Are traumatic dental injuries greater in alcohol or illicit drugs consumers? A systematic review and meta-analysis

Marcela Baraúna Magno[a], Karla Lorene de França Leite[a], Matheus Melo Pithon[a,b], Lucianne Cople Maia[a,*]

[a] Department of Pediatric Dentistry and Orthodontics, School of Dentistry, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil
[b] Southwest Bahia State University UESB, Jequié, Bahia, Brazil

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ABSTRACT

Introduction and aims: Traumatic dental injuries (TDI), alcohol and illicit drugs consumption are highly-prevalent public health concerns. The aim of this study was to evaluate the association between alcohol and/or illicit drugs consumption and the presence of TDI.

Design and methods: This review was performed in accordance with MOOSE and PRISMA guidelines. Electronic searches were performed to found observational studies that investigated subjects that consumed alcohol and/or illicit drugs associated with TDI. Data extraction and a risk of bias assessment were performed. Three meta-analyses (MA) were performed to evaluate the association between TDI and alcohol consumption (1st MA), subgrouping the studies into alcohol intake and binge-drinking, alcohol-related problems (2nd MA), and drugs (3rd MA). The odds ratio (OR) were calculated ($p \leq 0.05$) for all analyses. The evidence was certainty-tested using the GRADE approach.

Results: Twelve articles met the eligibility criteria. Nine studies were methodologically sound, while three had some confounding factors. In the pooled MA, an association between alcohol consumption and TDI (OR 1.57[1.33,1.85],p = 0.00001) was determined with moderate certainty of evidence, confirmed in the subgroups of alcohol intake (OR 1.49[1.17,1.90],p = 0.001) and binge-drinking (OR 1.68[1.30,2.18],p = 0.0001). No associations were found between TDI and risk for alcohol-related problems and drug use (OR 0.75[0.50,1.14],p = 0.18, and OR 1.20[0.82,1.75],p = 0.27, respectively), with both analyses having a very low certainty of evidence.

Discussion and conclusions: There is moderate evidence concerning the association between alcohol use and TDI. Despite the absence of an association between illicit drugs use, alcohol-related problems and the presence of TDI, these results should be viewed with caution, since they had very low-certainly-evidence.

1. Introduction

Traumatic dental injuries (TDI) are a significant public health problem due to their high prevalence (Cortes et al., 2001), their impact on quality of life with potential for negative impacts on social relations (Antunes et al., 2013) and treatment expense (Glendor et al., 2007). Several biological and anatomical factors have been associated with the increased prevalence of TDI, such as accentuated overjet and inadequate lip seal (Correa-Faria et al., 2015), obesity (Basha et al., 2015), and socioeconomic status (Correa-Faria et al., 2015); however, social determinants and behavioral risk factors also influence the occurrence of TDI and should not be neglected.

The use of illicit drugs and alcohol consumption have been considered to be significant social problems because they present high prevalence (Greene et al., 2017; Underwood et al., 2010) and an increasingly early onset (Stahre et al., 2009; Paiva et al., 2015). Alcohol and illicit drugs consumption can result in TDI through intentional and unintentional injuries once these substances consumption can affect cognitive judgment, psychomotor skills, reaction time, visual focus, and concentration, encouraging individuals to take on risk behavior, and hence making the user more prone to either intentional or accidental injury (Gould, 2010; Taylor et al., 2010). Besides that, compulsive drug-seeking behavior due to dependence can lead to risk-taking behaviors, such as violent acts and accidents (Degenhardt et al., 2014).

Studies in the literature that have evaluated the association between alcohol and/or illicit drugs and TDI have reported conflicting results (Paiva et al., 2015; Baig Enver et al., 2016; Damarasingh et al., 2008; Reis et al., 2014; Filho et al., 2014). While (Damarasingh et al., 2008) and Enver et al. (Baig Enver et al., 2016) found no support for an association between TDI and illicit drugs use and/or alcohol consumption, Filho et al. (2014) in their cross-sectional study, concluded that a higher prevalence of TDI was associated with the use of illicit drugs. Also, Paiva et al. (2015) and Reis et al. (2014) suggested that binge-drinking is associated with TDI. Elucidating these conflicting reports, and identifying the evidence among these associations, is fundamental for planning adequate intervention policies that can address both biological and behavioral factors that can serve as mediators of these public health problems.

To this end, the following systematic review was conducted in order to answer the following focused question: Are TDI greater in alcohol or illicit drugs users?

2. Materials and methods

2.1. Protocol and registration

This systematic review was registered in the PROSPERO database (PROSPERO registry number CRD42018096074), and was undertaken in accordance with the guidelines of the Meta-analysis Of Observational Studies in Epidemiology (MOOSE) Group (Stroup et al., 2000) and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher et al., 2009).

2.2. Sources, search and study selection

Five electronic databases were searched, up to November 2018, including PubMed, Scopus, Web of Science, Lilacs/BBO, and the Cochrane Library. The grey literature (OpenGrey) was also searched. The search strategy used MeSH terms and synonyms in order not to impose any restrictions, and to maximize the search for articles in this research phase (Table 1). The search strategy was adapted for each database, with no language or date restrictions. A manual search was also performed, and the reference lists of selected articles were used for obtaining additional relevant publications that could have been missed during the database searches. Articles available in more than one database were considered only once. Alerts containing the search strategy were created in the databases.

Based on the PICO/PECO criteria, observational studies that included children, adolescents or adults (P) that consumed/used alcohol and/or illicit drugs (E) compared to those that non-consumed/non-used (C) were included to determine the association between these variables and TDI (O), as primary or secondary outcomes. The drugs were classified as illegal according to the National Institute on Drug Abuse (Stroup et al., 2000; Moher et al., 2009; Ridderikhof et al., 2017) To identify presence of association, the included studies had to present statistical analyses, including prevalence ratio, odds ratio (OR), and risk ratio, or be studies that reported frequency of events, and the total number of individuals per group. Literature reviews, letters to the editor, case reports or case series, studies with only prevalence results, outcomes other than TDI, studies of quality of life and those that did not report any associations between TDI and consumption/use of alcohol and/or illicit drugs were excluded.

Two reviewers (M.B.M. and K.L.F.L.) discussed the search criteria and performed the search strategy, in order to identify eligible studies. These reviewers independently evaluated the titles and abstracts of all studies identified from the electronic databases. Full-text copies were retrieved from studies that met the inclusion criteria, or for which there were insufficient data in the title and abstract to make a clear decision possible. Any disagreements on the eligibility of the included studies, at any point in the process, were resolved through consensus, or through discussion with a third expert reviewer (L.C.M.).

2.3. Data extraction

Details of the study (author(s), year of publication, country, and study design), details of participants (age range, number of participants in case and control groups, and source of sample), study methods (evaluation criteria for alcohol and/or illicit drugs consumption/use), results (overall prevalence of TDI, prevalence of TDI in case and control groups, and p value), and study conclusions were extracted by two reviewers (M.B.M. and K.L.F.L.). In studies for which additional data were necessary, the corresponding authors were contacted by e-mail or LinkedIn (weekly, up to five times), in order to clear up doubts. If, after the contact attempt, there was no response from the author, the study was not included in the meta-analysis.

2.4. Risk of bias (quality assessment analysis)

Evaluation of the methodological quality of the selected studies was carried out separately and independently by the same two examiners (M.B.M. and K.L.F.L.), following the guidelines described by (Fowkes and Fulton, 1991). This quality assessment can be applied to cross-sectional, case-control, and cohort studies, and included questions about study design, study samples, control groups, the quality of measurements and outcomes, completeness, and distorting influences. For each included study, the analysed criteria assigned were: problems – major (+ +), minor (+), or no problems (Atanasov, 2003), in terms of their expected effect on the results. If the question was not applicable, 'NA' was written.

