceded by cameras and 2,340 vehicles on stretches without cameras.

Based on georeferenced information on the location of cameras on the arterial roads, we randomly selected the surveillance points and corresponding 200-meter stretches to be observed, considering the presence or absence of fixed cameras. The eligibility of each stretch (with and without fixed camera) was checked using Google Maps (http://maps.google.with.br) to view the roads' structural characteristics. Eligibility criteria for the checkpoint and corresponding stretch included: (1) speed limits not exceeding 60km/h, with speed limit signs posted; (2) safe roads with good visibility for the observers (unhindered observation, without obstacles); (3) conditions for the correct use of the speed camera, per protocol; (4) stationary and fully functional cameras (when applicable); (5) absence of speed reducers like speed bumps, stop signs or signals, pedestrian crosswalks, or any other device (permanent or otherwise); and (6) sufficient traffic flow of at least 30 vehicles every 15 minutes, as verified by flow counters at the start of observation.

For each surveillance point, two additional points were randomly selected as alternatives in case of ineligibility verified during the fieldwork. The points were allocated such that each stratum represented the three shifts and the days of the week.

Fieldwork and data collection

The data were collected every day of the week in three shifts (morning, afternoon, and evenings). On weekends (Fridays, Saturdays, and Sundays) an extra shift was added (midnight to dawn). Each shift lasted an average of 2h30m, with six 15-minute observation periods with five-minute breaks between.

A protocol was designed especially for this study, based on the Systematic Social Observation method (SSO) [21] and was applied to the selected stretches. The protocol included physical and dynamic characteristics of the roadway stretch, such as description of the roadway (dry/wet, good or poor maintenance); weather conditions (sunny, cloudy, light or heavy rain); presence of traffic signs; and traffic generators.

Traffic signage was defined here as the "*set of traffic signs and safety equipment deployed on the roadway to ensure adequate use, facilitating local traffic flow and greater safety for vehicles and pedestrians*" [22] (p. 173). The variables on this topic were: central divider strips, guardrails, pedestrian crosswalks, speed humps, horizontal signals, traffic lights, light signals, right-of-way lanes, and speed limit signs. Traffic generators were defined as "*large-scale enterprises that attract or produce large numbers of trips, causing negative effects on surrounding roadway circulation and in some cases jeopardizing accessibility in the entire vicinity, in addition to aggravating safety conditions for vehicles and pedestrians*" [23] (p. 8). This study identified the following traffic generators: schools, hospitals, supermarkets, factories, shopping centers, business districts, bus stops, and subway stations.

The average vehicle flow in the stretch was obtained by counting the vehicles at the beginning and end of the data collection shift for a period of 15 minutes, using digital counters. Two independent observers conducted the data collection.

The portable UltraLyte laser speed gun (Laser Technology Inc., Centennial, USA), approved by the Brazilian National Institute of Metrology, Quality, and Technology (INMETRO) was used to measure speed. The field team was positioned on the sides of the eligible roadways; a trained observer using the portable laser gun informed the speed to the other observer, who was responsible for filling out the form.

In addition, information on drivers and vehicles was collected by two other trained observers according to protocol, including type of vehicle, driver's gender, use of cell phone, helmets, and seatbelts.

In all stages of the study, the fieldwork team was exhaustingly trained, and the instruments were previously tested and validated in a pilot study.

The analysis was performed in three stages. The first consisted of the sample's internal validity based on the presence or absence of fixed laser guns in relation to the roadways' characteristics. In other words, we compared possible locally measured characteristics that might alter the driver's behavior, other than the presence of fixed cameras. One of these characteristics was evaluated by the vehicle per point variable, which estimated the average number of vehicles observed per data collection point, considering the presence or absence of a fixed camera.

The second phase focused on external validity, using an ecological comparison of the set of characteristics of the vehicles observed 200 meters after the speed cameras and those provided by the transit authority responsible for the roadway and referring to the same cameras selected according to the days of the week and shifts, including average traffic flow and speed, types of vehicles, and speeding rates. The data were supplied by the transit authority based on systematic recording by the fixed cameras, consisting of information on all the vehicles that passed by the camera during the study period. This phase aimed to measure our sample's representativeness compared to all the vehicles that drove by the cameras.

