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REVIEW

Hard drugs use and tooth wear: a scoping review

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Abstract

Objectives This study aims to map evidence on the relationship between hard drug use and dental wear. The scoping review is guided by the question: What is the relationship between hard drug consumption and dental wear?

Materials and methods Adhering to PRISMA-ScR guidelines, searches were conducted across PubMed, Embase, and four databases in March 2024. Inclusion criteria included studies investigating the association between hard drug use and dental wear, regardless of publication date or language. Data were presented through narrative exposition, tables, and a conceptual framework.

Results Twenty-eight studies (four case-control, three cross-sectional, five case reports, and sixteen literature reviews) were included. Among case-control studies, 75% observed an association between drug use and dental erosion; however, no cross-sectional studies demonstrated this association. Despite questionable quality, reviews established connections between drug use and dental erosion. Studies aimed to elucidate potential causes for dental erosion.

Conclusions Analysis suggests a potential link between hard drug use and dental wear, though indirect. Factors like bruxism and reduced salivary pH may contribute to dental wear among drug users. Further investigation through primary studies exploring this relationship is necessary.

Clinical relevance Dentists should focus not only on clinical characteristics of dental wear but also on mediating factors such as bruxism and decreased salivary pH associated with drug use. This holistic approach allows for a deeper understanding of dental wear mechanisms, enabling targeted preventive and therapeutic interventions.

Keywords Tooth Wear · Tooth Erosion · Illicit Drugs · Dentistry · Oral health

Introduction

It is estimated that approximately 275 million people worldwide consumed drugs in 2021, according to the United Nations Office on Drugs and Crime (UNODC) report, with recent projections indicating an expected 11% increase in global drug use by 2030 [1]. This consumption encompasses a wide range of substances, including hard drugs such as heroin, cocaine, methamphetamines, and ecstasy, resulting in a series of implications not only in terms of health risks and dependency but also in terms of social impacts [2]. Among the possible systemic consequences are heart attack, respiratory depression, liver cirrhosis, and nephropathy [3]. It is common for individuals who use drugs to seek medical care only in advanced stages of the disease, often hiding treatment [4]. Additionally, the lack of prioritization of oral health is common practice, with many opting for emergency treatments during drug abuse [5]. In this context, a growing concern emerges regarding the impacts on oral health, especially regarding consequences related to dental wear [6].

When discussing the oral health of drug users, it is crucial to consider effects such as dry mouth and nutritional deficiencies, which can indirectly contribute to dental wear. Research on the impact of drug use on dental wear is limited, with studies showing conflicting results and a lack of clarity. This situation highlights the need for more detailed and methodologically standardized investigations to explore the relationships between drug use and dental wear [7]. Considering the concern about oral health in individuals who consume drugs, the complex

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phenomenon of dental wear associated with hard drug use (HDU) is highlighted. This wear is the result of interactions among various factors that go beyond the chemical properties of drugs and include consumption-related behaviors. The literature emphasizes that different forms of drug administration can cause varying levels of harm, thus contributing to potential risk factors for dental wear [8]. Although research incisively addresses the possible relationship between dental wear and drug use [9, 10], a critical analysis of these findings is essential, taking into account individual factors such as consumption patterns and oral hygiene habits, as well as contextual factors such as the frequency of dentist visits and access to healthcare. The complexity of this interaction demands further investigation to avoid simplistic generalizations.

In the context of clinical practice and dental research, identifying and understanding the interactions between HDUs and dental wear represent significant challenges. It is essential to consider the diversity of substance use patterns, ranging from occasional to abusive and chronic [11]. The complexity of this phenomenon is accentuated by factors such as preexisting oral health conditions, genetic variability among individuals, and associations with other substances [12]. Early identification of drug-related wear lesions is challenging, mainly due to the overlap between the effects of various drugs and other health problems [6]. In other words, drug users commonly face various oral conditions in addition to dental wear, resulting from the disregard of health and cognitive changes caused by chronic drug use [7].

Drug use is intrinsically linked to adverse consequences in oral health, resulting in an increased incidence of diseases such as caries and periodontitis [13]. This relationship is clinically evidenced by the manifestation known as "meth mouth", characterized by symptoms including severe xerostomia, gingivitis, periodontitis, advanced caries lesions, and dental fractures [14]. Although some studies highlight an association between the use of substances such as methamphetamine and ecstasy and dental wear [9, 10], the understanding of this relationship remains inconclusive, as other research in similar populations has not identified this connection [15, 16]. Faced with this uncertainty, it is necessary to conduct studies that guide the available evidence to assess the relationship between HDU and dental wear. Therefore, this study aimed to conduct a scoping review to map the available evidence on the relationship between drug use and dental wear, and this review will be guided by the following question: What is the relationship between hard drug use and dental wear?

Methodology

Protocol and registration

The protocol for this scoping review was published prior to the study and is available at the following link: https://osf.io/ftvgw/. This scoping review was reported according to the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-analyses/Scoping Reviews*)* guidelines [17].

Eligibility criteria

The present investigation was guided by the following question: "What is the relationship between hard drug use and dental wear?" This question was delineated under the PCC approach [18] following the parameters outlined below: *population*: individuals without age restrictions or specific characteristics; *concept*: dental wear (abrasion, attrition, and erosive dental wear), regardless of diagnostic criteria; *context*: studies investigating the relationship between dental wear and the use of hard drugs (heroin, cocaine, ecstasy, methamphetamine (METH), and crack).

This review aimed to integrate original articles that investigated the relationship between the use of hard drugs and adverse effects on dental wear. Dental wear was defined as the gradual loss of mineralized substances from teeth due to physical or chemical-physical processes not associated with dental caries. Moreover, dental abrasion is characterized by physical loss of dental structure caused by objects other than teeth themselves, and dental attrition results from physical wear of the mineralized substance of the tooth by tooth-to-tooth contact. Finally, erosive dental wear was described as a chemical-mechanical process resulting in the cumulative loss of hard dental tissue but not caused by bacteria [19].

For this study, hard drugs were defined as those presenting higher associated risks than light drugs, especially in terms of health impact, potential for dependence, and consequences for public order [2]. Examples of hard drugs included heroin, cocaine, methamphetamines, crack, and ecstasy. Light drugs, though not without risks, were generally less harmful to health than hard drugs, including hashish, marijuana, sleeping pills, and sedatives. In the context of this review, observational studies, case reports, case series, and reviews investigating or describing the correlation between the use of hard drugs and dental wear in individuals were included. On the other hand, investigations focused on animals, in vitro studies, editorials, and letters to the editor were excluded. Additionally, studies addressing the relationship between dental wear and substances not categorized as hard drugs were excluded. This decision was made because light drugs (marijuana, tobacco, and alcohol)

have different mechanisms of action and physiological effects than the included drugs and including them could introduce additional variables complicating the interpretation of the results [20, 21]. Notably, there were no restrictions on language, publication date, or country of origin for the studies considered in this review.

Information sources

To identify potentially relevant documents, the following bibliographic databases were searched: PubMed, the Cochrane Library, Scopus, Embase, the Web of Science, Scielo, and Lilacs/BBO. Search strategies were devised by an experienced researcher and refined through team discussions. The final search strategy for MEDLINE can be found in Table 1, and additional searches are presented in the supplementary table. The final search results were exported to Mendeley software (London, England, United Kingdom), and duplicates were automatically removed via the software. The remaining duplicates were removed manually.

Search strategy

The review employed a three-stage search strategy. A literature search was conducted in the PubMed/Med database to map and identify keywords and terms used in articles related to dental wear in illicit drug users. Two groups of MeSH terms were selected for the strategy: (1) Drugs - "Illicit Drugs," "Crack Cocaine," "Cocaine," "Amphetamines," "Heroin," "Drug Users"; and (2) Dental wear - "Tooth Wear," "Tooth erosion," and "Oral health." Variations and associated terms were also included.

