Alcohol and cannabis use in traffic-related injuries in Mexico City

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ABSTRACT

Bacterkground There is debate on whether cannabis affects road traffic injuries (RTIs) separately from the effects of alcohol. Our goals are to report the possible increase in risk of an RTI among alcohol and cannabis users by type of exposure (biological, self-reported and combined) and the possible interaction of alcohol and cannabis in patients with an RTI in an emergency department in Mexico City.

Methods A case–crossover study with 433 cases of RTI (as a pedestrian, driver or passenger) during the period January–April 2022. A breath sample, an oral sample for cannabis detection and self-reported alcohol and cannabis use 6 hours prior to the RTI and in two control periods were used. We report ORs and 95% CIs from conditional logistic regressions for the case–crossover estimates.

Results Alcohol alone increased the risk of an RTI (OR=6.02, 95% CI 3.29 to 10.99) for most RTIs, regardless of whether we used information from self-reports or a breath sample in the hazard period. Conversely, cannabis only increased the RTI when we added information in the hazard period from self-reports or oral samples. Nevertheless, this increase in risk disappeared (OR=2.06, 95% CI 0.90 to 4.70) among those who only used cannabis. We also found no evidence of interaction between alcohol and cannabis in the risk of an RTI.

Conclusions Alcohol is the most commonly used substance in Mexico and a high-risk factor for RTI in Mexico City. Although cannabis alone was not associated with an RTI, continuous monitoring of its effects is required.

WHAT IS ALREADY KNOWN ON THIS TOPIC
⇒ Alcohol increases the risk of non-fatal road traffic injuries.

WHAT THIS STUDY ADDS
⇒ The risk of cannabis in road traffic injuries may depend on the information source

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY
⇒ The discrepancy between cannabis self-reports and biological markers should be investigated.

middle-income countries is becoming available.[8 12–14] Prior studies have shown that alcohol may impact types of RTI[3] differently, but few have investigated types of RTI and cannabis use among non-fatal injuries in emergency departments (EDs).[8 11 15]

Research on EDs has usually relied on exposure data (alcohol and drugs) prior to the RTI collected through biological specimens (blood, saliva, urine and breath) and/or self-reported data through standardised questionnaires.[16] While biological specimens have been used to describe exposure in samples of patients prior to RTI,[17 18] most research draws on self-reported data to calculate relative risks, usually by means of ORs from case–control[19 20] or case–crossover[21–24] studies. Few studies have investigated differences in relative risk estimates when using biological samples or self-reported exposure data (see Asbridge *et al* for alcohol and cannabis) (see Khanjani, Mousavi, Dehghanian, *et al* 2017, for cannabis) and only one study used a combination of information from both sources.[11 25] Asbridge *et al* found that cannabis increases the risk of RTI in a model using exposure by blood samples but not self-report data on cannabis, which was also observed by Khanjani *et al*.[14] Interestingly, combining blood and self-reports had a significant impact on estimates for cannabis but was negligible when both exposure measurements for alcohol were combined.[11] This has yet to be replicated.

Here we take advantage of new data collected on alcohol and cannabis use, through biological samples and self-reports, among patients with an RTI (drivers, passengers and pedestrians) in a large ED in Mexico City. Our goals are to report the possible increase in the risk of an RTI among alcohol and cannabis users by type of exposure (biological, self-reported and combined) and possible interactions, using a case–crossover study design.

INTRODUCTION

Alcohol is the main substance consumed in Mexico[1] and a known risk factor for road traffic injuries (RTIs) worldwide[2] and in Latin America, including Mexico.[3] According to the Global Burden of Disease study,[4] 6.06% of all RTI were attributable to alcohol consumption in 2019, a percentage that rises to over 8.98% in Mexico. Less is known about the role of cannabis use in RTI deaths,[5] and its role in non-fatal RTI injuries, especially among passengers and pedestrians, is still a matter of discussion.[6] The possibility that alcohol interacts with cannabis to increase the risk of a fatal[7] or non-fatal RTI[8] is also a matter of interest, partly because changes in legislation have made cannabis legal and more available, which may impact RTI.[9 10] Although most of the data available on the role of cannabis in non-fatal RTI comes from high-income countries such as Canada,[11] new research in low-income and

MATERIAL AND METHODS

Study design
A case–crossover study that included all cases of RTI (as a pedestrian, driver or passenger) seeking care in a large public ED in Mexico City.

