

Review Article

Prevalence and etiology of oral diseases in drug-addicted populations: a systematic review

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Abstract: As a global social problem, drug abuse is a serious public health concern. Epidemiologic research reveals that illicit drug use influences the genesis and progression of oral diseases. Indeed, oral diseases are among the most frequently reported health problems among drug abusers. Herein, we reviewed the prevalence, disease features and etiology of dental caries, periodontal disease, oral mucosal diseases, xerostomia, bruxism and jaw clenching, tooth wear, orofacial pain and temporomandibular disease (TMD) in the setting of addiction.

Keywords: Illicit drugs, addiction, oral health, dental caries, periodontal disease

As a global social problem, drug abuse increases social and economic burdens, crime rates, unemployment, and threatens public safety. At present, cannabis (marijuana) and methamphetamine (Meth) are the most commonly used illicit drugs worldwide [1], followed by opiates, hallucinogens, cocaine- and amphetamine-type stimulants, and various club drugs [2]. The World Health Organization reported that more than 35 million people worldwide used methamphetamine around the year 2000 [3]. Methamphetamine abuse is a serious problem in the United States, Mexico, South America, Middle East, Asia, and Australia. In 2005, the National Findings Report by the USA National Survey on Drug Use and Health stated that nearly 10.4 million (4.3% of respondents) people aged 12 years old and older used methamphetamine at least once in their lifetime [4]. Methamphetamine use was the reason for admission to a treatment facility in 2.6% of admissions in 1996, and 8.5% in 2012 for the U.S. In Iowa, these rates rose from 9.7 to 21.9% during this period [5]. The estimated toll on the United States Health care system is ~\$23.4 billion annually [6]. In China with the largest population in the world, from 1990 to 2012, the numbers of drug users registered officially increased 30-fold from 70,000 to 2,098,000.

The real number of drug addicts in China was estimated to be more than 14,000,000 at the end of 2014 [7].

Oral health is an integral part of general health. Poor oral health has been linked to mortality, coronary heart disease, poor nutrition, speech impediments, reduced employability and poor self-image. In addition, oral disease may exacerbate systemic conditions such as vascular disease, respiratory disease, and diabetes [8]. Oral health problems are among the most frequently reported health problems among drug abusers. With the improvement of living standards over the past few years, more attention has been paid to oral health, and the published data about influence of illegal drugs on oral health is growing. In a cross-sectional survey of 887 People Who Inject Drugs (PWID) in Australia, PWID have poorer oral health-related quality of life (OHRQoL) than the Australian general population [9]. In a USA survey of 301 methamphetamine users, methamphetamine users were more likely to have oral health problems than the matched NHANES III control participants [10]. At the same time, methamphetamine users expressed more concern about their dental appearance, problems with broken or loose teeth and teeth grinding (bruxism) or

erosion [10]. Those with a longer duration of drug use had a higher risk of developing bad oral health [9, 11, 12]. Compared to the general population, methamphetamine users in the USA had substantially more severe oral health deficits: they were 3.5 times more likely to experience painful toothaches, 6.6 times more likely to experience eating difficulty, and 8.6 times more likely to be self-conscious due to dental appearance [8]. Here we tried to summarize the oral health consequences of illicit drug abuse and the possible etiologies for these consequences.

Dental caries

Prevalence and manifestations of dental caries in drug abusers

As shown in **Table 1**, in most of the surveys, both the prevalence and severity of dental caries in drug-addicted populations were higher than that of general population. In a recent well-controlled survey in USA, using a covariate-balancing propensity score strategy, methamphetamine users were twice as likely to have untreated caries and 4 times more likely to have caries than the control group of National Health and Nutrition Examination Survey (NHANES) participants [13]. Additionally, Methamphetamine users were twice as likely to have two or more decayed, missing, or filled teeth than the NHANES participants [13].

The higher caries prevalence and severity in Methamphetamine addicts seems accompanied by different manifestations compared to the general population. In drug abusers, caries usually presents with extensive destruction, especially in the labial and buccal surfaces. The bistre or black destruction often extends to cervical regions, combining with wedge-shaped defects. Sometimes, the severe destruction in labial or buccal surfaces can take up more than half, and even the whole surface [28]. *Methamphetamine mouth* has been described as rampant caries, darkly stained and crumbling teeth, and appears akin to baby bottle tooth decay [37].

Interestingly, in a survey in France, half of cannabis abusers were reported pulpitis induction during periods of cannabis smoking. Perhaps pulpitis could be added to the list of vascular adverse effects linked to cannabis use previ-

ously reported in patients suffering from deep cavities [38].