The third phase was a bivariate analysis of the driver's gender and use of cell phones and seatbelts, considering the presence or absence of the fixed camera, aimed at verifying possible associations between drivers' characteristics and speeding.

Data processing used TELEform v10.2 (http://www.cardiff-teleform.with/). The proportions, means, and medians and their respective standard deviations were described and compared with the following tests: chi-square, Fisher's exact test, Student t test, analysis of variance (ANOVA), and multiple comparisons using the Bonferroni method, with significance set at 5%. The Stata package (StataCorp LP, College Station, USA) was used for the analyses.

This study is part of the *Life in the Traffic: Evaluation of the Life in the Traffic Project* in Belo Horizonte, Minas Gerais State, and Campo Grande, Mato Grosso do Sul State, approved by the Ethics Research Committee of the Federal University of Minas Gerais (Platform Brazil, November 29, 2012, review number 158.014).

Results

The sample consisted of 48 surveillance points and the respective roadway stretches, 35 of which were preceded by speed cameras and 13 were not, on 12 arterial roads, totaling 8,628 observed vehicles. Of these, 53 observations were excluded due to lack of information on speed or type of vehicle, resulting in 8,565 vehicles, and sample size with study power greater than 90%.

None of the characteristics evaluated to verify the sample's internal validity was associated with presence of cameras (Table 1), with the exception of vehicle flow, which was higher at the points with cameras ($p < 0.001$). This result was expected, considering the criterion adopted by the traffic department in choosing sites with heavier vehicle flow for the initial installation of fixed cameras.

In the current study, 40.0% of vehicles observed at points preceded by speed cameras and 33.6% on roadways without cameras ($p < 0.001$) were exceeding the legal speed limits.

In sites with fixed cameras, mean speed was 58.6 ± 12km/h, compared to 56.9 ± 12.5km/h on roadways without cameras. Types of vehicles did not differ significantly ($p = 0.929$). Overall vehicle distribution was the following: automobiles (72.7%), motorcycles (14.2%), buses (6.2%), and trucks (6.9%).

All the motorcyclists were wearing helmets. However, more than half of the motorcyclists were speeding, with the highest speeding levels, independently of the presence or absence of fixed cameras.

Automobiles and motorcycles showed the most discrepant values. All the types of vehicles showed slightly higher mean speed in the presence of fixed cameras, compared to stretches without cameras. In both types of sites, the mean speeds of automobiles and motorcycles were higher than the mean speeds of buses and trucks ($p < 0.001$) (Figure 1).

As for our observations' external validity, no differences were found between our study's observations at 200 meters from cameras and the data provided by the fixed cameras at the respective data collection points in terms of mean flow per minute and distribution of vehicle types

Table 1

Comparison of roadway characteristics and presence of speed cameras. Belo Horizonte, Minas Gerais State, Brazil, 2012.

	200m after speed camera (n = 35)	200m after comparison point without speed camera (n = 13)	p-value
Roadway characteristics			
Number of lanes * [n (%)]			0.999
One	1 (2.9)	0 (0.0)	
Two	33 (97.1)	13 (100.0)	
Roadway conditions * [n (%)]			0.999
Dry	31 (88.6)	11 (84.6)	
Wet	4 (11.4)	2 (15.4)	
Weather ** [n (%)]			0.093
Sunny	23 (65.7)	4 (30.8)	
Cloudy	11 (31.4)	8 (61.5)	
Raining	1 (2.9)	1 (7.7)	
Roadway slope ** [n (%)]			0.067
Flat	17 (50.0)	11 (84.6)	
Moderate	17 (50.0)	2 (15.4)	
Shift ** [n (%)]			0.426
Midnight-to-dawn	6 (17.1)	0 (0.0)	
Morning	9 (25.7)	5 (38.5)	
Afternoon	10 (28.6)	4 (30.8)	
Evening	10 (28.6)	4 (30.8)	
Signage * [n (%)]			0.999
Yes	34 (97.1)	13 (100.0)	
No	1 (2.9)	0 (0.0)	
Traffic generator * [n (%)]			
Yes	34 (97.1)	12 (92.3)	0.945
No	1 (2.9)	1 (7.7)	
Vehicle characteristics * **			
Total vehicles in sample	6,243	2,322	
Mean flow/point (vehicles/minute) ##	23	16	< 0.001 #
Vehicles/point ## [n (±DP)]	179 (178.3±2.0)	179 (178.6±1.3)	0.617
Speed ## [n (±DP)]	57 (58.6±12.0)	55 (56.9±12.5)	0.668
Type of vehicle/point ** [n (%)]			0.929
Automobiles	129 (72.1)	133 (74.3)	
Motorcycles	26 (14.8)	23 (12.7)	
Buses	11 (5.9)	12 (7.0)	
Trucks	13 (7.2)	11 (6.0)	