In the second stage, these terms were tested in other databases. Subsequently, in the final stage, a comprehensive search was conducted in all the databases, with the last search performed in March 2024. The strategy developed for PubMed/Medline, with the terms defined in the first search stage and the Boolean operator "OR" (as presented in Table 1), was adapted for the following databases: Cochrane Library, Scopus, Embase, Web of Science, Scielo and Lilacs/BBO. This search was conducted individually by two researchers (L.F. and A.M.), and any disagreements were resolved by a third researcher (K.C.).

In addition to the previously mentioned indexed databases, primary studies were also manually searched. This approach included reviewing the reference lists of selected articles for the final reading, corresponding to the second phase of selection.

Table 1 Structured search strategy carried out in the MedLine/PubMed database

Search	Topics and Terms
#3	Search #1 AND #2
#2	*Drugs use* ("Illicit Drugs" [Mesh] OR "Illicit Drugs" [Text Word] "Drugs, Illicit" [text word] OR "Drugs, Illegal" [text word] OR "Illegal Drugs" [text word] OR "Illicit Drug" [text word] OR "Drug, Illicit" [text word] OR "Illegal Drug" [text word] OR "Drug, Illegal" [text word] OR "Street Drugs" [text word] OR "Drugs, Street" [text word] OR "Street Drug" [text word] OR "Drug, Street" [text word] OR "Recreational Drugs" [text word] OR "Drugs, Recreational" [text word] OR "Recreational Drug" [text word] OR "Drug, Recreational" [text word] OR "Club Drugs" [text word] OR "Drugs, Club" [text word] OR "Club Drug" [text word] OR "Drug, Club" [text word] OR "Crack Cocaine" [Mesh] OR "Crack" [Text Word] OR "Cocaine, Crack" [Text Word] OR "Cocaine" [Mesh] OR "Cocaine" [Text Word] OR "Cocaine Hydrochloride" [Text Word] OR "Hydrochloride, Cocaine" [Text Word] OR "Cocaine HCl" [Text Word] OR "HCl, Cocaine" OR "Amphetamines" [Mesh] OR "Amphetamines" [Text Word] OR "Heroin" [Mesh] OR "Heroin" [Text Word] OR "Diacetylmorphine" [Text Word] OR "Diamorphine" [Text Word] OR "Diagesil" [Text Word] OR "Diamorf" [Text Word] OR "Min-I-Jet Morphine Sulphate" [Text Word] OR "Min I Jet Morphine Sulphate" [Text Word] OR "Heroin Hydrochloride" [Text Word] OR "Hydrochloride, Heroin" [Text Word] OR "Diacetylmorphine Hydrochloride" [Text Word] OR "Hydrochloride, Diacetylmorphine" [Text Word] OR "Drug Users" [Mesh] OR "Drug Users" [Text Word] OR "Drug User" [Text Word] OR "User, Drug" [Text Word] OR "Users, Drug" [Text Word] OR "Drug Abusers" [Text Word] OR "Abuser, Drug" [Text Word] OR "Abusers, Drug" [Text Word] OR "Drug Abuser" [Text Word] OR "Drug Addicts" [Text Word] OR "Addict, Drug" [Text Word] OR "Addicts, Drug" [Text Word] OR "Drug Addict" [Text Word] OR "Intravenous Drug Users" [Text Word] OR "Drug User, Intravenous" [Text Word] OR "Drug Users, Intravenous" [Text Word] OR "Intravenous Drug User" [Text Word] OR "User, Intravenous Drug" [Text Word] OR "Users, Intravenous Drug" [Text Word] OR "IV Drug Users" [Text Word] OR "Drug User, IV" [Text Word] OR "Drug Users, IV" [Text Word] OR "IV Drug User" [Text Word] OR "User, IV Drug" [Text Word] OR "Users, IV Drug" [Text Word] OR "People Who Inject Drugs"))
#1	*Tooth wear* (("Tooth Wear" [Mesh] OR "Tooth Wear" [Text Word] OR "Tooth Wears" [Text Word] OR "Wear, Tooth" [Text Word] OR "Wears, Tooth" [Text Word] OR "Tooth wear" [Text Word] OR "Tooth wears" [Text Word] OR "Wear, Dental" [Text Word] OR "Wears, Dental" [Text Word] OR "Tooth Erosion" [Mesh] OR "Tooth Erosion" [Text Word] OR "Erosion, Tooth" [Text Word] OR "Tooth Erosions" [Text Word] OR "Dental Erosion" [Text Word] OR "Dental Erosions" [Text Word] OR "Erosion, Dental" [Text Word] OR "Dental Enamel Erosion" [Text Word] OR "Dental Enamel Erosions" [Text Word] OR "Enamel Erosion, Dental" [Text Word] OR "Erosion, Dental Enamel" [Text Word] OR "Oral Health" [Mesh] OR "Oral Health" [Text Word])

The searches in the following databases: Cochrane Library, Scopus, Embase, Web of Science, Scielo, and Lilacs/BBO, were adapted according to the specific requirements of each database

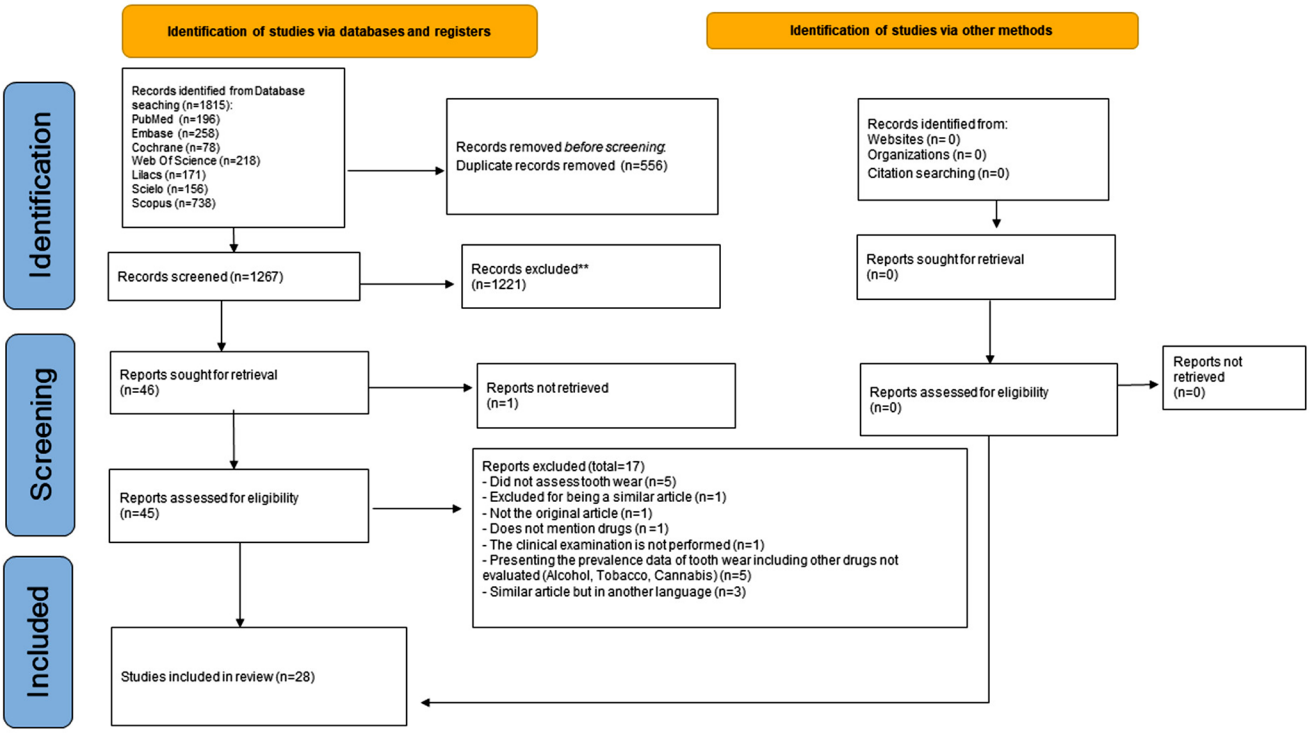

Fig. 1 Flowchart depicting the selection and inclusion steps of the studies

Selection of sources of evidence

The listings of articles found in each of the databases were transferred to the reference manager Mendeley Desktop® (Mendeley Ltd., Relx Group™ Elsevier, London, UK). After automatically removing duplicates, a consolidated file containing all identified studies was imported into the Rayyan application [22]to facilitate the study selection process.