The evaluation of each topic on the checklist was standardized by the evaluators. In 'source of sample', major problem (+ +) was assigned if the group of participants was not representative of the group from which this systematic review was drawn. In 'sampling method', minor problem (+) was assigned when no person, or local randomization, was related. In 'sample size', minor problem (+) was assigned when a representative sample, or the sample size calculation of the population, was not clear, and major problem (+ +) was assigned when, despite a representative sample being reported, it was not based on the general population age. In 'matching/randomization', if the case and control groups were not matched on age or sex, or if this was not clear in the paper, it was considered a major problem (+ +); and if overjet and/or lip covered was not matched between the case and control groups, it was considered a major problem (+ +) for 'comparable characteristics' and 'confounding factors'.

For 'reproducibility' and 'validity', it was considered a major problem (+ +) if the study did not use previously validated criteria for TDI or alcohol/drug consumption/use. For 'blindness', a minor problem (+) was assigned if the evaluator was not blinded to the group's case and control, or did not report any comments on this issue. Since the lack of evaluator blindness is not a major problem for the trauma diagnostic, major problem (+ +) was not considered for this topic. For 'quality control', it was considered to be a minor problem (+) if the study reported training and calibration of the evaluators, but kappa values were not reported; it was considered a major problem (+ +) if no training or calibration was reported, or if the study adopted self-reporting by participants. For 'compliance' and 'dropouts', it was NA if the study presented a cross-sectional or case-control design, a minor problem (+) if, in cohort studies, the number of dropouts was higher than 30%, but justified, and a major problem (+ +) if the number of dropouts was higher than 30%, but not justified. For 'distortion reduced by analysis', it was a major problem (+ +) if the case and control group were not paired for matching and confounding factors, and no multiple logistic regression analysis was performed to verify the effect of each confounding variable on the risk of TDI. In case of absence of significant difference, an NA* classification was adopted for 'distortion reduced by analysis' due to the impossible application of multiple logistic

Table 1
Search strategy.