* Fisher's exact test;

** Chi-square test;

** Mean flow and type of vehicle represent the mean of the total per point;

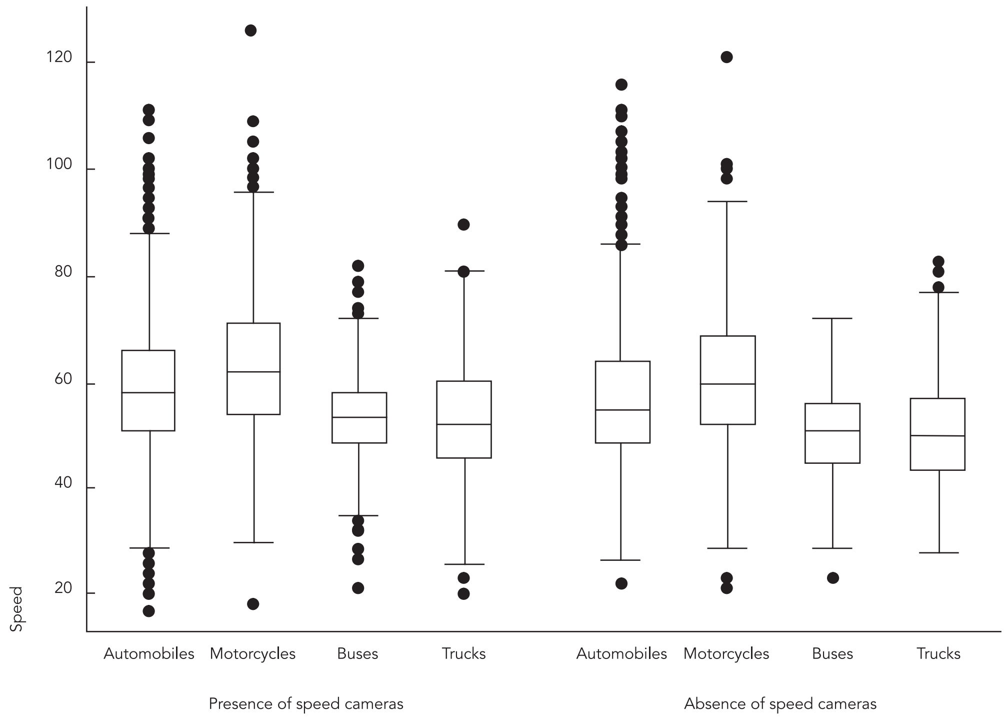
Student t test significant at 5%;

Student t test.

(p > 0.05). However, in the comparison of mean speeds and proportions in the distribution of the speed limit, the values were significantly lower according to the fixed cameras, provided by the BHTRANS transit company, with the measurements taken 200 meters after the cameras. In other words, at the point of the fixed camera, mean speed was lower (48.2km/h versus 57.9km/h, p <

Figure 1

Speed by type of vehicle at points with and without fixed speed cameras. Belo Horizonte, Minas Gerais State, Brazil, 2012.