Initially, the two researchers (L.F. and A.M.) underwent a calibration process by evaluating the first 100 selected articles, with supervised training by a more experienced researcher (K.C.). Considering the complete list, the retrieved records were classified as included, excluded, or uncertain. This selection was carried out individually and independently by the same two researchers (L.F. and A.M.) who conducted the search in two stages: (1) selection by reading titles and abstracts and (2) selection by reading the full texts. At each stage of the process, the selection lists were checked, and in case of divergence, the third reviewer participated again in the process. In the second stage, the reasons for exclusion were noted.

The data extracted from the included articles were carried out individually by the same two researchers involved in the previous stages, and the third researcher subsequently verified and resolved disagreements. The following data were extracted: author, year of publication, title, journal, study design, country, objective, study location, participant sex, age, population characteristics, number of participants, drugs evaluated, drug assessment criteria, drug use quantity, drug use occurrence, type of dental wear, wear assessment criteria, wear occurrence, and wear characteristics. If there was any uncertainty regarding the collected data, the authors of the articles were contacted via email and/or through the ResearchGate platform. This attempt to contact the patients was made twice, with a two-week interval between each attempt. If the authors did not respond to these attempts, the article was excluded from this analysis.

Critical appraisal of individual sources of evidence

The risk of bias analysis of eligible studies was conducted using the tools of the Joanna Briggs Institute [23], which were selected for different methodological designs (case–control studies, cross-sectional studies, and case reports) [23]. Based on the results, studies were classified as having high, moderate, or low risk of bias. The risk of bias was classified as high when the study obtained up to 49% 'yes' responses, moderate when the study obtained 50–69% 'yes' responses, and low when the study obtained more than 70% 'yes' responses. This analysis was independently conducted by two researchers (L.F. and A.M.). Subsequently, the results were compared, and discrepancies were resolved by a third researcher (K.C.).

Table 2 Overview of included observational studies: tooth wear assessment in drug-using populations ($n = 11$)

Author/year	Country	Objective	Evaluated drugs	Study location	Gender/Age (average-range)	Population	Occurrence of use	Type of wear/ Evaluation criteria	Measure of effect
Case–control (n = 4)									**OR (CI 95%)[#]**
Milosevic et al., 1999	England	To compare incisal and occlusal tooth wear in Ecstasy users and a group of nonusers of Ecstasy but users of other drugs.	Ecstasy	Rehabilitation Clinic	NI	30 users 28 nonusers	Four times per month, during the last 6 months	Incisal and occlusal wear/ Smith and Knight Dental Wear Index	12.5 (3.0-50.8)
Nixon et al., 2002	United Kingdom	To measure tooth wear in a sample of amphetamine-like drug users and compare nondrug users.	Meth, ecstasy, and cocaine	University Center	61.5% M/ 20.4–18 to 23	13 users 13 nonusers	Regular use on more than ten occasions in the whole life.	Attrition with erosive patterns/ Smith and Knight Dental Wear Index	*
Rommel et al., 2016	Germany	To investigate the pharmacological impact of meth on oral health (saliva function) and the contribution of the symptoms of bruxism and muscle trismus to potential oral health damage.	Meth	Rehabilitation Clinic	83.0% M/ 29.3 - NI	100 users 100 nonusers	Average 6.9 years a rate of 1 gram per week for at least 12 months.	NI/ Dental wear was assessed by presence of dental wear or dentine exposure or macroscopic fissures in the enamel.	6.7 (3.5–12.7)
van Kempen et al., 2022	The Netherlands	To determine if there is a difference in oral health between users and nonusers of ecstasy.	Ecstasy	University Center	67.1% M/30.3 - NI	149 users 149 nonusers	7.1 to 8.5 times per year.	Tooth wear/NI	0.79 (0.5–1.3)
Cross-sectional (n = 2)									**PR (CI 95%)[#]**

Table 2 (continued)

Author/year	Country	Objective	Evaluated drugs	Study location	Gender/Age (average-range)	Population	Occurrence of use	Type of wear/ Evaluation criteria	Measure of effect
Enguelberg-Gabbay et al.,2016	Israel	To compare the rates of bruxism and TMDs between prisoners with and without drug-use disorders and to assess the possible relationship between bruxism and pain.	Cocaine, heroin and ecstasy	Prison	100.0% M/34.4 - NI	152 prisoners	At least 5 years	Enamel and dentin erosion/ Dental abrasion was estimated for each tooth group considering the locally or generally occlusal/incisal morphology.	*
Paramitha et al., 2019	Indonesia	To determine the possible risk factors for TMD among amphetamine users in Indonesia.	Meth	Rehabilitation Clinic	100.0% M/ 29.7–18 to 45	152 patients	NI	Dental wear/ Self-made scale with at least one region exhibiting wear to dentin	*
Richards and Brofeldt, 2000	USA	Conduct a study to determine if methamphetamine users have distinct patterns of dental wear.	Meth	University Center	60.0% M	43 patients	At least 1 year	Dental wear/ Self-made scale with different levels of dental wear, at the enamel, dentin, and pulp exposure levels.	*
Case report (n = 5)									**Tooth wear characteristics**
Bassiouny, 2012	USA	To identify dental and oral clinical characteristics associated with chronic abuse of meth, cocaine, and diet soda.	Case 1: Meth; Case 2: Cocaine	NI	Case 1: Male/29 years Case 2: Male/51 years	2 patients	Case 1: More than 3 years Case 2: dependent for 18 years but quit 7 years ago.	Erosion/NI	Case 1: Upper anterior teeth exhibit erosive damage, affecting dentin and enamel. Case 2: Damaged teeth exhibit clear demarcation lines, indicative of erosive lesions.

Table 2 (continued)

Author/year	Country	Objective	Evaluated drugs	Study location	Gender/Age (average-range)	Population	Occurrence of use	Type of wear/ Evaluation criteria	Measure of effect
Krutchkoff et al., 1990	EUA	NI	Cocaine	NI	Male/31years	2 patients	Case 1: 6 years of heavy use but stopped usage 9 months; Case 2: NI	Dental erosion/ NI	Case 1: Destruction of enamel and dentin in teeth 33, 44 and 45. Case 2: Absence of enamel on the vestibular surfaces.
Kapila & Kashani, 1997	EUA	To document a case of rapid gingival recession and dental erosion associated with the local application of cocaine to the gums	Cocaine	University Center	NI/NI	1 patient	Regular use	Dental Erosion/ NI	NI
Murray & Wilson, 1998	United Kingdom	NI	Ecstasy	NI	Male/17 years	1 patient	NI	Dental Wear/NI	NI
Naidoo & Smit, 2011	South Africa	NI	Meth	University Center	Male/24 years	1 patient	NI	Attrition/NI	NI

* The articles lack sufficient data for calculating the odds ratio and prevalence ratio

The odds ratio and prevalence ratio were calculated by the researchers with data collected in de included studies

Synthesis of results

The data from the current study underwent qualitative analysis. Initially, our strategy was to categorize the findings based on the type of drug. However, as tooth wear data are typically not presented separately across various drug types in most studies, we opted to structure our data analysis according to the study design. This approach enables us to draw comparisons within groups of studies offering equivalent levels of evidence. To provide a better measure to estimate the odds of tooth wear, we calculated – when possible – the odds ratio [24].