Pubmed (922)	(((((Alcoholism[Mesh Terms] OR alcoholism[tiab] OR Alcohol Drinking[Mesh Terms] OR Alcohol Drinking[tiab] OR alcohol[tiab] OR Alcoholic Beverages[Mesh] OR Alcoholic beverage[tiab] OR Alcoholics[Mesh] OR Alcoholic*[tiab])) OR (Drug users[mesh terms] OR drug user*[tiab] OR Illicit Drug*[tiab] OR drug* abuse[tiab] OR drug*[tiab] OR Cannabis[mesh terms] OR cannab*[tiab] OR marijuana*[tiab] OR marihuana*[tiab] OR Codeine [mesh terms] OR codeine[tiab] OR crack cocaine[mesh terms] OR crack[tiab] OR cocaine[mesh terms] OR cocaine[tiab] OR Heroin[mesh terms] OR Heroin[tiab] OR Amphetamine[mesh terms] OR Amphetamine[tiab] OR methamphetamine[mesh terms] OR methamphetamine[tiab] OR Inhalant Abuse [mesh terms] OR Inhalant[tiab] OR glues[tiab] OR butane[tiab] OR propane[tiab] OR aerosol propellants[tiab] OR nitrous oxide[tiab] OR isobutyl[tiab] OR Methadone[mesh terms] OR Methadone[tiab] OR ecstasy[tiab] OR Lysergic acid diethylamide[mesh terms] OR LSD[tiab] OR Mescaline[mesh terms] OR mescaline[tiab] OR Psilocybin[mesh terms] OR Psilocybin[tiab]))) AND ((Tooth Injuries[mh] OR Tooth Avulsion[mh] OR Tooth Movement[mh] OR Tooth Fractures[mh] OR Teeth injur*[tiab] OR dental injur*[tiab] OR dental trauma[tiab] OR traumatic injur*[tiab] OR Teeth avulsion[tiab] OR Exarticulation[tiab] OR Dental dislocation[tiab] OR Tooth Movement[tiab] OR teeth extrusion[tiab] OR lateral luxation[tiab] OR Tooth Fractur*[tiab] OR crown fractur*[tiab] OR root fractur*[tiab]))
Scopus (1041)	(TITLE-ABS-KEY (alcoholism) OR TITLE-ABS-KEY ("Alcohol Drinking") OR TITLE-ABS-KEY ("Alcohol Drink") OR TITLE-ABS-KEY (alcohol) OR TITLE-ABS-KEY ("Alcoholic beverage") OR TITLE-ABS-KEY ("Alcoholic beverages") OR TITLE-ABS-KEY (alcoholic*) OR TITLE-ABS-KEY ("drug user") OR TITLE-ABS-KEY ("drug users") OR TITLE-ABS-KEY ("Illicit Drug") OR TITLE-ABS-KEY ("Illicit Drugs") OR TITLE-ABS-KEY ("drug abuse") OR TITLE-ABS-KEY ("drugs abuse") OR TITLE-ABS-KEY (drug*) OR TITLE-ABS-KEY (cannab*) OR TITLE-ABS-KEY (marijuana*) OR TITLE-ABS-KEY (marihuana*) OR TITLE-ABS-KEY (codeine) OR TITLE-ABS-KEY (crack) OR TITLE-ABS-KEY (cocaine) OR TITLE-ABS-KEY (heroin) OR TITLE-ABS-KEY (amphetamine) OR TITLE-ABS-KEY (methamphetamine) OR TITLE-ABS-KEY (inhalant) OR TITLE-ABS-KEY (glues) OR TITLE-ABS-KEY (butane) OR TITLE-ABS-KEY (propane) OR TITLE-ABS-KEY ("aerosol propellants") OR TITLE-ABS-KEY ("nitrous oxide") OR TITLE-ABS-KEY (isobutyl) OR TITLE-ABS-KEY (methadone) OR TITLE-ABS-KEY (ecstasy) OR TITLE-ABS-KEY ("Lysergic acid diethylamide") OR TITLE-ABS-KEY (lsd) OR TITLE-ABS-KEY (mescaline) OR TITLE-ABS-KEY (psilocybin)) AND (TITLE-ABS-KEY ("tooth avulsion") OR TITLE-ABS-KEY ("tooth injuries") OR TITLE-ABS-KEY ("tooth injury") OR TITLE-ABS-KEY ("tooth movement") OR TITLE-ABS-KEY ("tooth fracture") OR TITLE-ABS-KEY ("tooth fractures") OR TITLE-ABS-KEY ("teeth injury") OR TITLE-ABS-KEY ("teeth injuries") OR TITLE-ABS-KEY ("dental injury") OR TITLE-ABS-KEY ("dental injuries") OR TITLE-ABS-KEY ("dental trauma") OR TITLE-ABS-KEY ("traumatic injury") OR TITLE-ABS-KEY ("traumatic injuries") OR TITLE-ABS-KEY ("teeth avulsion") OR TITLE-ABS-KEY (exarticulation) OR TITLE-ABS-KEY ("dental dislocation") OR TITLE-ABS-KEY ("teeth extrusion") OR TITLE-ABS-KEY ("lateral luxation") OR TITLE-ABS-KEY ("crown fracture") OR TITLE-ABS-KEY ("crown fractures") OR TITLE-ABS-KEY ("root fracture") OR TITLE-ABS-KEY ("root fractures")) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "re")) AND (LIMIT-TO (SUBJAREA, "DENT"))
Web of science (878)	(alcoholism OR "Alcohol Drinking" OR "Alcohol Drink" OR alcohol OR "Alcoholic beverage" OR "Alcoholic beverages" OR alcoholic* OR "drug user" OR "drug users" OR "Illicit Drug" OR "Illicit Drugs" OR "drug abuse" OR "drugs abuse" OR drug* OR cannab* OR marijuana* OR marihuana* OR codeine OR crack OR cocaine OR heroin OR amphetamine OR methamphetamine OR inhalant OR glues OR butane OR propane OR "aerosol propellants" OR "nitrous oxide" OR isobutyl OR methadone OR ecstasy OR "Lysergic acid diethylamide" OR lsd OR mescaline OR psilocybin) AND ("tooth avulsion" OR "tooth injuries" OR "tooth injury" OR "tooth movement" OR "tooth fracture" OR "tooth fractures" OR "teeth injury" OR "teeth injuries" OR "dental injury" OR "dental injuries" OR "dental trauma" OR "traumatic injury" OR "traumatic injuries" OR "teeth avulsion" OR exarticulation OR "dental dislocation" OR "teeth extrusion" OR "lateral luxation" OR "crown fracture" OR "crown fractures" OR "root fracture" OR "root fractures")
Lilacs – BBO (1357)	((mh:(Alcoholism)) OR (mh:(Alcohol Drinking)) OR (mh:(Alcoholic Beverages)) OR (mh:(Drug users)) OR (mh:(Cannabis)) OR (mh:(Codeine)) OR (mh:(crack cocaine)) OR (mh:(cocaine)) OR (mh:(heroin)) OR (mh:(Amphetamine)) OR (mh:(methamphetamine)) OR (mh:(Inhalant Abuse)) OR (mh:(Methadone)) OR (mh:(Lysergic acid diethylamide)) OR (mh:(Mescaline)) OR (mh:(Psilocybin)) OR (tw:(alcoholism OR "Alcohol Drinking" OR alcohol OR "Alcoholic beverage" OR Alcoholic$ OR drug user$ OR Illicit Drug$ OR drug$ abuse OR drug$ OR cannab$ OR marijuana$ OR marihuana$ OR codeine OR crack OR cocaine OR Heroin OR Amphetamine OR methamphetamine OR Inhalant OR glues OR butane OR propane OR "aerosol propellants" OR "nitrous oxide" OR isobutyl OR Methadone OR ecstasy OR LSD OR mescaline OR Psilocybin OR alcool OR alcolismo OR maconha OR cocaina OR heroina OR anfetamina OR metanfetamina OR metadona OR inalantes))) AND ((mh:(Tooth Injuries)) OR (mh:(Tooth Movement)) OR (tw:("Tooth Injuries" OR "Tooth Avulsion" OR "Tooth Movement" OR Tooth Fractur$ OR Teeth injur$ OR dental injur$ OR "dental trauma" OR traumatic injur$ OR "Teeth avulsion" OR Exarticulation OR "Dental dislocation" OR "teeth extrusion" OR "lateral luxation" OR crown fractur$ OR root fractur$ OR "injuria dental" OR "avulsão dental" OR "movimentação dental" OR "fratura dental" OR "injurias dentais" OR "trauma dental" OR "injurias traumaticas" OR "deslocamento dental" OR extrusão dental" OR luxação lateral" OR "fratura coronária" OR "fratura radicular" OR exarticulação)))
Cochrane (187)	#1MeSH descriptor: [Alcohols] explode all trees34894 #2MeSH descriptor: [Alcohol Drinking] explode all trees3404 #3MeSH descriptor: [Alcoholic Beverages] explode all trees485 #4MeSH descriptor: [Alcohols] explode all trees34894 #5(alcoholism or "Alcohol Drinking" or alcohol or "Alcoholic beverage" or Alcoholic or alcohilics):ti,ab,kw21242 #6MeSH descriptor: [Drug Users] explode all trees100 #7MeSH descriptor: [Cannabis] explode all trees281 #8MeSH descriptor: [Crack Cocaine] explode all trees84 #9MeSH descriptor: [Cocaine] explode all trees898 #10MeSH descriptor: [Heroin] explode all trees292 #11MeSH descriptor: [Amphetamines] explode all trees1647 #12MeSH descriptor: [Methamphetamine] explode all trees443 #13MeSH descriptor: [Inhalant Abuse] explode all trees3 #14MeSH descriptor: [Methadone] explode all trees1145 #15MeSH descriptor: [Lysergic Acid Diethylamide] explode all trees66 #16MeSH descriptor: [Mescaline] explode all trees7 #17MeSH descriptor: [Psilocybin] explode all trees51 #18("drug user" or "drug users" or "Illicit Drug" or "Illicit Drugs" or "drug abuse" or "drugs abuse" or drug or drugs or cannabis or marijuana or marijuanas or marihuana or marihuanas or crack or cocaine or heroin or amphetamine or methamphetamine or inhalant or glues or butane or propane or "aerosol propellants" or "nitrous oxide" or isobutyl or methadone or ecstasy or "Lysergic acid diethylamide" or lsd or mescaline or psilocybin):ti,ab,kw 480,917 #19#1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18497844 #20MeSH descriptor: [Tooth Injuries] explode all trees255 #21MeSH descriptor: [Tooth Avulsion] explode all trees24 #22MeSH descriptor: [Tooth Fractures] explode all trees196 #23("Tooth Injury" or "tooth injuries" or "dental injury" or "dental injuries" or "dental trauma" or "traumatic injury" or "traumatic injuries" or "Tooth avulsion" or "tooth movement" or "Tooth Fracture" or "Tooth Fractures" or "crown fracture" or "crown fractures" or "root fracture" or "root fractures" or Exarticulation or "Dental dislocation" or "teeth extrusion" or "lateral luxation"):ti,ab,kw1169 #24#20 or #21 or #22 or #231173 #25#19 and #24187
OpenGrey (3)	(alcoholism OR "Alcohol Drinking" OR "Alcohol Drink" OR alcohol OR "Alcoholic beverage" OR "Alcoholic beverages" OR alcoholic* OR "drug user" OR "drug users" OR "Illicit Drug" OR "Illicit Drugs" OR "drug abuse" OR "drugs abuse" OR drug* OR cannab* OR marijuana* OR marihuana* OR codeine OR

Table 1 (*continued*)

crack OR cocaine OR heroin OR amphetamine OR methamphetamine OR inhalant OR glues OR butane OR propane OR "aerosol propellants" OR "nitrous oxide" OR isobutyl OR methadone OR ecstasy OR "Lysergic acid diethylamide" OR lsd OR mescaline OR psilocybin) AND ("tooth avulsion" OR "tooth injuries" OR "tooth injury" OR "tooth movement" OR "tooth fracture" OR "tooth fractures" OR "teeth injury" OR "teeth injuries" OR "dental injury" OR "dental injuries" OR "dental trauma" OR "traumatic injury" OR "traumatic injuries" OR "teeth avulsion" OR exarticulation OR "dental dislocation" OR "teeth extrusion" OR "lateral luxation" OR "crown fracture" OR "crown fractures" OR "root fracture" OR "root fractures")

regression. It was considered no problem (Atanasov, 2003) if the study performed statistical adjustments for matching and confounding factors not paired between groups. This quality check provided evidence for answering summary questions concerning the studies' methodological soundness.

Once a detailed appraisal of the methods and results had been conducted, a summary of the methodological quality was performed, based on three questions that allowed the determination of the possibility of 'results erroneously biased in a certain direction', 'serious confounding or other distorting influences', and 'results occurred by chance'. 'Distortion reduced by analysis' was directly related to the 'serious confounding or other distorting influences' question and, if the study presented no problem (Atanasov, 2003) to this criterion, the answer 'NO' was given to this summary question. If 'distortion reduced by analysis' had a minor or major problem, 'YES' was given to this summary question.

