CARIES PREVALENCE IN HEROIN ADDICTS

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SUMMARY – The aim of the study was to determine the prevalence of caries in patients who are heroin addicts and the effects of salivary flow and saliva pH on its prevalence. The study included 200 subjects (100 subjects diagnosed with heroin addiction as the test group and 100 subjects taking no addictive substances as the control group). In both groups, saliva status was established by determining flow rates and pH of stimulated and unstimulated saliva. The total number of dental caries cases was determined using the DMFT index and their more specific detection in the context of localization on the tooth using the DMFS index. The DMFT index was higher in the test group (mean 18.78) than in the control group (mean 5.32), with a statistically significant difference (P<0.000). The highest caries prevalence in both groups was recorded on occlusal dental surfaces (44.70% in the test group and 16.20% in the control group). The prevalence of caries of vestibular dental surfaces was higher in the test group (9.40%) than in the control group (2.34%), and the difference was statistically significant (P<0.000). A statistically significant correlation was established between heroin addiction and reduced production of unstimulated saliva (P<0.001) and stimulated saliva (P<0.002), as well as pH values of stimulated saliva (P<0.001) and unstimulated saliva (P<0.001). In conclusion, a higher prevalence of caries of hard dental tissue was found in the test group. The flow of stimulated and unstimulated saliva as was as saliva pH was lower in the test group.

Key words: Dental caries; Heroin dependence – complications; Saliva – physiology; Tooth demineralization

Introduction

Caries is a unique multifactorial disease of hard dental tissues. Understanding of the etiologic factors in caries formation and the efficiency of prophylactic methods has made it possible to put the disease under control. However, answers to important questions such as how to predict who will develop caries, why immunity to caries has not developed, etc., are yet unavailable. Previous as well as present concepts of caries formation are based on the chemical process of fermentation of carbohydrates (glucose, fructose, sucrose) by bacteria, which results in acid formation, thus lowering pH of the plaque, which, in turn, leads to demineralization of the hard dental tissues²⁻⁵. The bacterial composition of the plaque is relatively stable thanks to the synergic and antagonist microbiological interaction. However, frequent exposure of the plaque to low pH may lead to a reduction in the number of the bacteria sensitive to low pH with the resulting increase in the count of *Streptococcus mutans* and *Lactobacillus*. This changes the microbiological flora from gram-positive to gram-negative, chiefly anaerobic saccharolytic microorganisms⁶⁻⁹. Even though *Streptococcus mutans* is the most frequently researched cariogenic microorganism, it is only one of over 500 types of microorganisms that can be found in dental plaque⁵.

Saliva has a protective effect on the health of hard and soft oral cavity tissues¹⁰. Chronically reduced salivation is one of the most important factors that
increase the risk of caries\textsuperscript{11}. Determining the parameters of saliva is therefore an important factor in determining caries development risks. It is a generally accepted fact that saliva and its components play an important role in the preservation of oral health, but caries development depends on a number of factors, prominent among which are defense mechanisms of the entire body, the surface morphology of the tooth, general physical health, diet, hormonal status, oral hygiene, bad habits, and so on\textsuperscript{4}. The authors of previous studies believed that genetic factors such as tooth morphology, occlusions, time of tooth eruption, etc. played a lesser role in caries development than dietary and microbiological factors did\textsuperscript{12,13}. However, results of more recent studies in twin populations have shown that genetic factors also play an important role in caries development risk\textsuperscript{14,15}. Smoking and alcohol intake can also increase the risk of caries development, as can the presence of various diseases (diabetes, Sjögren's disease, etc.) that can result in xerostomia, as well as medicine intake (antihistamines, antidepressants)\textsuperscript{16-18}. In the past several years, various authors have described pathologic changes in soft and hard tissues in the oral cavity in drug addicts and correlated higher prevalence of caries with the intake of certain addictive substances\textsuperscript{19-24}. It is well known that opioids reduce gastric secretion but whether they reduce salivation\textsuperscript{25}, one of the most important protective factors in defense against caries, has not been proven. Caries may also appear as a result of disregard of one's general health\textsuperscript{26}, including poor oral hygiene\textsuperscript{7}. Excessive intake of carbohydrates\textsuperscript{28,29} is a consequence of excessive need for sugar intake in addicts\textsuperscript{30}. However, the exact mechanism of the higher prevalence has not been fully determined. Considering the increasingly widespread intake of various addictive substances, drug addiction represents a problem in modern society. The consequences of drug abuse are highly detrimental to the individual's physical and mental health. Reference to the available literature indicates the lack of information on the oral status of addicts, including those in Croatia. This study included only the patients who are addicted to heroin with the goal to have a higher quality sample and more accurate research results. The objective of this study was to determine the prevalence of caries in heroin addicts in the test group and control group. Moreover, it was necessary to analyze the influence of stimulated and unstimulated saliva pH in the test group and control group as well as the influence of the stimulated salivary flow on the prevalence of caries in both groups.

