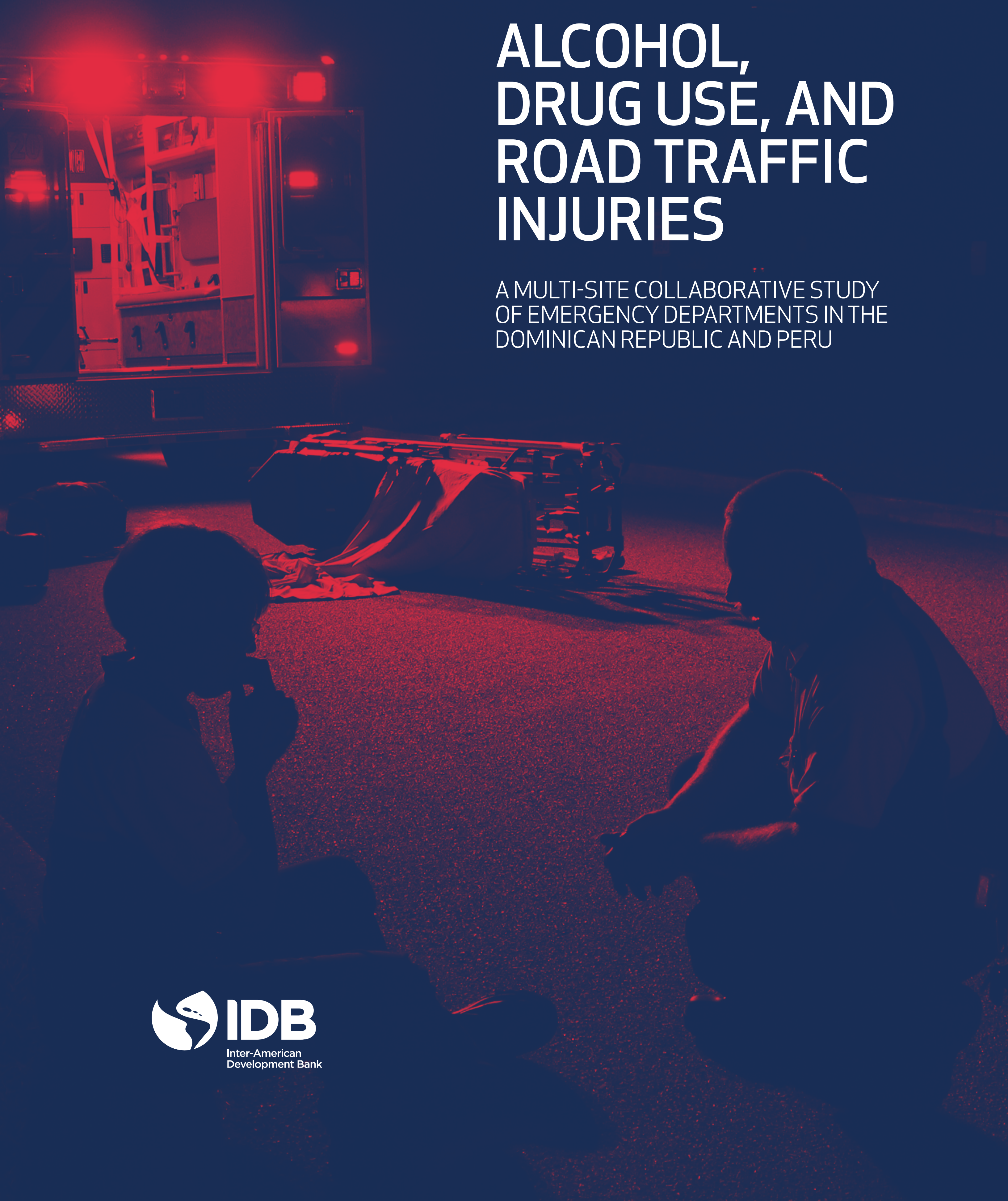
ALCOHOL, DRUG USE, AND ROAD TRAFFIC INJURIES

A MULTI-SITE COLLABORATIVE STUDY OF EMERGENCY DEPARTMENTS IN THE DOMINICAN REPUBLIC AND PERU



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Acknowledgments

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Abbreviations

BAC	blood alcohol concentration
CI	confidence interval
ED	emergency department
IDB	Inter-American Development Bank
LAC	Latin America and the Caribbean
MVC	motor vehicle crash
OR	odds ratio
PAHO	Pan American Health Organization
RTI	road traffic injury

Executive Summary

The objectives of this study are to report demographic and substance-use characteristics and risk of road traffic injury (RTI) from alcohol use, cannabis use, and combined use in a sample of emergency department patients from two countries in Latin America and the Caribbean: the Dominican Republic and Peru.

This was a cross-sectional study in which patients 18 years and older admitted within six hours of suffering an RTI to one emergency department in Santa Domingo, Dominican Republic (n = 501) and one in Lima, Peru (n = 431) were interviewed. Case-crossover analysis, based on self-reported use prior to the RTI, was used to analyze risk from alcohol, cannabis, and co-use.

Results show that 15.3% reported alcohol use prior to the event and 2.5% cannabis use. Drivers using alcohol only were over twice as likely to have an RTI (OR = 2.46, $p < 0.001$) and nearly eight times more likely if using both alcohol and cannabis (OR = 6.89, $p < 0.01$), but risk was not elevated for cannabis alone. Significant differences were not found for passengers or pedestrians.

This study concludes that risk of RTI for drivers in these two samples is significantly elevated from alcohol use, and more so for co-use with cannabis. Differences between the two countries underscore the need for similar data from the region to determine risk of RTI from substance use, including risk for passengers and pedestrians. Data suggest that alcohol contributes significantly to the burden of RTI, which calls for more stringent enforcement of alcohol control policy related to drink driving in the region. Findings will help inform intervention and prevention strategies to reduce substance-related harm from RTIs in this region.

