Article published online: 2023-11-17



# Dosage of Alcohol, Cocaine and Marijuana in Patients with Moderate and Severe Traumatic Brain Trauma Attended at the Hospital of Clinics of the Federal University of Uberlândia

## *Dosagem de álcool, cocaína e maconha em pacientes com traumatismo cranioencefálico moderado e grave atendidos no Hospital de Clínicas da Universidade Federal de Uberlândia*

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Arq Bras Neurocir 2023;42(4):e316–e322.

## Abstract

**Introduction** In Brazil, there are 125,000 hospitalizations a year for traumatic brain injuries (TBI) at a high socio-economic cost, causing serious and permanent sequelae, often associated with the use of alcohol, cocaine and marijuana.

**Objective** to discover the epidemiological characteristics of patients with moderate and severe TBI, treated at the Emergency Room of the Hospital of Clinics of the Federal University of Uberlândia (UFU), and their association with the use of alcohol, cocaine and marijuana.

**Material and Methods** saliva and urine samples were collected from 80 patients with moderate and severe TBI, aged ≥18 years, between September 2020 and December 2021. Research was made into the use of alcohol, cocaine and marijuana, using chromatographic immunoassay test kits.

**Results** A total of 28 cases (35%) were positive for alcohol, 22 cases for marijuana (27.5%) and 23 cases for cocaine (28.7%). The average age was 41 years old, with a predominance between 20 to 49 years old and of the male sex (90%). Accidents occurred mainly at night (52.5%) and on weekdays (65%). The most frequent cause of

**Keywords**
- cranio cerebral trauma
- alcohol intoxication
- cocaine
- marijuana

**received**
October 18, 2022
**accepted**
March 7, 2023

**DOI** https://doi.org/10.1055/s-0043-1776791.
**ISSN** 0103-5355.



Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

accident was transport (53.8%), followed by falls (22.5%) and aggression (16.2%). Of the transport accidents, motorcycle and automobiles accidents predominated (28.75%). Overall mortality was 16.2%, with zero positive cases for alcohol, 17.4% positive for cocaine and 27.3% positive for marijuana.

**Conclusion** we observed an association between TBI, alcohol, marijuana and cocaine, as well as an increase in cocaine and marijuana cases when compared with a study performed at this institution in 2003.

## Resumo

**Introdução** No Brasil, ocorrem 125 mil internações por ano por traumatismo cranioencefálico (TCE) com alto custo socioeconômico, causando sequelas graves e permanentes, muitas vezes associadas ao uso de álcool, cocaína e maconha.

**Objetivo** Conhecer as características epidemiológicas dos pacientes com TCE moderado e grave, atendidos no Pronto Socorro do Hospital de Clínicas da Universidade Federal de Uberlândia (UFU), e sua associação com o uso de álcool, cocaína e maconha.

**Material e Métodos** Foram coletadas amostras de saliva e urina de 80 pacientes com TCE moderado e grave, com idade entre 18 anos, entre setembro de 2020 e dezembro de 2021. Foi pesquisado o uso de álcool, cocaína e maconha, por meio de kits de testes cromatográficos de imunoensaio.

**Resultados** Um total de 28 casos (35%) foram positivos para álcool, 22 casos para maconha (27,5%) e 23 casos para cocaína (28,7%). A idade média foi de 41 anos, com predomínio entre 20 a 49 anos e do sexo masculino (90%). Acidentes ocorreram principalmente à noite (52,5%) e em dias úteis (65%). A causa mais frequente do acidente foi transporte (53,8%), seguida de quedas (22,5%) e agressões (16,2%). Dos acidentes de transporte predominaram os acidentes motociclísticos e automobilísticos (28,75%). A mortalidade geral foi de 16,2%, com zero casos positivos para álcool, 17,4% positivos para cocaína e 27,3% positivos para maconha.

**Conclusão** Observamos associação entre TCE, álcool, maconha e cocaína, bem como o aumento de casos de cocaína e maconha quando comparado com um estudo realizado nesta instituição em 2003.