If one of these three summary questions was answered with 'YES', then there was a high probability that the research was not methodologically sound, and presented a high risk of bias. This process was performed by two reviewers (M.B.M. and K.L.F.L.), independently, and was also checked by a third experienced reviewer (L.C.M.).

2.5. Quantitative synthesis (meta-analysis)

The meta-analysis was performed, using Review Manager software v. 5.3, in order to assess the relationship between alcohol consumption and TDI, and to assess the relationship between drugs use and TDI. Two pooled meta-analyses were performed to evaluate the association between TDI and alcohol intake, and another was performed for TDI and drugs consumption.

For the alcohol analysis, the first meta-analysis evaluated the association between alcohol consumption and TDI. This meta-analysis was subgrouped according to the quantity of alcohol intake (yes X no) and binge-drinking (defined as having five or more drinks on a single occasion) (Lima et al., 2005). For the analysis, the number of TDI (events) for the case/exposed and control groups was included. The second meta-analysis evaluated the association between risk for alcohol-related problems and TDI. For this one, the number of TDI (events) for the case/exposed (high risk for alcohol-related problems) and control (abstinence or a low risk for alcohol-related problems) group were included.

The third meta-analysis evaluated the association between illicit drugs use (yes X no) and the presence of TDI. The number of TDI (events) for the case/exposed (drugs use) and control (non-drugs use) groups were included in this analysis.

For all meta-analyses, the OR was calculated, a random-effect model was used, and heterogeneity was assessed, using the I^2 index. To be included in the meta-analysis, the studies had to be considered to be methodologically sound after application of all three summary questions proposed by the risk of bias assessment tool. If necessary, a sensitivity analysis was conducted in order to estimate and verify the influence of the studies, one by one, on the pooled result (Higgins and Green, 2011).

2.6. Assessment of the certainly of the evidence

The certainly of the evidence (certainty in the estimates of effect) was determined for the outcome using the Grading of Recommendations Assessment, Development and Evaluation (GRADE)

approach (Ryan and Hill, 2016), whereby observational studies start as low evidence, and the quality of, or certainty in, the body of evidence decreases to low or very low quality, if serious or very serious issues, related to risk of bias, inconsistency, indirectness, imprecision, and publication bias, are present. In addition, the quality of the evidence can be upgraded if the magnitude of effect is large or very large, a dose-response was showed, or if the effect of all plausible confounding factors would be to reduce the effect, or suggest a spurious effect. In this way, the quality of the evidence can vary from very low to high.

3. Results

3.1. Study selection

Initially, 4.388 of potentially relevant articles were retrieved from searched databases; 572 records were excluded because they were duplicates. After title, abstract, and full text evaluation, 12 studies (Paiva et al., 2015; Baig Enver et al., 2016; Damarasingh et al., 2008; Reis et al., 2014; Filho et al., 2014; de Paiva et al., 2015; Jorge et al., 2012; Oliveira Filho et al., 2013; de Paiva et al., 2016; Paiva et al., 2014; Perheentupa et al., 2001; Reece, 2007) met the inclusion criteria, and were selected for quality and risk of bias assessment. Nine studies were included in the quantitative synthesis, since they qualified through being found to have methodological soundness. No further articles were found by manual searching. Fig. 1 summarizes the study selection process.

3.2. Characteristics of studies included in the systematic review

All 12 included studies had observational designs. Of these, two were conducted in London (Baig Enver et al., 2016; Damarasingh et al., 2008), eight in Brazil (Paiva et al., 2015; Reis et al., 2014; Filho et al., 2014; de Paiva et al., 2015; Jorge et al., 2012; Oliveira Filho et al., 2013; de Paiva et al., 2016; Paiva et al., 2014), one in Queensland
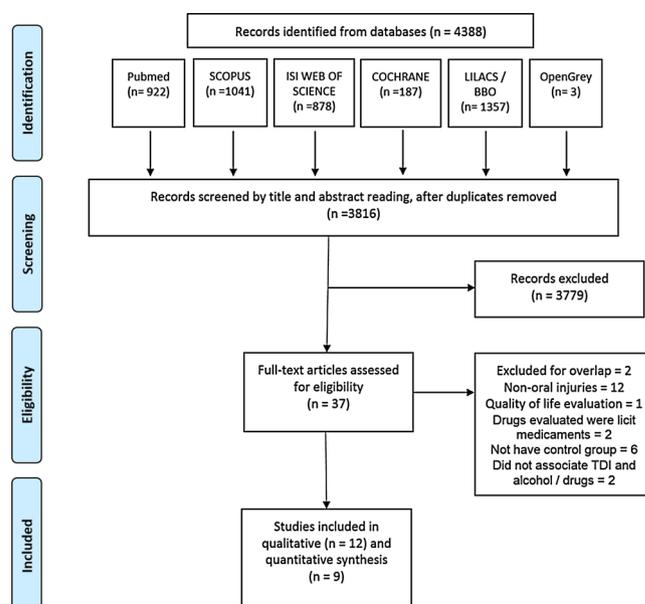

Fig. 1. Flow diagram of the search results from the databases.

(Reece, 2007), and one in Finland (Perheentupa et al., 2001), and the ages of the included participants ranged from 11 to 45 years old.

Ten studies evaluated the association between TDI and alcohol consumption, in which the Alcohol Use Disorders Identification Test (AUDIT) (Reis et al., 2014; Jorge et al., 2012; Oliveira Filho et al., 2013) and its short version, AUDIT-C (Paiva et al., 2015; de Paiva et al., 2015; Paiva et al., 2014), were the tests most used to identify the frequency of alcohol intake and binge-drinking. In addition, one study evaluated through personal recall (Reece, 2007), postal questionnaire (Perheentupa et al., 2001), health survey for young people in England, the Office for National Statistics (ONS) national surveys for adolescents (Baig Enver et al., 2016), and the Alcohol, Smoking and Substance Involvement Screening Test (ASSIST) (de Paiva et al., 2016).

Five studies evaluated the association between TDI and illicit drugs use, most of them applying the ASSIST questionnaire for this (Filho et al., 2014; Jorge et al., 2012; de Paiva et al., 2016). (Damarasingh et al., 2008) used questions taken from the UK ONS survey for teenagers, and Reece et al. (Reece, 2007) made an evaluation through personal recall.

TDI were assessed according to Andreasen et al.'s criteria (Paiva et al., 2015; Reis et al., 2014; Filho et al., 2014; de Paiva et al., 2015; Jorge et al., 2012; de Paiva et al., 2016; Paiva et al., 2014), Glendor et al.'s criteria (Baig Enver et al., 2016; Damarasingh et al., 2008; Oliveira Filho et al., 2013), a computer-based questionnaire (Perheentupa et al., 2001), and patient self-reporting (Reece, 2007).

The prevalence of TDI in case/exposition (consumption/use of alcohol and/or illicit drugs) groups ranged from 0% to 75%, while in the control groups, the prevalence of TDI ranged from 14.1% to 68.8%. Six studies supported the association between alcohol consumption and TDI (Paiva et al., 2015; Reis et al., 2014; Oliveira Filho et al., 2013; Paiva et al., 2014; Perheentupa et al., 2001; Reece, 2007), while three studies did not support it (Baig Enver et al., 2016; Jorge et al., 2012; Paiva et al., 2014). Concerning the relation between illicit drugs use and TDI, three studies supported this association (Filho et al., 2014; de Paiva et al., 2016; Reece, 2007), while two studies did not support it (Damarasingh et al., 2008; Jorge et al., 2012). Table 2 presents the description of the included studies.

