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Distracted driving in relation to risky road behaviors and traffic crashes in Bogota, Colombia

Andrea Arevalo-Tamara [a,b,*], Angela Caicedo [b], Mauricio Orozco-Fontalvo [c], Sergio A. Useche [d]

[a] Department of Civil Engineering, University of Granada, ETSI Caminos, Canales y Puertos, Spain
[b] Civil Engineering, Santo Tomas University, Bogotá, Colombia
[c] CERIS, Instituto Superior Técnico, Universidade de Lisboa, Av. Rovisco Pais, 1, 1049-001 Lisboa, Portugal
[d] ESIC Business & Marketing School, Valencia, Spain

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ABSTRACT

The growing evidence on road distraction during the recent years has shown how road distractions might be playing a relevant role on traffic crash causation. However, the empirical insights about how it works in low- and middle-income countries (LMICs) are really limited so far. The case of Colombian non-professional drivers remains virtually unexplored on this regard. This research aims to assess the effect of road distractions, driving-related issues and road behaviors on the self-reported crashes suffered by drivers in Bogotá, Colombia. To do so, a sample of 659 drivers (64% males and 36% females) with a mean age of 37.9 years (SD = 11.7) was gathered, who answered an online survey on road distractions, behaviors and self-reported crash history. Most of the distracting sources reported were found to be rather common among most of the drivers, even though only a few gender differences were found. Structural Equation Models show that there is a significant effect of road distractions on drivers' self-reported crash rates and that young adults are more prone to incur in these behaviors as a consequence thereof. These findings support the design of safety interventions that focus on mitigating the risk of being distracted. In the same vein, authorities should increase the efforts to enforce ICT-related laws while driving, thus contributing to reduce the prevalence and impact of distracting sources while driving.

1. Introduction

According to a report by the World Health Organization, the average annual number of deaths caused by road crashes is 1.35 million, making it the main cause of death in people aged between 15 and 29 (WHO, 2018). Additionally, despite the fact that crashes have been considered a public health problem for decades, their global trends do not seem to improve to a great extent, especially in the case of Low and Middle-Income countries, or LMICs (Tavakkoli et al., 2022). Something that seems to worsen the situation is the fact that human factors are the most relevant but, at the same time, the most understudied crash contributors, making it difficult to assess, control, and intervene them (Bucsuházy et al., 2020).

Human factors comprise different topics, e.g., alcohol-impaired or drug-impaired driving; sleepiness; fatigue; reckless driving; speeding; mood, attention, and risky road behaviors (Horberry et al., 2006; Lu et al., 2020; Mirón-Juárez et al., 2020; Sterkenburg and Jeon, 2020). This is partly because they increase the likelihood of a crash, but it's also because they're closely linked to contemporary transportation dynamics, one of which is distracted driving (Useche et al., 2021a; Pavlidis et al., 2016).

Studies such as Oviedo-Trespalacios et al. (2021, 2019, 2017) have empirically demonstrated that distracted driving, —which refers to both internal (psychological) and external (environmental) factors that could affect driver's attention— represents a growing threat to individuals' health and road safety. Also, Naumann & Dellinger (2013) argued that crashes caused by distraction are among the most likely to involve fatal and/or seriously injured victims, and the figures back it up. For instance, in the USA, about 14% of all car accidents are caused by distracted drivers, with 8% of these crashes being fatal, and another 15% involving seriously injured people (NHTSA, 2020). Furthermore, other studies explicitly agree on the fact that road distractions are a key issue to consider in policy-making on road safety (Kass et al., 2007; Ortiz et al., 2018; Oviedo-Trespalacios et al., 2021).

* Corresponding author.
E-mail addresses: asarevalo@correo.ugr.es (A. Arevalo-Tamara), angelacaicedo@usantotomas.edu.co (A. Caicedo), mauricio.orozco@tecnico.ulisboa.pt (M. Orozco-Fontalvo), sergioalejandro.useche@esic.edu (S.A. Useche).

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In addition, recent approaches emphasize that distracted driving is becoming increasingly complex. For instance, Gazder and Assi (2022) state that distraction can be classified into three types: manual, visual, and cognitive distraction, all of which are enhanced by critical factors such as the inadequate use of ICTs (Information and Communication Technologies; especially mobile phones) while driving (Iio, et al., 2021; Oviedo-Trespalacios et al., 2017). Meanwhile, some 'traditional' distracting sources, such as billboards, road obstacles, difficult weather conditions, and even the driver's inner world, remain highly prevalent (Jazayeri, Martinez, Loeb & Yang, 2021; Mahpour et al., 2019).

1.1. Some key empirical insights from literature on driving distractions

Specifically, when analyzing distraction and/or inattention-related issues affecting driving, some methodologies have focused on determining the main causes and mitigating the occurrence of crashes related to this issue. Shams et al. (2021) examined demographic variables, insomnia, and working conditions with the use of structural equation models (SEM). This was done in order to investigate the relationships between these latent variables and the demographics of truck drivers. Other methodologies have related driving distractions to key issues such as driving styles (Charlton & Starkey, 2020; Taubman-Ben-Ari & Skvirsky, 2016), drivers' vigilance, and their attempts to simultaneously perform various activities while driving (Nakano et al., 2019; Karthaus et al., 2020). Similarly, we find the propensity score weighting method, used by Lu et al. (2020), to measure the tendency to use a cell phone while driving. There are also the studies such as Soares et al. (2020), which intended to assess the elements that determine the presence of drowsiness and distraction in drivers, and Oviedo-Trespalacios et al. (2017), which helped to show the links between visual, cognitive, and psychological distractions.