**Palavras-chave**
- traumatismo cranioencefálico
- intoxicação alcoólica
- cocaína
- maconha

## Introduction

Traumatic brain injury (TBI) is one of the biggest causes of mortality in the modern era. Young men are more involved in most statistics, perhaps because they take more risks in traffic and are more likely to use alcohol and illicit drugs.[1,2] TBI is considered a major public health problem worldwide, as it incurs high socioeconomic costs, requiring prolonged hospitalizations and specialized treatments.[3] It is estimated that in Brazil the annual costs of hospitalization for patients suffering from traumatic brain injury are US$ 70,960.0004 or 376,698,256.00 reais (US dollar exchange rate as on 08/07/2022; source: Web site of the Central Bank of Brazil – bcb.gov.br). Among the most common causes of TBI are transport accidents, falls, assaults and being run over. Added to these factors is the use of alcoholic beverages and drugs such as marijuana and cocaine. In Brazil, there are very few publications referring to moderate and severe TBI associated with the use of alcohol and illicit drugs. The present study aims to describe the epidemiological characteristics of patients with severe and moderate TBI, treated at the emergency room of the Hospital of Clinics, UFU (Federal University of Uberlândia), from September 2020 through to December 2021 (period of the Covid-19 pandemic) and their associations with the use of alcohol, cocaine and marijuana.

## Methods

### Study Delimitation and Population

A descriptive, cross-sectional, qualitative and quantitative study was performed on individuals treated at the Emergency Room of the Hospital of Clinics (HC) of the Federal University of Uberlândia (UFU), with a diagnosis of severe and moderate TBI, over the period from September 1st, 2020, through to December 31st, 2021, aged 18 years or over. Severe injuries were classified as those with a score of 3 to 8 and moderate those with a score of 9 to 12 on the Glasgow Coma Scale (GCS) (►**Fig. 1**).

The study was approved by the Ethics and Research Committee of the Federal University of Uberlândia, under CAAE (Certificate of Ethical Presentation) no. 29782820.0.0000.5152 and notion no. 4.041.608, and in all cases an informed consent statement was collected.

 

| BEHAVIOR | RESPONSE | |
|---|---|---|
| **Eye opnening response** | 4- spontaneously<br>3- to speech<br>2- to pain<br>1-no response | |
| | | |
| **Best verbal response** | 5- fully oriented<br>4- confused<br>3-inappropriete words<br>2-incomprehensible sounds<br>1-no response | |
| | | |
| **Best motor response** | 6- obeys command<br>5- moves to lacalize pain<br>4- flex to withdraw from pain<br>3- abnormal flexion<br>2- abnormal extension<br>1-no response | |