Setting
A public hospital owned and administered by the Mexican Ministry of Health, located in the west of Mexico Cit, Mexico City (CDMX).

Procedures
Data collection took place between 17 January and 10 April 2022. Trained interviewers were present 24/7 in the ED, identifying all patients who met the following criteria and inviting them to participate: (1) adults (aged 18 years or over), (2) patients taken to the ED after an RTI (pedestrians, passengers or drivers of any type of vehicle), (3) seeking care for the first time for the index injury and (4) arriving at the ED in the 6-hour window after their RTI. Due to safety protocols, patients who had tested positive for SARS-CoV-2 or were identified by the admissions staff as having COVID-19 symptoms were not approached by the interviewers.[26] Patients in police custody were not included due to their limited autonomy to give their consent to participate in the study. Patients who arrived at the ED with the most severe injuries were approached when their condition had improved and were subsequently invited to take part in the interview.

All interviewers and research staff were extensively trained in study procedures at a 5-day workshop prior to data collection. During the fieldwork, 12 interviewers were divided into four groups to cover 12-hour shifts. Patient were approached in the ED as soon as possible to verify their eligibility and ask them to provide their formal written consent. They also requested and, if permission was granted, collected an oral fluid sample and took a breathalyser reading.

MEASURES

Substance use prior to the injury

Alcohol
Breath Alcohol Concentration (BAC) was measured, as soon as possible, using the Lifeloc F10 breath tester, with accuracy rates of ±0.005 BAC to 0.100 BAC, and ±5% from 0.100 to 0.400 BAC. Details are available at the company website (https://lifeloc.com/pub/media/pdf/userManualFC10.pdf).[24] For tabular purposes, BAC are categorised as negative (0.000) and positive (BAC+) if BAC >=0.001.

Cannabis
Cannabis use was assessed using ultimed's Saliva Screen 6 603 Multi-Drug Saliva Test, a rapid screening test for simultaneous assessment of several drugs and metabolites by visual analysis. This immunoassay is based on competitive binding, whereby drugs that may be present in an oral fluid specimen compete with their respective drug conjugate for binding sites in their specific antibody. The target drug and its corresponding cut-off concentration for qualitative determination (present/absent) was cannabis (THC, 12 ng/mL). Details are available at the company website (https://www.ultimed.org/produkte/salivascreen-doa-cassette/).[27]

For self-reports, data were collected using a questionnaire that took approximately 25 min to complete and was administered by trained interviewers. Patients reported their use of alcohol and marijuana in the 6 hours prior to the RTI that had caused them to be taken to the ED. For alcohol use during the 6 hours prior to the injury, the question posed was 'In the 6 hours before and up to your having your injury/accident, did you have any alcohol to drink, even one drink?' (yes/no).

Because this study uses the case–crossover methodology (see further), we also requested patients' information on alcohol and drug use in the two most recent days on which they were also drivers, passengers, or pedestrians at approximately the same time when the injury happened, to be used as control periods when they were considered at risk for an RTI. To this end, patients were asked about each day, beginning with the day before the injury and for up to 7 days, if they were in a similar situation to the one they had been in on the day of the injury. Patients who were unable to recall being in that situation during the previous 7 days were then asked about any day in the previous week or fortnight, between a month and 3 months earlier, up to 3 months earlier, or never. Information on alcohol use at the same time in the previous week was elicited as follows: 'I am now going to ask you to remember the two most recent occasions on which you were in a similar situation as on the day of your injury. You said you are here because of a traffic accident as a driver/passenger/pedestrian, and that the accident happened at about [time of the accident]'. After the subject listed the two most recent days, they were asked about alcohol use for each of the control periods, with the question 'Did you have any alcohol in the 6 hours before [time of the accident] on [date of the control period]'.

Parallel questions for the hazard and the control periods were also asked for cannabis use.

