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Scientific Research Journal

Journal of Oral Health & Oral Epidemiology

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Haapasalo M, Qian W: Irrigants and Intracanal Medicaments. In: Ingle JI, Bakland LK: *Endodontics* 6. 6<sup>th</sup> ed. BC Decker Inc, Hamilton; Ontario, Canada. 2008; Chapter 28: 997-9.

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Neville BW, Damm DD, Allen CM, Bouquot JE. *Oral and maxillofacial pathology*. 2<sup>nd</sup> ed. Philadelphia: W.B Saunders Co.; 2002. pp. 533-87.

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## Assessing the questionnaires on perceived oral healthcare need: A systematic review

Zahra Yaghoubi DDS<sup>1</sup>, Tayebeh Malek-Mohammadi DMD, PhD<sup>2</sup>,  
Mohammad Khajedaluae MD<sup>3</sup>, Maryam Salehi MD<sup>4</sup>

### Review Article

#### Abstract

**BACKGROUND AND AIM:** Perception of the need for oral healthcare plays a key role in creating motivation and demand for utilization of oral healthcare services. Furthermore, people with perceived needs to oral healthcare, due to the higher profit potential of services, will be on higher priority for services. The aim of this study was to undertake a systematic review of the existing literature about questionnaires used for assessing the perceived oral healthcare needs.

**METHODS:** The search was conducted in PubMed, ISI and Scopus databases in March 2016. Questionnaire-based and the papers which aimed to determine the perceived need for any type of oral healthcare and dental treatment were included to this study. After determining the appropriate papers, related data were extracted and reviewed.

**RESULTS:** Out of 7069 records found, 190 questionnaire-based papers were included in the review. Ninety-four papers were related to the overall evaluation of oral healthcare need, which did not ask the need for types of oral healthcare service. Sixty-six papers studied the need for a specified dental service, and thirty papers recorded the types of oral healthcare service via asking the open or multiple choices questions. There were not comprehensive and standard questionnaires covering all the common types of oral healthcare services.

**CONCLUSION:** Despite the importance of considering the perception of needs for oral healthcare, there is a lack of the comprehensive and standard questionnaires. Studies aimed to assess perceived oral healthcare needs should use questionnaires which include appropriate items on common types of oral healthcare services based on the characteristics of the target group. Concordance with perceived and normative need is an issue that should be addressed in future researches.

**KEYWORDS:** Oral Health; Surveys and Questionnaires; Review; Need

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Oral health is an important part of general health and life quality.<sup>1</sup> Awareness of oral health needs in population can be useful for promoting the oral healthcare system.<sup>2</sup> According to Oxford Dictionary definition, a need is circumstances in which something is necessary. Community health needs assessment is used in evaluating the burden of disease, quantified estimation of population healthcare needs, ascertaining

needs patterns in the population, emphasizing on populations priorities and areas with unmet needs, setting goals to respond to unmet needs, and making decision how to use resources.<sup>3</sup>

Although there is no generally agreed definition of need, the taxonomy suggested by Bradshaw (1972) is recommended. He defined healthcare need as three categories. Normative need is based on experts'

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opinions, perceived (felt) need is a self-evaluation of healthcare need, and the expressed need is a felt need which has led to action to get health services.<sup>3</sup>

The most commonly used methods of assessing the need for dental care are based solely on clinical criteria. The limitations associated with a total reliance on clinical indicators and normative need have been realized as lack of objectivity and reliability, negligence of quality of life concept and psychosocial aspects, lack of consideration for health behaviors and patient compliance, and neglect of consumer rights.<sup>3,4</sup>

In addition, need evaluation should include the patients' perceptions, the effect of ill-health on individuals and dysfunction levels.<sup>5</sup> However, to evaluate psychosocial aspects of oral health, oral health-related quality of life measures have been well developed,<sup>6</sup> but less effort has been made to develop structured questionnaires to comprehensively assess perceived oral healthcare needs. This is a necessity to develop a comprehensive and standard questionnaire which covers the perceived need for all the types of oral healthcare services. Therefore, the aim of this study was to carry out a systematic review of the existing literature on perceived oral healthcare need assessment in order to find standard and comprehensive questionnaires.

## Methods

We conducted a systematic review of the available literature by searching PubMed, ISI and Scopus databases in March 2016 to find papers about the perceived need for oral healthcare. A broad search strategy by a wide range of terms was pursued to capture as many relevant studies as possible; and therefore, a sensitive electronic search strategy was designed using the following terms based on title and abstract: (subjective OR perceived OR expressed OR perception OR felt OR self-report\* OR self-evaluate\* OR self-assess\* OR self-rate\* OR reported OR unmet) AND (dental OR oral OR restorat\*

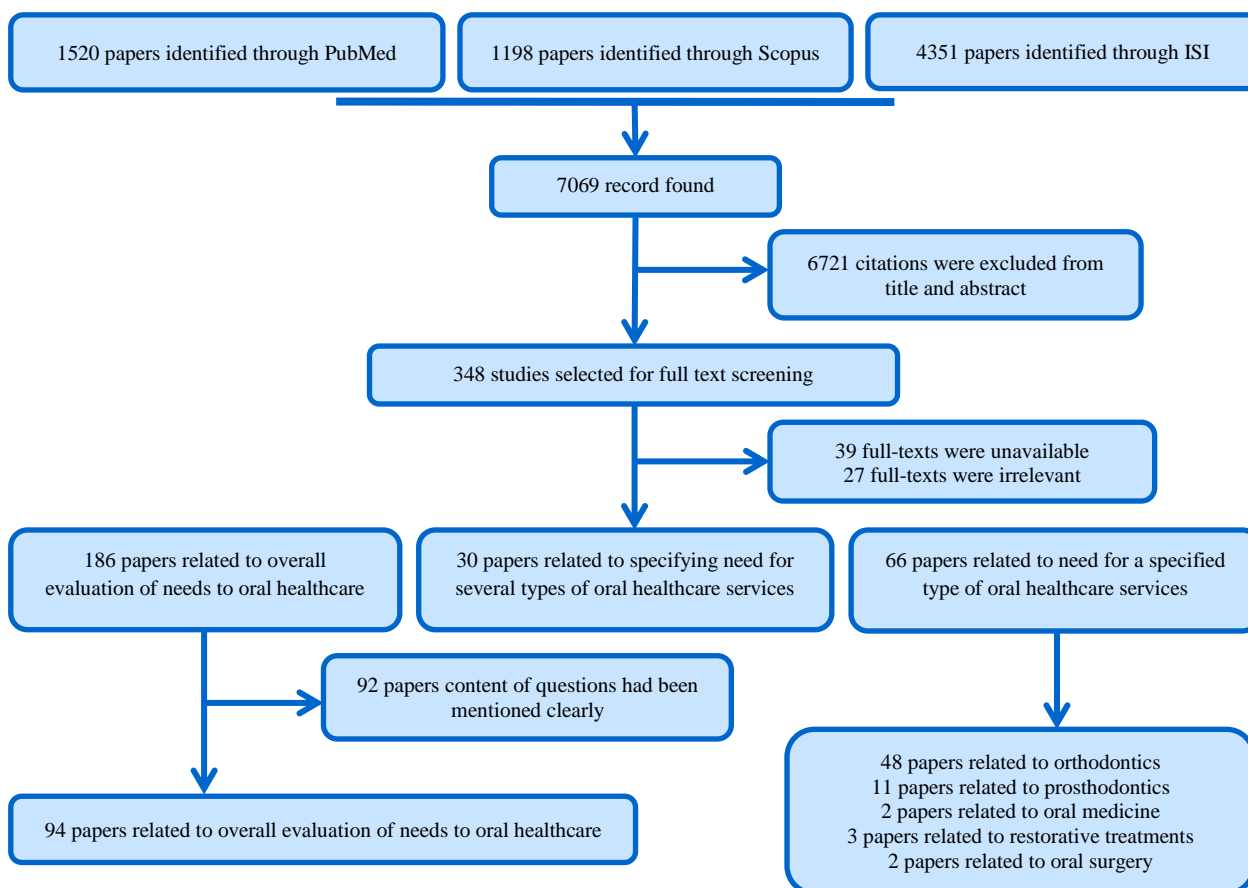
OR prosth\* OR denture OR implant OR orthodont\* OR appliance OR gingiv\* OR periodon\*) AND (questionnaire OR interview OR survey) AND (Need). No date restriction was applied. Unpublished studies and non-English papers were not considered for inclusion in this systematic review. The adopted search strategy led to 7069 potentially relevant citations, which were transferred to the EndNote library. Papers were potentially suitable for inclusion which aimed to determine the perceived need for any types of oral healthcare and dental treatment by interview or questionnaire.

After elimination of duplicate references, the related papers were screened from the titles and abstracts. Full-texts were reviewed carefully. After determining related papers, the related data were imputed into an excel datasheet. Each paper data was extracted based on the name of first author, year of publication, target population, interview or self-administered questionnaire, if questionnaire validation was reported, and whether papers asked from perceived need to several or a specified type of oral healthcare services.

## Results

Details of the identification, screening and selection process are presented in figure 1. We divided related papers into 3 categories. The first category included 186 papers related to the overall evaluation of perceived needs to oral healthcare, but in 92 citations the content of questions had not been mentioned clearly. Thus, these papers were excluded and 94 papers remained. The second category was 30 citations studied the perceived need for several types of oral healthcare services, and the third category included 66 citations evaluated the need for a specified type of oral healthcare services.

The first category was included 94 papers for the overall evaluation of perceived oral healthcare needs. Except for a study which used the specified score of an oral health-related quality of life measure as unmet oral healthcare need, these studies assessed the



**Figure 1.** Flow diagram of studies on the perceived need for oral healthcare services

perceived needs by single question without asking the type of oral healthcare services. The

concept of different applied questions is presented in table 1.