In regards to gender differences of drug effects, Shetty *et al.* found that women had higher rates of tooth loss and caries, as well as a greater prevalence of anterior caries [34], which is consistent with the result of Silverstein SJ *et al.* [17] and Ma H *et al.* [32]. Intravenous use of methamphetamine was significantly more likely to be associated with missing teeth than smoking methamphetamine [10], which is consistent with one recent report that users injecting methamphetamine had significantly higher rates of tooth decay compared with non-injectors [13]. As for the caries-induced effect of different drugs, in a cross-sectional survey of 58 intravenous drug users in USA, no difference was found in the quantity of decayed, missing or filled surfaces (DMFS) between the methamphetamine and heroin users [31].

Possible etiology of dental caries in drug abusers

Currently, it is suggested that the higher prevalence of caries in drug abusers has a close relationship with xerostomia, high carbohydrate diet, and poor oral hygiene [10, 37, 39, 40]. It is well known that saliva is an anticariogenic solution and appears to have a protective effect against caries. Any reduction in production of saliva is a severe problem for dental health [41]. Many illicit drugs can stimulate α -adrenergic receptors within the salivary gland vasculature, causing vasoconstriction and reduction of salivary flow (hyposalivation), which weakens the protective properties, such as the neutralization of plaque-induced acids and the remineralization of dental enamel [42]. Repetitive abuse can also lead to a decrease of the salivary pH [33, 43, 44], which elevates the risk for dental erosion [45], ultimately leading to an increase in the retention of cariogenic organisms [1]. Additionally, resulting from the long excitatory state and increased energy needs of drug abusers, the intake of glycemic sugary foods and carbonated beverage is increased greatly [45, 46]. Furthermore, the life-style of drug abusers is usually different from that of general population. They usually ignore their oral health and have poorer oral hygiene, which also augments the prevalence of dental caries.

Prevalence and etiology of oral diseases in drug addicts

Table 1. The prevalence and severity of dental caries in drug-addicted population (Abusers/Control)

Publication year	Author	Sample	Age	Drug type	Prevalence of dental caries (%)	DMFT	DT	DMFS	DS	Missing teeth	Country
1970	Shapiro S [14]	52	18-50	Narcotic	-	15.46/-	7.26/-	-	-	6.21/-	USA
1972	Colon PG Jr [15]	102	18-43	Narcotic	-	13.4-22.0/-	-	-	-	-	USA
1972	Picozzi A [16]	89	18-44	Heroin	-	21.8/11.3 (Blacks) 22.1/18.1 (Whites)	-	-	-	-	USA
1973	Silverstein SJ [17]	77	>16	Poly-drugs	-	15.09/- (female) 12.71/- (male)	4.09/-	-	-	1.38/-	USA
1975	Rosenstein DI [18]	36	19-37	Heroin	-	22.1/-	7.4/-	-	-	12.8/-	USA
1977	Gerlach D [19]	100	17-30	Poly-drugs	-	15.1-18.7/-	-	-	-	-	Germany
1984	Scheutz F [20]	134	18-37	Poly-drugs	-	18.3/-	-	50.2/-	-	-	Denmark
1984	Hurlen B [21]	40	20-54	Poly-drugs	-	20.5/-	-	-	-	-	Norway
1991	Angelillo IF [22]	124	18-34	Heroin	93.5/-	12.9	6.4	36.2	17.4	4.3	Italy
1994	Lamster IB [23]	138	41.8±7.2	Poly-drugs	-	20.9	-	-	-	-	USA
1996	Molendijk B [24]	121	20-40	Poly-drugs	-	16.9	-	52.1/38.9	18.3/3.0	-	Netherlands
2001	Lv B [25]	516	15-51	Poly-drugs	90.69/37.3	-	4.64/2.47	-	-	-	China
2002	Zhang HP [26]	200	15-55	Poly-drugs	68/34	4.68/2.72	-	-	-	-	China
2003	Sun DW [27]	520	16-56	Poly-drugs	91/45	4.2/2.5	-	-	-	-	China
2004	Huang SH [28]	216	16-58	Poly-drugs	60.19/55.32	-	2.59/1.60	-	-	-	China
2007	Reece AS [29]	233	19-45	Poly-drugs	-	13.13/4.74	-	-	-	3.9/1.43	Australia
2010	Shetty V [10]	301	36.5±7.9	Methamphetamine	-	-	-	-	-	4.58/1.96	USA
2012	Liang DZ [30]	228	18-56	Heroin	66.67/61.00	-	-	-	-	-	China
2012	Brown C [31]	58	18-36	Poly-drugs	-	-	-	28.6/- (MA); 29.9/- (Heroin)	-	-	USA
2012	Ma H [32]	445	20-59	Heroin	64.72/-	4.16/-	-	-	-	-	China
2013	Protrka N [33]	100	30.15 (mean)	Heroin	44.70/16.20 (caries on occlusal surfaces)	18.78/5.32	12.57/2.00	-	-	4.59/0.68	Croatia
2015	Smit DA [11]	308	28±6.7	Methamphetamine	98.05/-	10/-	5/-	-	-	4/-	South Africa
2015	Boyer EM [5]	174	17-53	Methamphetamine	-	-	7.8/5.8	-	20.4/13.9	4.7/3.7	USA
2015	Shetty V [34]	571	44.4±9.5	Methamphetamine	96/-	12.7/-	2.25/-	-	-	5.01	USA
2016	Rommel N [35]	100	-	Methamphetamine	-	12.3/7.2	-	32.5/17.9	-	-	Germany
2016	Ma ZF [36]	199	19-55	Poly-drugs	86.93/33.9	5.54/4.25	-	-	-	2.75/-	China