**Subjects and Methods**

**Study population**

The study included 200 subjects, 100 in the test group and 100 in the control group. The total sample included 94 women and 106 men. The mean age was 30.15 years in the test group and 27.5 years in the control group. The subjects in both groups signed an informed consent to taking part in the study. Test group subjects were on therapy for addiction to opiates at Department of Drug Addiction, Sestre milosrdnice University Hospital Center in Zagreb, Croatia, the Ethics Committee of which provided approval for the study. Control group consisted of patients attending Department of Endodontics and Restorative Dentistry, School of Dental Medicine, University of Zagreb, Zagreb, Croatia, who had never been taking drugs. The study protocol for the control group was obtained from the Ethics Committee of the Zagreb University Hospital Center. Data were collected by general examination of the subjects and filling in a questionnaire for each subject. The questionnaire included the following: general information (name, age, occupation); medical history; intake of sweetened and alcoholic beverages; smoking; and intake of various addictive substances (test group patients also answered questions related to the most frequently taken addictive substance, the period of intake, and mode of intake).

**Clinical examination**

Wearing a mask, an experienced dental practitioner (N. P.) conducted clinical examination by using a dental explorer and dental mirror under standard dental operating lights. Ten patients were examined for tooth decay on two separate occasions to test reproducibility and agreement between the scores. The intra-examiner reliability had a kappa value of 0.857, which indicated a very high level of agreement. Following compressed air drying, all surfaces were examined in the same order in all subjects, from tooth 18 to 48.
The codes set by the World Health Organization (WHO) are as follows31 (Table 1):

<table>
<thead>
<tr>
<th>Code</th>
<th>Tooth status</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Intact crown without evidence of treated or untreated clinical caries. Since caries preceding cavitation cannot be positively detected, it was ruled out. Intact crowns therefore may include the following defects:</td>
</tr>
<tr>
<td>1</td>
<td>Caries recorded as lesion on softened tooth surface, visible cavitation and undermined enamel. This includes teeth with temporary fillings</td>
</tr>
<tr>
<td>2</td>
<td>Tooth with filling and caries</td>
</tr>
<tr>
<td>3</td>
<td>Tooth with filling without caries – includes teeth restored with crowns because of caries</td>
</tr>
<tr>
<td>4</td>
<td>Tooth missing as a consequence of caries</td>
</tr>
<tr>
<td>5</td>
<td>Tooth missing for other reasons – used for congenital deficiencies or tooth extraction due to periodontal disease, trauma, or for orthodontic reasons</td>
</tr>
<tr>
<td>6</td>
<td>If a stamped tooth includes caries, it is marked as carious</td>
</tr>
<tr>
<td>7</td>
<td>Bridge, crown, or shell carrier – used for teeth that are restored or replaced for reasons other than caries; if shell is involved, the tooth is not carious</td>
</tr>
<tr>
<td>8</td>
<td>Unerupted tooth crown does not include congenital tooth absence or tooth lost due to trauma</td>
</tr>
<tr>
<td>T</td>
<td>Trauma represents fracture of a tooth surface as a result of trauma, without evidence of caries</td>
</tr>
<tr>
<td>9</td>
<td>Tooth not recorded – used for any erupted tooth that cannot be examined for a certain reason (e.g., orthodontic dividers).</td>
</tr>
</tbody>
</table>

The data obtained from dental status verification allowed for the calculation of two very important indices, Decayed, Missing and Filled Teeth (DMFT) index and Decayed, Missing, and Filled Surfaces (DMFS) index. The D-component encompasses categories 1 and 2, the M-component relates to 4 and 5, and the F-component only includes teeth under code 3. All the teeth and third molars were included, while teeth marked with 6 (dental filling stamps) and 7 (bridge carriers, special crowns or shells) were not included in the DMFT index.

