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Oral health among drug addicts and associated variables: a multivariate approach using a canonical correlation analysis

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Aim: To evaluate the association between oral health conditions with sociodemographic variables and the use of psychoactive substances by drug addicts assisted by Psychosocial Care Centers for Alcohol and Drugs (CAPS-ADs). **Methods:** This is an analytical cross-sectional study with a sample of 262 drug addicts assisted by CAPS-ADs in three cities in the state of São Paulo, Brazil. Participants were evaluated through intraoral clinical examinations (DMFT and CPI indexes) and they answered a socioeconomic questionnaire. The intensity of use of psychoactive substances was assessed through ASSIST questionnaire. Associations between variables were performed using the canonical correlation analysis method. **Results:** It was observed that the mean DMFT index was 13.9; 60.2% of the sample used cocaine/crack and 46.5% used marijuana. Regarding the analyses, the canonical correlation coefficient of the highest possible correlation between the combination of variables of oral health problems and the combination of variables of intensity of drug use was 0.4642 (p=0.0005). In addition, the canonical correlation formed by the combination of socioeconomic condition variables and the combination of oral health was statistically significant (canonical correlation coefficient=0.4533; p<0.0001). Thus, it was observed that the high consumption of drugs, mainly cocaine/crack and marijuana, was associated with oral health problems; in addition, worse socioeconomic conditions, mainly lower level of education of the mother and father, were associated with oral health problems in drug users. **Conclusion:** Both the type of psychoactive substance addiction and sociodemographic variables affected the oral health of drug addicts.

Keywords: Oral health. Mouth diseases. Substance-related disorders. Illicit drugs.

Introduction

According to the World Health Organization (WHO), "psychoactive drugs are substances that, when taken in or administered into one's system, affect mental processes, e.g. perception, consciousness, cognition or mood and emotions. Psychoactive drugs belong to a broader category of psychoactive substances, which also includes alcohol and nicotine"[1].

Psychoactive drugs can be classified as licit drugs, such as alcohol and cigarettes, or illicit drugs, such as marijuana, cocaine, opioids, among others[2]. There is an estimate projection that 11 per cent of the global population aged 15–64 years will use some kind of drugs by 2030[2].

In Brazil, the National Anti-Drug Policy was created in 2002 and, in 2006, the National System of Policies on Alcohol and Drugs - SISNAD, as well as Law 11,343 that differentiates for the magistrate the drug user or dependent, offering them the opportunity to receive treatment[3]. The Public Health System in Brazil, known as the Unified Health System, provides assistance to users of psychoactive substances through the Psychosocial care Centers for Alcohol and Drugs (CAPS-ADs), with extra-hospital care, thus reducing the need for admissions to psychiatric hospitals[4,5].

The abuse of psychoactive substances causes great damage to societies, such as health expenditures, rising levels of crime and violence and loss of productivity at school and at work[2]. However, the public health impact of drug addiction is not limited to the economic impact, but includes other outcomes such as irreparable damage to the user's physical health, psychological problems, domestic violence, child abuse, family disintegration and high risk of contracting infectious diseases[2,6].

In the dental field, it was observed that the consumption of alcohol, tobacco and illicit drugs is considered a risk factor for several oral diseases[7-11]. Drug addicts are at greater risk of having compromised oral health for various reasons, such as socioeconomic conditions, limited access to dental care, poor diet and poor oral hygiene habits[10-12]. Some studies indicate that drug addicts do not care about personal hygiene due to low self-esteem and lack of motivation, exposing them to greater risks of having oral problems[7-9,12].

The importance and severity of oral health problems among psychoactive substance users require the availability of comprehensive dental care programs. These programs must be integrated with health services. In addition, programs must adopt multiple approaches involving education, prevention, and treatment. Therefore, it is important to generate data from studies that evaluated the oral health condition of drug addicts and the socioeconomic and addiction-related variables associated with it in order to support the management of public policies aimed at this population.

In this study, a multivariate approach was used through canonical correlation analysis. Unlike multiple regression, which predicts a single dependent variable from a set of multiple independent variables, canonical correlation simulta-

neously predicts multiple dependent variables from multiple independent variables[13]. Therefore, the use of this analysis methodology enables determining the interrelationships between the group of dependent variables and the group of independent variables.

The aim of this study was to evaluate the associations between oral health conditions and the intensity of use of psychoactive substances and sociodemographic variables of drug addicts assisted by Psychosocial Care Centers for Alcohol and Drugs (CAPS-ADs).