DMFT: the mean number of decayed (caries), missing and filled teeth; DT: the mean number of decayed (caries) teeth; DMFS: the mean number of decayed (caries), missing and filled surfaces; DS: the mean number of decayed (caries) surfaces.

Periodontal diseases

Prevalence and manifestations of periodontal diseases in drug abusers

Periodontal disease is one of the most commonly found diseases in the reported oral health surveys of drug-addicted populations. As shown in **Table 2**, the periodontal condition of drug abusers is usually poorer than that of general population in most of oral health surveys, although different detection indexes (prevalence of gingival bleeding, dental calculus, periodontal pocket, gingivitis and periodontitis, clinical attachment level, and periodontal index) were used, and the detailed data varied greatly in different surveys.

In a periodontal health survey among drug addicts in Saudi Arabia, Kayal *et al.* found that all participants had some form of periodontitis with moderate or severe chronic periodontitis affecting 70.9% of the sample, while mild periodontitis affected 29.1% of the sample. More than half of the sample had deep pockets (>5 mm) [48]. In general adults 30 to 90 years old in USA, it is estimated that 21.8% are affected with mild periodontitis, and 12.6% are affected with moderate to severe periodontitis [49]. Another study of the adult general population in USA revealed that 8.7% are affected with mild, 30.0% affected with moderate, and 8.5% of the population affected with severe periodontitis [50]. It is suggested that drug addicts have a higher tendency for developing moderate to severe periodontitis [48]. In a prospective cohort study, Thomson *et al.* found that the incidence of combined attachment loss between the ages of 26 and 32 years in the none, some, and high cannabis exposure groups was 6.5%, 11.2%, and 23.6%, respectively. Although not assuring causation, cannabis smoking may be a risk factor for periodontal disease [51]. However, in another screening survey of Chilean high school students, no evidence supported that the use of cannabis was positively associated with periodontal diseases (the presence of necrotizing ulcerative gingival lesions or clinical attachment loss >3 mm), which might suggest that periodontal effects of a short-term exposure to cannabis differ from the effects of long-term exposure [52] or that other confounding influences are at play.

Possible etiology of periodontal diseases in drug abusers

It is suggested that the higher prevalence of periodontal diseases in drug-addicted population has close relationship with xerostomia, poor oral hygiene, decreased body immunity and endocrine dysfunction [47]. Tipton found that methamphetamine can increase bacterial lipopolysaccharide (LPS)-stimulated IL-1 β levels secreted by monocyte/macrophages, which could contribute to periodontitis in methamphetamine abusers [53]. Furthermore, under the influence of methamphetamine, suppressed murine immune system activity has been found [54]. Additionally, inhibition of receptor-mediated phagocytosis and MHC class antigen II processing and antigen presentation have been observed [55]. The immune effects of methamphetamine may result in disordered inflammatory processes, which, particularly during chronic methamphetamine abuse, will also involve periodontal tissues. Additionally, most drug addicts are also heavy smokers, which may also be a risk factor [56].