Data analysis
Patients who self-reported drinking or using cannabis at any time within the 6 hours prior to injury were considered exposed cases (hazard period). We performed a pair matching comparison, for each patient, their reported use of alcohol or cannabis during the 6 hours prior to injury with their use of alcohol/cannabis during the 2 days prior to injury (control periods) as detailed previously. In the matched pair analyses, the OR estimates used for the calculation only includes discordant pairs from each 2×2 table. The numerator included those exposed before the injury but not during the control period, while the denominator included not exposed before the injury but exposed in the control period. We then combined these two control periods for multiple (1:2) matching. We report the combined 1:M matched pairs for dichotomous exposures—in a 2×4 table—as suggested by Breslow and Day.[28] Conditional logistic regression was used to calculate matched pair ORs and 95% CI.[29] Interaction between alcohol and cannabis use was assessed using the relative excess risk due to interaction (RERI), a standard measure for interaction on the additive scale.[30 31]

Following Asbridge,[11] we also reported a model in which exposure during the hazard period was a biological measure (breath for alcohol or saliva for cannabis) if available or through self-reports, if no biological sample was available. Finally, we report a model that combined both sources of information, in which exposure was regarded as positive if a biological sample or self-report was positive.

Patient and public involvement
Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research

RESULTS
Figure 1 shows the patient flow and selection process for the study. Patients were first identified by the hospital admissions
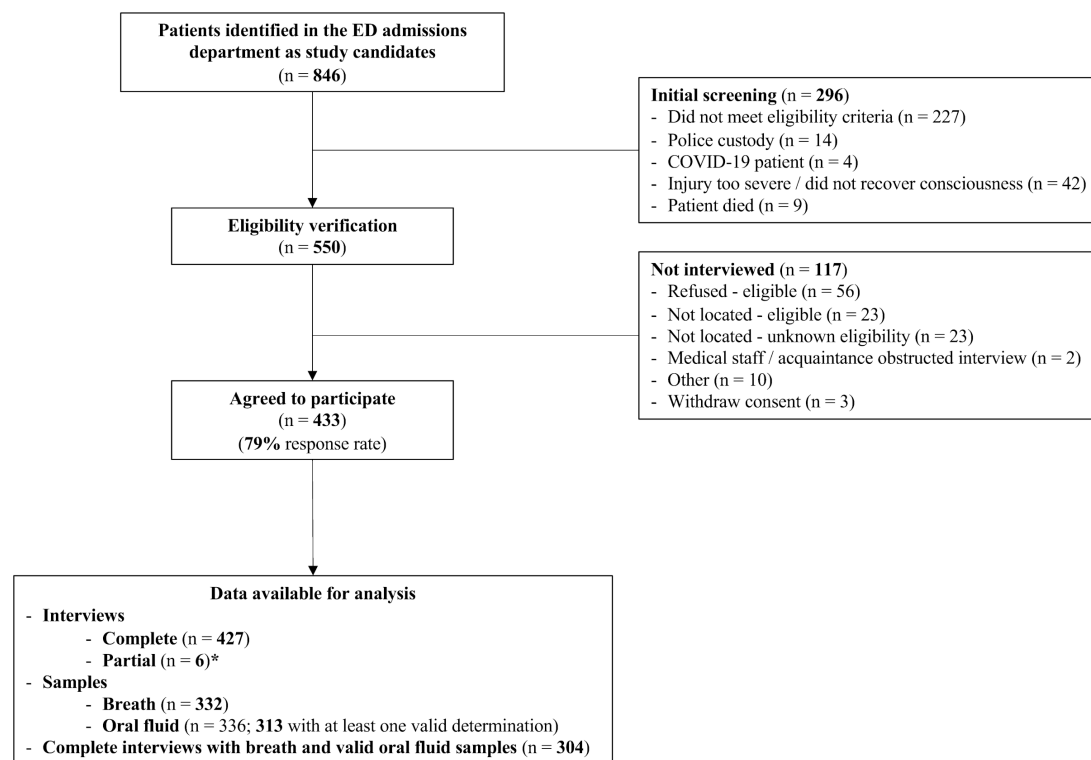
Figure 1 STROBE flow chart for the study road traffic injuries and use of psychoactive substances. One ED in Mexico City (2022). Fieldwork: 17 January–10 April 2022. ED, emergency department; STROBE, Strengthening the Reporting of Observational Studies in Epidemiology.

department. A total of 846 patients were identified during nearly months of data collection, out of which 550 met our inclusion criteria and 433 agreed to participate, equivalent to a 79% response rate. Among the 117 patients who did not participate, direct refusal was the most common reason (refused-eligible: n=56). Among participants who agreed to have a biological specimen collected, breath samples were obtained for 332 patients and 313 gave at least one valid determination for oral fluid (positive or negative). For self-reported interviews, complete data were obtained for 427 patients and partial data for another six.