The DMFT shows the representation of dental caries, and the numerical value of caries prevalence is obtained by adding the numbers of carious teeth (D or K), missing teeth (M or E) and teeth with fillings (F or P). If a tooth has both a filling and caries, it is considered to be carious only (D). A more detailed index is the DMFS index, which includes dental surfaces, five in the molars and premolars and four in the front teeth. Registration was conducted by way of filling in a form especially created for the purposes of this study.

Establishing and recording salivary status

Salivary status was determined by measuring salivary flow and determining pH of unstimulated and stimulated saliva in each subject. Buffer capacity was not established since a linear correlation exists between pH of saliva and buffer capacity of saliva, as well as salivary flow32. Salivary status was established first in the morning without prior tooth brushing. We asked each patient to take a seat and, from a relaxing position, spit out, without swallowing, the saliva collected within a one-minute period into a graded test tube through a glass funnel. The salivary flow was entered in the form, immediately after which the saliva pH was determined applying the colorimetric method and using a universal pH indicator paper.
0–14 (Panpeha, Schleicher&Schuell, Sigma-Aldrich GmbH, Germany). After that, the stimulated salivary flow rate was established by asking the patient to begin chewing 1.5 g of pure paraffin wax (Parafilm, American National Can., Greenwich, Ct., USA) for five minutes and, also without swallowing, spitting all the saliva into a graded test tube through a glass funnel. After entering the stimulated salivary flow in the form, the pH of the sample was immediately established using the same colorimetric method. It was necessary to measure pH of each sample immediately after entering the salivary flow because pH of the saliva exposed to air quickly changes toward alkaline as saliva loses carbon dioxide. The unstimulated salivary flow rates were grouped into three categories and thus recorded: 
1 = <0.5 mL/min  
2 = 0.5-1.0 mL/min  
3 = >1.0 mL/min  
The stimulated salivary flow rates were also grouped into three categories and thus recorded: 
1 = <1.0 mL/min  
2 = 1.0-2.0 mL/min  
3 = >2.0 mL/min  

pH levels of unstimulated saliva were recorded with pH values as follows: 
1 = <3  
2 = 4  
3 = 5  
4 = 6  
5 = 7  
6 = >8  
pH levels of stimulated saliva were recorded with pH values as follows: 
1 = <5  
2 = 5-7  
3 = >7.  

Data analysis  
The data obtained were entered in a database and processed using the SPSS 11.0 statistical package. The database comprised all the data obtained by the questionnaire and clinical examination of the subjects. The sample structure was described in relative frequencies (percentages). The data were initially described in a descriptive statistical manner, depending on the type, and with the use of the $\chi^2$-test. Frequency distribution was provided for qualitative data, while for quantitative data the mean value and standard deviation were calculated, as a dispersion measure. Moreover, the minimum and maximum values of the results were provided. Differences between the groups were tested using t-test on the mean value differences. The accepted value of statistical significance was 95% ($P<0.05$).  

Results  

Questionnaire results  
Analysis of data from the questionnaire showed a statistically significant difference between the test group and control group in the frequency of cigarette smoking, with a mean of 20.58 (SD=10.00) cigarettes per day in the test group and 6 cigarettes per day (SD=8.43) in the control group. A statistically significant difference was recorded in the frequency of coffee drinking, with a mean of 1-2 cups of coffee per day in the test group and only occasional coffee taking in the control group ($\chi^2=2.482; df=198; P<0.05$). Data analysis revealed 45% of the test group subjects to suffer from not only their main illness (addiction to opiates) but also from other, mostly mental illnesses (depression, personality disorder, schizophrenia, obsessive-compulsive disorder). Further data analysis included processing the parameters of the type of the drugs taken by the subjects, which revealed heroin, methadone, marijuana, and hashish to be the drugs taken most frequently (several times a day) for the longest period (over five years).  