Oral mucosal diseases

Prevalence of oral mucosal diseases in drug abusers

In the third National Oral Health Survey of China, the prevalence of oral mucosal abnormalities was 4949/100000 in the 35-44 age group, and 7965/100000 in the 65-74 age group [57]. In drug-addicted population in China, the prevalence of oral mucosa diseases was 13.07%-62.5% [47, 58]. In a survey in Hunan province of China, where people liking chewing betel nut is common, the prevalence of oral submucous fibrosis in drug abusers is 37.08%, compared to 3.0% in the general population [47]. However, in a survey of 301 methamphetamine abusers in USA, only 4.3% manifested a lesion or abnormality of the oral mucosa [10].

In drug abusers, the common oral mucosal diseases include leukoedema, oral candidal leukoplakia, leukoplakia, oral hairy leukoplakia, oral papilloma, gingival marginal erythema, mucosal ulcer, atrophic glossitis, oral submucous fibrosis, uvulitis, and nicotinic stomatitis [23, 30, 47, 58, 59]. The palatal gingiva and mucosa exhibit a nodular or "pebbly" appearance in cannabis abusers [59].

Prevalence and etiology of oral diseases in drug addicts

Table 2. The prevalence and severity of periodontal diseases in drug-addicted population (Abusers/Control)

Publication year	Author	Sample	Age	Drug type	Gingival bleeding	Dental calculus	Periodontal pocket	CAL	Gingivitis	Periodontitis	PI	Area
1970	Shapiro S [14]	52	18-50	Narcotic	-	-	-	-	-	-	2.22/-	USA
1972	Picozzi A [16]	89	18-44	Heroin	-	-	-	-	-	-	2.8/1.8 (Blacks) 3.0/1.3 (Whites)	USA
1973	Silverstein SJ [17]	77	>16	Poly-drugs	-	-	-	-	-	-	-	USA
1975	Rosenstein DI [18]	36	19-37	Heroin	-	-	-	-	-	-	2.3/0.6	USA
1991	Angelillo IF [22]	124	18-34	Heroin	-	-	-	-	-	-	1.37/-	Italy
2002	Zhang HP [26]	200	15-55	Poly-drugs	-	-	-	-	-	79%/46.3%	-	China
2003	Sun DW [27]	520	16-56	Poly-drugs	-	95%/90%	-	-	42%/30%	-	-	China
2007	Wang M [47]	178	16-52	Poly-drugs	-	-	-	-	59.55%/-	29.78%/-	-	China
2010	Liang DZ [30]	228	18-56	Heroin	82.46%/77.30%	100%/97.3%	82.01%/40.9%	-	-	-	-	China
2012	Ma H [32]	445	20-59	Heroin	99.55%/77.3%	96.63%/-	33.04%/40.9%	-	-	-	-	China
2014	Kayal RA [48]	57	-	Poly-drugs	-	-	-	2.70/3.18 (Amphetamines); 3.80/2.85 (Cocaine); 3.35/2.70 (Heroin)	-	100%/-	-	Saudi Arabia
2015	Shetty V [34]	571	44.4±9.5	Methamphetamine	-	-	-	-	-	88.5%/37%	-	USA
2016	Rommel N [35]	100	-	Methamphetamine	39.6%/28.4%	-	-	-	-	-	2.75/2.1	Germany
2016	Ma ZF [36]	199	19-55	Poly-drugs	97.99%/82.1%	98.49%/98.70%	37.69%/32.30%	-	-	-	-	China

CAL: clinical attachment level; PI: periodontal index.

Table 3. The prevalence of bruxism and jaw clenching in drug-addicted population (Abusers/Control)

Publication year	Author	Sample	Age	Drug type	Bruxism	Clenching	Jaw play	Area
1992	Liester MB [71]	20	28-55	MDMA	30%/-	50%/-	-	USA
1998	Redfearn PJ [61]	30	-	Poly-drug	-	89%/-	-	UK
2001	Winocur E [72]	55	24-46	Poly-drug	47.3%/19.2%	63.6%/28.8%	41.8%/19.2%	Israel
2005	McGrath C [60]	119	15-25	Poly-drug	75% (87% for MDMA abusers; 58% for non-MDMA abusers)/-	52%/-	-	Hongkong, China
2016	Enguelberg-Gabbay JV [66]	69	32.4±9.7	Poly-drug	52.2%/34.9% (sleep bruxism), 59.7%/30.1% (awake bruxism)	-	-	Israel
2016	Rommel N [44]	100	29.4±7.4	Methamphetamine	81%/39%	68%	-	Germany

Possible etiology of oral mucosal diseases in drug abusers

The higher prevalence of oral mucosal diseases in drug-addicted populations may be closely related to poor oral hygiene, endocrine dysfunction and hyp immunity, which together make the oral mucosa sensitive to adverse chemical or physical stimulus [30, 47, 58]. Additionally, many drug abusers may smoke and drink heavily. Chen *et al.* found that the prevalence of oral mucosal diseases in drug abusers who smoke more than 20 cigarettes a day was significantly higher than that in drug abusers who smoke less [58]. The potential additive effect between drug abuse and smoking needs further investigation.