**Total Score –** Best response - 15
Comatose - 8 or less
Totally inresponsive - 3

**Fig. 1** Glasgow Coma Scale.

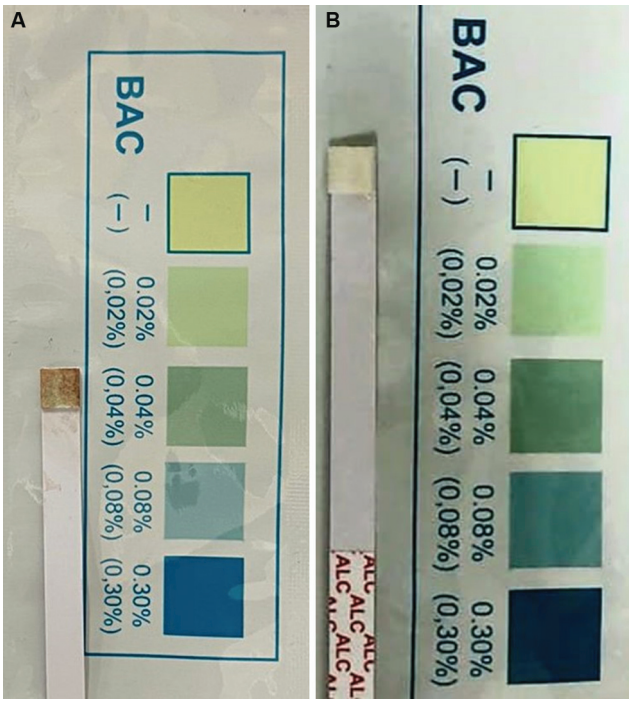


**Fig. 2** (A) Image of positive and negative tests for marijuana and cocaine: there was the appearance of a red line on C (control) and no appearance of a line for THC, indicating a positive test for marijuana. (B) Image of positive and negative tests for marijuana and cocaine: there was the appearance of a red line on C (control) and for THC, but not for cocaine, indicating a positive result for this drug. (C) Image of positive and negative tests for marijuana and cocaine: there was only the appearance of a red line on C and no appearance of a line on THC and COC, indicating a positive result for marijuana and cocaine. (D) - Image of positive and negative tests for marijuana and cocaine: appearance of a red line on C, THC and COC, indicating a negative test. C – control. COC –cocaine. THC - tetrahydrocannabinol.

### Data Collection and Variables Studied

The sample collection was performed exclusively by the same previously trained residents of the Neurosurgery Department of the Hospital of Clinics during the whole period, following the instructions on the test package.

Patients, immediately after initial care, were submitted to the saliva alcohol test using the Assure Saliva Alcohol Test, produced by Assure Tech (Hangzhou) Co. Ltd. This is a chromatographic immunoassay test based on an alcohol-sensitive enzyme reaction. It consists of a plastic strip with a small highly specific pad fixed on the tip containing Tetramethylbenzidine, Alcohol Oxidase, Peroxidase and other additives. Once this pad comes into contact with fresh saliva, it changes color depending on the concentration of alcohol present (►**Fig. 3a**).

For the qualitative measurement of cocaine and marijuana metabolites in urine, the Assure Multi 2 Test was used, produced by Assure Tech (Hangzhou) Co. Ltd. The test is an immunoassay based on the principle of competitive binding. This test consists of placing three drops of urine in a cassette filled with anti-marijuana and anti-cocaine antibodies. If these drugs are present in the patient's urine, it will produce a red line in the control region and will not appear at the indicated location for the drugs, thus indicating a positive test (►**Fig. 2a and –2b**).

Information related to the trauma was collected using a questionnaire made specifically for this purpose (Annex 2).

### Statistical Data Analysis Methods

Qualitative data were described with absolute and relative frequency. Quantitative data were described with the mean and 95% confidence interval error for the mean (normally distributed data) or were described with the median and interquartile range (non-normal distribution). When necessary for the analyses, discrete or continuous quantitative

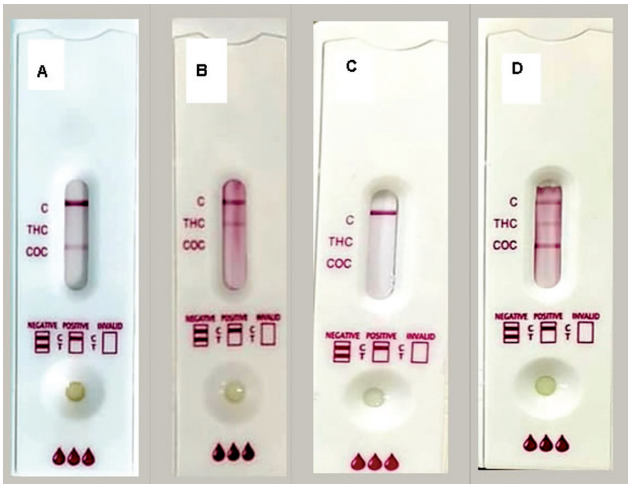


**Fig. 3** (A) Image of positive and negative tests for alcohol: A- Test showing a greenish coloration of the strip pad, indicating positivity for alcohol at a concentration of 0.04%. (B) – Image of positive and negative tests for alcohol: test showing no change in coloring, therefore negative for alcohol.