Salivary flow rate and pH  
There was significant correlation between the test group and control group according to unstimulated ($P<0.001$) and stimulated ($P<0.002$) salivary flow rates (Table 2). Moreover, significant correlation was established between pH values of unstimulated and stimulated ($P<0.001$ both) salivary flow rates between the test group and control group (Tables 3 and 4).  

DMFT and DMFS indices  
Dental status of both groups is shown in Table 5. The established frequency of caries, extracted teeth and filled teeth in the test group was 58.70%, as opposed to the control group, in which the frequency...
Caries prevalence in heroin addicts was 16.63%, yielding a statistically significant difference ($P<0.000$). In the test group, the prevalence of caries was 39.40%, extraction 14.34%, and teeth with fillings 5.0%. In the control group, the prevalence of caries was 6.25%, extraction 2.13%, and teeth with fillings 7.21%. Moreover, a statistically significant between-group difference was recorded in the prevalence of caries and extracted teeth ($P<0.000$). Concerning the number of teeth with fillings, there was no statistically significant between-group difference ($P<0.20$), although a higher mean number of teeth with fillings was found in the control group as compared with the test group (7.21% vs 5.0%).

Analysis of the results obtained by using the DMFS index showed caries to occur most frequently on occlusal surfaces in both groups, with a frequency of 16.2% in the control group and 44.7% in the test group. On smooth dental surfaces, it most frequently occurred on the proximal surfaces in both the test group (15.5%) and control group (8.6%). However, although the prevalence of caries was lower on the vestibular surfaces than on other dental surfaces in both groups, a statistically significant difference ($P<0.000$) was established between the groups. The frequency of vestibular surface caries was higher in the test group (9.4%) than in the control group (2.34%).

**Discussion**

A statistically significant difference was established according to smoking habits, i.e. the test group subjects smoked considerably more than those in the control group ($P<0.01$). The results are consistent with those reported from earlier studies. Cigarettes may have a drying effect on the mouth, that is, they may

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**Table 2. Absolute and relative frequencies of unstimulated and stimulated salivary flow rates in test group and control group**

<table>
<thead>
<tr>
<th>Group</th>
<th>Unstimulated salivary flow rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;0.5 mL/min (%)</td>
</tr>
<tr>
<td>Test</td>
<td>38 (38)</td>
</tr>
<tr>
<td>Control</td>
<td>21 (21)</td>
</tr>
</tbody>
</table>

**Stimulated salivary flow rate**

<table>
<thead>
<tr>
<th>Group</th>
<th>&lt;1 mL/min (%)</th>
<th>1-2 mL/min (%)</th>
<th>&gt;2 mL/min (%)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test</td>
<td>23 (23)</td>
<td>72 (72)</td>
<td>5 (5)</td>
<td>100 (100)</td>
</tr>
<tr>
<td>Control</td>
<td>20 (20)</td>
<td>54 (54)</td>
<td>26 (26)</td>
<td>100 (100)</td>
</tr>
</tbody>
</table>

**Table 3. Absolute and relative frequencies of some unstimulated saliva pH values in test group and control group**

<table>
<thead>
<tr>
<th>Group</th>
<th>Unstimulated saliva pH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total (%)</td>
</tr>
<tr>
<td></td>
<td>3 (%)</td>
</tr>
<tr>
<td>Test</td>
<td>2 (2)</td>
</tr>
<tr>
<td>Control</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

**Table 4. Absolute and relative frequencies of some stimulated saliva pH values in test group and control group**

<table>
<thead>
<tr>
<th>Group</th>
<th>Stimulated saliva pH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total (%)</td>
</tr>
<tr>
<td></td>
<td>&lt;5 (%)</td>
</tr>
<tr>
<td>Test</td>
<td>5 (5)</td>
</tr>
<tr>
<td>Control</td>
<td>1 (1)</td>
</tr>
</tbody>
</table>