Material and Methods

This study received approval from the Research Ethics Committee (CEP) of a Dental School under protocol nº 069/2012. Users of psychoactive substances received an informed consent form containing information regarding the responsibility, methodology and development of the study. Only after the consent of the participants, they were included in the study.

A cross-sectional study was conducted with a sample of adult drug addicts assisted by the three Psychosocial Care Centers for Alcohol and Drugs (CAPS-ADs) located in 3 medium-sized cities (Piracicaba, Limeira and Rio Claro) in the non-metropolitan area of the state of São Paulo – Brazil in 2013. The total population of CAPS amounted to 400 individuals at the time of the survey.

A probability sample was calculate considering the situation of higher probability of sampling error (p=0.50) assuming a confidence level of 95% and a sampling error of 5%. In addition, we calculated the sample size for estimating the oral health of participants, based on previous data with this population in the Brazilian literature that found an overall mean number of decayed, missing and filled teeth (DMFT index) of 14.9 with a standard deviation of 6.38[14]. When calculating the sample, the power of test of at least 80% with significance level of 5% and minimum significant odds ratio of 1.5 in association with the variables were taken into account, reaching a sample of 262 individuals. An additional percentage of 10% in the initial sample was calculated considering possible losses, reaching a minimum sample number of 286 participants. Convenience sampling was the methodology employed for collect data, that is, as the researcher visited the CAPS-AD, users were invited to participate in the research voluntarily.

The participants were clinically examined by one calibrated examiner (as to the presence of decayed, missing, and filled teeth (DMFT index), presence of periodontal disease (CPI index), use/need of dental prosthesis and need for dental treatment, all according to the criteria established by the World Health Organization (WHO) for epidemiological surveys in an outdoor setting, under natural light with ball-point probes and mirrors[15]. During theoretical discussions and calibration exercises it was obtanied an almost perfect level of agreement (Kappa>0.90). During the experimental phase, 10% of the volunteers in the sample were re-examined by the same examiner to verify the maintenance of the diagnostic criteria and assessment of intra-examiner sampling error. The mean intraexaminer agreement obtained in this activity was Kappa=0.89.

The following socioeconomic and demographic data were collected from the participants: age, sex, skin color (black, brown, yellow, white), monthly family income (Brazilian minimum wages – BMW), participant's and parents' education level, type of housing (own x others) and number of people in the house. The questionnaires were completed in a quiet room in each CAPS-AD and the interviews were conducted face to face and individually.

The intensity of use of psychoactive substances was evaluated through the Alcohol, Smoking and Substance Involvement Screening Test (ASSIST), which has been adapted to Brazilian Portuguese language[16,17]. It is a structured questionnaire containing eight questions about the use of nine classes of psychoactive substances (tobacco, alcohol, marijuana, cocaine, stimulants, sedatives, inhalants, hallucinogens, and opiates) and 'other' drugs. The questions address frequency of use, in life and in the last three months, problems related to use, concerns about use by people close to the user, impairment in performing expected tasks, unsuccessful attempts to stop or reduce use, feeling of compulsion and injection use. Each answer corresponds to a score, which ranges from 0 to 4, and the total sum can range from 0 to 20. A score ranging from 0 to 3 is considered as indicative of occasional or non-problematic use, from 4 to 15 as indicative of abuse, and ≥16 as suggestive of dependence/addiction[16,17].

In order to assess the relationship between oral health problems and intensity of use of psychoactive substances, the data set was initially divided into two groups: group I - variables related to oral health (DMFT index; need for dental treatment; CPI index; use and need for dental prosthesis) and group II - variables related to intensity of use of psychoactive substances. Multivariate analyses were performed using canonical correlation, measuring the association and contribution of each variable in the respective model.

Through canonical correlation analysis, we obtained orthogonal combinations of the variables within each group (I-oral health and II-drug use), which best explain the variability of the data. These combinations of features are called canonical variables. Correlations were tested separately by the approximate F test and together by Wilks' lambda (Wilks'Lambda), Pillai's criterion (Pillai's Trace), Hotelling's trace (Hotelling-Lawley Trace) and Roy's Greatest Root.

From the two sets, where p is the number of X variables (intensity of use of psychoactive substances) and q is the number of Y variables (oral health problems), the canonical correlation analysis provided the following combinations:

$$W1=a11x_1+a21x_2+...+ap1x_p \; v1=b11x_1+b21x_2+...+bp1x_p$$

Thus, the first pair of canonical variables was obtained, with the highest possible correlation (first canonical correlation). The coefficients of the combinations are called canonical coefficients or canonical weights. Next, a second set of canonical variables, uncorrelated with the first pair, with the second highest correlation coeffi-

cient was tested. This is the second pair of canonical variables, which contains the maximum remaining information that has not been covered by the explanation of the first pair of canonical variables and is given by:

$$W2=a12x_1+a22x_2+...+ap2x_p \; v2=b12x_1+b22x_2+...+bp2x_p$$

The construction process of the canonical variables occurred until the number of pairs of canonical variables was equal to the number of variables in the smaller group or until all covariance or correlation information between the two sets was explained by the pairs of selected variables.