3.3. Risk of bias (quality assessment)

Table 3 describes the risk of bias in the 12 included studies, classified according to the Fowkes and Fulton (1991) quality assessment.

For a representative sample, Paiva et al. (2014) and Reece (2007) did not describe any method for randomization, which was considered to be a minor problem. These two studies (Paiva et al., 2014; Reece, 2007) and Reis et al. (2014) did not report the sample size, adopting a convenience sample, thus this was a minor problem.

In relation to 'acceptance' of the control group, most of the studies presented major problems in 'matching' and 'comparable characteristics' due to not present, not evaluated, or not described pairing between the case and control groups for age and gender (Paiva et al., 2015; Filho et al., 2014; de Paiva et al., 2015; Oliveira Filho et al., 2013; de Paiva et al., 2016; Paiva et al., 2014), and for accentuated overjet and absence of lip covered (Paiva et al., 2015; Reis et al., 2014; Filho et al., 2014; de Paiva et al., 2015; Jorge et al., 2012; Oliveira Filho et al., 2013; de Paiva et al., 2016; Paiva et al., 2014; Perheentupa et al., 2001; Reece, 2007), respectively.

In relation to the quality of measurements and outcomes, Perheentupa et al. (2001) and Reece (2007) performed the TDI and alcohol/drugs use analyses through a questionnaire and, due to this methodology, these were classified with minor problems for 'validity' and 'reproducibility', and with major problems for 'quality control'. None of the included studies reported that the evaluators were blind, but this fact did not seem to influence the analyses or results.

Concerning completeness, Perheentupa et al. (2001) had the number of dropouts being higher than 30%, but not justified, so

considered a major problem.

With respect to 'distortion reduced by analysis', five studies (Paiva et al., 2015; Reis et al., 2014; Filho et al., 2014; de Paiva et al., 2015; Oliveira Filho et al., 2013) did not present case and control groups paired for gender, age, overjet, and absence of lip covered, but performed statistical treatments to minimize this problem, which was considered no problem. In two studies (Jorge et al., 2012; Paiva et al., 2014), this treatment was not possible due to 'non-statistical significance' observed in the crude analysis of the association between the variables in question in this systematic review (alcohol/drugs and TDI), so this criterion was classified as NA* for these studies. Paiva et al. (de Paiva et al., 2016), (Perheentupa et al., 2001), and Reece et al. (Reece, 2007) did not perform statistical adjustments for confounding variables, being a major problem.

Although some minor and major problems were identified, most of the studies were assessed as having high methodological quality (Paiva et al., 2015; Baig Enver et al., 2016; Damarasingh et al., 2008; Reis et al., 2014; Filho et al., 2014; de Paiva et al., 2015; Jorge et al., 2012; Oliveira Filho et al., 2013; Paiva et al., 2014). Two studies (Perheentupa et al., 2001; Reece, 2007) were considered as having 'results erroneously biased in a certain direction', and three (de Paiva et al., 2016; Perheentupa et al., 2001; Reece, 2007) were considered as having any 'serious confounding or other distorting influences'. Studies (de Paiva et al., 2016; Perheentupa et al., 2001; Reece, 2007) had major problems for 'validity', 'reproducibility', 'dropouts', and 'distortion reduced by analysis', were finally considered not methodologically sound in the summary questions, and so were not considered eligible for meta-analysis.

3.4. Meta-analysis and quality of evidence

Nine studies were include in the meta-analysis (Paiva et al., 2015; Baig Enver et al., 2016; Damarasingh et al., 2008; Reis et al., 2014; Filho et al., 2014; de Paiva et al., 2015; Jorge et al., 2012; Oliveira Filho et al., 2013; Paiva et al., 2014).

3.4.1. Alcohol consumption

Six studies were included in this meta-analysis. The overall heterogeneity was null ($I^2 = 15\%$, p = 0.47). For the alcohol intake subgroup, of the total individuals that consumed alcohol (n = 865), 30.6% (n = 265) presented TDI, while 21% (n = 284) of the total of individuals that did not consume alcohol (n = 1350) presented TDI. The alcohol intake people presented a 49% higher chance of suffering TDI (OR 1.49 [1.17, 1.90], p = 0.001, $I^2 = 15\%$). Concerning the binge-drinking subgroup, of the total binge-drinking individuals (n = 439), 34.5% (n = 151) presented TDI, while 25% (n = 208) of the total non-binge-drinking individuals (n = 833) presented TDI. Binge-drinking people presented a 1.68 higher chance of suffering TDI (OR 1.68 [1.30, 2.18], p < 0.0001, $I^2 = 0\%$).

Pooled results showed that alcohol consumption, independent of quantity, was associated with a greater prevalence of TDI (OR 1.57 [1.33, 1.85], p < 0.0001; Fig. 2). This evidence was qualified as moderate (Table 4).

3.4.2. Risk for alcohol-related problems

Three studies were included in this analysis. The heterogeneity was substantial ($I^2 = 70\%$, p = 0.04). During sensitivity analysis, the heterogeneity ranged from 0% to 82%. In an attempt to reduce heterogeneity, Oliveira Filho et al. (2013) was excluded from this analysis. Of the total individuals considered at high risk for alcohol-related problems (n = 165), 20% (n = 33) presented TDI, while 24.5% (n = 228) of the total individuals considered to be abstinent or at low risk for alcohol-related problems (n = 932) presented TDI. The level of risk for alcohol-related problems did not influence the chances of an individual suffering TDI (OR 0.75 [0.50, 1.14], p = 0.18, $I^2 = 0\%$, I^2 p = 0.46; Fig. 3). This evidence was qualified as low (Table 4).

Table 2
Description of included studies.

Author, year, country	Study design	Age range (years)	Source of sample	Number of participants		Evaluation criteria for alcohol	Evaluation criteria for drugs	Evaluation criteria for TDI	Prevalence of TDI	Episodes of TDI		Results	Conclusins
				Case	Control					Case (%)	Control (%)		
Damarasingh et al. 2018.[14] East London, UK.	Cross-sectional	15-16 (Phase III)	618	Phase I: 39　Phase II: 157	Phase I: 579　Phase II: 461	–	Questions taken from the UK ONS survey for teenagers	Glendor et al.	Phase III: 8.7%	Phase I: 7 (17%)　Phase III: 30 (19.1%)	Phase I: 98 (16.9%)　Phase III: 75 (16.3%)	There was no significant association between lifetime prevalence of illicit drug use reported at age 11–12 years OR: 1.07 (0.45–2.54) or age 15–16 years OR: 1.19 (0.74–1.93) and TDI.	This study did not support the association between illicit drug use and TDI.
Baig Enver et al., 2016.[13] East London, UK.	Cross-sectional	15-16 (Phase III)	635	Lifetime alcohol consumption: 92　Last month alcohol consumption: 22	Lifetime alcohol consumption: 543　Last month alcohol consumption: 613	Health Survey for young people in England and the ONS national surveys in adolescents	–	Glendor et al.	Phase III: 17%	Lifetime alcohol consumption: 16.3%　Last month alcohol consumption: 18.2%	Lifetime alcohol consumption: 17.7%　Last month alcohol consumption: 17.5%	No significant association of alcohol consumption with TDI was seen in these adolescents for either lifetime (adjusted OR: 0.87; 0.45–1.67) or last month consumption of alcohol (adjusted OR: 0.86; 0.28–2.69).	This study did not support the association between alcohol use and TDI.
Jorge et al., 2012.[26] Belo Horizonte, Brazil.	Cross-sectional	15-19	891	Alcohol: 135　Drugs: 135	Alcohol: 613　Drugs: 756	AUDIT	ASSIST	Andreasen et al.	220 (24.7%)	Alcohol: 18.2%　Drugs: 34 (25.2%)	Alcohol: 17.5%　Drugs: 186 (24.6%)	No statistically significant associations were found between alcohol and illicit drug use and a history of TDI.	This study did not support the association between alcohol and illicit drugs use and TDI.