**Table 1.** Types of questions applied for overall evaluation of perceived oral healthcare need

Types of questions in reviewed studies and study reference number	Absolute and relative frequency (%)
Determining the specified score of the oral health-related quality of life measures as unmet oral healthcare need <sup>7</sup>	1-1.6
Estimation of perceived needs based on using of collection of variables (such as collection of self-reported general and oral health, self-perceived unmet need, and self-perceived pain) <sup>8,9</sup>	2-2.12
Rating the perceived needs based on an ordinal scale such as high or low need <sup>10-14</sup>	5-5.31
Determining unmet needs as under-utilization of dental services <sup>15</sup>	1-1.06
Considering need to dental services by asking perception of need for dental filling or extraction <sup>16-20</sup>	5-5.31
Question of having unmet, feeling or perceived need for dental care <sup>21-48</sup>	28-29.7
Inability to get oral healthcare needed services during the specified period of time (18 and 24 months <sup>49</sup> , one-year <sup>50-75</sup> , 6 months <sup>76-82</sup> , 3 months <sup>83</sup> )	35-37.2
Determining unmet need as delay or failure to receive needed dental care <sup>56,60,61,63,68,71-74,84</sup>	10-10.6
Inability to get oral healthcare needed services due to cost <sup>50,84-86</sup>	4-4.25
Asking if respondent gone to the dentist tomorrow do they think they would need any treatment or not <sup>87-90</sup>	4-4.25
Unmet dental need defined as last visit to the dentist more than 1 year before the interview when the participant reports difficulty chewing hard foods <sup>91</sup>	1-1.06
Considering need for check-ups and preventive services in the content of the question that majorities of these papers were applied for children <sup>92-99</sup> and one paper applied for adults <sup>100</sup>	9-9.57

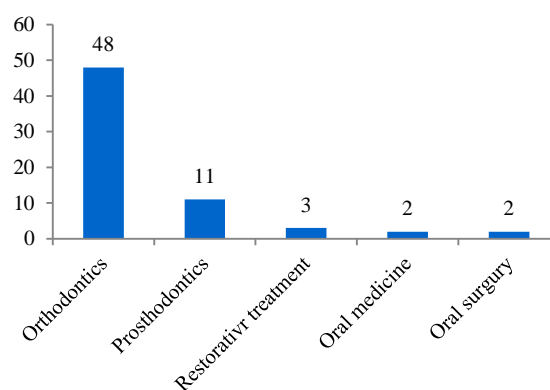
**Table 2.** Related items to each type of dental services

Types of dental service
Restorative treatment filling, sensitive teeth, decayed teeth, broken teeth, esthetic problems, cosmetic dentistry, tooth cavities, dental caries, broken tooth, restoration, tooth that hurts, chipped tooth
Orthodontics orthodontics, braces, need to improve appearance, teeth straightening, fill in gaps between teeth
Periodontics gum disease, periodontics, scaling, gum surgeries, gum treatment, swollen gum, loose tooth, gum soreness, gingival bleeding, gum bleeding, tooth mobility, gum boil, infected gum, polishing, gingival inflammation, gum hurt
Prosthodontics difficulty chewing, crown, bridge, tooth replacement, denture, denture work, new denture, denture repair, partial denture, denture adjustment, prosthesis, missing, cap, grinding or clenching of teeth
Oral medicine mouth sores, mouth ulcer, oral medicine, bad breath, dry mouth, halitosis, having white patch on the tongue, having cracks on the corners of the mouth, having white patch in the mouth, burning sensation in the mouth or on the tongue, care or assessment of specific problem (pain, infection, injury), current pain
Surgery extraction, abscessed tooth, teeth pulled, implants
Endodontics root canal, tooth or dental ache, endodontic, relief of pain, pain, oral pain
Prevention cleaning, X-rays, check-up, hygiene, examination, preventive care

The second category was included 30 papers which had evaluated perceived need by asking types of oral healthcare services and applied for the adult population. In this category, common format of questions was asked in a close-ended format including a combination of questions by yes/no answers followed by multiple choices of items related to oral problems or dental treatments.

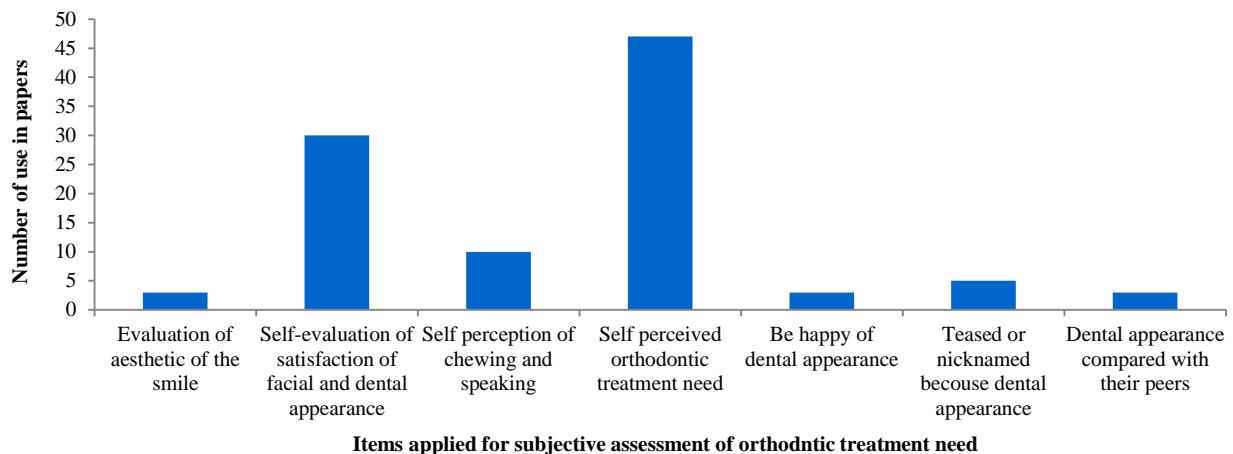
We extracted all proposed dental items and classified them to related dental services. Prosthetic services were the most frequent items which followed by restorative and periodontal services. Moreover, related items for assessment of the need for each type of dental services were asked by different terms. Items on restorative treatments had the most diversity. Related items to each type of dental service and different applied terms are presented in table 2.

In the third category, 66 citations were studied the perceived need for a specified type of oral healthcare services. A number of related papers to each dental service are presented in figure 2. Except for the papers related to perceived orthodontic treatment, other studies used limited items and applied to the adult population.

**Figure 2.** Numbers of related papers to each type of dental services

The prevailing target population of the orthodontic study was adolescents. For subjective assessment of orthodontic treatment, different items were used which presented in figure 3. Normative tools such as aesthetic component (AC) of the index of orthodontic treatment need (IOTN) were not included. Characteristics of the included papers in the second and third categories are presented in table 3.

59% of all the studies conducted by self-administered questionnaire. Characteristics of the included papers in the second and third categories are presented in table 3. Some papers



**Figure 3.** Number of items applied for subjective assessment of orthodontic treatment need

set in more than one category, so the sum of relative frequencies may be over 100%.

### Discussion

For understanding perceived oral healthcare need, a valid and comprehensive questionnaire is one of the main prerequisites. In this study, we explored questions of the existing papers on perceived oral healthcare need to find standard, comprehensive and acceptable questionnaires.

Reviewing the literature showed a variety of measures has been used. Majority of included studies merely explored presence or absence of the perceived need for oral healthcare without asking a variety of oral healthcare services separately (the first category of included papers). For an overall assessment of perceived oral healthcare need, mostly two common formats of questions were used. Some of the papers asked the

current need for oral healthcare services, whereas the other papers, mostly evaluated the need for oral healthcare in terms of unmet need, were asked the inability to get oral healthcare needed services during the specified period of time. This time course was mostly a one-year period with this format: During the past 12 months, was a time you need dental care but could not get it? Yes, no.

It seems that this method of perceived need assessment may not give much information. In fact, by knowing the types of services required separately policy-makers will be capable of more accurate planning for oral healthcare services delivery. Papers, which evaluated several types of dental treatments, were widely varied in terms of the number and items related to each dental service. These items varied in terms of types of proposed items on oral healthcare services. However, there were some similarities between applied items.

**Table 3.** Papers included in the second and third categories

Papers	Count of papers, number of references in the reference list	Year range of publication
Papers which asked types of oral healthcare services	I: 18 <sup>101-118</sup> Q: 12 <sup>119-130</sup>	1989-2013 1997-2016
Prostodontics	I: 2 <sup>131-132</sup> Q: 9 <sup>133-141</sup>	2009-2013 1983-2012
Orthodontics	I: 13 <sup>142-154</sup> Q: 35 <sup>155-189</sup>	1991-2015 1983-2015
Restorative treatment	Q: 3 <sup>190-192</sup>	2001-2014
Oral medicine	I: 2 <sup>193-194</sup>	1992-2016
Oral surgery	I: 1 <sup>195</sup> Q: 1 <sup>196</sup>	1994 2005

I: interview; Q: questionnaire



Most frequent items were related to prosthetic services which followed by restorative and periodontal services. Despite the importance of the prevention of oral problems, few items were about the need for prevention services. It may be due to the fact that people feel the need to dental services when feel the symptoms of oral problems. Furthermore, the utilization of oral healthcare services is influenced by socioeconomic factors so preventive cares may seem to be an unnecessary service.<sup>197,198</sup> Applied items for assessment of the need for each type of dental services were asked by different terms. The most variety was related to items on restorative treatments. For evaluating the need to prosthetic treatment, often same and common items were used. Most frequent items were full denture related treatments after that fixed prosthesis was asked in terms of bridge and crowns. Need for periodontal treatment was often examined by asking the gum related symptoms like gum bleeding.

Besides, few studies have evaluated treatment needs for some of the oral lesions and most of them were in HIV patients (white patches in the mouth, having cracks on the corners of the mouth, burning sensation) or older adults (dry mouth). Also, the majority of papers that used denture related items had been applied to older adults and elderly. It shows that the applied items must be selected according to the target group.