**Table 5. Dental disease characteristics in test group and control group**

<table>
<thead>
<tr>
<th>Group</th>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test</td>
<td>DMFT</td>
<td>18.78</td>
<td>7.50</td>
</tr>
<tr>
<td></td>
<td>Decay</td>
<td>12.57</td>
<td>6.30</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>4.59</td>
<td>4.37</td>
</tr>
<tr>
<td></td>
<td>Filling</td>
<td>1.60</td>
<td>2.93</td>
</tr>
<tr>
<td></td>
<td>DMFT</td>
<td>5.32</td>
<td>7.84</td>
</tr>
<tr>
<td></td>
<td>Decay</td>
<td>2.00</td>
<td>4.04</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>0.68</td>
<td>1.54</td>
</tr>
<tr>
<td></td>
<td>Filling</td>
<td>2.31</td>
<td>4.52</td>
</tr>
</tbody>
</table>

DMFT = Decayed, Missing and Filled Teeth index

was 16.63%, yielding a statistically significant difference ($P<0.000$). In the test group, the prevalence of caries was 39.40%, extraction 14.34%, and teeth with fillings 5.0%. In the control group, the prevalence of caries was 6.25%, extraction 2.13%, and teeth with fillings 7.21%. Moreover, a statistically significant between-group difference was recorded in the prevalence of caries and extracted teeth ($P<0.000$). Concerning the number of teeth with fillings, there was no statistically significant between-group difference ($P<0.20$), although a higher mean number of teeth with fillings was found in the control group as compared with the test group (7.21% vs 5.0%).

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**Discussion**

A statistically significant difference was established according to smoking habits, i.e. the test group subjects smoked considerably more than those in the control group ($P<0.01$). The results are consistent with those reported from earlier studies. Cigarettes may have a drying effect on the mouth, that is, they may
reduce salivary flow and saliva pH\textsuperscript{37}. Although this study did not show a statistically significant difference ($P<0.56$) between the two groups according to consumption of alcoholic beverages, the fact that 5% of the test group subjects had previously suffered from alcoholism should be taken into account because a correlation has been established between alcohol consumption and dental caries development\textsuperscript{38}.

Considering that the test group subjects were in the rehabilitation process, it was necessary to include the intake of methadone as an opiate agonist in the analysis. Methadone was most frequently ingested, which mode of intake provides direct contact between the drug and oral mucosa. Although the authors had previously established a link between methadone intake and xerostomia, this study did not show a statistically significant difference in the flow of stimulated and unstimulated saliva between the test group subjects having ingested methadone for more than five years and those having done it for less than five years\textsuperscript{39}. However, it should be noted that this study used a different sample and different methodology.

Study results showed that the test group subjects secreted on average smaller amounts of unstimulated and stimulated saliva than the control group. Considering that opiate addicts take a number of other addictive substances in addition to heroin, previous literature states various addictive substances that may lead to xerostomia, with hallucinogens and cannabis as the leading representatives\textsuperscript{20}.

Moreover, the value of unstimulated and stimulated saliva pH in the test group was lower, i.e. their saliva was more acidic. Consequently, caries potential was higher in the test group.

This type of research has not been conducted in Croatia, although the authors of a previous study established the mean DMFT of 7.76\textsuperscript{40}, and another mean of 9.53\textsuperscript{41} in the rest of the population in Croatia. However, they did not assess the prevalence of caries in addicts.

The higher prevalence of caries progression in the test group may be attributed to reduced salivary secretion and a reduced effect of its protective role and a decrease in saliva pH, which promotes the process of enamel demineralization. These results are consistent with the results of a previous study, in which Angelillo \textit{et al.} established a mean DMFT of 12.9 and mean DMFS of 36.2 in the addict group, whereas in our subjects the respective figures were 18.78 and 40.43\textsuperscript{27}. As the reason for such results, Angelillo \textit{et al.}\textsuperscript{27} state poor Oral Hygiene Index (OHI). However, this study used a different methodology and did not assess OHI but salivary status because reduced saliva secretion can be one of the potential factors in higher caries prevalence. Bearing in mind that addicts take a number of other addictive substances in addition to heroin, previous studies attempted to establish whether a difference existed between amphetamine abusers and heroin abusers and caries prevalence, but no statistically significant difference was established\textsuperscript{42}. In 1967, Lowenthal found a higher prevalence of caries on cervical tooth surfaces\textsuperscript{43}. This was confirmed by Angelillo \textit{et al.} in their study from 1991\textsuperscript{27}. The results obtained in the present study showed the highest prevalence of caries on occlusal surfaces in both groups, but the prevalence of caries in cervical area was higher in the test group, where the difference was statistically significant. This result is consistent with literature data.