In addition, multivariate analyses by canonical correlation were also performed to assess the relationship between the set of group I variables (DMFT index; need for treatment; CPI index; use and need for dental prosthesis) and socioeconomic variables, called group III variables (income, living in the same house, psychoactive substance user's level of education, mother's and father's level of education, type of housing)[18].

All analyses were performed according to Ferreira[18], using the CANCORR procedure of the SAS program.

Results

Of the 286 participants initially drawn, 24 did not agree to participate in the survey and the final sample was composed of 262 subjects. Of them, 85.5% were male, 17.9% report 1 or less BMW as their monthly family income, and the majority of the participants (61.1%) had up to 8 years of education. With respect to substance use, 80.9%, 46.5% and 60.3% of the sample were classified by ASSIST as having moderate/high risk of being alcohol, marijuana and cocaine/crack users.

In relation to the oral health conditions, it was observed that 71.7% of participants needed dental treatment. Regarding the CPI, 43.1% had dental calculus present and 27.1% had a healthy periodontium at the time of intraoral examination. Regarding the use/need of dental prostheses, 45.8% of participants did not need any type of prosthesis; however, 13.7% needed a complete denture. In relation to the caries experience, the mean DMFT index of the sample was 13.9 (SD±8.9), with a minimum value of 0.0 and a maximum value of 28.

In the multivariate analysis of the associations between oral health problems (Group I) and the intensity of use of psychoactive substances (Group II), group I was formed by five variables related to oral health and group II by nine related to alcohol consumption. As the number of canonical correlations that can be tested is equal to the number of variables in the smaller group, five independent canonical correlations were tested, that is, five different combinations of oral health and intensity of drug use variables (Table 1).

Table 1. Standardized canonical coefficients of the canonical variables intensity of use of psychoactive substances and oral health problems.

Variable	Standard canonical coefficients
Oral health problems (group I)	
DFMT	0.7908
Need for dental treatment	0.1997
CPI	0.2742
Use of dental prosthesis	0.1539
Need for dental prosthesis	0.1355
Intensity of use of psychoactive substances (group II)	
Tobacco products	0.1408
Alcoholic beverages	0.0384
Marijuana	0.2458
Cocaine, crack	0.7448
Amphetamine-type stimulants	0.2594
Inhalants	0.5156
Sedatives and sleeping pills	0.2994
Hallucinogens	0.2959
Opioids	0.0335

DMFT: number of Decayed, Missing due to caries, and Filled Teeth in the permanent teeth; CPI: Community Periodontal Index
Wilks'Lambda=0.7221 (p=0.0005); Pillai's Trace=0.2971 (p=0.0015); Hotelling-Lawley Trace=0.3589 (p=0.0002); Roy's Largest Root=0.2746 (p<0.0001).

Only the first canonical correlation (formed by combining the two groups of variables with the highest correlation) was significant (canonical correlation coefficient=0.4642; p=0.0005). This value represents the highest possible correlation between any combination of the oral health problem variables and any combination of the drug use intensity variables. The other possible correlation pairs were not significant (p=0.9311; p=0.9543; p=0.9960, and p=0.9737).

The bottom of Table 1 presents the multivariate statistics for the null hypothesis that all canonical correlations are zero. The low p-values for these tests (p<0.05) suggest rejecting the null hypothesis that all canonical correlations are zero in the population.

The standardized canonical coefficients (Table 1) represent the 'canonical weights' and are similar to the coefficients of a multiple regression. These coefficients express how much each variable was correlated with its canonical (set of variables). It was observed that the DMFT variable is the one that is most strongly correlated with the canonical oral health problems, with a 0.7908 correlation coefficient. The second most influential is the CPI variable, with a 0.2742 correlation coefficient with the canonical variable. The standardized canonical coefficients indicate that the canonical variable for the oral health problems group is a weighted combination of DMFT (0.7908), CPI (0.2742), need for treatment (0.1997), denture use (0.1539) and need

for dental prosthesis (0.1355) with emphasis on DMFT. The coefficients for the intensity of drug use variables indicate that the canonical variable for the group of these variables was formed by the intensity of use of cocaine/crack (0.7448), inhalants (0.5156), hypnotics (0.2994), hallucinogens (0.2959), amphetamines (0.2597), marijuana (0.2458), tobacco (0.1408), beverages (0.0384) and opioids (0.0335), with emphasis on cocaine/crack and inhalants.