Some of the studies in the second category used open questions and asked the respondent to specify all of their dental treatment needs. But this format may have problems. Response classification maybe hard, after all, respondents may not remember all of their dental treatment needs or reluctant to respond to questions that it takes a long time. Therefore, the responses to the close-ended questions may be more valid and reliable.<sup>199</sup> It is reasonable that a standard and comprehensive questionnaire for evaluating all the common types of oral healthcare services should be included

questions in several domains such as restorative, prosthetic, endodontic, periodontal and preventive services. As mentioned previously, it is better to apply close-ended question. Moreover, because each dental service may probably need more than the single item multiple-choice questions seem more suitable. With limited items, not including important symptoms of oral and dental diseases, all the types of oral healthcare needs may not adequately be assessed, resulting in underestimation.

For each dental service, use of the perceptible symptoms which is highly correlated with clinical finding may be suitable items. For instance, some of the studies evaluated restorative needs by word of "filling" but it looks applying items about main dental caries symptoms like cavities or hypersensitivity are more accurate. Also, asking the gum related symptoms, like gum bleeding and tooth mobility which highly correlate with clinical findings, appear to be appropriate items. Prosthetic services include a wide range of treatment options. So a comprehensive questionnaire should include more items for prosthetic services like the presence of missing and functional problems (problems with chewing and talking), getting new full or partial denture, crown and bridge and dental implant. Asking about a toothache is a suitable item for evaluating endodontic services. Moreover, preventive services should be included in the questionnaire by asking items on dental examination and check-up.

The third category was papers on specified types of oral healthcare services. The most of the papers that assessed perceived need for orthodontic treatment applied for adolescents (12-15-year old) and tried to do a comprehensive subjective assessment by structured questionnaires. However, few studies, which assessed perceived the need for other specified types of oral healthcare services, used the limited items by one or two questions.

We can say except for the papers related to

orthodontic treatment, less effort has been made to develop standard and comprehensive questionnaires to assess perception of other specified oral healthcare needs. For more accurate need assessment, it may be better to design a unique and standard questionnaire for perceived need for each type of dental services.

Using of validation methods were not always described, but were not used in the exclusion process. In the majority of studies, there was not a report on validity and especially reliability of the questionnaires and the results of these studies may be less accurate. Totally, almost more than half of studies used self-administered questionnaire and others conducted by face to face or telephone interview. Perhaps the most advantage of applying mail questionnaire is lower cost, but there is no one available to explain and clarify questions may be problematic especially for children and elderly.<sup>200</sup>

This study was carried out by some limitations. In this study, there was the lack of access to some of the full-text papers and were excluded from the study. In some full-text papers, the questions were not available, so the items were extracted from the results

and tables. Also, we did not include non-English papers in the review.

### Conclusion

In conclusion, we can say that despite the importance and necessity of considering the perception of needs for oral healthcare, there is a lack of the standard questionnaires. The difference in applied methods for perceived need assessment may make problems in generalizing of the result of these studies. Therefore, it is absolutely necessary to design standard questionnaires by considering the difference in needs of various age groups. Results of this systematic review can help researchers to design an appropriate and comprehensive questionnaire for assessment of the perceived need for oral healthcare services. For maximizing the accuracy of the results of these questionnaires, accordance with perceived and normative need is matters that should be addressed in future research.

### Conflict of Interests

Authors have no conflict of interest.

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### References

1. Sheiham A. Oral health, general health and quality of life. *Bull World Health Organ* 2005; 83(9): 644.
2. Petersen PE. Global policy for improvement of oral health in the 21st century--implications to oral health research of World Health Assembly 2007, World Health Organization. *Community Dent Oral Epidemiol* 2009; 37(1): 1-8.
3. Sheiham A, Tsakos G. Oral health needs assessment. In: Pine CM, Harris R, editors. *Community oral health*. London, UK: Quintessence Publishing; 2007. p. 59-76.
4. Sheiham A, Maizels JE, Cushing AM. The concept of need in dental care. *Int Dent J* 1982; 32(3): 265-70.
5. Luchi CA, Peres KG, Bastos JL, Peres MA. Inequalities in self-rated oral health in adults. *Rev Saude Publica* 2013; 47(4): 740-51.
6. Locker D, Allen F. What do measures of 'oral health-related quality of life' measure? *Community Dent Oral Epidemiol* 2007; 35(6): 401-11.
7. Singh H, Maharaj RG, Naidu R. Oral health among the elderly in 7 Latin American and Caribbean cities, 1999-2000: A cross-sectional study. *BMC Oral Health* 2015; 15: 46.
8. Vale EB, Mendes AC, Moreira RS. Self-perceived oral health among adults in Northeastern Brazil. *Rev Saude Publica* 2013; 47(Suppl 3): 98-108. [In Portuguese].
9. Ramraj C, Azarpazhooh A, Dempster L, Ravaghi V, Quinonez C. Dental treatment needs in the Canadian population: Analysis of a nationwide cross-sectional survey. *BMC Oral Health* 2012; 12: 46.
10. Lundegren N, Axtelius B, Hakansson J, Akerman S. Dental treatment need among 20 to 25-year-old Swedes: Discrepancy between subjective and objective need. *Acta Odontol Scand* 2004; 62(2): 91-6.
11. Rikardsson S, Jonsson J, Hultin M, Gustafsson A, Johannsen A. Perceived oral health in patients with Crohn's disease.

- Oral Health Prev Dent 2009; 7(3): 277-82.
12. Syed S, Bilal S, Dawani N, Rizvi K. Dental anxiety among adult patients and its correlation with self-assessed dental status and treatment needs. *J Pak Med Assoc* 2013; 63(5): 614-8.
  13. Stenberg P, Hakansson J, Akerman S. Attitudes to dental health and care among 20 to 25-year-old Swedes: Results from a questionnaire. *Acta Odontol Scand* 2000; 58(3): 102-6.
  14. Slayton RL, Damiano PC, Willard JC. Perceived dental needs of children enrolled in Iowa's Medicaid Supplemental Security Income (SSI) health plan. *ASDC J Dent Child* 2001; 68(3): 206-10, 152.
  15. Maserejian NN, Trachtenberg F, Link C, Tavares M. Underutilization of dental care when it is freely available: A prospective study of the New England Children's Amalgam Trial. *J Public Health Dent* 2008; 68(3): 139-48.
  16. Parker EJ, Jamieson LM. Associations between indigenous Australian oral health literacy and self-reported oral health outcomes. *BMC Oral Health* 2010; 10: 3.
  17. Jamieson LM, Mejia GC, Slade GD, Roberts-Thomson KF. Predictors of untreated dental decay among 15-34-year-old Australians. *Community Dent Oral Epidemiol* 2009; 37(1): 27-34.
  18. Parker EJ, Jamieson LM, Steffens MA, Cathro P, Logan RM. Self-reported oral health of a metropolitan homeless population in Australia: Comparisons with population-level data. *Aust Dent J* 2011; 56(3): 272-7.
  19. Sanders AE, Slade GD, Lim S, Reisine ST. Impact of oral disease on quality of life in the US and Australian populations. *Community Dent Oral Epidemiol* 2009; 37(2): 171-81.
  20. Sivanewaran S. The oral health of adults in NSW, 2004-06. *NSW Public Health Bull* 2009; 20(3-4): 46-51.
  21. Heft MW, Gilbert GH, Shelton BJ, Duncan RP. Relationship of dental status, sociodemographic status, and oral symptoms to perceived need for dental care. *Community Dent Oral Epidemiol* 2003; 31(5): 351-60.
  22. Gilbert GH, Duncan RP, Vogel WB. Determinants of dental care use in dentate adults: Six-monthly use during a 24-month period in the Florida Dental Care Study. *Soc Sci Med* 1998; 47(6): 727-37.
  23. Hugo FN, Hilgert JB, de Sousa ML, da Silva DD, Pucca GA, Jr. Correlates of partial tooth loss and edentulism in the Brazilian elderly. *Community Dent Oral Epidemiol* 2007; 35(3): 224-32.
  24. Weyant RJ, Manz M, Corby P, Rustveld L, Close J. Factors associated with parents' and adolescents' perceptions of oral health and need for dental treatment. *Community Dent Oral Epidemiol* 2007; 35(5): 321-30.
  25. Alpkilic BE, Ak G, Zulfikar B. Oral and general health-related quality of life among young patients with haemophilia. *Haemophilia* 2009; 15(1): 193-8.
  26. Okunseri C, Girgis D, Self K, Jackson S, McGinley EL, Tarima SS. Factors associated with reported need for dental care among people who are homeless using assistance programs. *Spec Care Dentist* 2010; 30(4): 146-50.
  27. Widstrom E, Seppala T. Willingness and ability to pay for unexpected dental expenses by Finnish adults. *BMC Oral Health* 2012; 12: 35.
  28. Hunt RJ, Beck JD, Lemke JH, Kohout FJ, Wallace RB. Edentulism and oral health problems among elderly rural Iowans: the Iowa 65+ rural health study. *Am J Public Health* 1985; 75(10): 1177-81.
  29. Hashim AN, Yusof ZY, Esa R. The Malay version of the Early Childhood Oral Health Impact Scale (Malay-ECOHis)-assessing validity and reliability. *Health Qual Life Outcomes* 2015; 13: 190.
  30. Tseveenjav B, Suominen AL, Varsio S, Knuutila M, Vehkalahti MM. Do self-assessed oral health and treatment need associate with clinical findings? Results from the Finnish Nationwide Health 2000 Survey. *Acta Odontol Scand* 2014; 72(8): 926-35.
  31. Locker D, Jokovic A. Using subjective oral health status indicators to screen for dental care needs in older adults. *Community Dent Oral Epidemiol* 1996; 24(6): 398-402.
  32. Muirhead VE, Quinonez C, Figueiredo R, Locker D. Predictors of dental care utilization among working poor Canadians. *Community Dent Oral Epidemiol* 2009; 37(3): 199-208.
  33. Thomas-Weintraub A. Dental needs and dental service use patterns of an elderly edentulous population. *J Prosthet Dent* 1985; 54(4): 526-32.
  34. Krisdapong S, Prasertsom P, Rattananangsim K, Sheiham A. Relationships between oral diseases and impacts on Thai schoolchildren's quality of life: evidence from a Thai national oral health survey of 12- and 15-year-olds. *Community Dent Oral Epidemiol* 2012; 40(6): 550-9.
  35. Lawal FB, Taiwo JO, Arowojolu MO. How valid are the psychometric properties of the oral health impact profile-14 measure in adult dental patients in Ibadan, Nigeria? *Ethiop J Health Sci* 2014; 24(3): 235-42.
  36. Martins AM, Barreto SM, Pordeus IA. Factors associated to self-perceived need of dental care among Brazilian elderly. *Rev Saude Publica* 2008; 42(3): 487-96. [In Portuguese].
  37. Mashoto KO, Astrom AN, David J, Masalu JR. Dental pain, oral impacts and perceived need for dental treatment in Tanzanian school students: a cross-sectional study. *Health Qual Life Outcomes* 2009; 7: 73.
  38. Abanto J, Tsakos G, Paiva SM, Goursand D, Raggio DP, Bonecker M. Cross-cultural adaptation and psychometric properties of the Brazilian version of the scale of oral health outcomes for 5-year-old children (SOHO-5). *Health Qual Life Outcomes* 2013; 11: 16.