Regarding experimental research on driving distractions, the literature shows how these studies are commonly based on practical exercises or tests measuring the impact of (e.g.) mobile phone use and mixed stimuli on driving performance. For example, Li et al. (2021) examined the distraction caused by voice messaging applications by simulating some test scenarios with drivers. In them, they varied the type of message received and measured how it influenced the inattention of drivers. On the other hand, Hancock et al. (2003) conducted tests that consisted of answering the phone while facing important decisions on the road, such as braking and modulating speed, on the basis of sociodemographic variables. Thus, similarly to Ortiz et al. (2018), who assessed the effect of WhatsApp-related texting on driver's distraction and its relationship to demographic variables such as age.

1.2. Research on road distractions: LMICs lag behind

Although all this evidence is interesting as a whole, the vast majority of these studies are developed in high- or middle-income contexts. Specifically, the research on this topic is very scarce in Latin American countries, most of which are considered LMICs. Only during the last few years have empirical studies started to explore the case of Colombian road users from an applied perspective. For instance, there are studies such as Martinez, Sanchez, & Yañez-Pagans (2019), presenting a statistical data review on various risk factors (driving distractions included) threatening road safety in Latin America and the Caribbean, or Useche et al. (2018), focused on the risk of cyclists. We can also note Useche et al. (2020), who studied the effects of work stress on the risk of traffic crashes reported by Colombian drivers from different cities. Nevertheless, no specific distraction assessment study has been conducted to date. According to the foregoing, distraction has been hypothesized to increase road risks worldwide, particularly in Latin America. Crash rates in the region illustrate how they represent one of the main causes of death for people aged 5–44, with 16 deaths per 100,000 inhabitants and around 630 fatalities per million vehicles (IDB, 2010). Even so, no research has been carried out to study how distraction and performance or non-performance errors of non-professional drivers influence the occurrence of traffic crashes. This indicates an even greater knowledge gap that hinders effective policy-making and the implementation of effective mitigating measures.

This study was developed in Bogotá, the capital city of Colombia. In the past, some studies have pointed out the existence of a difficult road safety panorama in the country. Accordingly, it is worsened by the lack of effective road training measures and road safety education for drivers (Jimenez et al., 2015; Porras Cataño et al., 2021). Furthermore, the actual influence of inattention and distraction in traffic crashes is very difficult to determine, making it frequently ignored, thus attributing the cause of many distraction-related crashes to other variables (e.g., speeding, poor road conditions, or generic reckless driving). This information reveals an important bias in the investigation of road events due to unobserved variables related to distraction. Moreover, this includes variables with possible heterogeneous effects (Mannering et al., 2016).

1.3. Aim, hypothesis and value of the study

The aim of this research was to assess the effect of road distractions, driving-related issues, and road behaviors on the self-reported crashes suffered by drivers from Bogotá, Colombia. In this regard, it was hypothesized that road-related distractions affecting drivers might have a significant predictive role in their risky driving behaviors and, in turn, potential traffic crashes.

To the best of our knowledge, this study constitutes the first empirical approach to this issue on a national scale, making it valuable as a baseline contribution for informed policy formulation. To do so, we conducted an online survey of 659 drivers and estimated a Structural Equation Model (SEM). This paper is structured as follows: literature review, methodology, modeling results and discussion, and finally conclusions and future work. To the best of our knowledge, this is the first paper addressing this issue in the city of Bogota. Therefore, this study is expected to provide the first empirical insights on the topic, something critical for proposing evidence-based policies intended to mitigate and manage factors that influence driving distraction.

2. Methods

In this chapter, we describe the case study context –providing key highlights on the road conditions, dynamics, and safety outcomes of the city addressed–, the sample used for the study, the questionnaire design, and the modeling framework.

2.1. Study context and setting

Bogotá is the capital of Colombia; it has a geographical area of 1,775 km^2 divided into 20 locations. It has a total of 9,708,000 inhabitants and a motorization rate (cars per 1,000 people) of 156.95, according to official data provided by the Secretariat of Mobility (2020). Between 2015 and 2019, about 374,000 drivers in the city were involved in road crashes: 2.75% were cyclists, 72.99% drivers, 12.05% motorcyclists, 6.51% passengers, and 5.70% pedestrians. In terms of severity, 56,677 crashes involved injured people, 114,140 involved only damage, and 2,624 reported fatalities (Secretariat of Mobility, 2020). It is also one of the cities that implemented "Vision Zero", that is, "a global movement to end traffic-related fatalities and serious injuries by taking a systemic approach to road safety. The premise of this strategy is that road deaths and injuries are unacceptable and preventable" (World Resources Institute, 2021).