Xerostomia

Prevalence of xerostomia in drug abusers

Xerostomia is common oral disease in drug-addicted population and affects quality of life. In a self-completed questionnaire survey about previous pattern of drug abuse and oral health (based on recall) of 119 drug abusers in Hong Kong, China, xerostomia was the most frequently recalled condition (95%) [60]. Interestingly, almost all 3,4-methylenedioxymethamphetamine (MDMA; Ecstasy) abusers (99%) reported xerostomia after taking drugs compared to 90% of non-Ecstasy abusers [60]. Similarly, in another study of MDMA abusers in Liverpool, UK, 93% of the users reported experiencing xerostomia during a trip [61, 62]. In a recent survey of 100 chronic methamphetamine abusers, 72% reported xerostomia [44]. In another survey of 459 MA users in Los Angeles, USA, methamphetamine users were 4.4 times more likely to report having too little saliva, 7.2 times more likely to frequently experience dry mouth when eating, and 3 times more likely to often have altered taste [10].

Possible etiology of xerostomia in drug abusers

As sympathomimetic amines, certain illicit drugs can stimulate the sympathetic nervous system and α -adrenoreceptors within the salivary gland vasculature, causing vasoconstriction and reduction of salivary flow, then leading to xerostomia [37, 63]. Alternatively, stimulation by methamphetamine of inhibitory α 2-adrenoreceptors in the salivatory nuclei may decrease

salivary flow rate [63]. Dehydration related to methamphetamine-induced elevation of metabolism and increase in physical activity may also contribute to xerostomia [64]. Additionally, Okubo *et al.* found that methamphetamine-withdrawal stress can activate a PACAP (pituitary adenylate cyclase-activating polypeptide)-DBI (diazepam-binding inhibitor) pathway in salivary glands, inhibiting salivary secretion in rats [65].

Prevalence and etiology of bruxism and jaw clenching in drug abusers

It is suggested that prolonged drug use may damage the stomatognathic system via oral motor overactivity [66]. Bruxism and jaw clenching (trismus) has been recognized as common side effect of some illicit drugs, especially MDMA [61, 67] and cocaine [68, 69]. As shown in **Table 3**, the prevalence of bruxism and jaw clenching in drug-addicted populations is significantly higher than that in reference populations. It is suggested that these effects probably result from the amphetamine-like properties of the drugs, which can produce choreiform motor activity that may involve facial and masticatory muscles, and result in unusual patterns of tooth wear [67, 70]. Resulting from the abnormal movement and its related abnormal stresses, bruxism and jaw clenching may compound the effects of periodontal disease and produce symptoms of temporomandibular disorders (TMD), such as tenderness in the temporomandibular joints and masseter muscles [60].

Severity and etiology of tooth wear in drug abusers

In a survey of MDMA abusers in UK, Redfearn *et al.* found that the mean tooth wear score for the posterior teeth in MDMA users was significantly higher than in the comparison group, which may result from the higher prevalence of bruxism and jaw clenching induced by MDMA [61]. This is consistent with the report of Milosevic *et al.* that the mean tooth wear score in MDMA users was 0.63 compared with 0.16 in non-users [73]. To some extent, the finding that there was greater tooth wear in the drug abuser group is not surprising because the condition of clenching within a corrosive environment (carbonated drinks) is ideal to promote wear. In addition, many subjects reported feel-

ing a dry mouth, and decreased lubrication effects of saliva would promote tooth wear [61]. Animal experimentation also revealed that repeated stimulation of the dopaminergic systems with apomorphine and cocaine enhances nonfunctional masticatory movements and increases the attrition rate of the mandibular incisors in rats [74].