39. Lintula T, Laitala V, Pesonen P, Sipila K, Laitala ML, Taanila A, et al. Self-reported oral health and associated factors in the North Finland 1966 birth cohort at the age of 31. *BMC Oral Health* 2014; 14: 155.
40. Ramraj CC, Quinonez CR. Emergency room visits for dental problems among working poor Canadians. *J Public Health Dent* 2013; 73(3): 210-6.
41. Agudelo-Suarez AA, Martinez-Herrera E, Posada-Lopez A, Sanchez-Patino D, Vinas-Sarmiento Y. Ethnicity and self-perceived oral health in Colombia: A cross-sectional analysis. *J Immigr Minor Health* 2014; 16(1): 111-8.
42. Molete MP, Yengopal V, Moorman J. Oral health needs and barriers to accessing care among the elderly in Johannesburg. *SADJ* 2014; 69(8): 352, 354-2, 357.
43. Hilton C, Simons B. Dental surgery attendance amongst patients with moderately advanced dementia attending a day unit: A survey of carers' views. *Br Dent J* 2003; 195(1): 39-40.
44. Nelson LP, Getzin A, Graham D, Zhou J, Wagle EM, McQuiston J, et al. Unmet dental needs and barriers to care for children with significant special healthcare needs. *Pediatr Dent* 2011; 33(1): 29-36.
45. Zollinger TW, Saywell J, Smith MA, Robinson RL, Knudson NE. Indiana Children's Special Healthcare Services Program: Impact of administrative changes on healthcare utilization, access to care, and unmet needs. *J Child Healthcare* 1999; 28(4): 349-64.
46. Lennon CA, Pellowski JA, White AC, Kalichman SC, Finitis DJ, Turcios-Cotto V, et al. Service priorities and unmet service needs among people living with HIV/AIDS: Results from a nationwide interview of HIV/AIDS housing organizations. *AIDS Care* 2013; 25(9): 1083-91.
47. Rosenbach M, O'Neil S, Cook B, Trebino L, Walker DK. Characteristics, access, utilization, satisfaction, and outcomes of healthy start participants in eight sites. *Matern Child Health J* 2010; 14(5): 666-79.
48. Kertesz SG, McNeil W, Cash JJ, Desmond R, McGwin G, Jr., Kelly J, et al. Unmet need for medical care and safety net accessibility among Birmingham's homeless. *J Urban Health* 2014; 91(1): 33-45.
49. Calvasina P, Muntaner C, Quinonez C. Factors associated with unmet dental care needs in Canadian immigrants: An analysis of the longitudinal survey of immigrants to Canada. *BMC Oral Health* 2014; 14: 145.
50. Shi L, Stevens GD. Vulnerability and unmet healthcare needs. The influence of multiple risk factors. *J Gen Intern Med* 2005; 20(2): 148-54.
51. Hosseinpoor AR, Itani L, Petersen PE. Socio-economic inequality in oral healthcare coverage: Results from the World Health Survey. *J Dent Res* 2012; 91(3): 275-81.
52. Macias EP, Morales LS. Utilization of healthcare services among adults attending a health fair in South Los Angeles County. *J Community Health* 2000; 25(1): 35-46.
53. Malecki K, Wisk LE, Walsh M, McWilliams C, Eggers S, Olson M. Oral health equity and unmet dental care needs in a population-based sample: Findings from the Survey of the Health of Wisconsin. *Am J Public Health* 2015; 105(Suppl 3): S466-S474.
54. Skinner AC, Slifkin RT, Mayer ML. The effect of rural residence on dental unmet need for children with special healthcare needs. *J Rural Health* 2006; 22(1): 36-42.
55. Lundegren N, Axtelius B, Isberg PE, Akerman S. Analysis of the perceived oral treatment need using Andersen's behavioural model. *Community Dent Health* 2013; 30(2): 102-7.
56. Heaton LJ, Mancl LA, Grembowski D, Armfield JM, Milgrom P. Unmet dental need in community-dwelling adults with mental illness: Results from the 2007 Medical Expenditure Panel Survey. *J Am Dent Assoc* 2013; 144(3): e16-e23.
57. Calzon FS, Fernandez AA, Martin JJ, Murphy MJ. The impact of the economic crisis on unmet dental care needs in Spain. *J Epidemiol Community Health* 2015; 69(9): 880-5.
58. Tan SH. Unmet Healthcare Service Needs of Children With Disabilities in Penang, Malaysia. *Asia Pac J Public Health* 2015; 27(8 Suppl): 41S-51S.
59. Shiboski CH, Cohen M, Weber K, Shansky A, Malvin K, Greenblatt RM. Factors associated with use of dental services among HIV-infected and high-risk uninfected women. *J Am Dent Assoc* 2005; 136(9): 1242-55.
60. Feinberg E, Swartz K, Zaslavsky A, Gardner J, Walker DK. Family income and the impact of a children's health insurance program on reported need for health services and unmet health need. *Pediatrics* 2002; 109(2): E29.
61. Kruger JS, Kodjebacheva GD, Kunkel L, Smith KD, Kruger DJ. Caregiver financial distress, depressive symptoms and limited social capital as barriers to children's dental care in a mid-western county in the United States. *Community Dent Health* 2015; 32(4): 252-6.
62. Newacheck PW, Hung YY, Park MJ, Brindis CD, Irwin CE, Jr. Disparities in adolescent health and healthcare: Does socioeconomic status matter? *Health Serv Res* 2003; 38(5): 1235-52.
63. Hughes DC, Duderstadt KG, Soobader MP, Newacheck PW. Disparities in children's use of oral health services. *Public Health Rep* 2005; 120(4): 455-62.
64. Wu CF, Eamon MK. Does receipt of public benefits reduce material hardship in low-income families with children? *Child Youth Serv Rev* 2010; 32(10): 1262-70.
65. Huang J, Birkenmaier J, Kim Y. Job loss and unmet healthcare needs in the economic recession: Different associations

- by family income. *Am J Public Health* 2014; 104(11): e178-e183.
66. Chaupain-Guillot S, Guillot O. Health system characteristics and unmet care needs in Europe: an analysis based on EU-SILC data. *Eur J Health Econ* 2015; 16(7): 781-96.
  67. Jang Y, Yoon H, Park NS, Chiriboga DA, Kim MT. Dental care utilization and unmet dental needs in older Korean Americans. *J Aging Health* 2014; 26(6): 1047-59.
  68. Hemmeter J. Health-related unmet needs of supplemental security income youth after the age-18 redetermination. *Health Serv Res* 2011; 46(4): 1224-42.
  69. Krause DD, May WL, Butler KR, Jr. Determining unmet, adequately met, and overly met needs for healthcare and services for persons living with HIV/AIDS in Mississippi. *AIDS Care* 2013; 25(8): 973-9.
  70. DeVoe JE, Krois L, Stenger R. Do children in rural areas still have different access to healthcare? Results from a statewide survey of Oregon's food stamp population. *J Rural Health* 2009; 25(1): 1-7.
  71. Xiang X, Lee W, Kang SW. Serious psychological distress as a barrier to dental care in community-dwelling adults in the United States. *J Public Health Dent* 2015; 75(2): 134-41.
  72. Iida H, Lewis CW. Utility of a summative scale based on the Children with Special Healthcare Needs (CSHCN) Screener to identify CSHCN with special dental care needs. *Matern Child Health J* 2012; 16(6): 1164-72.
  73. Fisher-Owens SA, Isong IA, Soobader MJ, Gansky SA, Weintraub JA, Platt LJ, et al. An examination of racial/ethnic disparities in children's oral health in the United States. *J Public Health Dent* 2013; 73(2): 166-74.
  74. Agaku IT, Olutola BG, Adisa AO, Obadan EM, Vardavas CI. Association between unmet dental needs and school absenteeism because of illness or injury among U.S. school children and adolescents aged 6-17 years, 2011-2012. *Prev Med* 2015; 72: 83-8.
  75. Iida H, Rozier RG. Mother-perceived social capital and children's oral health and use of dental care in the United States. *Am J Public Health* 2013; 103(3): 480-7.
  76. Mitchell JM, Gaskin DJ. Do children receiving Supplemental Security Income who are enrolled in Medicaid fare better under a fee-for-service or comprehensive capitation model? *Pediatrics* 2004; 114(1): 196-204.
  77. Lai B, Milano M, Roberts MW, Hooper SR. Unmet dental needs and barriers to dental care among children with autism spectrum disorders. *J Autism Dev Disord* 2012; 42(7): 1294-303.
  78. Boothroyd RA, Ware A. Impact of mental health problems on self-perceived oral health needs in a Medicaid population. *Eval Health Prof* 2015; 38(1): 73-93.
  79. Slifkin RT, Silberman P, Freeman V. Moving from Medicaid to North Carolina Health Choice: Changes in access to dental care for NC children. *N C Med J* 2004; 65(1): 6-11.
  80. Marcus M, Freed JR, Coulter ID, Der-Martirosian C, Cunningham W, Andersen R, et al. Perceived unmet need for oral treatment among a national population of HIV-positive medical patients: Social and clinical correlates. *Am J Public Health* 2000; 90(7): 1059-63.
  81. Wallace NT, Carlson MJ, Mosen DM, Snyder JJ, Wright BJ. The individual and program impacts of eliminating Medicaid dental benefits in the Oregon Health Plan. *Am J Public Health* 2011; 101(11): 2144-50.
  82. Heslin KC, Cunningham WE, Marcus M, Coulter I, Freed J, Der-Martirosian C, et al. A comparison of unmet needs for dental and medical care among persons with HIV infection receiving care in the United States. *J Public Health Dent* 2001; 61(1): 14-21.
  83. Capilouto EI, Piette J, White BA, Fleishman J. Perceived need for dental care among persons living with acquired immunodeficiency syndrome. *Med Care* 1991; 29(8): 745-54.
  84. Pourat N, Andersen RM, Marcus M. Assessing the contribution of the dental care delivery system to oral healthcare disparities. *J Public Health Dent* 2015; 75(1): 1-9.
  85. Bagewitz IC, Soderfeldt B, Palmqvist S, Nilner K. Dental care utilization: a study of 50- to 75-year-olds in southern Sweden. *Acta Odontol Scand* 2002; 60(1): 20-4.
  86. Kenagy GP, Linsk NL, Bruce D, Warnecke R, Gordon A, Wagaw F, et al. Service utilization, service barriers, and gender among HIV-positive consumers in primary care. *AIDS Patient Care STDS* 2003; 17(5): 235-44.
  87. Pau A, Croucher RE, Marcenés W. Demographic and socio-economic correlates of dental pain among adults in the United Kingdom, 1998. *Br Dent J* 2007; 202(9): E21-E29.
  88. Marshman Z, Porritt J, Dyer T, Wyborn C, Godson J, Baker S. What influences the use of dental services by adults in the UK? *Community Dent Oral Epidemiol* 2012; 40(4): 306-14.
  89. Marshman Z, Baker SR, Robinson PG. Does dental indifference influence the oral health-related quality of life of prisoners? *Community Dent Oral Epidemiol* 2014; 42(5): 470-80.
  90. Baker SR. Applying Andersen's behavioural model to oral health: What are the contextual factors shaping perceived oral health outcomes? *Community Dent Oral Epidemiol* 2009; 37(6): 485-94.
  91. Herr M, Arvieu JJ, Aegerter P, Robine JM, Ankrí J. Unmet healthcare needs of older people: Prevalence and predictors in a French cross-sectional survey. *Eur J Public Health* 2014; 24(5): 808-13.
  92. Wang H, Norton EC, Rozier RG. Effects of the State Children's Health Insurance Program on access to dental care and