This cross-sectional study was performed through an online survey written in Spanish and distributed to a pre-existing mailing list (exclusively shared among universities and research centers). This took place during the first half of 2021, setting filters to only invite individuals (*i*) labeled as licensed drivers, and (*ii*) over 18 years old as potential study

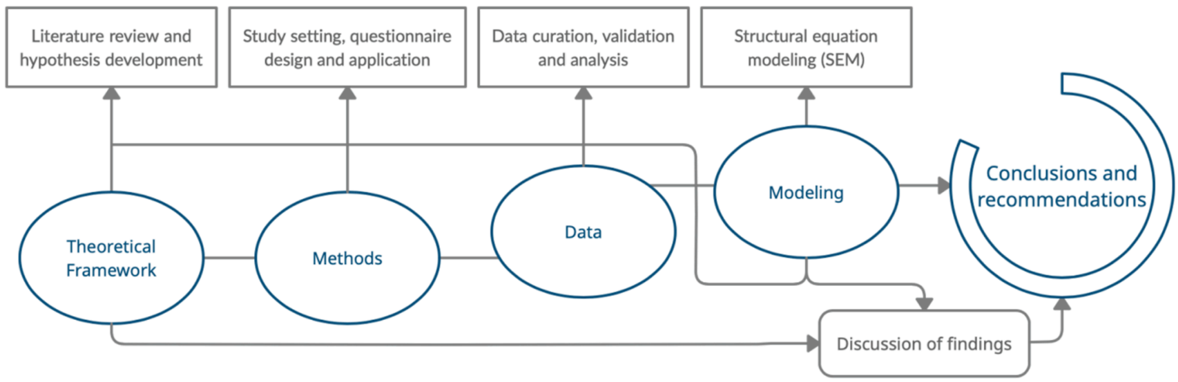

Fig. 1. Description of research stages and practical steps (flowchart).

subjects. In order to achieve an acceptable representativeness: (*i*) we assumed the full census of drivers of the city (approximately 5 million; RUNT, 2018) as the population size. Moreover, (*ii*) although population representativeness can be only partially supposed on the basis of a non-probabilistic sampling method, an a priori calculation of the minimum sample size was carried out. The minimum sample size required was of about 650 subjects, assuming a maximum margin of error of 5% (α = 0.05) and a beta (β) of 0.20, which allowed for an 80% power. The average time needed to respond to the electronic survey was about 10 min. To avoid potentially biased responses, before starting the survey, it was emphasized that the data would be exclusively used for statistical research purposes and that participation was anonymous. The response rate was approximately 37%, considering that the verified mailing list used for this purpose was composed of about 1,800 individuals.

This research was developed through a five-stage process, as shown in Fig. 1. In the first stage, a literature review was carried out to determine the appropriate methodology for data analysis. It was followed by the design and application of a questionnaire for data collection. Then, a structural equation model was estimated, followed by a discussion of the findings.

2.2. *Study sample*

The data used for this research was obtained from a sample of 659 drivers (64% males; 36% females) from the city of Bogotá, Colombia. The study sample had a mean age of M = 37.90 (SD = 11.71) years, ranging [18–71]. Table 1 shows further basic demographic data of the participants.

Additionally, regarding the demographic facts of the sample, it is worth mentioning that: (*i*) there was a third gender choice in the questionnaire. However, due to null responses obtained in this regard (as it usually happens in many emerging or LMIC countries as a result of cultural issues), it was not considered for analytic purposes. Therefore, gender was treated as a binary variable. In addition, (*ii*) the income level of drivers shows a standardized taxonomy (*strata*) officially used in Colombia. It is proved to be a proxy of household income (Cantillo-García et al., 2019), that ranges between [1 – 6], where: 1 = low income, 2 = low-middle; 3 = middle; 4 = middle-high, and 5 and 6 = high income.

Table 1
Demographic features of the study sample.

Variable		Frequency	%
Gender	Male	421	64%
	Female	238	36%
Age group	<25	105	16%
	26–35	206	31%
	36–45	184	28%
	46–55	102	15%
	>55	62	9%
Main Occupation	Employee	347	53%
	Unemployed	27	4%
	Independent	188	28%
	Student	97	15%
Self-reported income level	Low income	9	1%
	Low-middle income	97	15%
	Middle income	314	48%
	Middle-high income	186	28%
	High income	53	8%

2.3. *Description of the questionnaire*

Given the current situation of the pandemic (COVID-19), participants answered an online questionnaire. This research tool was divided into four sections as follows:

The first section asked about individual and demographic variables, such as age, gender, schooling, income level, and occupation. The structure of the second section referred to the behavior of vehicle drivers in Bogotá to measure possible behaviors associated with factors of inattention and distraction. For this purpose, a reduced version of the Driving Behavior Questionnaire (DBQ), developed by Reason et al. (1990) and adapted by Useche et al. (2021b), was used. This self-report questionnaire consists of eight questions, four of them aimed at measuring *traffic violations* (α = 0.610), and 4 to detect *errors* (α = 0.735).