Table 2 (*continued*)

Author, year, country	Study design	Age range (years)	Source of sample	Number of participants		Evaluation criteria for alcohol	Evaluation criteria for drugs	Evaluation criteria for TDI	Prevalence of TDI	Episodes of TDI		Results	Conclusins
				Case	Control					Case (%)	Control (%)		
Oliveira Filho et al., 2013.[27] Diamantina, Minas Gerais, Brazil	Cross-seccional	14-19	738			AUDIT	–	Glendor et al.	26.60%			Dental trauma was significantly associated with a high risk of problems related to alcohol intake (P = 0.031), hazardous alcohol use (P = 0.009) and binge drinking (P = 0.036). The results of the Poisson logistic regression revealed that hazardous alcohol use [PR = 1.30 (95% CI: 1.01–1.66) P = 0.042] remained associated with dental trauma independently from age, gender, overjet, and type of school.	This study support the association between alcohol use and TDI.
Oliveira Filho et al. 2014.[16] Diamantina, Minas Gerais, Brazil	Cross-seccional	14-19	701	48	639	–	ASSIST	Andreasen et al.	183 (26.6%)	21 (43.8%)	162 (25.5%)	Dental trauma was more prevalent among adolescents who had used marijuana and/or cocaine in their lifetime (P = 0.005). The Poisson regression results revealed that illicit drug use was still associated with dental trauma independent of other variables [PR = 1.54 (95% CI: 1.06–2.24)	This study support the association between illicit drugs use and TDI.

Table 2 (*continued*)

Author, year, country		Study design	Age range (years)	Source of sample	Number of participants		Evaluation criteria for alcohol	Evaluation criteria for drugs	Evaluation criteria for TDI	Prevalence of TDI	Episodes of TDI		Results	Conclusins
					Case	Control					Case (%)	Control (%)		
Paiva et al., 2014 (a).[29] Minas Gerais, Brazil		Cross-seccional	12	101	34	67	AUDIT-C	–	Andreasen et al.	33.70%	15 (45.5%)	23 (54.5%)	Statistically, dental trauma was not associated with the consumption of alcoholic beverages (p = 0.281) or abusive consumption of alcoholic beverages (p = 0.207). (OR: 1.54; 0.68, 3.73).	This study did not support the association between alcohol use and TDI.
Paiva et al. Minas Gerais, Brazil	2014 (b)[9]	Cross-seccional	12	588	Binge drinking: 136	Binge drinking: 452	AUDIT-C	–	Andreasen et al.	29.90%	Binge drinking: 55 (31.3%)	Binge drinking: 121 (68.8%)	The prevalence of traumatic dental injuries was significantly higher among those who engaged in binge drinking (adjusted PR = 1.410; 95% CI: 1.133–1.754)	This study support the association between alcohol use and TDI.
	201,525	Cross-seccional			Alcohol intake: 264 136	Alcohol intake: 324 452					Alcohol intake: 91 (51.7%) 55 (59.5%)	Alcohol intake: 85 (48.3%) 121 (26.7%)	Binge drinking remained significantly associated with TDI after adjustments (Adjusted OR 1.928 (1.213, 3.0.63)	This study support the association between alcohol use and TDI.
Paiva et al. 2016.[28] Minas Gerais, Brazil		Cross-seccional	12	588	Alcohol: 275 Marijuana: 9 Cocaine: 4 Inhalants:10 Hallucinogens: 1	Alcohol: 313 Marijuana: 579 Cocaine: 584 Inhalants: 578 Hallucinogens: 587	ASSIST	ASSIST	Andreasen et al.	29.90%	Alcohol: 91 (33.1%) Marijuana: 6 (66.7%) Cocaine: 3 (75%) Inhalants:3 (30%) Hallucinogens: 0	Alcohol: 85 (27.2%) Marijuana: 170 (29.4%) Cocaine: 173 (29.6%) Inhalants: 173 (29.9%) Hallucinogens: 176 (30%)	Alcohol: OR 133 (0,93-1,89) Marijuana: OR 481 (1,19-10,46) Cocaine: OR 712 (0,73-68,99) Inhalants: OR 103 (0,25-3,92) Hallucinogens: OR 070 (0,66-0,73)	This study support the association between illicit drugs use and TDI.

Table 2 (*continued*)

Author, year, country	Study design	Age range (years)	Source of sample	Number of participants		Evaluation criteria for alcohol	Evaluation criteria for drugs	Evaluation criteria for TDI	Prevalence of TDI	Episodes of TDI		Results	Conclusins
				Case	Control					Case (%)	Control (%)		
Perheentupa et al., 2001.[30] Northern Finland and Helsink.	Cohort	31 years longitudinal birth	5737	Dental fractures: Dental fractures Lower or average consumption: 3405 High consumption: 1653 Luxation and avulsion Lower or average consumption: 3401 High consumption: 1651	Dental fractures: 553 Luxation and Avulsion: 554	Postal questionnaire	–	Computer-based questionnaire	43.3% for fractures, 14.3% for luxation and avulsion	Dental fractures Lower or average consumption: 1353 (39.7%) High consumption: 839 (50.8%) Luxation and avulsion Lower or average consumption: 392 (11.5%) High consumption: 324 (19.6%)	Dental fractures: 233 (42.1%) Luxation and avulsion: 80 (14.1%)	Dental fractures: Lower or average consumption: RR 0.94, 0.85–1.05 High consumption: RR 1.20, 1.08–1.34* Luxation and avulsion Lower or average consumption: RR 0.80, 0.64–1.00 High consumption: RR 1.36, 1.08–1.70*	This study support the association between high consumption of alcohol and TDI.
Reece et al., 2007.[31] Brisbane, Queensland.	Cross-seccional	19-45	275	228	47	Personal recall (not specified)	Personal recall (not specified)	Patient report (not specified)	NR	Mean (SD)	Mean (SD)	Statistically, addicts had more TDI than non-addicts (p = 0.0434)	This study support the association between alcohol consumption and illicit drugs use and TDI.
Reis et al., 2014.[15] Minas Gerais, Brazil	Cross-seccional	11-19	207	NR	NR	AUDIT	–	Andreasen et al.	19.80%	0.12 (0.69) Use alcohol lifetime (32.6%) AUDIT low risk: 41 (20.5%) AUDIT high risk: 0	0.02 (0.15) Never use alcohol (16.1%)	Statistically, adolescents that consumption alcohol had more TDI than non-consumers (p = 0.013). Adjusted PR 057 (0,28-1,15) (0119)	This study support the association between alcohol consumption and TDI.

DI Traumatic Dental injuries. AUDIT Alcohol Use Disorders Identification Test. ONS Office for National Statistics. ASSIST Alcohol, Smoking and Substance Involvement Screening Test. NR Not reported.

Table 3
Quality assessment according Folks and Fulton (Fowkes and Fulton, 1991).