Furthermore, an exploratory theoretical model was developed based on the primary studies and included reviews, aiming to conduct a more comprehensive mapping of drug use and dental wear. All studies included in this review were analyzed to create this mapping, enabling a more detailed understanding of the associations between HDU and various types of dental wear observed. The methodology involved a thorough literature review to identify and analyze relevant studies investigating the relationship between HDU and dental wear. Subsequently, the data from these studies were synthesized and organized to identify patterns and trends, which served as the basis for constructing the theoretical model. This model was designed to provide a comprehensive conceptual framework that could elucidate the possible underlying mechanisms of the association between drug use and dental wear, thereby contributing to a better understanding of the relationship.

Results

Selection of sources of evidence

Figure 1 shows a flowchart outlining the identification, screening, and inclusion of articles during the scoping review process. The search process identified a total of 1,823 studies. After removing duplicates, eligibility criteria were applied to 1,267 articles, of which 1,221 articles were excluded based on title and abstract screening. Full-text reading was conducted for 44 studies; of these, 17 studies were excluded for the reasons listed in Fig. 1. Attempts were made to contact corresponding authors via e-mail to obtain

Table 3 Overview of reviews detailing dental erosion in drug-using populations ($n = 16$)

Authors	Title	Objective	Drugs mentioned	Type of dental wear mentioned	Excerpt from the study
Amaral & Guimarães, 2012	Oral manifestations of methamphetamine use [Manifestações orais do uso de metanfetaminas]	Describe the mechanism of action of meth as well as their oral manifestations	Meth	Attrition	*"A study by McGrath and Chan (2005) found that ecstasy users commonly experience sensations such as constant chewing (87%), teeth clenching/grinding (70%), and joint/muscle pain (70%) postconsumption. The observed dental attrition in these individuals accelerates the deterioration of already weakened teeth (McGrath, Chan, 2005; Klasser, 2005)."*
Blanksma & Brand, 2004	The effects of cocaine use on oral health and implications for dental treatments.	NI	Cocaine	Erosion	*"Two 31-year-old cocaine users showed enamel loss on their teeth, specifically on the buccal and occlusal surfaces. The teeth exhibited a smooth, glassy appearance due to the dissolution of hydroxyapatite caused by the reduction in saliva acidity when cocaine hydrochloride is dissolved in saliva (Krutchkoff* et al., *1990)."*
Brand et al., 2008	Ecstasy (MDMA) and oral health	NI	Ecstasy	Erosion	*"Reduced saliva secretion and buffering capacity increase the risk of enamel erosion in ecstasy users, with nausea and vomiting as potential contributors (Milosevic* et al., *1999; Solowij* et al., *1992). Ecstasy users exhibit a higher incidence (60%) of tooth wear into the underlying bone, particularly in premolar and molar regions, compared to nonusers (Milosevic* et al., *1999; Redfearn* et al., *1998; Nixon* et al., *2002). Severity is notably elevated for lower first molars (Nixon* et al., *2002)."*
Brand et al., 2008	Cocaine and oral health	NI	Cocaine	Attrition and erosion	*"Mild attrition affecting all canines, first premolars, and upper lateral incisors was observed in a patient with a two-year history of regular cocaine and drug use (Parry* et al., *1996). Cocaine powder dissolved in saliva leads to a substantial decrease in salivary pH, increasing the risk of dissolving tooth mineral calcium-hydroxyapatite. Some chronic users exhibit loss of facial and occlusal tooth enamel, resulting in a smooth and glassy appearance on tooth surfaces (Krutchkoff* et al., *1990)."*
Brand et al., 2009	Heroin use and oral health [Heroïnegebruik en mondgezondheid]	NI	Heroin	Attrition	*"Heroin can also cause bruxism, resulting in excessive dental wear. This could involve direct stimulation by opioids, but it could also be an indirect consequence of the stress that addiction brings (Colon, 1972; Colon, 1975)."*
Damante et al., 2011	The effects of illicit drugs on periodontal and oral health [Efeitos das drogas ilícitas em saúde periodontal e bucal]	Review the effects of major illicit drugs on oral health, emphasizing periodontal health.	Cocaine and ecstasy	Attrition and erosion	*"Attrition lesions are common in teeth as well as erosion due to the drop in oral pH caused by the dissolution of cocaine powder in saliva (Krutchkoff* et al., *1990). The combination of teeth clenching, excessive soda consumption and xerostomia results in 60% of users experiencing dental wear, primarily among premolars and molars (Brand* et al., *2008)."*
De-Carolis et al., 2015	Methamphetamine abuse and ‘’meth mouth" in Europe	Fill the gap in knowledge about methamphetamine use in the European Union and illustrate the main clinical effects of prolonged use	Meth	Attrition and erosion	*"Shetty* et al., *(2010) disproved the hypothesis that methamphetamine (MA) causes corrosive effects on teeth, demonstrating similarity in "meth mouth" among intravenous MA users. They identified tooth grinding or erosion in 22.3% of 301 patients, attributing excessive dental wear to grinding and potentially para-functional jaw activity, periodontal, or temporomandibular disorders. Richards and Brofeldt observed increased tooth wear in 43 MA users, with severity varying by administration route, being most pronounced in those who sniffed MA (Richards; Brofeldt, 2000; Shetty* et al., *2010)."*

Table 3 (continued)

Authors	Title	Objective	Drugs mentioned	Type of dental wear mentioned	Excerpt from the study
Donaldson & Goodchild, 2006	Oral health of the methamphetamine abuser	NI	Meth	Erosion and attrition	*"The acidic substances used to manufacture this drug have also been implicated as a cause of tooth decay and wear in methamphetamine users (American Dental Association, 2005). When methamphetamine containing phosphoric, sulfuric, or muriatic acid is smoked, the teeth are bathed in acid, contributing to enamel erosion and breakdown. During times of acute use, users tend to grind and clench their jaws, further contributing to tooth wear (Curtis, 2006)."*
Duxbury, 1993	Ecstasy-Dental Implications	NI	Ecstasy	Attrition and erosion	*"Repeated muscle rigidity, trismus, and bruxism can lead to attrition and myofascial complaints. Ecstasy causes xerostomia, which, exacerbated by dehydration resulting from vigorous activity, is often relieved by consuming sodas. Sodas often have a low pH, which, along with their sugar content, could increase enamel erosion. We can assume that a patient is an ecstasy user when there's an increase in vestibular enamel erosion and cervical caries where the causes are not related to dietary indiscretion, xerostomia, dental defects, or in association with palatal and lingual erosion in bulimia or acid regurgitation."*
Fratto & Manzon, 2014	Use of psychotropic drugs and associated dental diseases	Provide an overview of psychotropic medications used in the last 30 years, and their pharmacological profile, with special attention to side effects related to oral health.	Meth, ecstasy, and cocaine	Erosion	*"The use of ecstasy is associated with a risk of dental erosion (Brand* et al., *2008). Periodontitis, mucosal ulceration, and tooth surface loss after ecstasy consumption have also been documented. Cases of gingival recession and dental erosion have been described in cocaine users (Kapila; Kashani,1997)."*
Goodchild & Donaldson, 2007	Methamphetamine Abuse and the Impact on Dental Health	NI	Meth	Erosion and attrition	*"METH, containing acids, contributes to enamel erosion when smoked. A study by Navarro* et al. *(2001) found that despite high MDMA levels in saliva (similar to METH), the pH change from MDMA ingestion was not significant enough to cause demineralization and caries formation (Navarro* et al., *2001). Tooth wear in METH users is attributed to increased bruxism, especially during intense drug use and "tweaking" periods, where users grind and clench their jaws, contributing to tooth attrition (Curtis, 2006)."*
Hamamoto & Rhodus, 2009	Methamphetamine abuse and dentistry	NI	Meth	Erosion and attrition	*"Xerostomia significantly increases the risk of dental caries, erosion of enamel, and periodontal disease (Shaner* et al., *2006). Bruxism and excessive tooth wear may occur more frequently in chronic methamphetamine users (Richards; Brofeldt, 2000; McGrath; Chan, 2005; Donaldson; Goodchild, 2006). Amphetamine-like drugs can produce choreiform motor activity that may involve facial and masticatory muscles and result in unusual patterns of tooth wear (Duxbury, 1993; Redfearn* et al.,*1998; Milosevic* et al., *1999)."*