Conceptually, traffic violations are understood as deliberate deviations from the practices essential to maintain road safety (e.g., disregarding traffic lights, exceeding speed limits, harassing other drivers). Meanwhile, errors represent unintended/involuntary risky behaviors (e.g., performing a driving maneuver incorrectly). However, they can increase the likelihood of a crash, given its close relationship to driving performance (Martinussen et al., 2013; Useche et al., 2021c). The entire questionnaire used a 5-level frequency-based response scale (1 = never, 2 = not much; 3 = sometimes; 4 = frequently; 5 = almost always).

The third section, intended to assess self-reported distractions, consisted in the RDS (Road Distractions Scale; Useche et al., 2018). This could be defined as an 8-item scale presenting a series of different and commonly observed distractors on the road. It used dichotomous questions (yes/no) to assess whether drivers consider they are usually affected by them. This questionnaire was developed in order to determine their self-reported influence on road users' common trips. Thus, allowing them to provide descriptive data (as shown in Table 1) and using the total sum of the RDS as a continuous study variable (α = 0.780).

Further, and to assess road risk perception, it was used the Risk Perception subscale of the Risk Perception and Regulation Scale (RPRS; Useche et al., 2018). This brief questionnaire consists of a 7-item subscale (α = 0.810) aimed at assessing risk-related appraisals of road users in a Likert response form of 5 levels, ranging from 1 = strongly disagree, to 5 = strongly agree.

The last section of this questionnaire consisted of a series of questions related to the record of road crashes. The last 5 years were considered as the time frame, as used in previous studies on road distractions among various types of road users (e.g., Useche et al., 2019 and 2018). The full questionnaire is available in the Appendix I of this article.

2.4. Modeling framework

Structural equation models (SEM) were implemented herein to manage latent variables or unobserved variables and endogeneity in the data. These models consist of two parts: one is the measurement model, and the other is the structural model. The first one analyzes the way the exogenous variables correctly measure the latent variables (including predefined goodness-of-fit criteria), which is typically done through a classical factor analysis. On the other hand, the structural model analyzes how the variables are related to each other (Washington et al., 2020).

Bootstrap-based robust maximum likelihood estimations (i.e., 10,000 bootstrap samples and 95% confidence intervals) were performed. The aim of bootstrapping data was to handle non-normality issues, as most of study variables did not meet neither the basic assumption of univariate normality nor multivariate normality, as usually happens in self-report-based studies (Brown, 1994; Byrne, 2010). The model fit was evaluated by using Chi-square (χ^2) test, minimum discrepancy ratio (CMIN / df), Comparative Fit Index (CFI), Normed Fit Index (NFI), Tucker-Lewis Index (TLI), Incremental Fit Index (IFI) and Root Mean Square Error of Approximation (RMSEA).

Estimators were calculated controlling by age, gender, and vehicle type. According to the specialized literature, led by Marsh, Hau & Wen (2004), it is commonly accepted that a set of CFI / NFI / TLI / IFI coefficients > 0.900, in addition to a RMSEA < 0.080 (better if < 0.060) are reliable goodness-of-fit indicators (Useche, et al. 2021b). The model fit was improved whenever possible by considering the largest and most theoretically parsimonious modification indexes.

The indirect (or mediated) effects of the model, their confidence intervals (at 95%) and significance levels were calculated following the bootstrap method. Specifically, we used a Monte Carlo (parametric) bootstrapping procedure, favoring that (e.g.) the results of the estimates may be bias-corrected, do not pose any normality problems. In addition, type I errors (*false positives*) in regression paths can be avoided.

Finally, a gender-based comparative analysis of driving distraction scores was carried out through Welch's robust analysis. This comparative Student's *T*-based non-parametric statistical test entails a considerable set of advantages over parametric tests such as ANOVA. For instance, it is advisable when there are heteroscedastic variances, and compared group sizes are not proportional. IBM SPSS Statistics for Macintosh (Version 24.0; IBM Corp., Armonk, NY) was used to perform descriptive and comparative tests, and AMOS software (Version 26.0; IBM Corp., Armonk, NY) was used to perform SEM analyzes.

2.5. Ethics

This study received an ethical grant by the Ethics Committee, with IRB procedure number HE0002150221. This attests that the research protocol conforms with the principles provided in the Declaration of Helsinki and the risk level for participants is "Very Low".

A digital informed consent was also attached, explaining the aim, dynamics, and scientific purposes of the study to our potential subjects, as well as the data protection guidelines followed by the research team. All participants consented these conditions before participating, also certifying they were of legal age (≥18 years old) and had a valid driving license when answering the survey.

3. Results

Table 2 lists the factors that contributed to greater distraction among the drivers in this study. A first relevant outcome to consider is the fact that there are no statistically significant differences regarding gender in 7 of the 8 distractors evaluated. In other words, males and females self-report similar impact from most of potential distracting sources appended in the questionnaire. The exception is distractor 4 (*People I find attractive*) whose highest frequency corresponds to male drivers; a result expected in advance due to the sociocultural characteristics of the city.

The main distractors disregarding gender or age were, from most to least important: (*i*) other users' behavior, which is in line with Gupta, Choudhary & Parida (2021), whose analysis obtained high loadings for risky driving regarding surrounding vehicles' behavior, (*ii*) road conditions (in contrast with Gupta, Choudhary & Parida (2021), where this factor was the least affecting driving behavior), and (*iii*) phone calls.