0.001) and more vehicles were moving at or below the speed limit (99.7% versus 61.9%, p < 0.001). Meanwhile, 200 meters after the cameras, the vehicles showed significantly higher mean speed (57.9km/h) and a higher proportion (38.1%) of vehicles above the speed limit (Table 2).

When analyzing drivers' characteristics, data were missing due to flaws in field observations as follows: 9.1% for gender, 16.2% for cell phones, and 17.2% for seatbelts (not counting motorcycles). Analysis of cell phone use was based on 7,048 observations and seatbelt use on 5,980 observations. Of the drivers with this information, 87.6% were men, 3.3% were using their cell phones, and 74.6% were wearing seatbelts.

On roadway stretches preceded by fixed cameras, no significant association was observed between driver's gender and cell phone use (p = 0.581) among drivers at or below the speed limit, but there was a borderline association in drivers over the speed limit (p = 0.053) (Table 3). Compared to men, although more women were wearing seatbelts (88.89% versus 71.80% p < 0.05), regardless of the speed limit and presence of fixed cameras, women also used their cell phones more while at the wheel (5.02% vs. 3.00%, p = 0.001). On roadways without cameras, these differences were significantly greater when compared to male drivers (6.47% vs. 2.71%, p = 0.001), regardless of whether they were driving within the speed limit (Table 3).

Discussion

According to the current study, 40.0% of vehicles on roadway stretches preceded by cameras and 33.6% on roadways without cameras (p < 0.001) were exceeding the speed limit. Mean speed and distribution of the speed limit were significantly associated with distance from the speed camera. In other words, at the point where the fixed camera was installed, vehicles showed the lowest mean speed and the highest proportion of vehicles within the speed limit. Two hundred meters after the cameras, the study showed the highest mean speed and the highest proportion of vehicles exceeding the speed limit (38.1%).

Table 2

Comparison of data from the Vida no Trânsito Project and Belo Horizonte Urban Transport and Transit Company (BHTRANS), adjusted by the vehicle fleet in Belo Horizonte, Minas Gerais State, Brazil, 2012. External validity.

Variables	BHTRANS (at speed camera) [n = 34,627]	Vida no Trânsito Project (200m after the speed camera) [n = 4,825]	p-value
Mean flow (vehicles/minute) * [n (±SD)]	23.9 (±18.0)	23.5 (±14.7)	0.134
Mean speed (km/h) * [n (±SD)]	48.2 (±6.5)	57.9 (±11.8)	< 0.001 **
Type of vehicle *** [n (%)]			0.597
Automobiles	28,861 (75.4)	3,557 (71.0)	
Motorcycles	3,067 (13.4)	703 (12.7)	
Buses/Trucks	2,699 (11.2)	565 (16.3)	
Speed limit *** [n (%)]			< 0.001 **
Within speed limit	34,581 (99.7)	2,985 (61.9)	
Up to 20% over speed limit	44 (0.2)	1.305 (27.1)	
20% to 50% over speed limit	2 (0.1)	507 (10.5)	
More than 50% over speed limit	0 (0.0)	28 (0.5)	

* Student t test;
** Significant at 5%;
*** Chi-square test.

Table 3

Comparison of male and female drivers according to cell phone use, seatbelt use, presence of speed camera, and speeding. Belo Horizonte, Minas Gerais State, Brazil, 2012.

	Speeding									
	Within speed limit				p-value	Over speed limit				p-value
	Male		Female			Male		Female		
	n	%	n	%		n	%	n	%	
Presence of speed camera										
Yes										
Cell phone use										
Yes	90	3.6	16	4.1	0.581	42	2.5	9	4.9	0.053
No	2,425	96.4	370	95.9		1,655	97.5	174	95.1	
Seatbelt use										
Yes	1,556	70.8	323	87.8	< 0.001 *	974	73.3	159	89.8	< 0.001 *
No	642	29.2	45	12.2		355	26.7	18	10.2	
No										
Cell phone use										
Yes	36	2.7	11	6	0.015 *	18	2.7	7	7.3	0.019 *
No	1,292	97.3	171	94		643	97.3	89	92.7	
Seatbelt use										
Yes	830	72.5	153	87.4	< 0.001 *	357	70.4	77	95.1	< 0.001 *
No	315	27.5	22	12.6		150	29.6	4	4.9	

* Chi-square test significant at 5%.