 

**Table 1** Descriptive Analysis of Variable Data

| Variable | Modality | n (%) |
|---|---|---|
| **Sex** | Female | 8(10%) |
| | Male | 72(90%) |
| **Location** | Other | 29(36.3%) |
| | Uberlandia | 51(63.7%) |
| **Time of Accident** | Daytime | 38(47.5%) |
| | Nighttime | 42(52.5%) |
| **Day of the Week** | Weekend | 28(35%) |
| | Midweek | 52(65%) |
| **Holiday** | Yes | 4(5%) |
| | No | 76(95%) |
| **Typeof Accident** | Aggression | 13(16.2%) |
| | Run over | 6(7.5%) |
| | Fall | 18(22.5%) |
| | Transport | 43(53.8%) |
| **Victim** | Passenger | 5(6.2%) |
| | Driver | 40(50%) |
| **Vehicle** | Motorbike | 23(28.75%) |
| | Car | 23(28.75%) |
| | Other* | 6(7.5%) |
| **Use of Seatbelt** | No | 7(30.4%) |
| | Yes | 1(4.34%) |
| **Use of Helmet** | No | 8(34.7%) |
| | Yes | 13(56.3%) |
| **Alcohol** | No | 52(65%) |
| | Yes | 28(35%) |
| **Marijuana** | No | 58(72.5%) |
| | Yes | 22(27.5%) |
| **Cocaine** | No | 57(71.3%) |
| | Yes | 23(28.7%) |
| **Brain Injury** | Diffuse Injury** | 10(12.5%) |
| | Contusions | 3(3.8%) |
| | Bruising | 6(7.5%) |
| | Traumatic SAH | 24(30%) |
| | Multiple Injuries*** | 37(46.2%) |
| **Severity** | Moderate | 14(17.5%) |
| | Severe | 66(82.5%) |
| **Surgery** | No | 58(72.5%) |
| | Yes | 22(27.5%) |
| **Evolution** | Death | 13(16.2%) |
| | Release | 67(83.8%) |
| **Resuscitation at the Site of the Accident** | Yes | 11(13.8%) |
| | No | 69(86.2%) |
| **Alcohol and Cocaine** | Yes | 9(11.2%) |
| | No | 71(88.8%) |
| **Cocaine and Marijuana** | Yes | 15(18.7%) |
| | No | 65(81.3%) |
| **Alcohol and Marijuana** | Yes | 7(8.7%) |
| | No | 73(91.3%) |
| **Alcohol, Marijuana and Cocaine** | Yes | 7(8.7%) |
| | No | 73(91.3%) |
| **Agression** | Yes | 13(83.7%) |
| | No | 67(16.3%) |
| **No drug use** | Yes | 33(41.25%) |
| | No | 47(58.75%) |

Abbreviation: SAH, Subarachnoid Hemorrhage.
**Key**: n: number of patients. Other*: truck (1), bus (1) and bicycle (4).
Diffuse injury**: cerebral o edema and diffuse axonal injury.
Multiple injury***: associations between focal lesions.

variables were dichotomized for better description of the data due to representativeness or adjustment to inferential analyses.

To compare the data of the quantitative variables between the two groups, the data for each group were tested for normality using the Shapiro-Wilk test. Where both groups were normal, the differences between the means were tested with Student's *t*-test for homogeneous and/or heterogeneous variances, and when at least one of the groups was not normal, the medians were compared using the unpaired Wilcoxon test (Mann-Whitney).

The independence between the groups and qualitative variables was tested with the Chi-Square test of independence (when expected frequencies were greater than five) or with Fisher's Exact test (when at least one of the expected frequencies was less than five). The Chi-Square test had continuity correction in the $2 \times 2$ contingency Tables (2 rows by 2 columns).

For all analyses the data were analyzed in SPSS software version 19.0 or in the R environment (R CORE TEAM 2019). A significance of 5% was adopted for all analyses.