Previous studies report that addicts neglect their health\textsuperscript{26,44}, have a high sugar intake\textsuperscript{28,29} and, if the fact is taken into account that they seek help when the situation is very serious, i.e. when symptoms of pain and swelling in the mouth appear\textsuperscript{30}, it may be said that a different approach is necessary in the addicts' oral cavity repair to alleviate the symptoms as much as possible.

Moreover, previous studies have established that opioids reduce gastric secretion, although not proving whether they reduce salivary secretion as well\textsuperscript{25,45}. The results obtained in our study showed that salivary secretion was reduced, which, in addition to poor oral hygiene, may have a powerful effect on caries development. Future studies should therefore pay more attention to establishing the cause of hyposalivation in opiate addicts.

In addition to their main disease, addicts also suffer from other mental disorders and pains, which is believed to be a potential reason for increased fear of dental intervention\textsuperscript{46}. Dentists should be aware of the mental state of such patients in order to make cooperation with the patient more successful and to fully implement the therapy plan.

As the latest studies have shown that early detection of drug substance in urine and new therapy
Caries prevalence in heroin addicts

Conclusions

Stimulated and unstimulated salivary flow was lower in the test group, and saliva pH was more acidic. Caries prevalence was considerably higher in the test group than in control group, which may be attributed to reduced salivary secretion and a decrease in saliva pH. Moreover, a higher prevalence of atypical caries of the cervical area on smooth tooth surfaces was recorded in the addicts.

References


Sažetak

**UČESTALOST KARIJESA KOD PACIJENATA OVISNIH O HEROINU**

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Provedena je studija kako bi se odredila pojavnost karijesa kod pacijenata ovisnih o heroinu i utvrdio utjecaj količine sline i pH sline na njihovu pojavnost. U studiju je bilo uključeno 200 ispitanika (100 ispitanika kojima je dijagnosticirana ovisnost o heroinu činili su testnu skupinu i 100 ispitanika koji nisu uzimali nikakva sredstva ovisnosti činili su kontrolnu skupinu). Status sline obiju skupina ispitanika određen je tako da je utvrđena količina i pH stimulirane i nestimulirane sline. Ukupan broj karijesnih promjena na zubima određen je pomoću indeksa DMFT, a njihova preciznija identifikacija u smislu lokalizacije na zubu pomoću indeksa DMFS. Indeks DMFT bio je veći kod testne skupine ispitanika (srednja vrijednost 18,78) nego kod kontrolne skupine (srednja vrijednost 5,32) sa statistički značajnom razlikom (P<0,000). Kod ispitanika obiju skupina utvrđena je najveća pojavnost karijesa na okluzalnim plohama zuba (testna skupina 44,70% i kontrolna skupina 16,20%). Učestalost karijesa vestibularnih ploha zuba bila je veća kod testne skupine ispitanika (9,40%) nego kod kontrolne skupine ispitanika (2,34%), a razlika se pokazala statistički značajnom (P<0,000). Utvrđena je statistički značajna povezanost ovisnosti o heroinu i smanjene količine stimulirane i nestimulirane sline te pH stimulirane (P<0,001) i nestimulirane (P<0,001) sline. U zaključku, kod ispitanika testne skupine utvrđena je veća pojavnost karijesa tvrdih zubnih tkiva. Količina stimulirane i nestimulirane sline bila je manja, a pH sline niži kod testne skupine ispitanika.

Ključne riječi: Zubi karijes; Heroin, ovisnost – komplikacije; Slina – fiziologija; Zubi, demineralizacija