Table 2 presents the canonical correlation coefficients between the variables related to drug use and the canonical oral health. It can be observed that these two characteristics are related (R^2=0.2154), that is, the variation in the intensity of drug use explained approximately 22% of the variation in the variables related to oral health. Thus, high consumption of drugs, especially cocaine/crack and marijuana, was associated with oral health problems.

Table 2. Canonical correlation coefficients between variables related to drug use and the canonical of oral health problems

Variables related to intensity of use of psychoactive substances	Canonical variable related to oral health
Tobacco products	0.0290
Alcoholic beverages	0.0071
Marijuana	0.2730
Cocaine, crack	0.3934
Amphetamine-type stimulants	0.1498
Inhalants	0.1419
Sedatives and sleeping pills	0.0269
Hallucinogens	0.0390
Opioids	0.0190
Characteristics of the canonical axis	r=0.4641; R^2=0.2154; F=1.87; p=0.0005

In the multivariate analysis of the associations between the oral health variables (Group I) and variables related to the users' living conditions (Group III), group I was formed by the five oral health variables and group III by the six variables related to the user´s socioeconomic conditions. As the number of canonical correlations that can be tested is equal to the number of variables in the group with the smallest number of variables, five independent canonical correlations were tested.

Only the first canonical correlation (formed by combining the two groups of variables with the highest correlation) was significant (canonical correlation coefficient=0.4533; p<0.0001). This value represents the highest possible correlation between any combination of the oral health problem variables and any combination of the living condition variables. The other correlation pairs, which are not correlated with the first, were not significant (p=0.3039; p=0.7929; p=0.8945 and p=0.9335) (Table 3).

Table 3 presents the multivariate statistics for the null hypothesis that all canonical correlations are zero. The low p-values for these tests ($p<0.05$) suggest rejecting the null hypothesis that all canonical correlations are zero in the population.

Table 3. Standardized Canonical Coefficients of the canonical variables related to socioeconomic condition and oral health problems in drug users.

Variables	Standardized Canonical Coefficients
Oral health problems (group I)	
DMFT	0.8551
Need of dental treatment	0.1904
CPI	0.3724
Use of dental prosthesis	0.1331
Need of dental prosthesis	0.0529
Socioeconomic conditions (group III)	
Monthly income	0.2474
Number of people in the house	0.2288
Participant's education	0.1823
Mother's education	0.5761
Father's education	0.3181
Type of housing	0.1143

Wilks'Lambda=0.7226 ($p<0.0001$); Pillai's Trace=0.2980 ($p<0.00001$); Hotelling-LawleyTrace=0.3561 ($p<0.0001$); Roy's Largest Root=0.2586 ($p<0.0001$)

The standardized canonical coefficients show that the first canonical variable for the oral health problems group is a weighted combination of DMFT (0.8551), CPI (0.3724), need for treatment (0.1904), denture use (0.1331) and need for prosthesis (0.0529) with emphasis on DMFT and CPI indexes.

The coefficients for the socioeconomic condition group variables showed that the canonical variable for the group of these variables was formed by the mother's education level, father's education level, income, number of people in the house, user's level of education and type of housing, with emphasis on the mother's (0.5761) and father's (0.3181) level of education.

Table 4 presents the canonical correlation coefficients between the living condition variables and the canonical oral health. It can be seen that these analyzed characteristics are related ($R^2=0.2055$), that is, the variation in living conditions explained 20% of the variation in oral health problems in drug users. Worse living conditions, especially lower education levels of mothers and fathers, were associated with oral health problems in addicted patients.

Table 4. Canonical correlation coefficients between socioeconomic condition variables and the canonical of oral health problems.

Variables related to socioeconomic conditions	Canonical variable related to oral health
Monthly income	0.2050
Number of people in the house	0.1729
Participant's education	0.2043
Mother's education	0.3827
Father's education	0.3226
Type of housing	0.0187
Characteristics of the canonical axis	r=0.4533; R^2=0.2055; F=2.84; p<0.0001

Discussion

The present study demonstrated, through multivariate analyses, that variables related to intensity of use of psychoactive substances and socioeconomic and demographic variables were associated with oral health problems.

Governments and public health systems have intensified their concern to provide specialized care to this population[1,2]. In the case of Brazil, these individuals are assisted in CAPS-ADs by multiprofessional teams and those with dental problems should be referred for treatment at Family Health Units, as dental professionals are not part of teams working in CAPS-ADs[19]. This fact may hinder quick dental care of those patients who usually present high rates of oral problems, including dental pain[20].