Introduction

More than 1.3 million people are killed on the world's roads every year. More than 30 million suffer life-changing injuries. Based on current trauma levels, an estimated 400 million people will be killed or injured between now and 2030. To the people involved and their families there is only one acceptable vision—Vision Zero—where no one is killed or injured. To reach zero, the international community must be ambitious, be innovative, and act at a scale necessary to make a difference; however, without sufficient local evidence and actual research on the risk factors, road safety strategies and their interventions are less than efficient or effective. Partnerships are key to success, and for that reason, the Inter-American Development Bank (IDB) and the Pan American Health Organization (PAHO) joined forces in 2016 to carry out a study on the relationship between the presence of alcohol and drugs and the incidence of road traffic injuries (RTI) in emergency departments in two countries of Latin America and the Caribbean (LAC): the Dominican Republic and Peru.

The IDB works to improve lives in LAC. Through financial and technical support for countries working to reduce poverty and inequality, it helps improve health and education and advance infrastructure. Its aim is to achieve development in a sustainable, climate-friendly way. With a history dating back to 1959, today the IDB is the leading source of development financing for LAC. The IDB provides loans, grants, and technical assistance, and conducts extensive research. The IDB maintains a strong commitment to achieving measurable results and the highest standards of increased integrity, transparency, and accountability.

The IDB current focus areas include three development challenges: social inclusion and inequality, productivity and innovation, and economic integration; and three cross-cutting issues: gender equality and diversity, climate change and environmental sustainability, and institutional capacity and the rule of law.

PAHO is the specialized international health agency for the Americas. It works with countries throughout the region to improve and protect people's health. PAHO engages in technical cooperation with its Member States to fight communicable and noncommunicable diseases and their causes, to strengthen health systems, and to respond to emergencies and disasters.

To advance these goals, PAHO promotes technical cooperation between countries and works in partnership with ministries of health and other government agencies, civil society organizations, other international agencies, universities, social security agencies, community groups, and other partners. PAHO promotes the inclusion of health in all public policies and the engagement of all sectors in efforts to ensure that people live longer, healthier lives, with good health as their most valuable resource.

This is a joint publication, developed by PAHO and IDB, and is based on the original research "Road traffic injuries and substance use among emergency department patients in the Dominican Republic and Peru," published in the *Pan American Journal of Public Health* (*1*). This version, in a monograph format, intends to disseminate the methodology and findings from this research to a general audience.

1. Background

Road traffic injuries (RTI) were responsible for 1.35 million fatalities worldwide in 2016, up from 1.2 million in 2013, despite the fact that the death rate relative to the world's population has remained constant during this time (*2*). They are the ninth leading cause of death across all age groups and the leading cause among those aged 5–29 years. Risk of RTI fatalities is more than three times higher in low-income countries compared with high-income countries, accounting for 93% of all such deaths while having only 60% of the world's vehicles in circulation. Between 2013 and 2016, no reduction in RTI deaths was observed in low-income countries, while some reductions were apparent in middle- and high-income countries (*2*).

Alcohol consumption is a known risk factor for injury morbidity and mortality, including those from RTIs (*3–5*). Worldwide, alcohol is the seventh leading risk factor for mortality and disability-adjusted life years (DALYs) and the leading risk factor among those aged 15–49 (*6*). Injuries constitute a major portion of the global burden of disease attributable to alcohol, with 28.7% of the alcohol-attributable mortality coming from injuries (41% in the Americas), and 40% of the alcohol-attributable DALYs (48.6% in the Americas) (*7*). Alcohol consumption in the LAC region is considered one of the highest and most hazardous to health worldwide and an important component of the global burden of disease in the region (*8, 9*), with a significant impact on injuries, including RTI (*10*). One recent study of emergency department (ED) patients in the LAC region found that risk of an RTI was five times greater for those reporting drinking within six hours prior to the event compared with those not drinking, and the risk increased by 13% for each drink consumed during this time (*11*).

There is sufficient evidence showing that drinking alcohol causally increases the risk of road traffic crashes (*4, 5*). This link has also been demonstrated in some countries in the region (*12*). Among RTI patients attending EDs from countries in the region, it was found that alcohol use was self-reported by 12.9% in Canada to 40.3% in Guatemala (*10*). The relative risk of a traffic-related injury, if the patient drank six hours prior to the RTI, was 5.37 (95% CI 3.17, 9.11) and it increased in a dose-response fashion (*10*). Data also suggest that road traffic deaths reduce life expectancy in Brazil (*3, 10*).

There is sufficient evidence showing that drinking alcohol causally increases the risk of road traffic crashes

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The Region of the Americas is of special concern regarding the association between alcohol and road traffic casualties. Alcohol consumption is nearly 40% higher than the global average, and injuries (25% of which are caused by motor vehicle crashes) represent the main cause of death for adult men in the low- and middle-income countries (*3*). In Brazil, for example, it is estimated that 40% of traffic-related deaths are attributable to alcohol (*13, 14*). However, in other countries of the Region, there is still much unknown about the proportion of alcohol-related RTIs and deaths (*13, 14*).

More recently, a major concern has been raised regarding the role and potential impact of other psychoactive drug use on RTI and death. In 1990, drug use was ranked in the 28th place as a risk factor for the global burden of disease, but it was in the 15th place in 2013 (*15*). In 2013, drug use ranked in the 6th place for males aged 15–49 years and in the 11th place for females in this age group (*15*). In addition, the prevalence of drug use is expected to increase as a result of changes in drug policies, although less information has been available about this trend, including in Latin American countries (*16*). No information is available on whether other drug use combined with driving will increase the prevalence of RTI and deaths.

Much less is known about driving under the influence of psychoactive substances. Global estimates show that illicit drug use is responsible for 50,000 road traffic deaths (*17*). Approximately 40,000 of these deaths were men and 10,000 women. In about half of these deaths, amphetamine-induced impairment was found to be a key risk, while cannabis impairment was found in 20% of deaths (*17*). In some countries, the role of drug use in RTIs is shown to be increasing, while the role of alcohol use in these accidents may be decreasing (*18*). The literature on drug use and traffic-related crashes and deaths is more limited, but recent reviews and meta-analyses (*19, 20*) suggest that most drugs, especially cannabis, impact reaction time and several skills (*21, 22*). Drug users can hence become at risk of an injury and death. This risk could be observed in all drivers under the influence, passengers in a vehicle driven by an individual under the influence, or pedestrians (under the influence; regardless of the driver's drug use). The current estimates for the impact of drug use on crashes are likely to be underestimates, as new meta-analyses suggest that amphetamines, cannabis, cocaine, and opiates increase the risk of a road traffic crash (*17*).