Table 3 (continued)

Authors	Title	Objective	Drugs mentioned	Type of dental wear mentioned	Excerpt from the study
Naiido & Smit, 2011	Methamphetamine abuse: a review of the literature and case report in young male	Provide oral health professionals with a comprehensive overview of the general effects of methamphetamine and specifically its impact on the oral cavity.	Meth	Erosion	*"Distinct wear patterns based on administration routes have been observed for methamphetamine. Snorted meth shows higher tooth wear in anterior maxillary teeth compared to injection, smoking, or ingestion. Chronic vasoconstriction from frequent snorting may reduce arterial blood supply to this area (Richards; Brofeldt, 2000). Smoking meth with acidic components may contribute to enamel erosion. Drug-induced hyperactivity and bruxism accelerate tooth wear. Ingestion of acidic soft drinks weakens tooth surface molecules (Goodchild; Donaldson, 2007)."*
Shaikh et al., 2011	Meth mouth	Summarize current perspectives on the importance of this issue and assist professionals in recognizing and treating dental patients with a history of meth abuse.	Meth	Attrition	*"Bruxism and excessive tooth wear may occur more frequently in chronic methamphetamine users. Amphetamine-like drugs can produce choreiform motor activity that may involve facial and masticatory muscles and result in unusual patterns of tooth wear (Hamamoto; Rhodus, 2009)."*
Shekarchizade et al., 2013	Oral Health of Drug Abusers: A Review of Health Effects and Care	Review oral complications associated with drugs, oral health care in addiction rehabilitation, available health services and barriers to oral health promotion among individuals with substance dependencies.	Meth, cocaine and ecstasy	Attrition and erosion	*"Cocaine use in individuals commonly results in bruxism, leading to dental attrition (Blanksma; Brand, 2005). Tooth wear from ecstasy use, attributed to grinding and clenching, is more prevalent on back teeth's occlusal surfaces than on incisal edges, potentially caused by jaw clenching (Milosevic* et al., *1999; Redfearn* et al., *1998). Increased consumption of carbonated drinks to alleviate dry mouth postdrug use can contribute to dental caries and erosion (Brand* et al., *2008). Cocaine powder, when orally or nasally administered, lowers saliva pH, increasing susceptibility to dental erosion (Krutchkoff* et al., *1990)."*
Sun et al., 2018	Prevalence and etiology of oral diseases in drug-addicted populations: a systematic review	Summarize the oral health consequences of illicit drug abuse and explore potential causes behind these consequences.	Cocaine and ecstasy	Attrition and erosion	*"Bruxism and jaw clenching, common side effects of illicit drugs like MDMA and cocaine, result from the drugs', amphetamine-like properties, causing tooth wear (Redfearn* et al., *1998; Hamamoto; Rhodus, 2009). Studies show higher tooth wear scores in drug abusers, possibly due to increased prevalence of bruxism induced by drug use (Redfearn* et al., *1998; Milosevic* et al., *1999). The corrosive environment during clenching and decreased saliva lubrication contribute to tooth wear. Repetitive drug abuse can decrease salivary pH, increasing the risk of dental erosion (Krutchkoff* et al., *1990; Rommel* et al., *2016)."*

information from studies that did not provide separate data on tooth wear or grouped these data with other drugs [25–29]; however, we did not receive responses from any of the authors, resulting in the exclusion of these studies.

Characteristics of the sources of evidence

Observational studies

The included articles were published between 1990 and 2022 in 12 scientific journals. Researchers from 8 different countries were listed as corresponding authors of the publications, with the United States having the highest number

Table 4 Risk of bias assessed by the joanna briggs institute critical appraisal checklist for case control studies

Authors	Q.1	Q.2	Q.3	Q.4	Q.5	Q.6	Q.7	Q.8	Q.9	Q.10	Yes%/Risk
Milosevic et al., 1999	U	U	N	N	N	N	N	Y	U	N	10% high
Nixon et al., 2002	Y	Y	Y	N	N	N	N	Y	N	N	40% high
Rommel et at., 2016	Y	Y	Y	N	N	N	U	N	Y	N	40% high
van Kempen et al., 2022	Y	Y	Y	N	N	N	N	N	U	N	30% high

*The risk of bias was classified as high when the study reached up to 49% 'yes' scores, moderate when the study reached 50–69% 'yes' scores, and low when the study reached over 70% 'yes' scores. U: indicates unclear, S: yes, N: no. Q.1: Were the criteria for inclusion in the sample clearly defined? Q.2: Were the study subjects and the setting described in detail? Q.3: Was the exposure measured in a valid and reliable way? Q.4: Were objective, standard criteria used for measurement of the condition? Q.5: Were confounding factors identified? Q.6: Were strategies to deal with confounding factors stated? Q.7: Were the outcomes measured in a valid and reliable way? Q.8: Was appropriate statistical analysis used?

Table 5 Risk of bias assessed by the joanna briggs institute critical appraisal checklist for analytical cross-sectional studies

Authors	Q.1	Q.2	Q.3	Q.4	Q.5	Q.6	Q.7	Q.8	Yes/%Risk
Enguelberg-Gabbay et al., 2016	Y	Y	N	N	N	N	N	N	25% high
Paramitha et al., 2019	Y	Y	N	N	N	N	N	N	25% high
Richards and Brofeldt, 2000	N	N	N	N	N	N	N	N	0% high

*The risk of bias was classified as high when the study reached up to 49% 'yes' scores, moderate when the study reached 50–69% 'yes' scores, and low when the study reached over 70% 'yes' scores. U: indicates unclear, S: yes, N: no. Q.1: Were the criteria for inclusion in the sample clearly defined? Q.2: Were the study subjects and the setting described in detail? Q.3: Was the exposure measured in a valid and reliable way? Q.4: Were objective, standard criteria used for measurement of the condition? Q.5: Were confounding factors identified? Q.6: Were strategies to deal with confounding factors stated? Q.7: Were the outcomes measured in a valid and reliable way? Q.8: Was appropriate statistical analysis used?