There is no significant difference in distracted driving regarding age. This result is consistent with the findings of Ortiz et al. (2018), concluding that distractions due to smartphone use while driving are not only an issue for young drivers, but common across different age groups, even though this trend remains remarkably stronger among them (Tosi et al., 2020).

Table 2
Prevalence of self-reported road distractions by drivers' gender and age.

Distracting sources		Age group					Gender		χ^2 (Gender)
		<25	26–35	36–45	46–55	>55	Male [1]	Female [0]	
1. Texting or chat	Freq. (yes)	59	91	105	51	21	230	116	2.117; p = .085
	%. (yes)	51%	49%	58%	49%	37%	48.7%	54.6%	
2. Phone calls	Freq.	76	127	125	66	33	285	153	0.793; p = .210
	%	66%	69%	68%	63%	58%	67.7%	64.3%	
3. Billboards	Freq.	44	39	46	29	15	104	70	1.735; p = .111
	%	38%	21%	25%	28%	26%	24.7%	29.4%	
4. People I find attractive	Freq.	43	57	50	26	16	169	30	54.699; p < .001
	%	37%	31%	27%	25%	28%	40.1%	12.6%	
5. My own thoughts and concerns	Freq.	72	95	86	43	20	205	119	0.104; p = .405
	%	63%	52%	46%	41%	35%	48.7%	50%	
6. Weather conditions	Freq.	76	118	119	62	27	257	159	2.168; p = .082
	%	66%	64%	64%	59%	47%	61%	66.8%	
7. Other Road Users' behavior	Freq.	92	149	151	78	44	335	192	0.115; p = .408
	%	80%	81%	82%	74%	77%	79.6%	80.7%	
8. Road conditions	Freq.	95	158	153	77	41	340	198	0.601; p = .253
	%	83%	86%	83%	73%	72%	80.8%	83.2%	

3.1. Structural equation modeling

Considering the theoretical assumptions and empirically tested relationships among the study variables, while bearing in mind the study hypothesis, we carried out a SEM analysis to explain the self-reported driving crash rates during the last five years (dependent variable). We used driving-related variables, behaviors, and distractions as potential predictors (independent variables). It was initially hypothesized that road behaviors could mediate the relationship between age, risk exposure, and distractions, as well as the self-reported number of traffic crashes suffered while driving.

The resulting Structural Equation Model provides the following indexes: ($x^2_{(3)} = 10.492$, $p = .015$; CMIN / df = 3.497; NFI = 0.981; CFI = 0.986; TLI = 0.901; IFI = 0.986; RMSEA = 0.060, IC90%: 0.023 – 0.101). Overall, the goodness-of-fit (GOF) can be assumed as good. That is, if we consider the cut-off points previously described for interpretation as well as the theoretical parsimony and logical sense of the directionality observed in its different paths. Then, the RMSEA was ≤ 0.060, all the CFI/NFI/TLI/IFI values were adequate-to-optimal > 0.940 (except for TLI = 0.901, which is still adequate), consistent with the reported reference values for GOF, as generally accepted in specialized literature.

All standardized parameter estimates are presented in Table 3 and graphically shown in Fig. 2. In this figure, the unidirectional arrows indicate the direction of the explanatory relationship between the study variables included in the model. Qualitatively, the significant structural model shows that traffic crash rates could be explained by several study variables (including driving distractions). They could be based on both direct and indirect effects.

The standardized path coefficients (SPCs; see Table 1 and values next to solid lines in Fig. 2) of the model suggest positive associations between distractions while driving. Moreover, they also depict both types of risky driving behaviors (deliberate and undeliberate). Meanwhile, the path analysis reveals that risk perception is negatively associated with

Table 3
Variables included in the model, estimates and significance levels of the SEM paths to explain self-reported traffic crashes in a 5-year term.

Variable			SPC[a]	S.E.[b]	C.R.[c]	p^d	Bootstrap bias-corrected values[e]				
							Est[f]	S.E.[b]	95% CI[g]		p^d
Age	→	Errors	-0.008	0.002	-0.263	0.792	-0.001	0.002	-0.005	0.004	0.734
Risk Exposure	→	Errors	0.042	0.037	1.233	0.217	0.045	0.035	-0.011	0.112	0.164
Risk Perception	→	Errors	-0.226	0.036	−6.438	***	-0.232	0.032	-0.304	-0.188	**
Driving distractions	→	Errors	0.334	0.136	9.488	***	1.291	0.136	1.053	1.503	**
Age	→	Traffic violations	-0.084	0.002	−2.435	*	-0.005	0.002	-0.008	-0.002	**
Risk Exposure	→	Traffic violations	0.078	0.027	2.253	*	0.060	0.026	0.022	0.109	*
Risk Perception	→	Traffic violations	-0.156	0.026	−4.374	***	-0.115	*	-0.151	-0.071	**
Driving distractions	→	Traffic violations	0.345	0.099	9.713	***	0.958	0.092	0.806	1.119	**
Age	→	Crashes (5 years)	-0.081	0.002	−2.22	*	-0.004	0.002	-0.007	-0.001	*
Risk Exposure	→	Crashes (5 years)	-0.019	0.028	-0.526	0.599	-0.015	0.03	-0.059	0.04	0.761
Risk Perception	→	Crashes (5 years)	-0.235	0.028	−6.087	***	-0.173	0.03	-0.216	-0.115	*
Driving distractions	→	Crashes (5 years)	-0.004	0.113	-0.094	0.925	-0.011	0.112	-0.164	0.183	0.894
Traffic violations	→	Crashes (5 years)	0.106	0.043	2.432	*	0.106	0.043	0.025	0.175	*
Errors	→	Crashes (5 years)	0.009	0.032	0.21	0.834	0.007	0.03	-0.043	0.055	0.801