Speed cameras

Wilson et al. [12], corroborating various authors, state that interventions designed to reduce traffic speed are essential to prevent road traffic accidents. Such interventions include installing speed control cameras. In a systematic review in 2013, the authors showed that cameras helped reduce the mean speed, decreased the percentage of speeding vehicles, and reduced drivers' speed. However, these results cannot be generalized, since the available studies on the theme were conducted in high-income countries.

One of the problems associated with electronic speed cameras is the tendency of some drivers to brake when they pass the camera and then speed up over the limit when they are out of the camera's reach.

Although various studies have shown that speed control with cameras is effective in reducing accidents up to 200 meters after the camera, our study showed that by 200 meters after the speed camera, only 60% of drivers were still obeying the speed limit. We thus observed the so-called "kangaroo effect", described as slowing down before cameras and accelerating after them [24]. This finding suggests that new strategies are needed to mitigate this rebound effect, associated with changes in the speeding culture in order to have a positive impact on drivers' behavior in relation to cameras [25]. A relatively new method with the potential to prevent the abovementioned effect is to control the entire roadway stretch, or monitor average speed. Unlike conventional automatic speed control devices that measure a vehicle's speed at a single point, average speed controls measure speed for a distance of at least 500m, and up to several kilometers [25]. The literature also recommends rigorous and more unpredictable surveillance, including mobile laser speed guns.

The difference of nearly 10km per hour between the average speed at the fixed camera points and 200 meters away from them does indeed suggest the impact of this urban engineering intervention close to the cameras, but that the effect diminishes as vehicles move farther away from the cameras.

Characteristics related to speeding: gender, type of vehicle, seatbelts, and cell phones

According to our study, motorcycles were the type of vehicle with the highest mean speed and the highest recorded speed (126km/h). According to the World Health Organization (WHO) [9], motorcyclists belong to the most vulnerable group on public roadways, running a high risk of severe or fatal injuries in crashes. The higher the vehicle's speed, the higher the risk of a crash and the greater the likelihood of severe injuries.

Some epidemiological characteristics of road traffic accidents in Brazil (and specifically in Belo Horizonte) have been the increase in motorcycle accidents, excess male mortality, and higher incidence in young adults (20 to 39 years) [26]. Almeida et al. [27], in a descriptive study to estimate the potential years of life lost (PYLL) due to road traffic accidents in the State of Pernambuco, Brazil, showed that overall PYLL was 104.3 years per 100,000 inhabitants; motorcyclists showed the highest PYLL rate (PYLLR), 28.4 PYLL per 100,000 inhabitants; for all road traffic accidents, PYLLR was always higher among men (923.9 years) when compared to women (173.4 years), and was also higher in the 20 to 39 year age bracket for all types of victims.

To test the hypothesis that predictors of behavior for serious road traffic accidents correlate with unfavorable attitudes towards traffic safety, Nabi et al. [28] conducted a cohort study in France with 13,447 participants, using questionnaires applied over the course of three years. Cell phone use while driving was an important determinant of serious road traffic accidents, and individuals with a strong tendency towards risk behaviors associated with serious road traffic accidents were more prone to negative traffic safety attitudes.

In our study, cell phone use at the wheel was seen in 3.3% of the observations, and was more prevalent among women. These results were similar to a study in Barcelona, Spain, in 2011, with 3.8% prevalence of cell phone use by drivers, and where the multivariate analysis showed that women drivers were more likely to use their cell phones [29]. Meanwhile, in a study in Mexico that measured cell phone use by drivers in three cities and identified associated demographic and environmental factors, overall prevalence was 10.78% (95%CI: 10.11-11.48), and there was no association with gender. Factors associated with cell phone use were travelling alone, driving on major thoroughfares (3-5 lanes), and driving on weekdays (Mondays through Fridays) [30].