The 433 patients with an RTI were mainly male (73.9%), young (78.1% were aged 18–39 years) and single (56.4%). Most cases occurred on weekdays/nights (66%), with motorcycle drivers comprising most of the sample (49.9%). When asked about control periods, most patients reported data on the previous day (first control period: 53.5%) and 2 days earlier (for the second control period: 44.7%) (online supplemental table S1).

Table 1 shows the distribution of alcohol by self-reports, breath samples and a combination of the two. About a fifth of the patients reported alcohol through self-reports or a breath sample, but only 6.9% reported alcohol through self-reports in the first control period and 5.0% reported it in the second period. By the same token, 7.4% reported cannabis through self-reports and 6.7% tested positive through oral fluid. Approximately 6.1% reported cannabis through self-reports in the first control period and 7.0% reported it in the second period.

Table 1 Prevalence of substance use among road traffic injury patients

	Before injury (6 hours)		First control period		Second control period	
	n	%	n	%	n	%
Alcohol						
Self-report	93	21.5	23	6.9	15	5.0
Alcosensor (BAC≥0.001)	63	19.0	–	–	–	–
Self-report or alcosensor	102	23.6	–	–	–	–
Alcosensor or SR if missing	82	18.9				
Cannabis						
Self-report	32	7.4	20	6.1	21	7.0
Oral fluid	21	6.7	–	–	–	–
Self-report or oral fluid	47	10.9	–	–	–	–
Oral fluid or SR if missing	29	6.7	–	–	–	–

Before injury and two control periods, by type of substance and measurement. One public hospital from Mexico City, 2022 (n=433*).
*Prevalences were computed with different sample sizes, according to type of measurement and time period (see the STROBE diagram).
BAC, breath alcohol concentration; STROBE, Strengthening the Reporting of Observational Studies in Epidemiology.

Table 2 OR estimates of substance use before injury with every control period and total, by type of substance and measurement

	First control period			Second control period			Multiple matching		
	obs†	OR	95% CI	*obs†*	OR	95% CI	*obs†*	OR	95% CI
Alcohol									
Self-report	664	5.62*	(2.65 to 11.93)	606	5.71*	(2.56 to 12.76)	967	5.49*	(3.06 to 9.84)
Alcosensor (BAC≥0.001)	516	3.67*	(1.75 to 7.66)	470	3.22*	(1.53 to 6.81)	751	3.70*	(2.04 to 6.72)
Self-report or alcosensor	664	6.25*	(2.96 to 13.18)	606	6.43*	(2.90 to 14.25)	967	6.14*	(3.45 to 10.93)
Alcosensor or SR if missing	664	3.55*	(1.82 to 6.92)	606	3.00*	(1.56 to 5.77)	967	3.43*	(2.02 to 5.83)
Cannabis									
Self-report	658	1.30	(0.57 to 2.96)	604	0.80	(0.32 to 2.03)	962	1.12	(0.50 to 2.47)
Oral fluid	484	0.67	(0.27 to 1.63)	448	0.77	(0.34 to 1.75)	710	0.69	(0.31 to 1.57)
Self-report or oral fluid	658	2.22*	(1.01 to 4.88)	604	1.89	(0.84 to 4.24)	962	2.40*	(1.18 to 4.88)
Oral fluid or SR if missing	658	0.86	(0.40 to 1.85)	604	0.75	(0.35 to 1.59)	962	0.83	(0.41 to 1.67)

ORs were estimated using conditional logistic regression.
*P<0.05.
†*obs* are the number of case and control periods used in each model (ie, each person contributed with a maximum of three observed case and control periods for the multiple matching models).
BAC, breath alcohol concentration; SR, self-report.

Forty-five patients reported alcohol use 6 hours prior to the RTI but did not drink in the first control period, while eight patients reported not drinking in the 6 hours prior to the accident but having drunk alcohol in the first control period (discordant pairs), for an OR of 5.6 (45/8) (online supplemental table S2). For the multiple matching, alcohol use increases the likelihood of an RTI whether we use self-reports (OR=5.49) or breath samples (OR=3.70) in the hazard period. For cannabis, neither self-reports (OR=1.12) nor oral fluid samples (OR=0.69) during the hazard period increased the likelihood of RTI (table 2). However, when the self-report and the oral sample were combined, cannabis increased RTI with an OR=2.40. These results for the combination of self-reported and biological data may reflect that agreement between self-reports and biological samples was very good for alcohol (kappa=0.734) yet substantially lower for cannabis (kappa=0.210) (see online supplemental table S3), meaning that combining the two sources of information was more complementary for cannabis than alcohol.