Notes: [a] SPC = Standardized Path Coefficients (can be interpreted as b-linear regression weights); [b] S.E. = Standard Error; [c] CR = Critical Ratio; [d] p-value: *significant at the level $p < .05$; **significant at the level $p < .010$; ***significant at the level $p < .001$; [e] Bootstrapped (bias-corrected) model; [f] Unstandardized estimates; [g] Confidence Interval at the level 95% (lower bound – left; upper bound – right).

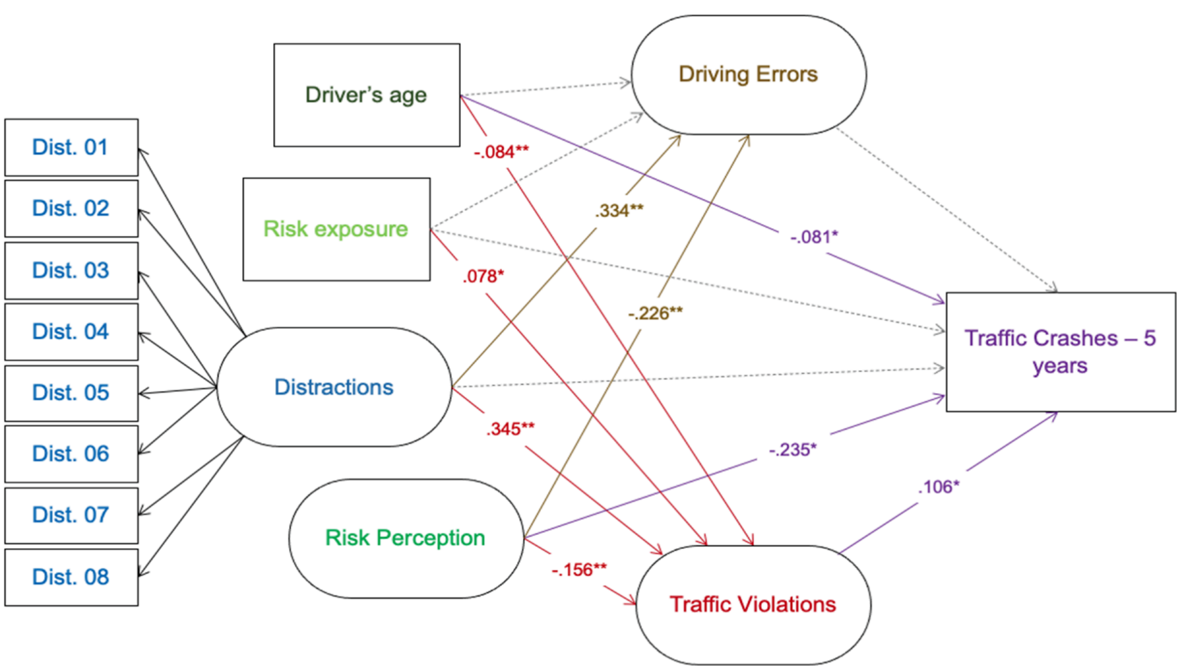

Fig. 2. Standardized parameter estimates. Solid lines represent significant paths. *Notes:* All estimates listed in solid lines are significant (as shown in Table 1); ellipses represent inferred (latent) variables; squares represent observed ones.

both risky behaviors and traffic crash rates reported by participants.

In other words, as depicted in Fig. 2, nine direct effects were significant. Driving distractions and risk perception remarkably explained driving errors. Meanwhile, age, risk exposure, distractions, and road risk perception directly explained work traffic crashes (WTC). Also, traffic violations directly explained self-reported driving crash rates. On the other hand, no significant effects were found between driving errors and traffic crashes.

As for indirect effects of the study variables on WTC, traffic violations have shown to exert full mediations between (*i*) risk exposure and (*ii*) driving distractions (independent variables), and self-reported traffic crash rates suffered in the last 5 years while driving (dependent variable).

4. Discussion

This study aimed to assess the effect of road distractions, driving-related issues, and road behaviors on the self-reported crashes suffered by drivers from Bogotá, Colombia. Overall, the results of this research support the assumption that road distractions pose a latent threat to driving safety. The reason for this is that, in this study, driving distractions have shown a significant statistical effect on both deliberate and undeliberate risky road behaviors (e.g., traffic violations and errors).