The prevalence of drugged driving also remains unknown in most regions of the world, including in the Americas, and particularly in LAC. In the United States of America, results from the 2013–2014 National Roadside Survey show that approximately 22% of drivers tested positive for either an illicit or prescription drug (*23*). In general, evidence on drug use and RTI from low- and middle-income countries is lacking, but there are reports for some selected risk groups showing this association (*24*). In the region, Brazil is a country that has developed a research agenda on this topic.

So, less is known about the risk of RTI associated with drug use other than alcohol, although psychoactive drugs affect reaction time and other skills required for driving; and still less is known about the risk associated with the use of psychoactive drugs combined with alcohol, which might be expected to be even greater than the risk from the use of each alone. The use of psychoactive substances is on the rise globally, with cannabis the second most commonly used psychoactive drug (after alcohol) and the drug most frequently used with alcohol (*16*).

Following alcohol, cannabis is the drug most frequently associated with impaired driving and accidents (*25*). Increased use of cannabis has been found, with increased availability associated with more liberal marijuana policies (*26, 27*) in many countries, paralleling a significant increase in both fatal and non-fatal RTIs (*28–30*). Among 36 epidemiological studies, 23 reported a significant association between cannabis and motor vehicle crashes (MVC) (*19*) with risk ranging from 1.2 (*31*) to 2.66 (*32*); however, two-thirds of these crashes did not result in an injury. Another recent systematic review found a risk ratio of 2.84 for the presence of cannabis in MVCs (*33*).

Greater impairment has been found when alcohol is combined with cannabis than when either substance is used alone (*34–37*), with alcohol increasing the tetrahydrocannabinol (THC) level in the blood over that found for the same dose of cannabis without alcohol (*38, 39*). One study found that low doses of THC only moderately impaired driving, but severely impaired driving when administered with a low dose of alcohol (*40*), while another study found the presence of cannabis elevated risk of a fatal RTI nearly two-fold at zero blood alcohol concentration (BAC) and almost four-fold at a BAC less than 0.05 (*41*). While existing literature on cannabis and alcohol suggests that risk for RTI is substantially increased with combined use of the two drugs over use of either alone (*36, 42*), research on this is scant.

It is also important to consider other substances in the risk of RTI. The European Monitoring Centre for Drugs and Drug Addiction assigned risk levels of being seriously injured or killed as a driver as a slightly increased risk for cannabis or alcohol <0.05; a moderately increased risk for cocaine, opiates, benzodiazepines, or alcohol 0.05–0.08; and a highly increased risk for amphetamines, multiple drugs, or alcohol >0.08 (*43*). However, little research has been conducted on the risk of injury from these other psychoactive drugs.

Following alcohol, cannabis is the drug most frequently associated with impaired driving and road crashes

Opioid use significantly impairs psychomotor functioning (*22*) and has reached epidemic proportions in some areas of the world (*44–46*). The percentage of opioid-involved drivers in MVCs in the United States of America was found to have increased seven-fold between 1995 and 2015, and 30% of these had an elevated BAC (*47*).

Research on RTI drivers and amphetamines (or similar stimulants) report mixed findings for non-fatal injuries, but moderately significant evidence for fatalities (*48*), with amphetamine use most risky in severe MVCs (*49*). A recent review found risk of a fatal RTI increased seven-fold for amphetamine use and was double for cannabis use, with use of other drug classes falling in between (*43*).

Cocaine, also a central nervous system stimulant, when combined with alcohol produces a new metabolite, cocaethylene, which lasts 3–5 times longer than cocaine and produces synergistic psychomotor deficits with alcohol (*50–53*). In combination with alcohol, cocaine has been found to be 2.5–6.4 times more likely to be present among RTI fatalities than cocaine alone (*54–59*).

Although a moderate increase in risk of being seriously injured or killed in an RTI has been assigned to benzodiazepines (*43*), two studies found this drug class to present the lowest risk of RTI (*35, 49*).

Greater impairment has been found when multiple substances are combined (polydrug use) (*49, 60–62*). One review found 25% of MVC drivers were positive for multiple drugs and were at greater risk than those using a single substance (*63*), while another study found 44% of fatally injured drivers tested positive for drugs, with more than half positive for two or more drugs (*64*). In that study, cannabis and opioids were found in over half of the drivers, and half of the drivers who tested positive for alcohol also tested positive for other drugs, including cannabis (38%) and opioids (16%), with 4% positive for both. Another study of RTIs found drivers in the opioid–benzodiazepine class, which accounted for 33% of the polydrug users, were at highest risk and also more likely than other polydrug users to have consumed alcohol (*65*).

Evidence on the contribution of alcohol and other substance use to RTI is more abundant in high-income than low-income countries, where the literature is scant and sound epidemiological studies are lacking. Additionally, many studies of RTI do not distinguish between drivers and passengers, and pedestrians (who may be particularly vulnerable to RTIs when using substances) are seldom included in these studies.

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Alcohol and drugged driving are considered key risk factors for road safety, according to the World Health Organization (WHO) (*17*). Using the available information for policy-making and for raising awareness in LAC has proved to be difficult. Part of this difficulty is related to the lack of specific data in countries, which could be used to help mobilize public policymakers' support to act against driving while under the influence of these substances. In recognition of the toll of RTIs and deaths on communities worldwide, and the role of alcohol and drugs in RTIs and deaths, the United Nations General Assembly adopted a resolution in 2010 that led to the establishment of the Decade of Action for Road Safety (2011–2020) (*66*).

The resolution called on Member States to take the necessary steps to make their roads safer (*66*). In addition to the Decade of Action, international action on road safety has increased recently with the adoption of the 2030 Agenda for Sustainable Development, which set a goal (Target 3.6) of reducing road traffic deaths and injuries by 50% by 2020 (*67*), to be amended for another decade, thus to be reached by 2030. To help accomplish these goals, measures to decrease modifiable risk factors, such as alcohol and drug use while driving, are key targets.

In the past decades, some countries, especially high-income countries, showed a decrease in road traffic mortalities, despite the growth in the number of vehicles. However, the number of non-fatal crashes has continued to grow but little is known about their severity. Studies show that several factors are related to the severity of RTI, including age, gender, type of crash, type of vehicle, use of safety equipment, and alcohol use (*68, 69*).