- use of dental services. *Health Serv Res* 2007; 42(4): 1544-63.
93. Fulda KG, Johnson KL, Hahn K, Lykens K. Do unmet needs differ geographically for children with special healthcare needs? *Matern Child Health J* 2013; 17(3): 505-11.
  94. Kane D, Mosca N, Zotti M, Schwalberg R. Factors associated with access to dental care for children with special healthcare needs. *J Am Dent Assoc* 2008; 139(3): 326-33.
  95. Liu J, Probst JC, Martin AB, Wang JY, Salinas CF. Disparities in dental insurance coverage and dental care among US children: The National Survey of Children's Health. *Pediatrics* 2007; 119(Suppl 1): S12-S21.
  96. Paschal AM, Wilroy JD, Hawley SR. Unmet needs for dental care in children with special healthcare needs. *Prev Med Rep* 2016; 3: 62-7.
  97. Kenney GM, McFeeters JR, Yee JY. Preventive dental care and unmet dental needs among low-income children. *Am J Public Health* 2005; 95(8): 1360-6.
  98. McKinney CM, Nelson T, Scott JM, Heaton LJ, Vaughn MG, Lewis CW. Predictors of unmet dental need in children with autism spectrum disorder: Results from a national sample. *Acad Pediatr* 2014; 14(6): 624-31.
  99. Lewis CW. Dental care and children with special healthcare needs: A population-based perspective. *Acad Pediatr* 2009; 9(6): 420-6.
  100. Caban-Martinez AJ, Lee DJ, Fleming LE, Arheart KL, Leblanc WG, Chung-Bridges K, et al. Dental care access and unmet dental care needs among U.S. workers: The National Health Interview Survey, 1997 to 2003. *J Am Dent Assoc* 2007; 138(2): 227-30.
  101. Armfield JM, Stewart JF, Spencer AJ. The vicious cycle of dental fear: Exploring the interplay between oral health, service utilization and dental fear. *BMC Oral Health* 2007; 7: 1.
  102. Ghiabi E, Matthews DC, Brilliant MS. The oral health status of recent immigrants and refugees in Nova Scotia, Canada. *J Immigr Minor Health* 2014; 16(1): 95-101.
  103. Patton LL, Strauss RP, McKaig RG, Porter DR, Eron JJ, Jr. Perceived oral health status, unmet needs, and barriers to dental care among HIV/AIDS patients in a North Carolina cohort: Impacts of race. *J Public Health Dent* 2003; 63(2): 86-91.
  104. Ekanayake L, Perera I. Perceived need for dental care among dentate older individuals in Sri Lanka. *Spec Care Dentist* 2005; 25(4): 199-205.
  105. Astrom AN, Kida IA. Perceived dental treatment need among older Tanzanian adults - a cross-sectional study. *BMC Oral Health* 2007; 7: 9.
  106. Luo Y, McGrath C. Oral health status of homeless people in Hong Kong. *Spec Care Dentist* 2006; 26(4): 150-4.
  107. Diu S, Gelbier S. Oral health screening of elderly people attending a community care centre. *Community Dent Oral Epidemiol* 1989; 17(4): 212-5.
  108. Robinson PG, Nadanovsky P, Sheiham A. Can questionnaires replace clinical surveys to assess dental treatment needs of adults? *J Public Health Dent* 1998; 58(3): 250-3.
  109. Ramraj C, Quinonez CR. Self-reported cost-prohibitive dental care needs among Canadians. *Int J Dent Hyg* 2013; 11(2): 115-20.
  110. Marino R, Schofield M, Wright C, Calache H, Minichiello V. Self-reported and clinically determined oral health status predictors for quality of life in dentate older migrant adults. *Community Dent Oral Epidemiol* 2008; 36(1): 85-94.
  111. Vargas CM, Ronzio CR. Relationship between children's dental needs and dental care utilization: United States, 1988-1994. *Am J Public Health* 2002; 92(11): 1816-21.
  112. Seirawan H, Sundaresan S, Mulligan R. Oral health-related quality of life and perceived dental needs in the United States. *J Public Health Dent* 2011; 71(3): 194-201.
  113. Osborn M, Butler T, Barnard PD. Oral health status of prison inmates--New South Wales, Australia. *Aust Dent J* 2003; 48(1): 34-8.
  114. Jones E, Shi L, Hayashi AS, Sharma R, Daly C, Ngo-Metzger Q. Access to oral healthcare: The role of federally qualified health centers in addressing disparities and expanding access. *Am J Public Health* 2013; 103(3): 488-93.
  115. Ettinger RL, Warren JJ, Levy SM, Hand JS, Merchant JA, Stromquist AM. Oral health: Perceptions of need in a rural Iowa county. *Spec Care Dentist* 2004; 24(1): 13-21.
  116. Hoad-Reddick G. A study to determine oral health needs of institutionalised elderly patients by non-dental healthcare workers. *Community Dent Oral Epidemiol* 1991; 19(4): 233-6.
  117. Drake CW, Beck JD, Strauss RP. The accuracy of oral self-perceptions in a dentate older population. *Spec Care Dentist* 1990; 10(1): 16-20.
  118. Talekar BS, Rozier RG, Slade GD, Ennett ST. Parental perceptions of their preschool-aged children's oral health. *J Am Dent Assoc* 2005; 136(3): 364-72.
  119. Ornstein KA, DeCherrie L, Gluzman R, Scott ES, Kansal J, Shah T, et al. Significant unmet oral health needs of homebound elderly adults. *J Am Geriatr Soc* 2015; 63(1): 151-7.
  120. Balappanavar AY, Sardana V, Nagesh L, Ankola AV, Kakodkar P, Hebbal M. Questionnaire vs clinical surveys: The