Table 6 Risk of bias assessed by the joanna briggs institute critical appraisal checklist for case series

Authors	Q.1	Q.2	Q.3	Q.4	Q.5	Q.6	Q.7	Q.8	Yes%/Risk
Bassiouny, 2012	U	U	Y	N	NA	NA	NA	N	12.5% high
Krutchkoff et al., 1990	N	N	U	N	NA	NA	NA	N	0% high
Kapila & Kashani, 1997	N	Y	U	N	NA	NA	NA	U	12.5% high
Murray & Wilson,1998	N	U	U	N	NA	NA	NA	U	0% high
Naidoo & Smit, 2011	U	N	Y	N	NA	NA	NA	N	12.5% high

*The risk of bias was classified as high when the study reached up to 49% 'yes' scores, moderate when the study reached 50–69% 'yes' scores, and low when the study reached over 70% 'yes' scores. U: indicates unclear, S: yes, N: no, NA: not applicable. Q.1: Were the patient's demographic characteristics clearly described? Q.2: Was the patient's history clearly described and presented as a timeline? Q.3: Was the current clinical condition of the patient on presentation clearly described? Q.4: Were diagnostic tests or assessment methods and the results clearly described? Q.5: Was the intervention(s) or treatment procedure(s) clearly described? Q.6: Was the postintervention clinical condition clearly described? Q.7: Were adverse events (harms) or unanticipated events identified and described? Q.8: Does the case report provide takeaway lessons?

of corresponding authors ($n=4$, 42%). A variety of study types were observed in the sample, with a higher prevalence of case reports ($n=5$, 42%), followed by case–control studies ($n=4$, 33%) and cross-sectional studies ($n=3$, 25%). The drugs evaluated were methamphetamine ($n=5$, 31%), ecstasy ($n=5$, 31%), cocaine ($n=5$, 31%), and heroin ($n=1$, 6%). The study population was predominantly composed of males (range 58–100%), with mean ages ranging from 20.4 to 34.4 years. The study locations were diverse and included university centers ($n=5$, 56%), rehabilitation clinics ($n=3$, 33%), and prisons ($n=1$, 11%). Only three studies did not specify the location of the lesions (27%). For the evaluation of dental wear, the majority did not report which criteria were used for assessing dental wear ($n=6$, 55%), and only two articles were based on a validated criterion (18%).

Literature review

The included reviews were published between 1993 and 2018 in 14 scientific journals. None of the selected reviews were systematic reviews, nor did they have a systematic search methodology. Additionally, none of them had the specific objective of evaluating the association between dental wear and drug use. Among the drugs evaluated in the reviews were methamphetamine ($n=9$, 41%), cocaine ($n=6$, 27%), ecstasy ($n=6$, 27%) and heroin ($n=1$, 5%).

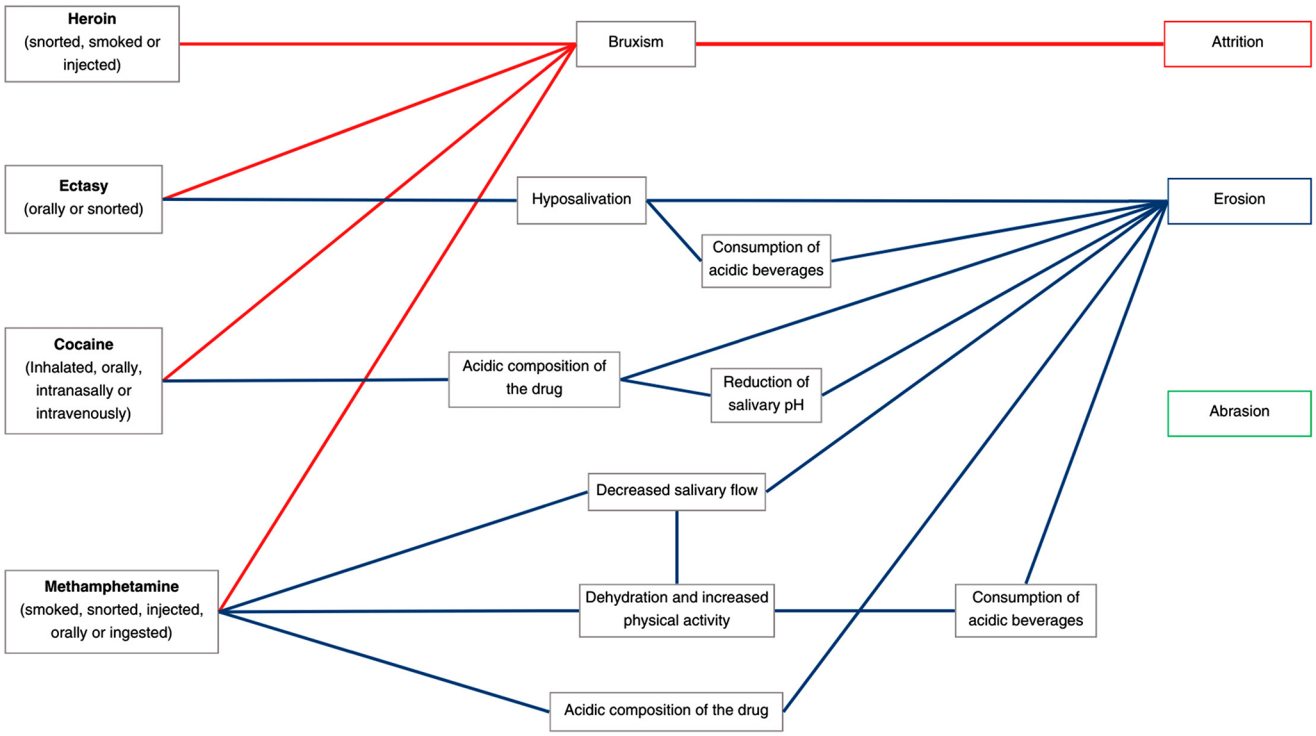

Fig. 2 Exploratory conceptual framework of drug use and tooth wear based on the included reviews

Results from individual sources of evidence

Results of the case–control studies

Of the four included case–control studies, three (75%) reported an association between drug use and dental wear, as presented in Table 2. In one of these studies investigating ecstasy users, a greater likelihood of experiencing dental wear was found compared to that of nonusers [OR 12.5 (95% CI: 3.0–50.8)] [9]. Another study on ecstasy users and nonusers highlighted significant differences in scores for the first molars of the lower arch ($F = 5.32$, $P = 0.03$), suggesting an association between drug use and dental wear; however, it was not possible to calculate the odds ratio due to the absence of data [10]. In a separate investigation examining methamphetamine users and nonusers, an OR of 6.7 (95% CI: 3.5–12.7) was found, indicating a strong and statistically significant association between consistent substance use and dental wear [30]. Conversely, a study evaluating recreational ecstasy users did not identify a significant difference in the presence of dental wear between users and nonusers of the drug [OR 0.79 (95% CI 0.5–1.3)] [16].

Results of the cross-sectional studies

Of the three cross-sectional studies listed in Table 2, neither demonstrated an association between dental wear and drug use. Although statistically significant differences in dental wear scores were not found between drug users and nonusers, the first study revealed a greater degree of wear on molar teeth in individuals in custody who were drug users than in nonusers ($F = 1.35$, SD ± 0.88) [31]. For the second study, while it did not specifically aim to investigate the association between drug use and dental wear, a prevalence of dental wear of 72.4% was observed in methamphetamine users. Additionally, statistically significant associations were detected between dental wear, temporomandibular disorders (TMDs), bruxism, and oral habits ($p < 0.001$), suggesting a potential relationship between methamphetamine use and dental wear [15]. The third study did not aim to determine whether tooth wear was more common among drug users than among nonusers. Instead, it focused on evaluating the different forms of drug administration, seeking to identify which one could be more detrimental to tooth wear. Therefore, due to this specific focus, no conclusions have been drawn regarding a possible association between methamphetamine use and the development of tooth wear [8]. Due to the lack of data, it was not feasible to calculate the prevalence ratio in the included studies.

Results of the case reports

The case reports complement the obtained results, showing dental damage characterized by distinct demarcation lines, suggesting the presence of advanced erosive wear. Additionally, there is a tendency toward the presence of thin or absent enamel on vestibular surfaces, giving them a vitreous and smooth texture [32, 33]. Among the drugs addressed in the studies, cocaine was the most frequently mentioned, followed by methamphetamine. Only two studies provided information on where they were conducted, indicating that these reports were carried out at a university center.