This first outcome is consistent with previous studies assessing the relationship between road distractions and risky behaviors while driving. Furthermore, it highlights how road distractions are arguably not only a "typical" issue for driving safety but also an increasingly growing concern. This concern is emphasized, especially if the growing number of potential distracting sources (e.g., mobile phones, social networks, navigators, and external issues, also frequently "connected") is considered on a large scale (Oviedo-Trespalacios et al., 2019 and 2017; Stavrinos et al., 2018). In this regard, the model developed in this study points an interesting factor, an age-based segment of the driving population in Bogotá: the group of young drivers, i.e., those aged under 25. According to official data, this age segment has shown an increasing rate of traffic violations (23% increase from 2016 to 2018), many of which are related to distracting sources, among which the use of mobile phones while driving stands out (RUNT, 2018).

Precisely, the model depicts how age is inversely associated with the number of self-reported crashes, which is consistent with the young driver literature. Overall, it systematically illustrates that younger drivers tend to commit more traffic violations, often preceded by the influence of active distracting sources, such as mobile phones or other connected devices. Added to further risk factors, e.g., driving sensation seeking, inexperience and speeding, the current literature seems to uniformly point out that technology-related trends in driving might increase the likelihood of suffering a higher number of crashes among certain groups of drivers (e.g., young male drivers), and prompt solutions are needed (Kass et al., 2007; Mirón-Juárez et al., 2020; Naumann and Dellinger, 2013; Shope, 2006). In this regard, some recent studies have suggested that interventions focused on strengthening road safety skills (e.g., risk perception, learning the traffic rules, and emotional management) might contribute to decreasing the impact of driving safety impairers. Of course, this includes the impact of road distractions on driving safety outcomes, particularly for younger drivers (Pope, Bell, & Stavrinos, 2017; Lee, 2014).

Another key outcome is the apparently complex relationship between distractors, which may work as a "domino effect". For example, distractions 1 (texting/chatting), 5 (own thoughts and concerns) or 7 (other users' behaviors on the road) may generate stress. Henceforth, potentially triggering emotional responses that could produce driving errors or risk-related decisions, such as conventional traffic violations (Kontogiannis, 2006; Useche et al., 2021c). Similarly, there are relevant reports, such as the one recently provided by the National Center for Statistics and Analysis (2020), which are commonly absent in the low and middle-income economies. In the same vein, these reports underline how the causes of traffic crashes differentiate crashes by distractions from those potentially explainable through performance or non-performance errors. Notwithstanding, the outcomes herein suggest that this fact should be (rather) analyzed jointly, as driving distractions might be related to both types of risky road behaviors.

In addition, other studies have systematically shown how traffic environmental information (often acting as a distracting source) would have a certain effect on driving behavior, especially when driving (e.g.) under stressful conditions, in difficult road environments, or at high speeds, thus increasing their likelihood of suffering severe traffic crashes (Li et al., 2018; Llamazares et al., 2021; Thompson et al., 2013).

Finally, and unlike other studies where gender is a predictor of driving errors or distracted driving, our study found no significant difference between distractors regarding gender. That is, except for the distracting source number 4 ("people I find attractive"), where men are strongly distracted if they notice someone they find attractive while driving, whereas only 13% of women stated getting distracted for this reason. Although at first glance, this is a "typical" outcome, this descriptive finding suggests that, in demographic terms, driving distractibility does not only correlate with age-based patterns. This means that gender roles and specificities might contribute to developing further insights on drivers' features that would potentially explain differential needs for intervention, training, and management of road distractions (Gauld et al., 2020; Prat et al., 2015; Barr et al., 2015).

5. Limitations of the study

This study analyzed the data from a relatively large sample of drivers, and the essential statistical and theoretical assumptions (including GOF criteria) were successfully met. However, it is worth acknowledging some fundamental shortcomings and technical limitations, since they could affect the outcomes of this research. This way, readers will make a careful interpretation of the work we have just described.

Firstly, despite the questionnaire being anonymous, we cannot guarantee the non-existence of common method biases (CMBs). Moreover, and most especially as potentially sensitive topics (e.g., their own road behavior and safety outcomes) have been addressed in the research. In this regard, previous studies have shown how measuring negative issues, including attitudes, experiences, and behaviors, may increase respondents' social desirability (Nasaescu et al., 2020; Ruiz-Hernández et al., 2020), or remain largely dependent on the memory and recalling capacity of the participants. Secondly, there are many other factors potentially affecting drivers' safety outcomes that remain unexplored in this research. For instance, while driver's experience has been proven to affect distraction-related outcomes, we did not gather specific information on it. Although it is usually collinear with age, analyzing individuals' driving experience may add some additional insights to further studies. Finally, even though it virtually affects all contemporary applied research, we must consider the current changes in terms of transportation dynamics and travel behaviors (Montoro et al., 2022; Sevtsuk et al., 2021). Specifically, since they are accelerated as a result of the current COVID-19 pandemic, this might impact the information provided by our respondents.

6. Conclusions

This study designed and applied an online questionnaire to a considerably large sample of drivers from Bogotá, the capital of Colombia, an emerging country where traffic-related crash, injury, and fatality rates have been rising during the last decades. This is claimed to be a phenomenon that is intertwined with different gaps, disparities, and shortcomings evident in the traffic environment. The SEM-based results show that there is a significant effect of road distractions on drivers' self-reported crash rates. Additionally, it shows how young adults are more prone to incurring these behaviors as a consequence thereof.