This situation of difficulty in accessing oral health services by those patients unfortunately is a worldwide phenomenon as pointed out by the scientific literature[7,9,19,21]. Sheridan et al.[22] (2001) evaluated the oral health conditions and access to dental treatment of a sample of drug users and non-users and concluded that drug users reported having greater difficulty in accessing dental treatment and had a significantly higher level of oral health problems. In the present study, 71.7% of patients presented dental treatment needs, corroborating the high prevalence of oral problems in these individuals as in other studies[7,9,19-22].

The multivariate analysis indicated that there was a significant correlation between the intensity of drug use and oral health problems in the evaluated patients (p<0.05). This fact can be explained by several reasons: users of illicit drugs often neglect their oral hygiene; drugs can harm mouth and teeth by inducing dry mouth, which favor bacterial growth and acid in the mouth. In addition, drugs can induce teeth grinding, acid reflux, loss of blood flow to gums, and greater intake of sugar food or beverages, which damage their teeth[9,23,24].

In this study, the variation in the intensity of drug consumption explained approximately 22% of the variation in the variables related to oral health. Thus, high consumption of drugs, especially cocaine/crack and marijuana, was associated with oral health problems.

This fact indicated that cocaine/crack were the worse drugs associated with oral health outcomes. According to Gaio et al.[25] (2021), in a study with a sample of

7,381 participants in the National Crack Survey, individuals who smoked crack cocaine were polyusers, a fact that can increase the impact of addiction on oral health. Cury et al.[26] (2017) compared the oral health of 40 cocaine users with 120 non-users and found a statistically significant association when considering the missing component of the DMFT index. Antoniazzi et al.[27] (2021) observed that crack cocaine users had a greater frequency of tooth loss, severity of dental caries and periodontal disease and less use of dental services than the control group. In addition, Toledo et al.[28] (2017) describe that cocaine users are the ones with the greatest difficulty in accessing health services. Together, all these factors end up interfering with the oral health of this type of drug user.

Regarding the analysis of associations between sociodemographic variables and oral health, information on all exposure variables (living conditions) and the sets of outcome variables (oral health problems), the variation in living conditions explained 20% of the variation in oral health problems. These results confirmed that worse living conditions, mainly low level of education of the mother and father, were associated with oral health problems in drug users. According to Jorge et al.[29] (2017), lower socioeconomic status is a variable associated with higher consumption of psychoactive substances at same time that it exerts an influence on the health situation.

As expected, since these are studies with human beings, the correlation coefficients are not very high, since many other variables are involved in the oral health of each individual. However, this analysis is of great importance for a holistic and expanded interpretation regarding the association between the intensity of illicit substance use and oral health problems.

This study presents some limitations. It was a cross-sectional study and a temporal relationship between variables cannot be established. Data collection was carried out in 2013 and, therefore, may not represent the current condition of this population. Despite that, it is one of the few studies to date that carried out this type of analysis in this population, contributing to new evidence of association between the variables analyzed.

It is concluded that high consumption of drugs, mainly cocaine/crack and marijuana, was associated with oral health problems. In addition, worse living conditions, especially lower education of the mother and father, were associated with oral health problems in drug users. Public health and intersectoral interventions aimed at providing holistic care and facilitating access to dental care for this population may improve the quality of life and oral health of these individuals.

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Data Availability

Datasets related to this article will be available upon request to the corresponding author.

Conflict of Interest

None.

Author Contribution

Tais Cristina Nascimento Marques: conception and design of the work; acquisition of data for the work; drafting the work or reviewing it critically for important intellectual content. **Karin Luciana Migliato Sarracini:** acquisition of data for the work; drafting the work or reviewing it critically for important intellectual content. **Vanessa Gallego Arias Pecorari:** drafting the work or reviewing it critically for important intellectual content. **Karine Laura Cortellazzi:** conception and design of the work; drafting the work or reviewing it critically for important intellectual content. **Marcelo de Castro Meneghim:** conception and design of the work; drafting the work or reviewing it critically for important intellectual content. **Luciana Estevam Simonato:** acquisition of data for the work; drafting the work or reviewing it critically for important intellectual content. **Fábio Luiz Mialhe:** conception and design of the work; drafting the work or reviewing it critically for important intellectual content. **Gláucia Maria Bovi Ambrosano:** conception and design of the work; analysis of the data for the work; drafting the work or reviewing it critically for important intellectual content. All authors actively revised and approved the final version of the manuscript.

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