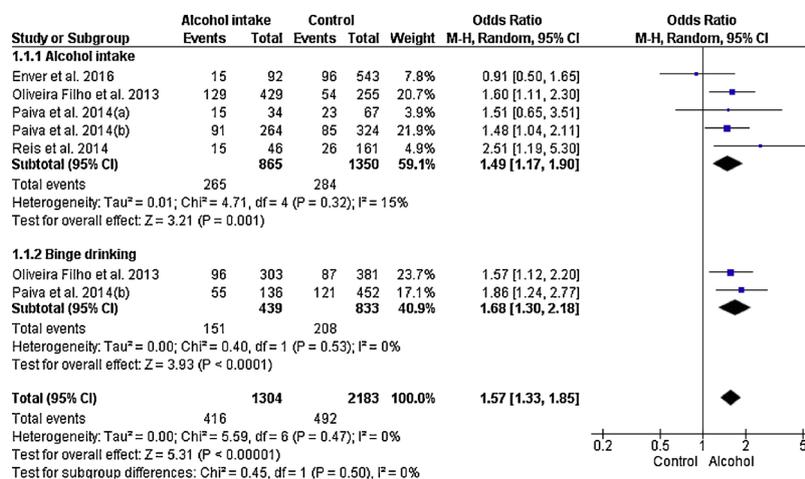| Guideline	Objective	Checklist / Common design	Damarasingh et al. 2018.[14]	Enver et al. 2016.[13]	Jorge et al. 2012.[26]	Oliveira Filho et al. 2013.[27]	Oliveira Filho et al. 2014.[16]	Paiva et al. 2014. (a)[29]	Paiva et al. 2014. (b)[9]	Paiva et al. 2015.[25]	Paiva et al. 2016.[28]	Perheentupa et al. 2001.[30]	Reece et al. 2007.[31]	Reis et al. 2014.[15]
Study design appropriate to objective?	Prevalence	Cross sectional	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Prognosis	Cohort	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Treatment	Controlled trial	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Cause	Cohort, case–control, cross-sectional	0	0	0	0	0	0	0	0	0	0	0	0
Study sample representative?	Source of sample		0	0	0	0	0	0	0	0	0	0	0	0
	Sampling method		0	0	0	0	0	+	0	0	0	0	+	0
	Sample size		0	0	0	0	0	+	0	0	0	0	+	+
	Entrycriteria/exclusions		0	0	0	0	0	0	0	0	0	0	0	0
	Non-respondents		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Control group acceptable?	Definition of controls		0	0	0	0	0	0	0	0	0	0	0	0
	Source of controls		0	0	0	0	0	0	0	0	0	0	0	0
	Matching/randomization		0	0	+	++	++	++	++	++	++	+	+	++
	Comparable characteristics		0	0	++	++	++	++	++	++	++	++	++	++
Quality of measurements and outcomes?	Validity		0	0	0	0	0	0	0	0	0	+	+	0
	Reproducibility		0	0	0	0	0	0	0	0	0	+	+	0
	Blindness		+	+	+	+	+	+	+	+	+	+	+	+
	Quality control		0	0	0	0	0	0	+	0	0	++	++	0
Completeness?	Compliance		+	+	NA	NA	NA	NA	NA	NA	NA	0	NA	NA
	Dropouts		+	+	NA	NA	NA	NA	NA	NA	NA	++	NA	NA
	Deaths		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Missing data		0	0	0	0	0	0	0	0	0	0	0	0
Distorting influences?	Extraneous treatments		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Contamination		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Changes over time													
	Confounding factors		0	0	++	++	++	++	++	++	++	++	++	++
	Distortion reduced by analysis		0	0	NA*	0	0	NA*	0	0	++	++	++	0
Summary questions	Bias - Are the results erroneously biased in a certain direction?		NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	YES	NO
	Confounding - Are there any serious confounding or other distorting influences?		NO	NO	NO	NO	NO	NO	NO	NO	YES	YES	YES	NO
	Chance - Is it likely that the results occurred by chance?		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Fig. 2. Forest plot of association between alcohol consumption and TDI.

3.4.3. Drugs use

Three studies were included in this meta-analysis with insignificant heterogeneity (I^2 = 24%, p = 0.27). Of the total individuals that already used drugs (n = 68), 22.7% (n = 299) presented TDI, while 23.2% (n = 440) of the total individuals that never used drugs (n = 1894) presented TDI. People that used and did not use illicit drugs presented a similar chance of suffering TDI (OR 1.20 [0.82, 1.75], p = 0.35; Fig. 4). This evidence was qualified as very low due serious problems with imprecision (Table 4).

4. Discussion

This systematic review, using four meta-analyses, shows that alcohol intake and binge-drinking are associated with TDI, while a high risk for alcohol-related problems and drugs use are not.

The studies included in this review were carefully evaluated through a validated methodological checklist, following the guidelines described by Fowkes and Fulton (1991). Whilst these guidelines were created for the evaluation of medical studies, they have previously been used in the dental field (Penoni et al., 2017; Lenzi et al., 2015). Considering these guidelines, the studies of Perheentupa et al. (2001) and Reece et al. (Reece, 2007) had certain methodological limitations, as only participant self-reporting was used to access the presence of TDI, without professional statements or dental files. As TDI diagnostics should ideally be performed based on clinical and/or radiographic examination (Diangelis et al., 2017), their results could have been erroneously biased in a certain direction. Apart from that, those two studies (Perheentupa et al. (2001); Reece, 2007) and that of Paiva et al. (de Paiva et al., 2016) did not perform statistical adjustments to eliminate confounding factors and, because of this, their results could have contained serious confounding, or other distorting, influences.

The studies included in this review had enough in common that it made sense to synthesize their information; however, they were performed in different countries, with different age-range populations and TDI criteria for diagnosis. Because of this, it could not be assumed that the studies were functionally equivalent and, since the goal of meta-analysis is usually to generalize to a range of scenarios (Borenstein et al., 2007), the random-effects model was applied in all of the meta-analyses.

The presented meta-analysis results show that alcohol consumption was significantly associated with TDI. Previous studies have reported that alcohol consumption is associated with aggressive behavior (Kivimaki et al., 2014), violence (Sonderlund et al., 2014), and traffic accidents (Karakus et al., 2015), which can result in dental and maxillofacial trauma (Goulart et al., 2015; Jayaraj et al., 2012). The greater effect for the binge-drinking subgroup (OR 1.68), in relation to the

effect of the alcohol intake subgroup (OR 1.49), could suggest that the amount of alcohol consumption is related to the increased chance of TDI. This is in accordance with Savola et al. (2005) and Lee et al. (2017), who reported the involvement of binge-drinking in head and maxillofacial fractures, and that trauma risk increased with increasing blood alcohol levels.

This finding emphasizes the adverse consequences of binge drinking due the deleterious effects of alcohol on psychomotor skills and the lack of preventive mechanisms to respond to situational hazards. The quantity of alcohol consumption has been shown to be more predictive of interpersonal violence related injury than frequency of drinking (Borges et al., 1998). Besides that, excess alcohol use is associated with poor mental health (Paljarvi et al., 2009) and is known to have adverse consequences on sleep and in the long-term on anxiety (Roehrs and Roth, 2001; Vitiello, 1997; Kushner et al., 2000). All these factors could interact with each other, once previous studies reported that sleep problems were associated with a higher prevalence of TDI (Todero et al., 2018) and anxiety levels is greater in children that suffered TDI and with aggressive behavior (Haliti and Juric, 2017).

The AUDIT questionnaire scores helped to identify individuals with risk or abuse of alcohol consumption. Scores ranging from 0 to 7 indicated abstinence or low risk for alcohol-related problems, and scores ranging from 8 to 40 denoted high risk or possible dependence (Lima et al., 2005). Individuals with absence of, or low- and high risk for, alcohol-related problems presented a similar chance of suffering TDI. This result could be associated with the low prevalence of individuals with high risk for alcohol-related problems (15%) due to the young age of the participants (11 to 19 years), who may have unconsolidated drinking habits. Oliveira Filho et al. (2013) suggested that different results can be obtained when using the AUDIT in a young population, relative to an adult population. Besides that, some authors have argued a tendency concerning lower alcohol intake and its association with fewer TDI (Jorge et al., 2012), which would be in accordance with the lower prevalence of TDI in the low-risk group presented in this meta-analysis. The association of the risk for alcohol-related problems and TDI still needs to be elucidated and confirmed from the perspective of population coverage and cases of low-intensity TDI underreporting.