These findings support efforts to design safety interventions aimed at mitigating the risk of getting distracted while driving. In addition, authorities should increase efforts to enforce ICT-related laws while driving. Therefore, this contributes to reducing the prevalence and impact of distracting sources on the road. Unsurprisingly, road conditions and other users' behaviors were important self-reported distractors in our sample. This could be regarded as a specific outcome for our case study given the poor road conditions (e.g., potholes, cracks, etc.) and the reckless driving of other users. Some examples are sudden maneuvers, turning without "blinkers" and, lately, motorcycles and cyclists (mainly from delivery apps) making all kinds of traffic violations.

Finally, regarding further research in the region, this paper emphasizes the need to consider road-related distractions as a key study factor, since they have been commonly left aside in previous studies performed in Latin American countries and many other LMICs. It would be a first step to developing a more efficient and context-based policymaking.

CRediT authorship contribution statement

Andrea Arevalo-Tamara: Data curation, Investigation, Project administration, Writing – original draft, Writing – review & editing. **Angela Caicedo:** . **Mauricio Orozco-Fontalvo:** Conceptualization, Formal analysis, Investigation, Writing – original draft, Writing – review & editing. **Sergio A. Useche:** Writing – review & editing, Writing – original draft, Validation, Software, Methodology, Investigation, Formal analysis, Conceptualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix I. Research questionnaire

I. Demographics

1. Gender: Man ☐ Woman ☐.
2. Age: __ years.
What Is your main occupation?
☐ Student.
☐ Employee.
☐ Independent (Self-Employed).
☐ Unemployed.
☐ Other.
Highest Educational level (ongoing or completed):
☐ None.
☐ Primary education.
☐ Secondary Education - Baccalaureate.
☐ Technical-intermediate training.
☐ Undergraduate degree.
☐ Post-graduate degree.
Socio-economic strata (from 1 to 6, as assigned to your place of residence): __

F-DBQ (Driving Behavior) (8-items)

Please estimate how often you do the following when cycling, using this scale:
1 = Never; 2 = Almost never; 3 = Sometimes; 4 = Frequently; 5 = Almost always / always

Item	Frequency				
1. Overtaking a slow-moving vehicle in the inside lane	1	2	3	4	5
2. Deliberately disregarding the speed limits late at night or very early in the morning	1	2	3	4	5
3. Taking a chance and crossing when lights have turned red	1	2	3	4	5
4. Slowly pulling the vehicle out of an intersection until those coming must stop and give way	1	2	3	4	5
5. Misjudging the speed of an oncoming vehicle when passing on an undivided road	1	2	3	4	5
6. Misjudging your crossing interval when turning left/right, or doing it at an inadequate speed	1	2	3	4	5
7. Failing to read a traffic sign correctly, or confusing it with another	1	2	3	4	5
8. Getting into the wrong lane at a roundabout or approaching a road junction	1	2	3	4	5

III. RDS (Road Distractions) (8-items)

Normally, do these factors distract you and/or impair your driving performance during your journeys?

Potential distracting source	Yes	No
1. Text messages or chats		
2. Phone calls		
3. Billboards		
4. People that I find attractive		
5. My own thoughts or concerns		
6. Weather conditions		
7. The behavior of other users of the road		
8. The obstacles in the way		

Risk perception scale (RPRS) (7-items)

To what extent do you agree with the following statements?
1 = Strongly Disagree; 2 = Disagree; 3 = Neither agree nor disagree; 4 = Agree; 5 = Strongly agree

Item	Degree of Agreement				
1. I understand the potential consequences of being involved in a traffic crash, for example, with another vehicle	1	2	3	4	5
2. I perceive potentially higher risks for my integrity when I go inside a car, than when I am on board of a big vehicle	1	2	3	4	5
3. I am aware of the other vehicles that surround me on the road	1	2	3	4	5
4. I realize that there are signaling and infrastructure problems that can affect my safety	1	2	3	4	5
5. I believe that driving under the influence of certain substances (alcohol, illegal and / or prescribed drugs) affects my ability to drive	1	2	3	4	5
6. I am aware of the risks involved when using headphones and cellphones while driving	1	2	3	4	5
7. Driving in urban areas is especially risky, considering the number of vehicles and the complexity of the roads	1	2	3	4	5

IV. Driving-related information

6. I use the car for the following purposes (You can mark more than one).
☐ To move regularly to / from school or workplace (“commuting”).
☐ To make a short trip to a specific point of the city.
☐ Recreation.
☐ As a mean of working.
7 In a week, approximately how many hours do you use the car as a driver?
About _____ hours per week.
8 What type of car do usually **drive?** (The most frequent).
_________________.
9 In the last 5 years, have you had any crash/accident while driving a car?
Yes ☐ No ☐.
9.1 If you answered “YES” to the previous question:
Regardless of their severity, how **many accidents/crashes have you had** in the last 5 years? ___ accidents/crashes.

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