- right choice?--A cross-sectional comparative study. *Indian J Dent Res* 2011; 22(3): 494.
121. Luciano M, Overman VP, Frasier PY, Platin E. Survey of oral health practices among adults in a North Carolina Hispanic population. *J Dent Hyg* 2008; 82(2): 20.
  122. Arrow P. Service Use and Perceived Need among an Aboriginal Population in Western Australia. *J Healthcare Poor Underserved* 2016; 27(1 Suppl): 90-100.
  123. Gift HC, Atchison KA, Drury TF. Perceptions of the natural dentition in the context of multiple variables. *J Dent Res* 1998; 77(7): 1529-38.
  124. Azodo CC, Ehizele AO, Umoh A, Ojehanon PI, Akhionbare O, Okechukwu R, et al. Perceived oral health status and treatment needs of dental auxiliaries. *Libyan J Med* 2010; 5.
  125. Rungsiyanont S, Vacharotayangul P, Lam-Ubol A, Ananworanich J, Phanuphak P, Phanuphak N. Perceived dental needs and attitudes toward dental treatments in HIV-infected Thais. *AIDS Care* 2012; 24(12): 1584-90.
  126. Lodi G, Sardella A, Bez C, Demarosi F, Cicardi M, Carrassi A. Dental experience and self-perceived dental care needs of patients with angioedema. *Spec Care Dentist* 2001; 21(1): 27-31.
  127. Stiefel DJ, Truelove EL, Martin MD, Mandel LS. Comparison of incoming dental school patients with and without disabilities. *Spec Care Dentist* 1997; 17(5): 161-8.
  128. Leroy R, Declerck D. Objective and subjective oral healthcare needs among adults with various disabilities. *Clin Oral Investig* 2013; 17(8): 1869-78.
  129. Yazdani R, Vehkalahti MM, Nouri M, Murtomaa H. Oral health and treatment needs among 15-year-olds in Tehran, Iran. *Community Dent Health* 2008; 25(4): 221-5.
  130. Atchison KA, Davidson PL, Nakazono TT. Predisposing, enabling, and need for dental treatment characteristics of ICS-II USA ethnically diverse groups. *Adv Dent Res* 1997; 11(2): 223-34.
  131. Sipila K, Napankangas R, Kononen M, Alanen P, Suominen AL. The role of dental loss and denture status on clinical signs of temporomandibular disorders. *J Oral Rehabil* 2013; 40(1): 15-23.
  132. Colussi CF, De Freitas SF, Calvo MC. The prosthetic need WHO index: A comparison between self-perception and professional assessment in an elderly population. *Gerodontology* 2009; 26(3): 187-92.
  133. Tervonen T, Knuutila M. Awareness of dental disorders and discrepancy between "objective" and "subjective" dental treatment needs. *Community Dent Oral Epidemiol* 1988; 16(6): 345-8.
  134. Shigli K, Hebbal M, Angadi GS. Attitudes towards replacement of teeth among patients at the Institute of Dental Sciences, Belgaum, India. *J Dent Educ* 2007; 71(11): 1467-75.
  135. Walter MH, Wolf BH, Rieger C, Boening KW. Prosthetic treatment need in a representative German sample. *J Oral Rehabil* 2001; 28(8): 708-16.
  136. Teofilo LT, Leles CR. Patients' self-perceived impacts and prosthodontic needs at the time and after tooth loss. *Braz Dent J* 2007; 18(2): 91-6.
  137. Tuominen R, Rajala M, Sintonen H, Paunio I. Normative and subjective need and utilization of complete denture services. *Community Dent Oral Epidemiol* 1984; 12(3): 165-8.
  138. Ariga P, Bridgitte A, Rangarajan V, Philip JM. Edentulousness, denture wear and denture needs of the elderly in rural South India. *Iran J Public Health* 2012; 41(7): 40-3.
  139. Kronstrom M, Palmqvist S, Soderfeldt B, Vigild M. Subjective need for implant treatment among middle-aged people in Sweden and Denmark. *Clin Implant Dent Relat Res* 2002; 4(1): 11-5.
  140. Palmqvist S, Soderfeldt B, Arnbjerg D. Subjective need for implant dentistry in a Swedish population aged 45-69 years. *Clin Oral Implants Res* 1991; 2(3): 99-102.
  141. Palmqvist S, Soderfeldt B, Arnbjerg D. Influences of some background factors on the subjective need for dental implants in a Swedish population. *Acta Odontol Scand* 1993; 51(1): 9-14.
  142. Nagarajan S, Pushpanjali K. The relationship of malocclusion as assessed by the Dental Aesthetic Index (DAI) with perceptions of aesthetics, function, speech and treatment needs among 14- to 15-year-old schoolchildren of Bangalore, India. *Oral Health Prev Dent* 2010; 8(3): 221-8.
  143. Xiao-Ting L, Tang Y, Huang XL, Wan H, Chen YX. Factors influencing subjective orthodontic treatment need and culture-related differences among Chinese natives and foreign inhabitants. *Int J Oral Sci* 2010; 2(3): 149-57.
  144. Christopherson EA, Briskie D, Inglehart MR. Objective, subjective, and self-assessment of preadolescent orthodontic treatment need--a function of age, gender, and ethnic/racial background? *J Public Health Dent* 2009; 69(1): 9-17.
  145. Howell S, Morel G. Orthodontic treatment needs in Westmead Hospital Dental Clinical School. *Aust Dent J* 1993; 38(5): 367-72.
  146. de Oliveira CM, Sheiham A, Tsakos G, O'Brien KD. Oral health-related quality of life and the IOTN index as predictors of children's perceived needs and acceptance for orthodontic treatment. *Br Dent J* 2008; 204(7): 1-5.
  147. Freitas CV, Souza JG, Mendes DC, Pordeus IA, Jones KM, Martins AM. Need for orthodontic treatment among Brazilian adolescents: Evaluation based on public health. *Rev Paul Pediatr* 2015; 33(2): 204-10. [In Portuguese].
  148. Tuominen ML, Tuominen RJ. Factors associated with subjective need for orthodontic treatment among Finnish

- university applicants. *Acta Odontol Scand* 1994; 52(2): 106-10.
149. Stenvik A, Espeland L, Mathisen A. A longitudinal study on subjective and objective orthodontic treatment need. *Eur J Orthod* 1997; 19(1): 85-92.
  150. Christopherson EA, Briskie D, Inglehart MR. Preadolescent orthodontic treatment need: Objective and subjective provider assessments and patient self-reports. *Am J Orthod Dentofacial Orthop* 2009; 135(4 Suppl): S80-S86.
  151. Dias PF, Gleiser R. Orthodontic concerns of Brazilian children and their parents compared to the normative treatment need. *J Oral Sci* 2010; 52(1): 101-7.
  152. Chu CH, Choy BH, Lo EC. Occlusion and orthodontic treatment demand among Chinese young adults in Hong Kong. *Oral Health Prev Dent* 2009; 7(1): 83-91.
  153. Burgersdijk R, Truin GJ, Frankenmolen F, Kalsbeek H, van't Hof M, Mulder J. Malocclusion and orthodontic treatment need of 15-74-year-old Dutch adults. *Community Dent Oral Epidemiol* 1991; 19(2): 64-7.
  154. Badran SA, Sabrah AH, Hadidi SA, Al-Khateeb S. Effect of socioeconomic status on normative and perceived orthodontic treatment need. *Angle Orthod* 2014; 84(4): 588-93.
  155. Spalj S, Lajnert V, Ivankovic L. The psychosocial impact of dental aesthetics questionnaire--translation and cross-cultural validation in Croatia. *Qual Life Res* 2014; 23(4): 1267-71.
  156. Kerosuo H, Abdulkarim E, Kerosuo E. Subjective need and orthodontic treatment experience in a Middle East country providing free orthodontic services: A questionnaire survey. *Angle Orthod* 2002; 72(6): 565-70.
  157. Tuominen ML, Nystrom M, Tuominen RJ. Subjective and objective orthodontic treatment need among orthodontically treated and untreated Finnish adolescents. *Community Dent Oral Epidemiol* 1995; 23(5): 286-90.
  158. Sheats RD, Gilbert GH, Wheeler TT, King GJ. Pilot study comparing parents' and third-grade schoolchildren's attitudes toward braces and perceived need for braces. *Community Dent Oral Epidemiol* 1995; 23(1): 36-43.
  159. Searcy VL, Chisick MC. Perceived, desired, and normatively determined orthodontic treatment needs in male US Army recruits. *Community Dent Oral Epidemiol* 1994; 22(6): 437-40.
  160. Kragt L, Tiemeier H, Wolvius EB, Ongkosuwito EM. Measuring oral health-related quality of life in orthodontic patients with a short version of the Child Oral Health Impact Profile (COHIP). *J Public Health Dent* 2016; 76(2): 105-12.
  161. Josefsson E, Bjerklin K, Lindsten R. Factors determining perceived orthodontic treatment need in adolescents of Swedish and immigrant background. *Eur J Orthod* 2009; 31(1): 95-102.
  162. Josefsson E, Bjerklin K, Halling A. Self-perceived orthodontic treatment need and culturally related differences among adolescents in Sweden. *Eur J Orthod* 2005; 27(2): 140-7.
  163. Mandall NA, McCord JF, Blinkhorn AS, Worthington HV, O'Brien KD. Perceived aesthetic impact of malocclusion and oral self-perceptions in 14-15-year-old Asian and Caucasian children in greater Manchester. *Eur J Orthod* 2000; 22(2): 175-83.
  164. Tsakos G, Bernabe E, O'Brien K, Sheiham A, de Oliveira C. Comparison of the self-administered and interviewer-administered modes of the child-OIDP. *Health Qual Life Outcomes* 2008; 6: 40.
  165. Oshagh M, Salehi P, Pakshir H, Bazayr L, Rakhshan V. Associations between normative and self-perceived orthodontic treatment needs in young-adult dental patients. *Korean J Orthod* 2011; 41(6): 440-6.
  166. Momeni DS, Salehi P. Association between normative and self-perceived orthodontic treatment need among 12- to 15-year-old students in Shiraz, Iran. *Eur J Orthod* 2010; 32(5): 530-4.
  167. Grzywacz I. The value of the aesthetic component of the Index of Orthodontic Treatment Need in the assessment of subjective orthodontic treatment need. *Eur J Orthod* 2003; 25(1): 57-63.
  168. Shue-Te YM, Koochek AR, Vlaskalic V, Boyd R, Richmond S. The relationship of 2 professional occlusal indexes with patients' perceptions of aesthetics, function, speech, and orthodontic treatment need. *Am J Orthod Dentofacial Orthop* 2000; 118(4): 421-8.
  169. Koochek AR, Yeh MS, Rolfe B, Richmond S. The relationship between Index of Complexity, Outcome and Need, and patients' perceptions of malocclusion: A study in general dental practice. *Br Dent J* 2001; 191(6): 325-9.
  170. Ng'ang'a PM, Stenvik A, Ohito F, Ogaard B. The need and demand for orthodontic treatment in 13- to 15-year-olds in Nairobi, Kenya. *Acta Odontol Scand* 1997; 55(5): 325-8.
  171. Nobile CG, Pavia M, Fortunato L, Angelillo IF. Prevalence and factors related to malocclusion and orthodontic treatment need in children and adolescents in Italy. *Eur J Public Health* 2007; 17(6): 637-41.
  172. Onyeaso CO, Arowojolu MO. Perceived, desired, and normatively determined orthodontic treatment needs among orthodontically untreated Nigerian adolescents. *West Afr J Med* 2003; 22(1): 5-9.
  173. Pratelli P, Gelbier S, Gibbons DE. Parental perceptions and attitudes on orthodontic care. *Br J Orthod* 1998; 25(1): 41-6.
  174. Liepa A, Urtane I, Richmond S, Dunstan F. Orthodontic treatment need in Latvia. *Eur J Orthod* 2003; 25(3): 279-84.
  175. Soh J, Sandham A. Orthodontic treatment need in Asian adult males. *Angle Orthod* 2004; 74(6): 769-73.
  176. Chew MT, Aw AK. Appropriateness of orthodontic referrals: Self-perceived and normative treatment needs of patients referred for orthodontic consultation. *Community Dent Oral Epidemiol* 2002; 30(6): 449-54.