It is well established that alcohol intoxication, in addition to the increased risk of traffic crash involvement, increases the probability of drivers not using safety devices such as helmets and seatbelts. In addition, there is an increased risk for over-speeding, which in turn increases the severity of RTIs (*70, 71*). However, the relationship between RTI severity and the use of other drugs is not well documented. A recent study found that in a sample of 503 injured cyclists, 30% had BAC 0.08 or above (*70*). In the same group, 42% also tested positive for other drugs and they were hospitalized longer with higher mortality than those who were not intoxicated (*70*).

In summary, while there is evidence from high-income countries on the importance of both alcohol and drug use in RTIs and death (*23, 72*), including European countries participating in the large Driving Under the Influence of Drugs, Alcohol and Medicines (DRUID) project (*73*), data from LAC are scarce or simply lacking. Some countries, such as Brazil, have contributed with a large number of research studies (*12*), mostly focusing on alcohol, but only scattered references are available for drugs such as cannabis or stimulants. If local action is to be taken to decrease the burden of substance use on RTI, current and sound epidemiological data related to RTI are urgently needed.

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2. Implementation of the Study and Methods

The multi-site collaborative study was implemented in two hospitals: the Dr. Dario Contreras Traumatology Hospital in Santo Domingo, Dominican Republic (from October 2018 to January 2019) and the José Casimiro Ulloa Emergency Hospital in Lima, Peru (from December 2018 to June 2019). Training was conducted in Santo Domingo on 11–12 September 2018 and in Lima on 4–5 October 2018. In Santo Domingo, 10 medical residents at the Dr. Dario Contreras Traumatology Hospital where the study was conducted were trained, while in Lima two of the four nurses from the José Casimiro Ulloa Emergency Hospital were trained.

For both sites, training included a PowerPoint presentation on the background and purpose of the study and study protocols, followed by orientation on the questionnaire and practice interviewing. The tablets with the computerized version of the interview were not available for training in Santo Domingo. A short YouTube video tutorial of the Alere Oratect oral fluid drug screen device was shown, followed by practice with the screening kits and the AlcoMate Premium breathalyzer. In Lima, the computerized version of the questionnaire was available for training while the Alere Oratect and AlcoMate Premium breathalyzers were not; however, the YouTube video was shown. At both sites, training the second day occurred in the respective ED, where it was possible to determine the logistics for implementing the study, following which interviewers had an opportunity to interview patients and obtain saliva and breath samples.

The study protocol followed that developed by Cherpitel (1989) (*74*) and previously used in all ED studies in the International Collaborative Alcohol and Injury Study (ICAIS) (*75*). All sampled consecutive patients 18 years and older, admitted to the ED within six hours of an RTI as either a driver, passenger, or pedestrian, were approached by a trained interviewer to provide informed consent to participate in the study, as soon as possible after ED admission. Following informed consent, a BAC estimate was obtained (using the AlcoMate breathalyzer) and the saliva sample taken (using the Alere Oratect, which determines use of cannabis, amphetamines, cocaine, methamphetamines, opiates, and phencyclidine). The patient was then interviewed using a computerized instrument which took about 35 minutes to administer.

The questionnaire included items eliciting information on the RTI (including whether the patient was the driver, passenger, or pedestrian and the type of vehicle(s) involved), drinking and drug use by class within six hours prior to the event, amount of alcohol/cannabis consumed, whether the patient felt intoxicated/impaired at the time, whether the patient felt the RTI would have happened if he had not been drinking/using (causal attribution), drinking and drug use by class during the same six-hour period for each of the seven days prior to the event day and the amount of alcohol/cannabis used during each time period, frequency of usual drinking and amount consumed, frequency of higher consumption times (12+ on an occasion, 5–11 on an occasion, 1–4 on an occasion), symptoms of alcohol use disorder (RAPS4), frequency of usual drug use by class, symptoms of a drug use disorder, and demographic characteristics.

The study included only RTI patients who arrived at the ED within six hours following the injury event, since patients coming to the ED shortly after injury occurrence would be expected to have a good recall of the event and their drinking and drug use at the time. The BAC and saliva sample, both measured at the time of ED arrival, would also be a better approximation of substance use at the time of the injury event. Lastly, injured patients arriving in close proximity to the event may likely have incurred more severe injury than those arriving later.

3. Data Analysis

Risk of RTI from alcohol or drug use was calculated using case-crossover analysis (*76, 77*) in which each patient's substance use in the six hours preceding the injury is compared with use in the same six-hour period for each of the seven days (seven control periods) preceding the day of injury. This method controls for stable risk factors such as gender, age, and usual substance use patterns. Substance use data were only obtained for those control periods for which the patient's activity (driver, passenger, pedestrian) was the same as the activity at the time of the RTI. Control periods matched by activity for each patient were then merged and an average taken of substance use over all matched periods.

Those patients for whom a match was not obtained for any of the seven control periods were asked the last time they had been engaged in the same activity they were engaged in at the time of the RTI, spanning a period of one hour before to one hour after the time of the RTI. The majority of patients matched on at least one of the seven days and analysis including those patients who did not match on one of these control periods was not significantly different than analyses including only those on whom a match was achieved. Consequently, data reported here only include those on whom a seven-day match was obtained.

Conditional logistic regression was used to estimate odds ratios (OR) and 95% confidence intervals (CI) for risk of injury, separately for alcohol use, cannabis use, and co-use within six hours prior to the RTI for the whole sample and by RTI type (driver, passenger, pedestrian). Both additive and multiplicative interactions (*78*) between alcohol and cannabis use were estimated. For additive interaction, Relative Excess Risk Due to Interaction (RERI) assessed whether the joint effect from combined use was larger than the expected added effects from use of each alone. Multiplicative interaction was assessed by entering the interaction term between alcohol and cannabis use in the conditional logistic regression.

All patients were approached by a trained interviewer to provide informed consent to participate in the study prior to obtaining breath and saliva samples and interviewing the patient. Data were identified by a study ID number only, prohibiting any linkage to the patient. Both studies were reviewed by the appropriate national ethics committee or institutional review board, as well as the PAHO Ethics Review Committee.