Table 3 presents ORs for three types of RTI, for multiple matching. Whereas ORs for alcohol were higher for all RTIs, they were not within statistical limits for pedestrians, probably because of the small number of cases. Testing for the homogeneity of these ORs suggests that they are similar ($\chi^2_{(2)}=1.15$; p=0.564). For cannabis, results were mixed, with the only significant increase being observed among drivers, with a combination of self-reports and oral fluid.

Table 4 shows OR estimates for alcohol alone, cannabis alone and the two substances together for the risk of RTI. These results show that alcohol alone is always a risk factor for RTIs, ranging from OR=3.39 when biological samples were used in the hazard period to as much as 6.02 when self-reports and breath samples were combined. At the same time, cannabis alone was not associated with RTI by any type of exposure or combination of types of exposure. In this table, we also present the RERI, which shows the lack of interaction between alcohol and cannabis in the risk of RTI.

DISCUSSION

In this study, we found that alcohol increased the risk of an RTI for most types of RTI, regardless of whether we used information in the hazard period from self-reports or breath samples.

Table 3 Multiple matching OR estimates of substance use before injury, by type of substance and measurement and type of road traffic injury

	Pedestrian: multiple matching			Driver: multiple matching			Passenger: multiple matching		
	obs†	OR	95% CI	*obs†*	OR	95% CI	*obs†*	OR	95% CI
Alcohol									
Self-report	123	2.67	(0.62 to 11.50)	657	5.84*	(2.77 to 12.33)	187	7.26*	(2.04 to 25.86)
Alcosensor (BAC≥0.001)	91	4.48	(0.47 to 42.70)	519	3.79*	(1.79 to 8.04)	141	3.34*	(1.11 to 10.06)
Self-report or alcosensor	123	3.31	(0.81 to 13.54)	657	6.49*	(3.10 to 13.60)	187	7.92*	(2.25 to 27.92)
Alcosensor or SR if missing	123	1.76	(0.45 to 6.86)	657	3.72*	(1.87 to 7.40)	187	4.13*	(1.43 to 11.98)
Cannabis									
Self-report	123	1.82	(0.28 to 11.95)	652	0.96	(0.36 to 2.55)	187	1.20	(0.16 to 9.20)
Oral fluid	–	–	–	492	1.04	(0.41 to 2.60)	138	0.59	(0.05 to 7.43)
Self-report or oral fluid	123	1.82	(0.28 to 11.95)	652	2.26	(1.00 to 5.10)	187	5.16	(0.53 to 50.41)
Oral fluid or SR if missing	–	–	–	652	0.94	(0.42 to 2.13)	187	2.06	(0.33 to 13.05)

The multiple matching estimate for pedestrian's cannabis detection with oral fluid was not computed due to cells with zero counts.
ORs were estimated using conditional logistic regression.
*P<0.05.
†*obs* are the number of case and control periods used in each model (ie, each person contributed with a maximum of three observed case and control periods for the multiple matching models).
BAC, breath alcohol concentration.

Table 4 OR estimates of the interaction of alcohol and cannabis use on injury

	Self-report (obs†=962)		Biological measure (obs†=698)		Self-report or biological measure (obs†=962)		Biological measure or self-report if missing (obs†=962)	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Interaction								
Only alcohol	5.30*	(2.90 to 9.70)	3.39*	(1.73 to 6.64)	6.02*	(3.29 to 10.99)	3.34*	(1.93 to 5.77)
Only cannabis	0.72	(0.27 to 1.98)	0.72	(0.31 to 1.70)	2.06	(0.90 to 4.70)	0.67	(0.29 to 1.53)
Both	5.71*	(1.53 to 21.26)	0.62	(0.06 to 5.99)	8.59*	(2.45 to 30.15)	3.19	(0.82 to 12.40)
RERI	0.69	(−15.2 to 16.6)	−2.49	(−5.2 to 0.2)	1.51	(−25.1 to 28.2)	0.18	(−10.1 to 10.5)

Multiple matching estimates.
ORs were estimated using conditional logistic regression.
*P<0.05.
†obs are the number of case and control periods used in each model.
RERI, relative excess risk due to interaction.