The reviews included in Table 3 establish associations between drug use and dental wear, making assertive statements about this relationship, despite evidence of questionable quality. Although these studies have methodological limitations, they strive to elucidate the mechanisms underlying dental wear resulting from drug use. These mechanisms include attrition and erosion, which are often associated with the use of specific drugs, such as methamphetamine, cocaine, and ecstasy. Attrition wear has frequently been related to bruxism and parafunctional masticatory activity, while erosive wear has been associated with decreased salivary pH and increased consumption of acidic substances.

Critical appraisal of the sources of evidence

The risk of bias was assessed for each study in this review using the Joanna Briggs Institute Critical Appraisal Tool for case–control studies, cross-sectional studies, and case reports [23]. This assessment revealed that all included studies had a high risk of bias. Tables 4 and 5, and 6 detail the bias risk in the included studies. Case–control studies have shown significant deficiencies in standardized, valid, and reliable exposure measurements; consistency between cases and controls; identification of confounding factors; and statement of strategies to address these issues. The cross-sectional studies in this analysis also exhibited deficiencies in six out of the eight evaluated criteria. Valid and reliable exposure measurements, the use of standardized and objective criteria for assessment and identification, and strategies to address confounding factors, as well as precise and reliable outcome measures, were problematic areas in all cross-sectional studies considered. Case reports also revealed limitations in terms of providing a clear description of patients' demographic characteristics, providing a detailed explanation of the evaluation methods and diagnostic results, and providing lessons learned; these were some of the deficient aspects of the included case reports. Failures in these analyses compromise the robustness of the results, precluding meaningful conclusions from these studies.

Synthesis of the results

This figure presents an exploratory conceptual model illustrating the potential pathways leading to dental wear and the use of heroin, ecstasy, cocaine, and methamphetamine.

Figure 2 shows the results of the studies included in this scoping review. Different pathways may connect dental wear to the use of heroin, ecstasy, cocaine, or methamphetamine. A possible association between heroin use and bruxism was observed, which could contribute to dental wear through attrition. Conversely, ecstasy appears to trigger bruxism, potentially resulting in dental wear through attrition and possibly influencing hyposalivation, which may be related to dental erosion. There is evidence of a link between cocaine and bruxism, which could lead to dental wear through attrition, while the acidic characteristics of the drug may directly or indirectly contribute to dental erosion, possibly due to a reduction in salivary pH. The use of methamphetamine could be associated with bruxism and decreased salivary flow, potentially resulting in dental erosion. Additionally, methamphetamine-induced dehydration may increase the consumption of acidic beverages, which could exacerbate the risk of dental erosion.

The results of this review highlight the complex interconnection between HDU and the occurrence of wear lesions. However, it is important to note that the studies included in this review exhibit questionable methodological quality and are subject to various limitations. Heterogeneity in assessment methods, lack of control of confounding variables, and absence of longitudinal studies limit the ability to establish definitive causal relationships between the use of these drugs and the observed damage. Therefore, although the results suggest possible associations between the consumption of heroin, ecstasy, cocaine, or methamphetamine and dental wear, it is essential to interpret these associations cautiously due to the methodological limitations of the included studies, which hinder the attainment of significant conclusions [9, 10, 30].

Discussion

The present study represents a significant advancement in investigating the relationship between dental wear and drug consumption, providing a mapping of the factors involved in this relationship based on a scoping review. The choice to conduct a scoping review arose from the need to comprehensively investigate the literature, aiming to guide future studies through evidence synthesis. Scoping reviews allow us to identify and assess knowledge gaps, as well as map potential factors related to the use of hard drugs and dental wear [34]. Additionally, we opted for a scoping review

due to the abundance of publications on the topic in the literature yet lacking a methodologically rigorous synthesis of available evidence addressing the relationship between hard drug use and dental wear. This underscores the necessity for a review with a broader and exploratory scope. Simultaneously, the decision to conduct bias assessment was made with the aim of analyzing the methodological quality of the included articles. This approach enables the review to identify the main methodological weaknesses of existing studies and, consequently, guide the formulation of future studies with more robust methodologies, as well as to elucidate the quality of the currently available evidence.

A wide range of studies were included, covering different populations and methodologies, to provide a more comprehensive understanding of these interactions. Furthermore, considering the practical importance of the review, its relevance to dental practice and patient care is highlighted. This review not only consolidates existing knowledge about the relationship between dental wear and drug consumption, but also promotes a more holistic and integrated approach in managing this patient profile, taking into account not only the outcome, but also the mediating factors. Despite the relevance of the topic, studies that exclusively explore dental wear associated with the direct or indirect effects of drug use are rare. Based on the available data, it is suggested that the relationship between dental wear and the use of these drugs is more related to phenomena such as bruxism, grinding habits, and teeth clenching than to hyposalivation or the chemical properties of the drugs themselves [9, 10]. However, it is important to note that all proposed associations stem from studies with a high risk of bias, raising concerns about making such assertive statements regarding erosive wear, a phenomenon often overestimated in the analyzed studies. Thus, further investigation into the pathways supposedly leading to erosion is necessary to minimize premature interpretations and provide a more accurate understanding of the erosive process.

Dental wear, characterized by the gradual loss of mineral material in teeth, is influenced by three main mechanisms: tension, biocorrosion, and friction. These factors act jointly on the dental structure and may be associated with exposure to nonbacterial acids and abnormal mechanical forces, such as malocclusion and parafunctional activities [19, 35, 36]. Among the studies included, the occurrence of attrition, originating from direct tooth-to-tooth contact, and erosion, a chemical-mechanical process resulting in the cumulative loss of hard dental tissue [37], is highlighted. The lack of specific, standardized criteria for evaluating dental wear in these studies affects the reliability and comparability of the results. This inconsistency complicates distinguishing dental wear types and identifying specific wear patterns related to drug use. The use of indices like the Tooth Wear Index (TWI) [38], Basic Erosive Wear Examination (BEWE) [39], and Tooth Wear Evaluation System (TWES) [40] is crucial for systematic classification and objective analysis. Advanced techniques such as intraoral scanning or scanning electron microscopy are key for measuring changes in dental surfaces [41, 42].

In this context of measurement challenges, evaluating drug use is consistently difficult. The studies analyzed reveal complexities in discerning drug use patterns due to a lack of specific criteria for measuring usage quantity and frequency. Urine analysis remains the preferred method for detecting illicit drugs qualitatively, though its quantitative accuracy depends heavily on blood tests [43]. Traditional methods face significant measurement challenges across different research settings. Self-report instruments or interviews, such as the Drug Abuse Screening Test (DAST-10), offer an alternative by providing insights into drug use problems [44]. The absence of biological markers complicates establishing a clear dose-response relationship for dental wear, which limits the conclusions that can be drawn from the studies. Furthermore, the complexity of drug abuse and the likelihood of polydrug use among consumers pose challenges in identifying the independent effects of each drug or behavioral aspect on wear [45]. This complexity obstructs a precise understanding of oral health conditions and isolates the impacts of each factor.