4. Study Findings

4.1 Demographic Characteristics

Completion rates averaged 88.3%, resulting in 501 completed interviews in the Dominican Republic and 431 in Peru. Reasons for non-interviews included refusing (7.6%), incapacitation (1.9%), leaving prior to completing the interview (0.4%), language barriers (0.6%), and other reasons (1.9%). Patients who were too severely injured to be approached in the ED were followed into the hospital and interviewed once their condition had stabilized.

The majority of patients were male (74.4%), <30 years of age (51.6%), married (49.4%), had at least a high school education (65.9%), and were employed (68.3%) (Table 1). Patients were more likely to be drivers, to be on motorcycles/scooters, and not to be wearing a helmet. Significant differences were found between the two sites, with those in the Dominican Republic more likely to be male, younger, and less educated than those in Peru (all $p < 0.001$). Nearly three-quarters of patients in the Dominican Republic were drivers (74.1%) compared with less than half in Peru (42.2%) ($p < 0.001$). Excluding pedestrians, 86.4% of RTIs involved a motorcycle/scooter in the Dominican Republic, compared with 43% in Peru; while in Peru, 32.5% of patients were in a car, compared with 11.5% in the Dominican Republic ($p < 0.001$). While patients in the Dominican Republic were more likely to be on a motorcycle/scooter than those in Peru, they were less likely to be wearing a helmet (19.9% vs. 39.8%) ($p < 0.001$).

Table 1.
Demographic Characteristics

		DOMINICAN REPUBLIC	PERU	COMBINED SAMPLES
	(N)	(501)	(431)	(932)
		%	%	%
	Male gender	85.5	61.4	74.4
	Age <30 years	58.0	44.2	51.6
MARITAL STATUS	Married/partnered	48.6	50.4	49.4
	Single, never married	40.9	34.8	38.0
	Widowed/separated/divorced	10.6	14.9	12.6
EDUCATION	Less than high school	45.2	20.8	34.1
	High school completion	38.8	22.0	31.1
	Any college/tech school	16.1	57.2	34.8
EMPLOYMENT STATUS	Working 30 hours or more/week	66.3	70.8	68.3
ROAD TRAFFIC INJURY TYPE	Driver	74.1	42.2	59.3
	Passenger	18.6	32.7	25.1
	Pedestrian	7.4	25.1	15.6
VEHICLE TYPE (EXCL. PEDESTRIANS)	Car/truck	11.5	32.5	20.1
	Bus	0.6	10.8	4.8
	Motorcycle or scooter/moped	86.4	43.0	68.6
	Bicycle	0.4	11.1	4.8
	Other	1.1	2.5	1.7
WERE YOU USING A ... (EXCL. PEDESTRIANS)	Seatbelt	5.4	10.0	7.3
	Helmet	19.9	39.8	28.1
	Nothing	74.7	50.2	64.6

4.2 Substance Use Characteristics

Overall, 17.8% of patients were positive for alcohol based on the breathalyzer, and 11.2% were over 0.08 g/dL (Table 2). The legal level of BAC in both countries is 0.05 g/dL. Of the patients, 15.3% reported drinking within six hours prior to the RTI. Although no difference was found between the two sites in the proportion of positive BAC, patients in the Dominican Republic were more likely to report drinking prior to the event (19.3%) than those in Peru (10.2%) ($p < 0.001$).

Among those drinking in the six hours preceding the RTI, close to half reported more than eight drinks (49.6%), with 78% of these patients reporting being at least a little intoxicated at the time and 69.1% believing or were unsure whether the RTI would have occurred if they had not been drinking (causal attribution). Of those attributing a causal association, 80% reported being at least a little intoxicated at the time (not shown). Among current drinkers, 28.7% reported five or more drinks on an occasion at least weekly.

Those in the Dominican Republic were more likely to report eight or more drinks prior to injury (52.3%) than those in Peru (41.9%) and were more likely to report being intoxicated (81.2% vs. 69.4%); however, differences were not significant, although those in the Dominican Republic were significantly more likely to report a causal association of their injury with drinking (87.1% vs. 47.4%, $p < 0.001$). Those in the Dominican Republic were also significantly more likely to report frequent heavy drinking (five or more drinks on an occasion at least weekly) (32.2%) compared with those in Peru (12.3%) ($p < 0.001$).

Of the sample, 12.3% tested positive for at least one drug, with patients in the Dominican Republic almost twice as likely to be positive (17.9%) than those in Peru (9.6%) ($p < 0.001$). Cannabis was the most frequently detected drug (11.8%), and those in the Dominican Republic were significantly more likely to be positive (15.7%) compared with those in Peru (6.6%) ($p < 0.001$). The legal level of cannabis in both countries is zero. Those in the Dominican Republic were also more likely to be positive for opiates (2.1%) than those in Peru (0.3%) ($p < 0.05$). All drugs other than cannabis were detected in relatively small percentages.

Overall, 3.5% of the patients reported drug use prior to injury, with 2.5% reporting cannabis use. Most cannabis users reported one to several puffs from a joint (62%) and the remainder from one to almost two joints. Among those reporting any drug use prior to injury, 58.3% reported being at least a little impaired at the time of the RTI and 66.7% believed or were unsure whether the RTI would have occurred if they had not been using drugs. While 75% of those in the Dominican Republic reported being at least a little impaired compared with 25% in Peru, they were less likely to attribute a causal association of their injury with using (62.5% vs. 75%), although differences were not significant due to small numbers of patients reporting drug use prior to injury. The majority of cannabis users reported usual use less than once a week (55.6%), with those in the Dominican Republic significantly more likely to report more frequent use (≥weekly) (63.6%) than those in Peru (14.3%) ($p < 0.01$).