Conversely, cannabis only increased RTI when we added information on the hazard period from self-reports or oral samples. Nevertheless, when we examined the results between those who only used cannabis, this increase in risk disappeared. We also found no evidence of interaction between alcohol and cannabis in the risk of an RTI.

Alcohol was the main substance by this sample of patients. Our results on the impact of alcohol use in the risk of an RTI (OR=5.49 for self-reports) are similar to an earlier study of 1119 RTI patients visiting six EDs in Latin America (OR=5.07), including 44 RTI cases in Mexico City (OR=3.14).[3] These results are also similar to other recent case–crossover studies in the Americas.[8 11 13] Our findings that all types of RTIs had similar ORs is also congruent with previous research on a group of EDs in Latin America.

We did not replicate findings that cannabis alone increased risk in RTI patients in EDs.[8 11] In our study, when cannabis was considered separately from alcohol, it increased the risk of an RTI when we used a combined measure of self-reports and oral samples but lacked conventional statistical significance. Cannabis, alone or in combination with alcohol, affects driving performance,[32] and a meta-analysis suggests that it may impact crash risk to a low or medium extent.[33] Since our small number of cannabis users may have resulted in a limited ability to test this association, continuous monitoring of its effects is required. Because Mexico is undergoing changes in the legalisation/decriminalisation of cannabis, we recommend further studies on the potential effects of cannabis legalisation on crash fatalities and injuries, as has been done in other countries in the region such as Uruguay[34 35] and Canada.[25]

Using two sources of exposure in the hazard period has been reported before[11 14] in case–crossover. Combining self-report data for alcohol in our study increased the amount of information yet barely affected the estimates for alcohol as a risk factor for RTI, as reported by Asbridge.[11 15] This finding could be explained by the high concordance between self-reports and breath samples for alcohol among patients in EDs in our study and elsewhere.[36] Very different results were obtained from the addition of oral fluid and self-reported cannabis use, which greatly increased the OR for an RTI, while self-reports or oral fluids alone failed to increase ORs. Asbridge[11] and Khanjani[14] reported that self-reports alone of cannabis were not associated with the risk of RTI but that using blood tests yielded increased risk. It is not immediately obvious whether we should rule out self-report data on cannabis among patients in EDs. In our study, several inconsistencies between oral fluid and self-reported cannabis use were observed in those self-reporting cannabis use

who did not test positive in oral fluids (approximately 75% of positive cases self-report), which is similar to an earlier report on EDs patients in British Columbia, Canada, which found that among those who admitted using cannabis, only 21.1% had positive saliva tests,[16] whereas in Belgium, only 38% of drivers who self-report cannabis use had positive saliva tests.[37] This is obviously an area for further studies that may have a major impact in countries like Mexico, where collection and testing by biological samples is much less common and reliance on self-reported data is required.

This study is limited to a data analysis of a representative sample of patients with RTI drawn from a specific ED during a short time frame (3 months) in the COVID-19 pandemic in Mexico. Cases cannot be assumed to be representative of other individuals experiencing an RTI who did not seek medical care. Analyses reported here are based on patients' reported alcohol consumption across different times, which may not be uniformly accurate across time periods. Biological measures of blood alcohol content and THC at time of injury are desirable, but there are no biological measures available for control periods. Indeed, some of the few validity studies of self-reports on substance use in EDs have found that both self-reports of alcohol[36] and self-reports of drugs[16] are good options for the measurement of acute substance use prior to the injury. The use of biological tests alone for the hazard period and their combination with self-reported data have been proposed before, but further research is required on the validity of such an approach. Case–crossover studies are well suited to control for between-person confounders (such as age and sex), but they do not remove the possibility that within-person confounders exist. For example, in our study, it is possible that a patient may have been suffering an episode of fatigue exacerbated by an increase in alcohol consumption. This co-occurrence of fatigue and alcohol use could confound our estimates of ORs. Because we lack measures of other acute variables that vary over time, besides alcohol and cannabis, and that could be considered possible confounders of the relationship between acute alcohol use and RTI, we cannot quantify this bias or adjust our results accordingly.

Conclusion

Despite these limitations, this is the first study in Mexico using self-reports and biological data on alcohol and cannabis use as significant triggers of RTI patients. Alcohol use prior to RTI was a high-risk factor overall and for all three types of RTIs. Cannabis use alone was not associated with RTI, but because of the small number of patients exposed to cannabis in our data, studies with larger samples are required.

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