## Results

Of a total of 168(one hundred and sixty-eight) patients treated at the ER of the Hospital of Clinics with a diagnosis of moderate and severe TBI over the period of the 1st of September 2020 to the 31st of December 2021, 5(five) patients were excluded for being underage and 8(eight) patients were excluded for having died shortly after initial care. Of the remaining 155(one hundred and fifty-five) patients, 80(eighty) were studied, which represent 51.6% of all patients treated over this period.75(seventy-five) patients were excluded, being that for 18 (eighteen) of

 

**Table 2** Descriptive analysis of the stratified database in patients with alcohol, marijuana and cocaine consumption (qualitative variables)

| Variable | Modality | No | Yes | |
|---|---|---|---|---|
| | | n (%) | n (%) | Statistics(*p*) |
| Type of Accident | Aggression | 7(13.5%) | 6(21.4%) | $X^2$ =1.131 0.77 |
| | Run over | 4(7.7%) | 2(7.1%) | |
| | Fall | 13(25%) | 5(17.9%) | |
| | Transport | 28(53.8%) | 15(53.6%) | |
| Evolution | Death | 13(25%) | 0(0%) | 0.003 |
| | Release | 39(75%) | 28(100%) | |
| Agression | No | 45(86.5%) | 22(78.6%) | 0.362 |
| | Yes | 7(13.5%) | 6(21.4%) | |

**Abbreviations:** n, number of patients; $X^2$, Chi-square statistic; *p:* probability.

them, the person responsible for the patient was not present at the time of initial care and for 57(fifty-seven), the accompanying person did not agree to sign the consent forms. Thirty-three (41.25%) tested negative for any of the drugs. Forty-seven patients (58.75%) tested positive of those, 28 (twenty-eight) were positive for alcohol, 23(twenty-three) for cocaine and 22(twenty-two) for marijuana. As for the isolated use of substances, 18(eighteen) patients tested positive only for alcohol, 4 (four) for cocaine and 5 (five) for marijuana. Twenty patients tested positive for a combination of the three drugs (►**Table 3**).

Of these 80(eighty) patients, 72(90%) were male and eight (10%) were female. The average age was 41.9 years old. Fifty-one patients (63.7%) were from Uberlândia and 29 patients (36.3%) were from other locations. The accidents occurred predominantly at night (52.5%) and on midweek days (65%).

The most common types of accident were transport accidents (53.8%) and falls (22.5%), followed by aggression (16.2%) and being run over (7.5%). Regarding the types of vehicles, accidents involving motorbikes and cars were of a similar incidence (28.75%) and others (bicycle/4, truck/1, tractor/1) 7.5%. In 40 cases (50%) the victim was the driver of the vehicle and in five (6.2%), a passenger. One case was not informed. As for seat belts, just 1.2% of patients were wearing one, 8.7% were not, and 90.1% was not informed. Of 23 motorbike accidents and 5 bicycle accidents, 13(thirteen) patients were wearing a helmet,8(eight) were not, and 7 (seven) were not informed. Regarding the types of brain injury shown on tomography, multiple injuries (more than one type of injury) were predominant (46.2%), followed by traumatic subarachnoid hemorrhage (30%), diffuse injuries (12.5%), bruising (7.5%) and contusions (3.8%). Of the 80 patients tested, 82.5% presented severe TBI and 17.5% moderate TBI. Surgical treatment was performed on 27.5% of the patients. Only 13.85% of the patients were resuscitated on the site of the accident. The total mortality rate was 16.2% and 83.8% of patients were released (►**Table 1**).

The cocaine and marijuana tests performed on urine samples and the alcohol on saliva samples were then analyzed in the emergency room and their images recorded (►**Fig. 1**). Positive testing for alcohol was found in 28 patients (35%). Marijuana and cocaine were detected in 22 (27.5%) and 23 (28.7%) of patients, respectively (►**Table 1**). As for the patients under the influence of alcohol, transport accidents were predominant in 15 (53.6%) followed by aggression in 6 (21.4%), with a zero hospital mortality rate and an average number of days of hospitalization of 23.98 ± 5.94 (►**Table 3**).