Table 2. Substance Use Characteristics

		DOMINICAN REPUBLIC	PERU	COMBINED SAMPLES
	(N)	(501)	(431)	(932)
		%	%	%
BLOOD ALCOHOL (POSITIVE) [a]		18.8	16.6	17.8
BLOOD ALCOHOL CONCENTRATION ≥0.8 g/dL		12.6	9.5	11.2
POSITIVE SALIVA TEST, ANY DRUG [b,c]		17.9	9.6	14.3
POSITIVE SALIVA TEST, BY TYPE	Cannabis	15.7	6.6	11.8
	Amphetamine	0.6	0.0	0.4
	Cocaine	3.2	3.8	3.5
	Methamphetamine	0.2	0.0	0.1
	Opiates	2.1	0.3	1.3
	Phencyclidine	0.0	0.0	0.0
SELF-REPORT ALCOHOL USE WITHIN 6 HOURS PRIOR TO INJURY		19.3	10.2	15.3
NUMBER OF DRINKS AMONG 6-HOUR DRINKERS	≤3.0 drinks	53.5	38.7	49.6
	3.1–8.0 drinks	22.1	19.4	21.4
	> 8 drinks	24.4	42.0	29.1

Continued

FEELING IMPAIRED/INTOXICATED AT THE TIME AMONG THOSE DRINKING WITHIN 6 HOURS PRIOR TO INJURY	Not intoxicated	18.8	30.6	22.0
	A little intoxicated	39.6	38.9	39.4
	Somewhat intoxicated	31.3	25.0	29.5
	Very intoxicated	10.4	5.6	9.1
CAUSAL ATTRIBUTION OF EVENT TO ALCOHOL USE AMONG 6-HOUR DRINKERS		78.1	47.5	69.1
DRINKING PATTERN AMONG CURRENT DRINKERS	Non-heavy drinking (no 5+ occasions)	15.7	8.2	14.4
	Occasional heavy drinking (5+ occasions < weekly)	52.2	79.5	56.9
	Frequent heavy drinking (5+ occasions ≥ weekly)	32.2	12.3	28.7
ANY SELF-REPORTED DRUG USE WITHIN 6 HOURS PRIOR TO INJURY		4.0	2.8	3.5
SELF-REPORTED CANNABIS USE WITHIN 6 HOURS PRIOR TO INJURY		2.8	2.1	2.5
NUMBER OF JOINTS/PIPES AMONG 6-HOUR CANNABIS USERS	Several joints/pipes	0.0	0.0	0.0
	Almost 2 joints/pipes	21.4	14.3	19.0
	Almost 1 joint/pipe	14.3	28.6	19.0
	One or more puffs of joint/pipe	64.3	57.1	61.9
FEELING IMPAIRED/INTOXICATED AT THE TIME AMONG THOSE USING ANY DRUG WITHIN 6 HOURS PRIOR TO INJURY	Severely impaired/intoxicated	12.5	0.0	8.3
	Moderately impaired/intoxicated	25.0	0.0	16.7
	A little impaired/intoxicated	37.5	25.0	33.3
	Not impaired/intoxicated at all	25.0	75.0	41.7
CAUSAL ATTRIBUTION OF EVENT TO DRUG USE AMONG 6-HOUR USERS		62.5	75.0	66.7
FREQUENCY OF CANNABIS USE AMONG CURRENT USERS	<weekly	36.5	85.7	55.6
	≥weekly	63.6	14.3	44.4

[a] Among the 97% who were breathalyzed, and includes the 1% who reported drinking after the injury event
[b] Among the 90% who were saliva tested, and includes the 0.07% who reported using drugs after the injury event
[c] Percentage calculated including the 7.3%–8.5% of saliva tests that were indeterminate

4.3 Risk of RTI from Alcohol Consumption, Cannabis Use, and Combined Use

As shown in Table 3, 19.3% of drivers reported drinking within six hours prior to the RTI, compared with 12.5% of passengers and 10.3% of pedestrians. Likelihood of RTI was elevated over two and a half times (OR = 2.60, $p < 0.001$) from drinking, and was significant for drivers (OR = 2.57, $p < 0.001$) and for passengers (OR = 2.77, $p < 0.05$), but was not significant for pedestrians (OR = 2.54), possibly due to the smaller number of pedestrians.

Table 3. Odds Ratios for Any Alcohol Use on Risk of a Road Traffic Injury

	N[a]	OR	95% CI
All RTIs combined	3,298	2.60	(1.85, 3.76)***
Drivers	2,346	2.57	(1.77, 3.90)***
Passengers	522	2.77	(1.07, 7.18)*
Pedestrians	430	2.54	(0.62, 10.35)

[a] Ns are number of valid person-periods used for 1:m matching (1 injury period vs m=1-7 control periods) in the case-crossover analysis

* p<0.05,

***p<0.001

While risk of RTI was significant ($p < 0.001$) at all levels of consumption, and almost four times greater (OR = 3.76) for up to three drinks, risk was over 10 times greater (OR = 10.33) for 3–8 drinks prior to injury (Table 4). Risk fell at over eight drinks (OR = 6.69). Few patients reported drinking 3–8 drinks in the control periods (possibly reflecting the country-level drinking pattern in these countries) which inflated the OR for this level of drinking. Findings were similar for drivers, but the fewer number of passengers and pedestrians precluded analysis in some drinking categories.

Table 4. Odds Ratios for Volume Levels on Risk of a Road Traffic Injury

	N[a]	OR	95% CI
All RTIs combined (ref. no alcohol)	3,298		
0.1—3.0 drinks		3.76	(2.15, 6.58)***
3.1—8.0 drinks		10.33	(4.51, 23.66)***
>8.0 drinks		6.69	(3.52, 12.73)***
Drivers (ref. no alcohol)	2,346		
0.1—3.0 drinks		3.77	(2.08, 6.83)***
3.1—8.0 drinks		10.14	(3.98, 25.85)***
>8.0 drinks		7.39	(3.61, 15.13)***
Passengers (ref. no alcohol)	522		
0.1—3.0 drinks		4.13	(0.68, 25.07)
3.1—8.0 drinks		NA[b]	
>8.0 drinks		5.41	(0.80, 36.57)
Pedestrians (ref. no alcohol)	430		
0.1—3.0 drinks		NA	
3.1—8.0 drinks		4.48	(0.48, 42.01)
>8.0 drinks		2.27	(0.19, 26.55)

[a] Ns are number of valid person-periods used for 1:7 matching (1 injury period vs 1-7 control periods) in the case-crossover analysis

[b] NA (not available): OR cannot be generated because of empty cell

***$p<0.001$

As shown in Table 5, 3.7% of drivers reported using cannabis within six hours prior to the RTI, compared with 3% of passengers and 3.5% of pedestrians. Likelihood of RTI was over three times greater (OR = 3.17) from cannabis use and over four times greater (OR = 4.23) for drivers ($p < 0.05$). Risk was not significant for either passengers or pedestrians. To test whether risk from cannabis use changed after controlling for alcohol volume, both cannabis use and alcohol volume were entered into the equation. ORs from cannabis use dropped to 2.12 for the total sample and 2.76 for drivers, and neither effect estimate was significant (not shown).