177. Svedstrom-Oristo AL, Pietila T, Pietila I, Tolvanen M, Varrela J, Alanen P. An analysis of residual orthodontic treatment need in municipal health centres. *Eur J Orthod* 2015; 37(4): 398-402.
178. Helm S, Kreiborg S, Solow B. A 15-year follow-up study of 30-year-old Danes with regard to orthodontic treatment experience and perceived need for treatment in a region without organized orthodontic care. *Community Dent Oral Epidemiol* 1983; 11(4): 199-204.
179. Spalj S, Slaj M, Athanasiou AE, Govorko DK, Slaj M. The unmet orthodontic treatment need of adolescents and influencing factors for not seeking orthodontic therapy. *Coll Antropol* 2014; 38(Suppl 2): 173-80.
180. Hirvinen H, Heikinheimo K, Svedstrom-Oristo AL. The objective and subjective outcome of orthodontic care in one municipal health center. *Acta Odontol Scand* 2012; 70(1): 36-41.
181. Baubiniene D, Sidlauskas A. The factors effecting satisfaction of dental appearance and self-perceived need for orthodontic treatment in 10-11 and 14-15 year-old Lithuanian schoolchildren. *Stomatologija* 2009; 11(3): 97-102.
182. Tickle M, Kay EJ, Bearn D. Socio-economic status and orthodontic treatment need. *Community Dent Oral Epidemiol* 1999; 27(6): 413-8.
183. de Almeida AB, Leite IC. Orthodontic treatment need for Brazilian schoolchildren: A study using the Dental Aesthetic Index. *Dental Press J Orthod* 2013; 18(1): 103-9.
184. Badran SA, Al-Khateeb S. Factors influencing the uptake of orthodontic treatment. *J Public Health Dent* 2013; 73(4): 339-44.
185. Ahmed B, Gilthorpe MS, Bedi R. Agreement between normative and perceived orthodontic need amongst deprived multiethnic school children in London. *Clin Orthod Res* 2001; 4(2): 65-71.
186. Svedstrom-Oristo AL, Pietila T, Pietila I, Vahlberg T, Alanen P, Varrela J. Acceptability of dental appearance in a group of Finnish 16- to 25-year-olds. *Angle Orthod* 2009; 79(3): 479-83.
187. Onyeano CO, Aderinokun GA. The relationship between dental aesthetic index (DAI) and perceptions of aesthetics, function and speech amongst secondary school children in Ibadan, Nigeria. *Int J Paediatr Dent* 2003; 13(5): 336-41.
188. Kok YV, Mageson P, Harradine NW, Sprod AJ. Comparing a quality of life measure and the Aesthetic Component of the Index of Orthodontic Treatment Need (IOTN) in assessing orthodontic treatment need and concern. *J Orthod* 2004; 31(4): 312-8.
189. Fisher MA, Taylor GW, Shelton BJ, Debanne SM. Predictive values of self-reported periodontal need: National Health and Nutrition Examination Survey III. *J Periodontol* 2007; 78(8): 1551-60.
190. Kamppi A, Pakkila J, Tanner T, Patinen P, Tjaderhane L, Anttonen V. Validity of a questionnaire in estimating restorative treatment need among young adults. *Community Dent Health* 2014; 31(4): 245-50.
191. Tortopidis D, Hatzikyriakos A, Kokoti M, Menexes G, Tsiggos N. Evaluation of the relationship between subjects' perception and professional assessment of esthetic treatment needs. *J Esthet Restor Dent* 2007; 19(3): 154-62.
192. Falcon HC, Richardson P, Shaw MJ, Bulman JS, Smith BG. Developing an index of restorative dental treatment need. *Br Dent J* 2001; 190(9): 479-86.
193. De Kanter RJ, Kayser AF, Battistuzzi PG, Truin GJ, Van 't Hof MA. Demand and need for treatment of craniomandibular dysfunction in the Dutch adult population. *J Dent Res* 1992; 71(9): 1607-12.
194. Hongxing L, Astrom AN, List T, Nilsson IM, Johansson A. Prevalence of temporomandibular disorder pain in Chinese adolescents compared to an age-matched Swedish population. *J Oral Rehabil* 2016; 43(4): 241-8.
195. Eklund SA, Burt BA. Risk factors for total tooth loss in the United States; longitudinal analysis of national data. *J Public Health Dent* 1994; 54(1): 5-14.
196. Juggins KJ, Nixon F, Cunningham SJ. Patient- and clinician-perceived need for orthognathic surgery. *Am J Orthod Dentofacial Orthop* 2005; 128(6): 697-702.
197. Listl S. Income-related inequalities in dental service utilization by Europeans aged 50+. *J Dent Res* 2011; 90(6): 717-23.
198. Okullo I, Astrom AN, Haugejorden O. Social inequalities in oral health and in use of oral healthcare services among adolescents in Uganda. *Int J Paediatr Dent* 2004; 14(5): 326-35.
199. Kalton G, Schuman H. The effect of the question on survey responses: A review. *J R Stat Soc Ser A* 1982; 145(1): 42-73.
200. Hochstim JR. A Critical comparison of three strategies of collecting data from households. *J Am Stat Assoc* 1967; 62(319): 976-89.

## Clinical decision support system, a potential solution for diagnostic accuracy improvement in oral squamous cell carcinoma: A systematic review

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### Review Article

#### Abstract

**BACKGROUND AND AIM:** Oral squamous cell carcinoma (OSCC) is a rapidly progressive disease and despite the progress in the treatment of cancer, remains a life-threatening illness with a poor prognosis. Diagnostic techniques of the oral cavity are not painful, non-invasive, simple and inexpensive methods. Clinical decision support systems (CDSSs) are the most important diagnostic technologies used to help health professionals to analyze patients' data and make decisions. This paper, by studying CDSS applications in the process of providing care for the cancer patients, has looked into the CDSS potentials in OSCC diagnosis.

**METHODS:** We retrieved relevant articles indexed in MEDLINE/PubMed database using high-quality keywords. First, the title and then the abstract of the related articles were reviewed in the step of screening. Only research articles which had designed clinical decision support system in different stages of providing care for the cancer patient were retained in this study according to the input criteria.

**RESULTS:** Various studies have been conducted about the important roles of CDSS in health processes related to different types of cancer. According to the aim of studies, we categorized them into several groups including treatment, diagnosis, risk assessment, screening, and survival estimation.

**CONCLUSION:** Successful experiences in the field of CDSS applications in different types of cancer have indicated that machine learning methods have a high potential to manage the data and diagnostic improvement in OSCC intelligently and accurately.

**KEYWORDS:** Squamous Cell Carcinoma; Clinical Decision Support System; Neoplasm; Dental Informatics

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Oral cavity cancer refers to all malignancies of the lips, mouth and neck, among which oral squamous cell carcinoma (OSCC) is the most common one.<sup>1,2</sup> Etiology and biological behavior studies of OSCC have suggested that this carcinoma develops a more

aggressive behavior with poor prognosis.<sup>3,4</sup>

In response to the need for early detection of OSCC, several diagnostic techniques have been developed over the years, mostly including vital staining, light-based detection systems, histological techniques, cytological techniques, molecular analyses and imaging

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techniques.<sup>5,6</sup> One of the most considerable improvements in the healthcare area is a trend to the non-invasive interventions in the diagnosis and treatment of diseases.

In recent years, numerous studies have been conducted to identify and assess the diagnostic biomarkers for OSCC. Identification of reliable biological tumor markers showed high sensitivity, efficiency and specificity for oral cancer and can be an additional tool for diagnosis, prognosis and treatment monitoring of patients with cancer.<sup>7</sup>

Also, use of the computers to assist health professionals in their activities has become popular in recent decades. The first efforts focused on the development of diagnostic systems. Clinical decision support systems (CDSSs) are the most important diagnostic technologies used to help health professionals to analyze patient data and make decisions.<sup>8</sup>

The advent of high information technology and dental devices has produced vast amounts of data. Moreover, the use of data mining algorithms and artificial intelligence techniques in dental informatics has a great potential to manage new big data. However, few efforts have been made to apply these techniques and relatively little research has been conducted to retrieve meaningful information from dental data. Some studies have used k-means clustering methods to establish normative data on tooth size<sup>9</sup> in order to categorize the patients with facial asymmetry into the groups with different characteristics.<sup>10</sup> Detection of oral cancer by applying k-means clustering and principal component analyses was carried out by the spectra obtained from autofluorescence spectroscopy.<sup>11</sup>

The use of expert systems also has been associated with successful experiences in dentistry. For example, an expert system has helped decision making and treatment of the most common periodontal conditions.<sup>12</sup> Another expert system has used neural artificial intelligence to test the accuracy of periodontal disease risk assessment.<sup>13</sup>

Moreover, another expert system has determined the diagnosis, disease severity and the treatment methods in periodontal diseases based on the patient clinical data and radiographic findings.<sup>14</sup>

The appearance of CDSS in dentistry has addressed the several major areas of dental practice. Different types of knowledge representation and different modalities have been used in its development. A prediction system was developed in orthodontics where extraction/non-extraction decisions are very important. This system has been successfully optimized to obtain the concise representation of the expertise knowledge elements with prediction accuracy.<sup>15</sup> A triage tool was designed and successfully evaluated to determine the patient's examination waiting time by describing their clinical symptoms in the dental care unit.<sup>16</sup> A study was conducted with the objective of developing a decision support system for predicting the degree of color change after in-office tooth whitening by using colorimetric values. The patients' post-treatment color was largely close to the system prediction.<sup>17</sup>

A comprehensive review of the literature on decision support applications in dentistry, grouped these systems into seven subareas of dentistry: dental emergencies and trauma, orofacial pain, oral medicine, oral radiology, orthodontics, pulpal diagnosis, and restorative dentistry.<sup>18</sup>

CDSSs have a great potential for providing the opportunities to improve patient care in various fields of oral medicine especially in oral cancer, through managing a large amount of data intelligently.