Meanwhile, Sabbour & Ibrahim [31], in a study of 450 medical students using a self-administered questionnaire that focused on driving styles and behaviors and their association with road traffic accidents, found that speeding and not wearing a seatbelt and talking on the cell phone while driving were more prevalent among male drivers. Cell phone use while driving and speeding (among other factors) were significantly associated with medical students' involvement in car accidents.

The study's contributions and limitations

This study's limitations include some factors related to data collection: especially the observers' dependency on the data collection, preventing reliability studies, the short observation period, two weeks, not allowing the detection of possible seasonal variations, and the lack of data on speed collected with the same methodology but before speed cameras were installed in the city.

On the other hand, the study's strengths include the fact that (as far we know) this is the first roadside-type study in Brazil with a sampling design covering daily traffic variations, which allowed testing the effect of speed cameras on vehicle speed 200 meters after their installation points, which included the possibility of verifying internal validity in the design by comparing the results with roadways without the speed camera effect. It especially tested external validity, comparing the speed camera's effect at its installation point and 200 meters past it.

The study's strengths also include the care in avoiding possible data collection biases by establishing a rigorous collection protocol aimed at guaranteeing the data quality; exhaustive training of the data collection team, in addition to allocating two observers at each surveillance site.

In short, the study's contributions exceeded its limitations, showing satisfactory internal and external validity. The proposed model was especially relevant given the possibility of assessing the impact of social change processes or community interventions such as new programs, policies, or legislation.

Conclusions

The current study makes original and important contributions by demonstrating drivers' behavior in relation to speed on urban roadways in a developing country. The information fills an important gap in knowledge on the population's exposure to this risk factor in Brazil. We found that the presence of speed cameras had a great impact on speed at the exact installation points, but failed to ensure compliance with speed limits by a significant share of drivers 200 meters after the cameras.

The results show that compliance with speed limits and changing individual and community behavior require more than structural interventions.

Motorcyclists are the group that speeds the most, which aggravates the vehicle's inherent risk by increasing the driver's vulnerability, confirming the need to identify effective and sustainable strategies targeting driving behavior in order to improve speed control in developing countries [32].

Speed surveillance studies in urban areas, aimed at reducing road traffic accidents by evaluating the impact of speed cameras, need to be rethought, considering new structural and technological strategies. Possibilities feature alternating the cameras by periodically changing their fixed points and monitoring the average speed on roadway stretches, among others. However, in addition to new structural and technological strategies, evaluation studies should include new data collection to allow analyses of time trends and other measurement methodologies that will allow a better understanding of differences in traffic behaviors.

Another issue that facilitates such studies is collaboration through inter-institutional partnerships, established during this study's development, from its planning to its conclusion. Close collaboration between traffic safety authorities and health services was crucial for this study, starting with an academic institution. This suggests that the complexity of traffic accidents requires efforts by all representatives of society in dealing with this important public health problem.

Resumen

Este estudio observacional fue realizado para estimar la prevalencia de los conductores que no respetan el límite de velocidad en vías urbanas y estudiar los factores relacionados con este comportamiento. La muestra consistió en 8.565 vehículos circulando en zonas con y sin radares fijos en funcionamiento. Se encontró que 40% de los vehículos a 200 metros mas allá del radar estacionario y 33,6% de los observados en las zonas sin radar exceden los límites legales (p < 0,001). Las motos registran una velocidad máxima más elevada (126km/h). Los hombres fueron mayoría (87,6%), el uso de celular mientras se conduce representó un 3.3% de todas las observaciones y el 74,6% de los conductores estaban usando cinturones de seguridad entre los automobilistas. En sitios donde no había presencia de radar estacionario, se observó una mayor proporción de mujeres que usan el teléfono y el cinturón de seguridad (p < 0,05 para ambas comparaciones), independientemente de los límites de velocidad. Se sugiere que la adherencia a las normas referidas a velocidades máximas va más allá de las intervenciones estructurales.

Accidentes de Tránsito; Prevención de Accidentes; Medición de Velocidades; Salud Urbana

Contributors

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