Table 5. **Odds Ratios for Any Cannabis Use on Risk of a Road Traffic Injury**

	N[a]	OR	95% CI
All RTIs combined	3,298	3.17	(1.15, 8.74)*
Drivers	2,346	4.23	(1.32, 13.57)*
Passengers	522	0.49	(0.02, 13.38)
Pedestrians	430	2.00	(0.13, 29.95)

[a] Ns are number of valid person-periods used for 1:m matching (1 injury period vs m=1-7 control periods) in the case-crossover analysis

* $p<0.05$

Patients who reported using alcohol may also have been using other drugs, including cannabis, while those reporting cannabis use may also have been using other drugs, including alcohol. As seen in Table 6, for all RTI types, alcohol use (OR = 2.41, $p < 0.001$) and combined use with cannabis (OR = 7.85, $p < 0.01$) were significantly predictive of RTI, while cannabis use, alone, was not. Risk of RTI was over three times greater for combined use of alcohol and cannabis than from use of alcohol alone, reaching almost eight-fold. However, neither additive nor multiplicative interaction was found significant (RERI = 5.27, $p = 0.284$; multiplicative interaction OR = 2.80, $p = 0.260$). For drivers, both alcohol use (OR = 2.46, $p < 0.001$) and combined use with cannabis (OR = 6.89, $p < 0.01$) were significant predictors of RTI (but not cannabis use alone), with combined use over two and a half times more risky than alcohol use alone. Again, no significant interaction was observed for drivers. Due to relatively small numbers, risk estimates could not be produced for passengers or pedestrians for cannabis alone or for cannabis combined with alcohol. For alcohol alone, however, risk was marginally significant ($p = 0.064$) for passengers, but not for pedestrians.

Table 6. Odds Ratios for Alcohol and Cannabis Combined Use on Risk of a Road Traffic Injury

	N[a]	OR	95% CI
All RTIs combined	3,298		
Alcohol only		2.41	(1.68, 3.47)***
Cannabis only		1.16	(0.26, 5.16)
Both alcohol and cannabis		7.85	(2.24, 27.57)**
Drivers	2,346		
Alcohol only		2.46	(1.64, 3.69)***
Cannabis only		3.34	(0.70, 15.85)
Both alcohol and cannabis		6.89	(1.65, 28.73)**
Passengers	522		
Alcohol only		2.52	(0.95, 6.71)[c]
Cannabis only		NA[b]	
Both alcohol and cannabis		NA[b]	
Pedestrians	430		
Alcohol only		1.83	(0.39, 8.62)
Cannabis only		NA[b]	
Both alcohol and cannabis		NA[b]	

[a] Ns are number of valid person-periods used for 1:m matching (1 injury period vs m=1-7 control periods) in the case-crossover analysis
[b] NA (not available): OR cannot be generated because of empty cell
[c] p=0.064, **p<0.01, ***p<0.001

4.4 Prediction of Alcohol-Related and Cannabis-Related RTI

Table 7 shows the predictive value of gender, age, country, and usual drinking patterns on having an alcohol-related RTI, defined as reporting drinking within six hours prior to the event. Only frequent heavy drinking (reporting five or more drinks on an occasion at least weekly) was significantly predictive ($p < 0.001$) of an alcohol-related RTI, with those reporting this pattern of drinking over four times more likely to have an alcohol-related RTI than those reporting no 5+ drinking occasions.

Table 7. Predictors of Alcohol-Related Road Traffic Injury among Current Drinkers (n = 505)

	(N)	Model 1 (486)		Model 2 (407)	
		OR	95% CI	OR	95% CI
DEMOGRAPHICS	Male	1.42	(0.78, 2.59)	1.09	(0.55, 2.14)
	Age ≤ 30	0.81	(0.54, 1.23)	0.77	(0.48, 1.25)
	Dominican Republic (Peru ref.)	1.16	(0.72, 1.89)	1.58	(0.75, 3.33)
DRINKING PATTERN	Non-heavy (ref.)				
	Occasional heavy			1.65	(0.72, 3.79)
	Frequent heavy			4.30	(1.86, 9.93)***

***$p<0.001$

Table 8 shows the same data for drivers. Male drivers were significantly less likely to have an RTI than female drivers (OR = 0.22, $p < 0.05$). Again, a frequent heavy drinking pattern was significantly predictive ($p < 0.001$) of having an RTI as a driver (OR = 4.15). Sufficient data were not available for passengers or pedestrians to analyze demographic characteristics or drinking pattern as predictors of an alcohol-related RTI.

Table 8. Predictors of Alcohol-Related Road Traffic Injury as a Driver among Current Drinkers (n = 359)

	(N)	Model 1 (344)		Model 2 (302)	
		OR	95% CI	OR	95% CI
DEMOGRAPHICS	Male	0.37	(0.14, 1.01)	0.22	(0.07, 0.70)*
	Age ≤ 30	0.64	(0.40, 1.05)	0.65	(0.37, 1.12)
	Dominican Republic (Peru ref.)	1.35	(0.71, 2.58)	2.14	(0.78, 5.48)
DRINKING PATTERN	Non-heavy (ref.)				
	Occasional heavy			1.77	(0.63, 4.97)
	Frequent heavy			4.15	(1.45, 11.83)**

* p<0.05,
*** p<0.001

Table 9 shows similar data for a cannabis-related RTI, defined as any cannabis use within six hours prior to the RTI. Only frequent cannabis use of weekly or greater was significantly predictive of a cannabis-related RTI (OR = 7.74, $p < 0.05$), with those using at this frequency nearly eight times more likely to have a cannabis-related RTI than those using less frequently. It should be noted that usual use of cannabis may have involved use of other drugs as well, especially alcohol, and the cannabis-related event may also have involved alcohol. Sufficient data were not available for analysis of demographic characteristics and cannabis use patterns separately for drivers, passengers, or pedestrians.