Conditions of orofacial pain and TMD in drug abusers

In oral health surveys of drug abusers, orofacial pain and TMD were seldom mentioned. However, it is reported that drug abusers suffer from heavy myofacial pain and abnormal tongue movement [67]. In a controlled study conducted on a heavily drug-addicted population in Israel, the addicted group had a higher prevalence of signs and symptoms of TMD (morning headache, joint noises, joint catching, joint locking, joint and masticatory muscle tenderness to palpation) compared to the controls [72]. In another similar survey in Israel, the prevalence of TMDs among drug-user prisoners was statistically insignificantly higher than non-drug-user prisoners (46.3% vs. 25.6%) [66]. In a recent survey of 100 chronic methamphetamine abusers, almost half (47%) experienced pain in the temporomandibular joint (TMJ) [44]. Mcgrath *et al.* reported that 56% of drug abusers felt "pain or tenderness in jaw muscle or TMJ", 40% recalled feeling some sort of "numbness" in their mouth, and 29% felt their "joints clicked or popped when eating or opening their mouth", and 28% reported some "difficulty in opening their mouth fully" after abusing drugs [60]. Interestingly, participants with awake bruxism were statistically more sensitive to muscle palpation compared with participants with sleep bruxism [66]. In a recent survey of 459 methamphetamine users in Los Angeles, USA, methamphetamine users were 3.5 times more likely to experience recurrent painful toothaches compared to the general population [8].

Conditions of other oral diseases in drug abusers

Besides the above-mentioned diseases, there are some rare diseases induced by drug abuse, for example, jaw osteomyelitis [75], acute uvular oedema and post-operative airway obstruction induced by recent inhalation of marijuana before general anaesthesia [76], and loculated

purulent collections within the maxillary sinus of probable odontogenic origin induced by methamphetamine abuse [1]. In addition, several case reports suggest that chronic marijuana use may result in gingival enlargement with clinical characteristics similar to phenytoin-induced enlargement [59, 77, 78].

Matters needing attention in treatments of oral diseases for drug abusers

Illicit drug abuse can affect multiple organ systems and cause a variety of clinical manifestations, including the central nervous system, respiratory system and cardiovascular system [1]. For example, methamphetamine can block reuptake of norepinephrine, resulting in increased sympathetic activity. The effects of this increase in sympathetic activity on the cardiovascular system includes cardiac dysrhythmias, hypertension, and tachypnea, etc [70]. Local anesthesia is a common operation during the treatments of oral diseases. To decrease the amount of bleeding and get clear view, vasoconstrictor (especially norepinephrine) is widely used during the treatment. However, if patient has used methamphetamine within the last 24 hours, vasoconstrictor in the local anesthetic could result in further sympathetic drive to the cardiovascular system putting the patient at increased risk for cardiac dysrhythmias, hypertension, myocardial infarction, and cerebrovascular accidents. Thus, if local anesthesia is needed for delivery of dental treatment, a local anesthetic without vasoconstrictor should be used [70].

Conclusions and future directions

In summary, there are substantial negative effects of illicit drugs on oral health. Longer duration of exposure to illicit drugs leads to higher prevalence of dental caries, periodontal diseases, oral mucosal diseases, xerostomia, bruxism and jaw clenching, tooth wear, orofacial pain and TMD, resulting in poor dental appearance, orofacial pain, and dysfunction of stomatognathic system, even poor nutrition and speech impediments can result. All of these effects may seriously diminish quality of life.

Accordingly, illicit drug users have specific dental needs, and programs to improve their oral health should be an integral part of strategies to improve addiction treatment and reduce

harm of addiction. Unfortunately, drug abusers still experience a number of barriers (morality, law, discrimination, ignorance, etc.) in accessing dental services globally [79]. There is a distinct lack of national policy and guidance relating specifically to drug abusers, and therefore, problems persist.

Facing with the cruel reality, the “4E” principle (education, encouragement, employment and enrollment) should be suggested and implemented. The first “E”, education, involves education of the illicit drug-addicted population and general population about the harm of drug addiction on our organs, and that the continued use of the drug may result in severe dental, neurological and other complications that will be difficult to treat. This theme should be added into the basic education globally, and everyone should be educated to face drug abusers fairly and equally. The second “E”, encouragement, means that past and present drug abusers should be encouraged to admit the addiction fact frankly, stop the drug abuse, and undertake a formal health examination bravely. The third “E”, employment, means that multidisciplinary health professionals should be employed into specific organization or departments, to serve the drug-addicted population. For example, the approach to oral health management needs to be multidisciplinary with specific emphasis on prevention, promotion, restoring teeth and assessing salivary gland functioning [80]. In such an organization, direct and frank communication will occur not only between health professionals and drug abusers, but also among health professionals from different disciplines. The fourth “E”, enrollment, means that the present drug-addicted population should be engaged as comprehensively as possible into such programs, under proper supervision. In future research, more controlled researches on this underexplored subject are recommended.

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None.

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