Amidst this challenging scenario, there has been widespread global availability of synthetic psychostimulants, such as ecstasy, which present significant new challenges for public health [46]. The constant emergence of chemically and pharmacologically diverse molecules is associated with an extensive range of clinical implications, likely due to alterations in dopaminergic neurotransmission. These changes can result in excessive activation of the serotonergic system through various mechanisms, culminating in a classic triad of symptoms involving alterations in mental state, neuromuscular effects, and autonomic hyperactivity, contributing to the development of bruxism and subsequent attrition [47]. The complex and intriguing relationship between drug consumption and adverse effects on oral health is evident, with the acidic composites of drugs potentially playing a fundamental role in this context. For example, cocaine, which is a benzoylmethylecgonine ester, contains the substance methylecgonine acid and plays a crucial role in drug synthesis. This presence can result in serious ramifications for oral health, especially due to the potential reduction in pH in the oral cavity, creating an acidic environment conducive to the initiation of the erosive process [33]. However, based on the available evidence, it does not seem that a decrease in pH alone is sufficient to cause erosive wear. The erosive process is complex and multifactorial, involving not only the acidity of the oral environment but also

patient-related risk factors such as gastroesophageal reflux, which can be easily overlooked, as well as many aspects associated with the erosive potential of beverages and foods [48]. Drug consumers may present these risk factors, thus contributing to the onset of erosive lesions. The association between drug consumption and dental wear does not seem to follow a linear or direct relationship. In contrast, mediating elements such as bruxism and decreased salivary pH are likely causative factors [30].

The conceptual model outlined by the included studies offers an elucidative perspective on the complex interactions between the consumption of different drugs and dental wear. This representation can be seen not only as a synthesis of existing evidence but also as a starting point for future investigations or as an auxiliary tool in delineating new studies aimed at understanding this relationship. The hypothesis that heroin use is associated with bruxism, which results in dental attrition, suggests a link between opioids and dental wear [49]. This connection seems to manifest both through direct opioid stimulation and the consequences of drug consumption [50, 51]. In the case of ecstasy, studies indicate that the consumption of this drug is associated with bruxism, which, in turn, can lead to attrition [52]. Additionally, ecstasy can trigger hyposalivation, which, when combined with the intake of acidic beverages, contributes to the erosive process [53]. Cocaine, on the other hand, has distinct effects on both bruxism and the acidic composition of the drug, predisposing individuals to both attrition and dental erosion, respectively [33].

In the context of methamphetamine, a greater presence of pathways was observed in the studies analyzed. Bruxism associated with this drug can lead to attrition, while the acidic composites of methamphetamine are considered potential causes of erosion [54]. Additionally, a decrease in the salivary flow rate related to methamphetamine can directly contribute to erosion or dehydration, consequently increasing the consumption of acidic beverages and expanding the risk of dental erosion [55]. However, the findings are questionable quality evidence, implying a critical analysis of the results obtained. These results are based on studies with significant methodological limitations that may compromise the internal validity of the studies, making it necessary to interpret the results with caution. Furthermore, it is essential to consider other potential factors that may influence the effects of drug consumption on dental wear, such as the presence of additional medical conditions or simultaneous medication use. For example, medical conditions like gastrointestinal disorders can alter saliva composition and increase acidity in the oral cavity, which can exacerbate the damage caused by drug consumption [29]. The inclusion and analysis of additional factors have the potential to significantly enrich our understanding of this complex relationship, providing a more comprehensive and accurate insight into the impact of drug consumption on oral health.

Although a significant portion of users of these drugs are individuals with favorable financial conditions, it is important to highlight that there is a large segment of consumers who are homeless [56]. These individuals, often marginalized, face a variety of challenges related to health, both generally and orally. Marginalization often results in the neglect of oral health conditions, including dental wear, as these individuals may not have adequate access to healthcare or may face social stigmas that limit their seeking of dental treatment [3]. Despite evidence pointing to oral health problems in drug-dependent individuals, several barriers hinder the effective provision of preventive and curative interventions. Dental professionals often exhibit negative attitudes and lack willingness to treat patients with addiction [57]. On the other hand, dependents often avoid seeking nonemergency dental care and do not prioritize oral health [4]. Additionally, they face difficulties in complying with treatment procedures and resisting the suggested plan [58]. Based on the evidence found in this scoping review, it is not possible to definitively identify prevention strategies for the causal factors of dental wear, as there is a lack of clarity regarding what they are. Therefore, as a preventive measure to avoid additional damage to dental tissues, practices that promote overall oral health are recommended, such as regular dental check-ups, along with strategies for controlling bruxism and hyposalivation, as these appear to be factors related to the causal mechanism of dental wear in drug users [59].

This study has several limitations that deserve consideration when interpreting its results. Some limitations stem from methodological choices in conducting a scoping review with diverse approaches. This is because there is a potential risk of inconsistency in data analysis and synthesis attributable to variations in the data collection and analysis methods, which may impede the comparison and interpretation of the results. It is worth noting that many articles lack clear delineation between mere experimental drug use, habitual use, and drug abuse, which could result in a distorted result, either amplifying or diminishing the experience of tooth wear in hard drug users and subsequently affecting the findings. Additionally, the exclusion of soft drugs (such as alcohol, tobacco, and marijuana) from the analysis could pose a limitation, as certain studies amalgamate data on soft drugs with that of hard drugs, consequently diminishing the pool of evidence available for the study.

One of the main limitations lies in the high risk of bias in the included studies. The low quality of these studies precludes a quantitative analysis of the relationship between drug use and dental wear. Additionally, the lack of standardized data makes it difficult to generalize the findings, making it essential to address this gap in future studies. To

conduct these studies effectively, it is imperative to adopt a clearly delineated methodology, including the careful selection of participants covering diverse age groups, genders, and socioeconomic strata, to comprehensively represent the population's diversity. Furthermore, it is essential to establish explicit criteria for drug use, considering not only the frequency and quantity but also the variety and specific types of substances consumed. In studies, it is imperative to incorporate precise criteria for classifying dental wear, ensuring an objective and comparable assessment. However, it is crucial to acknowledge the limitations inherent in exposing a study to consumers of different drugs compared to users of specific drugs. While the inclusion of different groups allows for broader generalizations, the specificity of the target group can provide information for more targeted interventions.

To deepen the understanding of the impacts of drug use on oral health, it is essential to focus on detailed studies of the biological and physiological mechanisms that link substance consumption to dental wear. These investigations should explore how drugs affect the composition of saliva, enamel integrity, and other oral conditions, using advanced methods of biochemical analysis and microscopy to observe changes at the cellular and molecular level. Additionally, longitudinal studies are needed to assess the long-term effects of drug use, tracking individuals over the years, and considering variables such as frequency of use and sociodemographic factors, to provide a more accurate analysis of the impact on oral health. In other words, a comprehensive study utilizing a solid methodological design and clear criteria for drug use and dental wear is essential for clarifying the exact relationship. Moreover, conducting longitudinal follow-ups of cases, controlling, and identifying factors such as the presence of bruxism, pH measurement, intraoral scanning, and establishing a dose-response analysis are crucial components for these new studies.

Conclusion

In summary, the analysis of the relationship between drug consumption and dental wear reveals a possible association, although this effect may not be direct. Mediating factors such as the occurrence of bruxism and a reduction in salivary pH may emerge as causal factors in the process of dental wear among drug users. The complexity of this relationship requires a more in-depth approach, especially through primary studies dedicated to exploring this relationship more specifically. The continuity of related studies is essential for clarifying more precisely the underlying mechanisms involved and thus proposing effective preventive and therapeutic strategies for managing dental wear associated with drug consumption.

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Author contributions Laura da Silva Fonseca: Conceptualization, Methodology, Investigation, Data curation, Writing and original draft, Writing e review & editing. André Luiz Rodrigues Mello: Conceptualization, Investigation, Data curation, Writing and review & editing. Luiz Alexandre Chisini: Methodology, Validation, Formal analysis, Writing and review & editing. Kauê Collares: Conceptualization, Methodology, Validation, Formal analysis, Writing and review & editing, Supervision, Project administration.

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Data availability All data used for this study are presented in the paper.

Declarations

Competing interests The authors declare no competing interests.

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