Table 9. Predictors Cannabis-Related Injury among Current Users

	(N)	Model 1 (43)		Model 2 (35)	
		OR	95% CI	OR	95% CI
DEMOGRAPHICS	Male	1.83	(0.17, 20.31)	1.40	(0.06, 33.40)
	Age ≤ 30	0.39	(0.10, 1.55)	0.23	(0.04, 1.39)
	Dominican Republic (Peru ref.)	1.40	(0.39, 4.97)	0.42	(0.07, 2.49)
CANNABIS PATTERN OF USE	Monthly or less (ref.)		--		
	Weekly or greater		--	7.74	(1.10, 54.64)*

* p<0.05

5. Discussion and Recommendations

Risk of RTI was significant for alcohol use (but not cannabis) and was greater for alcohol combined with cannabis, although a significant interaction was not observed. Risk for alcohol use was lower (OR = 2.6 vs. 5.0) than that found in an earlier study of RTI in this region (*11*). Risk of RTI was primarily among drivers. Passengers had a greater risk of RTI from alcohol use than drivers, but not when alcohol was considered alone, suggesting that many of these passengers may also have been using cannabis or other drugs along with alcohol prior to injury, while drivers may have been less likely to combine drugs. Drivers using cannabis were at significantly increased risk of RTI, but when risk for those using cannabis alone was examined this risk was not significant. Prior research has found that a larger number of drinks is reported in the six hours prior to injury among those also using other drugs during this same time, than among those using only alcohol (*79*). When alcohol volume was controlled, the ORs for risk from cannabis use dropped to insignificance. These data highlight the importance of considering multiple drug use in risk of RTI. This is the first research reported that has disaggregated risk of RTI from alcohol combined with cannabis for drivers, passengers, and pedestrians. The added risk for drivers from alcohol combined with cannabis compared with alcohol alone, with cannabis on its own not posing a significant risk, is important for prevention and intervention efforts.

A dose-response relationship of alcohol and risk of RTI was apparent, but the middle dose category may have been inflated due to small numbers of patients reporting this level during the control periods. This may reflect the typical drinking patterns in these countries, where individuals tend to drink at either a lower level of consumption or a high level, with fewer reporting drinking between these two extremes. The number of passengers and pedestrians was too small for analysis in all three dose-response categories.

Large variations in demographic and substance-use characteristics were found between the two sites. The vast majority of patients in the Dominican Republic were injured in an event involving a motorcycle/scooter but only 20% reported helmet use, while slightly more than half of those in Peru were injured in events involving these two-wheeled vehicles (as well as bicycles), but 40% reported helmet use. A little over 10% of those in the Dominican Republic were injured in events involving a car, and less than half reported seatbelt use, while a third of those in Peru were so injured and only 10% reported seatbelt use.

Similar percentages of patients in the Dominican Republic and Peru were positive on the breathalyzer, but those in Peru were again only half as likely to report drinking in the six hours prior to injury compared with those in the Dominican Republic. While those in the Dominican Republic were almost twice as likely to be drug positive as those in Peru, and over twice as likely to be positive for cannabis, small percentages in both sites reported drug use within six hours prior to injury. It is possible that the saliva screening test covered a much broader period of time than the six-hour period preceding the injury.

Among those drinking prior to injury, patients in the Dominican Republic were more likely to attribute a causal association of RTI with their drinking than those in Peru. In both sites, those believing they were intoxicated were more likely to report a causal association than those not feeling intoxicated, suggesting that these patients were aware of their risky drinking habits. Those in the Dominican Republic were also more likely to report frequent heavy drinking compared with those in Peru. Cultural discomfort to disclose use of alcohol in Peru may have led to under-reporting of causal attribution, as well as under-reporting of usual use (*80*).

The number of patients reporting any drug use was small, rendering differences between the Dominican Republic and Peru not significant; however, it appears that those in the Dominican Republic may have been more likely to use drugs prior to the RTI and to report being impaired at the time, but less likely to attribute a causal association of the RTI with use. They were also significantly more likely to report usual cannabis use at greater frequency than those in Peru.

Limitations to the study include the relatively small number of passengers and pedestrians, which resulted in less definitive analysis of risk of injury from alcohol and cannabis for these two groups, especially in relation to a dose-response relationship for alcohol. Additionally, the study was limited to only one ED in each of the two countries, precluding generalization of findings beyond the individual ED in which the data were collected.

Nevertheless, given the proportion of patients reporting drinking prior to the RTI, the large number of drinks consumed, and the proportions reporting being intoxicated and attributing a causal association of their drinking with the event, these data suggest that alcohol, especially in combination with cannabis, contributes significantly to the burden of RTI, and this is especially true for drivers.

Differences found between the two countries underscore the need for data from similar studies on alcohol in combination with cannabis throughout the region for drivers, passengers, and pedestrians to determine, at the regional level, the risk of RTI from alcohol and drug use. Additional countries would also provide the necessary number of patients to analyze risk of injury more definitively from combined use of alcohol and cannabis and the dose-response risk of RTI, especially for passengers and pedestrians. Moreover, these data suggest that if saliva testing for substance use is implemented as a surveillance tool, confirmatory analyses would be required. Given the contribution of alcohol alone and in combination with cannabis to the burden of RTI found in this study, more stringent enforcement of alcohol and drug control policy related to driving is recommended. These data also highlight the need for educational and awareness campaigns aimed at increasing knowledge regarding the additional risk of combining alcohol with cannabis when driving, as well as the need for advocacy and enforcement of public policies focused on use of protective devices such as helmets and seatbelts.

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This report summarizes results from a collaborative study by the Inter-American Development Bank and the Pan American Health Organization on the risks of road traffic injury (RTI) from alcohol use, cannabis use, and combined use in a sample of emergency department patients from two countries in Latin America and the Caribbean: the Dominican Republic and Peru.

Results indicate that the risk of RTI for drivers in these two samples is significantly elevated from alcohol use, and more so for co-use with cannabis. Differences between the two countries underscore the need for similar data from the region to determine risk of RTI from substance use, including risk for passengers and pedestrians. Data suggest that alcohol contributes significantly to the burden of RTI, which calls for more stringent enforcement of alcohol control policy related to drink driving in the region. The findings will help inform intervention and prevention strategies to reduce substance-related harm from RTIs in this region.

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