**Table 3** Descriptive analysis of the stratified database in patients with alcohol, marijuana and cocaine consumption (quantitative variables)

| Drug | Variable | No | | Yes | | Statistic |
|---|---|---|---|---|---|---|
| | | Average ± CI95% | Median (IQR) | Average ± CI95% | Median (IQR) | *Z(P)* |
| Alcohol | Age (Years) | 42.42 ± 4.37 | 42(18) | 40.93 ± 6.04 | 39(26) | 701(0.785) |
| | Duration of Hospitalization | 23.98 ± 5.94 | 20(28) | 25.71 ± 11.04 | 13(31) | 699.5(0.774) |
| Marijuana | Age (Years) | 44.88 ± 4.19 | 43.5 (21) | 34.05 ± 5.15 | 34 (19) | 386 (0.007) |
| | Duration of Hospitalization | 25.21 ± 6.39 | 18(28) | 22.95 ± 10.41 | 14(27) | 591(0.612) |
| Cocaine | Age (Years) | 44.04 ± 4.21 | 43 (20) | 36.61 ± 5.96 | 36 (23) | 484.5 (0.069) |
| | Duration of Hospitalization | 22.77 ± 6.18 | 14(26) | 29.09 ± 11.02 | 21(34) | 546.5(0.246) |

**Abbreviations:** IQR, interquartile range; *p,* probability; *Z*, statistic *Z* approximate for the Mann-Whitney test.

 

In patients positive for cocaine use, the rate of transport accidents was 43.5%. Assaults totalled 21.7% and mortality was 17.4%, with an average length of hospitalization of $22.7 \pm 6.18$ (►**Table 3**). Among those positive for marijuana, transport accidents also predominated (50%), followed by aggression and falls (22.7%), with six deaths and an average number of days of hospitalization of $25.21 \pm 6.39$ (►**Table 3**). When analyzing the variables age and length of hospitalization for the three drugs tested, no significant differences were observed (►**Table 3**).

Among the 9 (nine) patients positive for the concomitant use of alcohol and cocaine, 5 (five) were victims of transport accidents, 2 (two) of aggression, 1 (one) of being run over and 1 (one) of falling, with a mortality rate of zero and a mean of $23.69 \pm 5.32$ days of hospitalization. Regarding the association between alcohol and marijuana, of 7 (seven) patients, transport accidents predominated at 5 (five), followed by aggression at 1 (one) and falling at 1 (one), with no cases of being run over in this association. Mortality was zero, with an average length of hospitalization of $24.52 \pm 6.04$ days. For the 15 (fifteen) patients with positive association between cocaine and marijuana, 6 (six) were victims of a transport accident, 5 (five) of a fall, 3 (three) of aggression and 1 (one) of being run over. Mortality was 13.3% and the average hospital stay was $25.32 \pm 6.04$ days. We also observed the concomitant use of the three tested substances, alcohol, marijuana and cocaine, in 7 (seven) patients, with a predominance of transport accidents at 5 (five), aggression at 1 (one) and a fall at 1 (one). Nobody was run over in this association. Mortality was zero and the average length of hospitalization was $24.52 \pm 5.45$ days.

## Discussion

Samples from 80 patients were analyzed and we found 28 cases (35%) positive for alcohol in saliva. The average hospitalization was $25.71 \pm 11.04$ days to $23.98 \pm 5.94$ days for those not under the influence of alcohol, with no statistical difference (►**Table 3**). It is interesting to note that hospital mortality was zero in patients positive for alcohol, in contrast to a mortality of 25% (13 cases) in those negative for alcohol. Mortality is related to the severity of the trauma and to other associated injuries, and not necessarily to the use of alcohol.[5,6] Alcohol causes psychoactive effects such as euphoria, disinhibition, drowsiness and inattention[7]and is associated with more than 50% of injuries that require admission to trauma centres,[8] however its effect is temporary due to its short life. We chose to use a test for measuring alcohol in saliva and not in blood (alcoholaemia), as it is a non-invasive method of low technical complexity, it does not require storage of the collected material, and the result is obtained immediately.

We found positivity for alcohol in 35% of the patients evaluated, data similar to those of Lindembaum (1989).[1] Other studies found positivity in 22.8% and 37% respectively.[9,10] Our values are similar to those found in these same bibliographic citations.[9,10] When comparing our data with those found by Faria (2008)[11] who observed a positive blood alcohol level of 39.3%, it can be inferred that under the conditions of the dry law, there is no significant difference. Our study was performed under Decree 6,489 of 19/06/2008, which in turn became Law 11,705, popularly known as the Dry Law, and other laws that prohibited the sale of alcohol due to the Covid-19 pandemic. We expected that the ban on the sale of alcoholic beverages in this period would lead to a reduction in the percentage of positivity, which did not happen.