The type of drug could be related to the result observed in the drugs meta-analysis. The most prevalent drug reported in the meta-analysis was cannabis (Damarasingh et al., 2008; Filho et al., 2014; Jorge et al., 2012). This finding is in accordance with the National Institute on Drug Abuse (Ridderikhof et al., 2017), which reported cannabis to be the most commonly used illicit substance. Cannabis' short-term effects are related to enhanced sensory perception and euphoria, followed by drowsiness and relaxation, slowed reaction times and problems with balance and coordination (Ridderikhof et al., 2017). The slowness, in

Table 4
Evidence profile: Association between alcohol or drugs use and TDI.

	Certainty assessment					Summary of findings					
№ of participants (studies) Follow-up	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Overall certainty of evidence	Study event rates (%) With Control	With Drugs and alcohol	Relative effect (95% CI)	Anticipated absolute effects Risk with Control	Risk difference with Drugs and alcohol
Alcohol consumption											
3487 (5 observational studies)	not serious	not serious	not serious	not serious	all plausible residual confounding would reduce the demonstrated effect	⊕⊕⊕◯ MODERATE	492/2183 (22.5%)	416/1304 (31.9%)	OR 1.57 (1.33 to 1.85)	225 per 1.000	**88 more per 1.000** (54 more to 125 more)
Binge drinking											
1272 (2 observational studies)	not serious	not serious	not serious	serious [a]	none	⊕◯◯◯ VERY LOW	208/833 (25.0%)	151/439 (34.4%)	OR 1.68 (1.30 to 2.18)	250 per 1.000	**109 more per 1.000** (52 more to 171 more)
Drugs use											
2193 (3 observational studies)	not serious	not serious	not serious	serious [a]	none	⊕◯◯◯ VERY LOW	440/1894 (23.2%)	68/299 (22.7%)	OR 1.20 (0.82 to 1.75)	232 per 1.000	**34 more per 1.000** (34 fewer to 114 more)

tandem with the relaxation and drowsiness observed in individuals who have used cannabis may have contributed to the non-significant increase in the prevalence of TDI in this group.

The underestimation of drug use by participants in such studies could be related to the stigmatization of people who consume illicit drugs, leaving the participant embarrassed about answering affirmatively to drug-related questions (Lloyd, 2013); however, all studies included in the drugs meta-analysis used self-administered questionnaires, so eliminating this hypothesis. This type of administration has been supported in the literature as a valid method for defining drug use (Brener et al., 2003).

The drugs meta-analysis results, however, should be interpreted with caution, since three of the six studies that evaluated the association between TDI and drugs were not included in the meta-analysis due to their methodological biases. More studies, with high methodological quality, designed for evaluating the association between these two factors, are necessary to support the results presented here.

Of the 12 studies included in this review, 10 (Paiva et al., 2015; Baig Enver et al., 2016; Damarasingh et al., 2008; Reis et al., 2014; Filho et al., 2014; de Paiva et al., 2015; Jorge et al., 2012; Oliveira Filho et al., 2013; de Paiva et al., 2016; Paiva et al., 2014) were performed with children and adolescents (11–19 years old). This could be considered a limitation of this systematic review, since the low prevalence of drug use limits multivariate analyzes, as well as adequate matching and randomization. Future studies, in adults population, with case-control studies and a cohort with good randomization and pairing can contribute to elucidate these results.

Besides that, the higher number of studies with adolescents is worrisome, since this vulnerable population is in transition between childhood and adulthood (Schulenberg et al., 2004; Kessler et al., 2010). The professionals dealing with TDI need to be attentive and aware of this issue, as earlier experience with alcohol and drugs consumption could be related to more serious problems from a wide variety cases, like alcohol-related sexual assault (Abbey, 2002), mental and behavioral disorders, major noncommunicable diseases (such as liver cirrhosis, some cancers and cardiovascular diseases), injuries resulting from violence and road clashes, as well as premature death (WHO, 2019). In addition, the precocious exposure to alcohol consumption in young populations may be related to an increased risk of TDI and alcohol-related problems when this population reaches majority legal age. World Health Organization reports that alcohol consumption could be related with arises from unintentional and intentional injuries and fatal alcohol-related injuries tend to occur in relatively younger age groups (WHO, 2019).

The results of this review should be taken into consideration when developing longitudinal studies to gain a better understanding of the dynamic nature of alcohol and drug consumption, their consequences (quality of life, chemical dependence, etc.), and their relationship with TDI. Public health strategies and intervention studies are encouraged for evaluating the effectiveness of guidance strategies on the harmful effects of these substances in early school age, in the prevention of alcohol and drug consumption and, consequently, in preventing the occurrence and recurrence of dental and maxillofacial trauma.

5. Conclusions

There is moderate evidence concerning the association between alcohol use and TDI occurrence. Although absence of an association between illicit drugs use, alcohol-related problems and the presence of TDI was found, these results should be viewed with caution, since they were determined from very low-quality evidence studies.

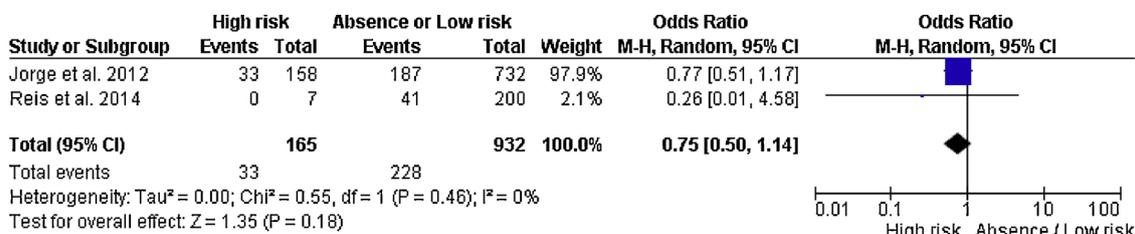### Role of funding source

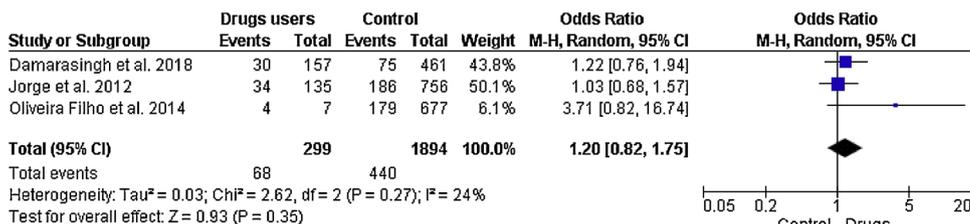**Fig. 3.** Forest plot of association between high risk for alcohol-related and TDI.

Fig. 4. Forest plot of association between drugs use and TDI.

Contributors

M.B.M. contributed to conception and design of the study, acquisition, analysis and interpretation of data, wrote and edited the manuscript text. K.L.F.L. contributed to design of the study and acquisition of data. L.C.M. contributed to conception and design of the study, analysis and interpretation of data, supervised the work, participated in revising the manuscript critically for important intellectual content. M.M.P.participated in revising the manuscript critically for important intellectual content. All authors reviewed the manuscript and give final approval of the version to be submitted and any revised version.

Conflict of interest

The authors declare that they have no conflict of interest concerning this article.

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