Research performed in the city of Seattle, Washington, USA, studying TBI patients admitted to a neurosurgical intensive care unit, mentions the need to measure blood alcohol. Signs such as agitation, tachycardia and hypertension can manifest in both alcohol intoxication and intracranial hypertension, which could confuse the diagnosis and delay treatment.[12]

We found 27.5% of positive cases for marijuana, practically, in absolute terms, triple the cases found by Faria (2011).[13] Hawley (2018)[14]in the state of Colorado, USA, identified in his work that 74% of patients with severe and moderate TBI had used marijuana, of those, 63% having used for recreational purposes, 72% to reduce anxiety and stress, and 55% to control insomnia. We did not collect data on our patients' activities. Faria (2008)[11]observed that this event occurred in male patients, during the night, on weekends, and mainly within an age group from 50 to 59 years old. Our study showed a higher incidence of TBI at night on weekdays, which differs from other studies.[3,15] There was a predominance in the age groups from 21 to 25 years old and from 36 to 40 years old for marijuana. The observed mortality was 27.3% and 14.3%[16]respectively. Regarding the types of accidents, we observed that in this group that transport accidents corresponded to 50%, followed by falls and assaults at 22.7% each. The average length of hospitalization was $25.21 \pm 6.39$ days.

There are few studies in Brazil relating the use of cocaine to TBI, probably due to underreporting and a lack of health policies that involve research in emergency units as a routine of care. We found that 28.7% of the patients in our study tested positive for cocaine, a higher frequency than that found by Faria,[12] which was 13.9%. In both, the use predominated in males and in young people. In these cases, transport accidents were the most common type. Faria observed a positive association between cocaine and trauma from aggression, when compared with other causes.[13] In our study, the main cause was transport accidents (43.5%), followed by falls (26.1%) and aggression (21.7%). A survey showed that 29.5% of cocaine-dependent individuals reported having suffered TBI during their lifetime compared with the 8% control,[17] emphasizing the importance of this association.

Faria[16] reports in his study that the associations between alcohol and cocaine and between alcohol and marijuana were the most frequent, followed by the association of the three drugs. We found positivity in the association between alcohol and cocaine at 11.25%, alcohol and marijuana at 8.75%, and alcohol, marijuana and cocaine at 8.75%.

A previous study found aggression to be the most common cause of trauma associated with the use of alcohol, marijuana

 

and cocaine.[1] In the current study, we found transport accidents to be the most common cause, followed by aggression and falls.

Studies performed in the USA showed that 35 to 80% of all patients hospitalized for trauma tested positive for illicit drugs.[18,19] In Brazil, despite intensive surveillance by the authorities in the fight against drug trafficking (80,607 tonnes of cocaine and 27,124 tonnes of marijuana were seized from 2020 to November 2021),[20] the presence of marijuana and cocaine associated with severe and moderate TBI may be underestimated. We emphasize that in our country there is no obligation to investigate these drugs in the emergency care departments of our hospitals.

## Conclusion

An association was observed between the use of alcohol, cocaine and marijuana with moderate and severe TBI in patients attended at the Emergency Room of the Hospital of Clinics of the Federal University of Uberlândia. The percentage of patients positive for cocaine (28.7%) and marijuana (27.5%) increased when compared with a study performed at this institution in 2003, when positivity was observed for cocaine (13.9%) and marijuana (8.2%). A future study will be necessary to investigate the causal nexus of these associations.

## Limitations

1. Difficulty in acquiring tests for the dosage of alcohol in saliva and for the dosage of cocaine and marijuana in urine during the period of the Covid-19 pandemic.
2. Several family members or guardians were either not identified or refused to sign the consent form.
3. Difficulty in implementing a routine for collecting the tests in the emergency room.

Financial Support
The author did not receive financial support.

Conflict of Interest
No conflict of interest to declare.

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