The present study aims to review the literature on the CDSS applications in cancer with special attention to oral cancer. Therefore, key questions in this study include: 1- What are the CDSS applications in the process of providing care for the cancer patient? 2- What applications have been used in oral cancer? 3- Have been CDSS applications used in OSCC?

A description with details of the CDSS

applications in health processes related to different types of cancer provides an appropriate model for highlighting their potentials for diagnostic accuracy improvement in OSCC.

## Methods

This study was a systematic review to identify articles published in PubMed and focusing on CDSS applications in cancer. We searched the database in September 2016 with the following strategy: ("Neoplasms"[MeSH]) AND "Decision Support Systems, Clinical"[MeSH] AND Humans [MeSH] AND English [lang]) Filters: Humans; English.

After the identification step, we screened the titles and abstracts of the related articles according to the inclusion/exclusion criteria. Inclusion criteria included only original articles, designed and used clinical decision support system in different stages of providing care for the cancer patients. No date restriction was applied to the search. Due to the limitations of searching database alone and in order to avoid missing related articles, we focused on article citations and before-and-after studies. Studies were excluded where they were not relevant to the key questions. The search was limited to journal articles written in the English language. Letters, reviews and conference

proceedings also were excluded.

After screening the titles and abstracts of potential articles, remaining studies were subjected to the screening of their main content, which in turn, their full-texts were reviewed. Figure 1 shows the flow of the article selection procedure.

Data extraction and validity assessment were performed in two steps. First, a checklist was developed as an assessment tool with the aim of answering the key questions. Intended variables included references, objective, cancer type and result. Details from each article were extracted by two independent reviewers. In the second step and in order to have a systemic investigation, the variables collected in the data extraction form were classified into separate groups.

## Results

A total of 414 potentially relevant titles, abstracts, and articles were found in MEDLINE/PubMed search. Non-pertinent papers were excluded according to inclusion and exclusion criteria after screening the titles and abstracts. We reviewed the full-texts of the remaining 82 articles. Finally, 17 articles met the inclusion criteria and considered as the final samples. Table 1 indicates the variable extracted from articles.

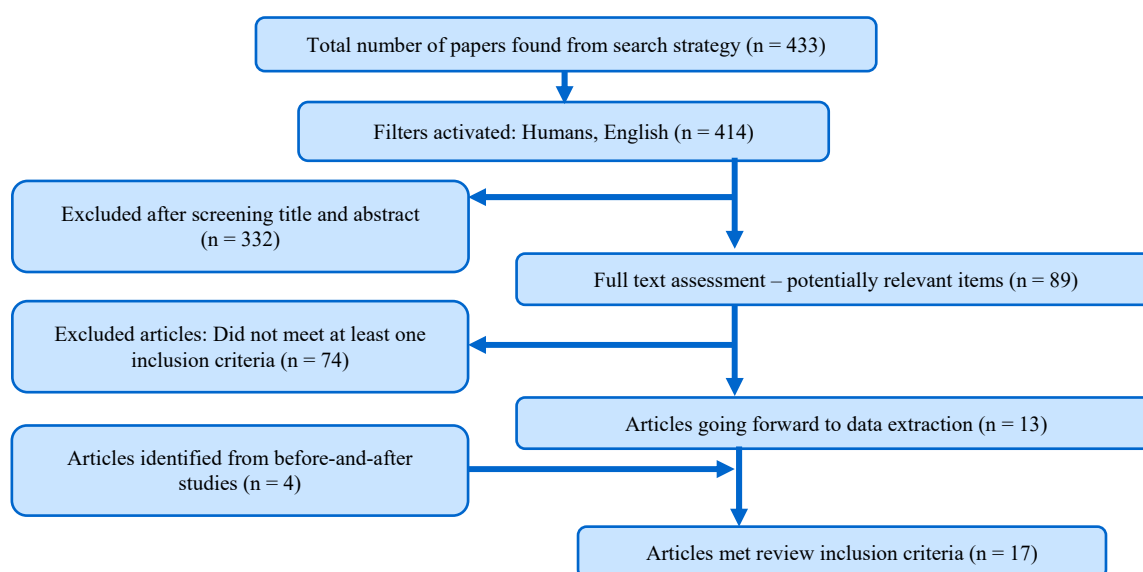


Figure 1. Article selection procedure

Table 1. Characteristics of included studies

Reference	Objective	Cancer type	Result
Abernethy et al. <sup>19</sup>	Educates clinical decision makers and healthcare professionals about the burden of cancer pain in their individual populations	ALL	Leads to improved pain control with modest increases in resource use
Finlayson et al. <sup>20</sup>	Providing an analytical engine and user interface that enables physicians to gain clinical insights by rapidly identifying and analyzing cohorts of patients similar to their own	Melanoma	The MRLU is an important component in building an RLS for data-driven precision medicine in melanoma treatment that could be generalized to other clinical disorders
Mi et al. <sup>21</sup>	To select predictive features from clinical and PET-based features, in order to provide doctors with informative factors so as to anticipate the outcome of the patient treatment	ALL	Addition of prior knowledge improves the robustness and accelerates the convergence
Cakir and Demirel <sup>22</sup>	To help to oncology doctor for the suggestion of application of the treatment methods about breast cancer patients	Breast cancer	Data mining approach can be a useful tool for medical applications particularly at the treatment decision step
Bury et al. <sup>23</sup>	To assist with dosage adjustments during maintenance therapy for childhood ALL	Lymphoblastic Leukaemia	Improvement in time taken to manage each case; accuracy of dosage calculations
Gerbert et al. <sup>24</sup>	To determine whether decision support software can help primary care physicians proficiently triage lesions suggestive of basal cell and squamous cell carcinoma	Skin cancer	Use of decision support software could improve primary care physicians' triage decisions for lesions suggestive of non-melanoma skin cancer, and potentially reduce morbidity and health care costs
Emery et al. <sup>25</sup>	To evaluate the effect of an assessment strategy using the computer decision support system (the GRAIDS software), on the management of familial cancer risk	Familial breast or colorectal cancer	Improved practitioner confidence and had no adverse psychological effects in patients
Ozanne et al. <sup>26</sup>	Provides automated risk assessment and personalized decision support designed for collaborative use between patients and clinicians	Breast cancer	The ability to integrate risk assessment and decision support in real time will allow for informed, value-driven, and patient-centered breast cancer prevention decisions
Javan Amoli et al. <sup>27</sup>	Electronic risk assessment system as an appropriate tool for the prevention of cancer	ALL	Electronic pathways have been applied for clinical and genetic decision support, workflow management, update recommendation and resource estimates
Shelton et al. <sup>28</sup>	Implemented guidelines seeking to reduce PSA-based screening for prostate cancer in men aged 75 years and older	Prostate cancer	With this simple intervention, evidence-based guidelines were brought to bear at the point of care, precisely for the patients and providers for whom they were most helpful, resulting in more appropriate use of medical resources
Hills et al. <sup>29</sup>	Improving guideline-consistent cervical cancer screening practices in an urban safety net clinic	Cervical cancer	Patients screened according to guidelines nearly doubled while the number of underscreened patients was reduced by nearly half. Similarly, there was a threefold decrease in patients screened more frequently than recommended
Maserat et al. <sup>30</sup>	To detail engineering of information requirements and workflow design of CDSS for a colorectal cancer screening program	Colorectal cancer	A CDSS facilitates complex decision making for screening and has key roles in designing optimal interactions between colonoscopy, pathology and laboratory departments
Lundin et al. <sup>31</sup>	To evaluate the accuracy of an Internet-based method for survival estimation in breast cancer	Breast cancer	A web-based case-match system can generate survival curves for user-defined prognostic factor combinations and identify patients with a varying risk for breast cancer recurrence

Table 1. Characteristics of included studies (continue)

Reference	Objective	Cancer type	Result
Sidiropoulos et al. <sup>32</sup>	Supporting rare cancers decision making operates on a GPU and adjusting its design in real-time based on user-defined clinical questions in contrast to standard CPU implementations	Brain cancer	Enables real-time, optimal design of a CDSS for any user-defined clinical question for improving diagnostic assessments, prognostic relevance and concordance rates for rare cancers in clinical practice
Exarchos et al. <sup>33</sup>	To identify the factors that dictate OSCC progression and subsequently predict potential relapses (local or metastatic) of the disease	Oral squamous cell carcinoma	The discrimination potential of each source of data is initially explored separately, and afterward, the individual predictions are combined to yield a consensus decision achieving complete discrimination between patients with and without a disease relapse
Nguyen et al. <sup>34</sup>	To classify automatically lung TNM cancer stages from free-text pathology reports using symbolic rule-based classification	Lung tumor	It was verified that the symbolic rule-based approach using SNOMED CT can be used for the extraction of key lung cancer characteristics from free-text reports
Nguyen et al. <sup>35</sup>	Development of a Web-enabled relational database integrated with decision-making tools for teaching flow cytometric diagnosis of hematologic neoplasms	Hematologic neoplasm	This database shows significant improvement in diagnostic accuracy over our previous database prototype

ALL: Acute lymphoblastic leukemia; MRLU: Melanoma rapid learning utility; RLS: Rapid learning system; PET: Positron emission tomography; PSA: Prostate-specific antigen; CDSSs: Clinical decision support systems; GPU: Graphics Processing Unit; CPU: Central processing unit; OSCC: Oral squamous cell carcinoma; TNM: Tumor-node-metastasis; SNOMED CT: Systematized nomenclature of medicine-clinical term

In order to answer the key questions, we categorized the articles according to CDSS applications in the different stages of providing care for the cancer patients, including diagnosis, treatment, risk assessment, screening and survival estimation.

CDSSs play an important role in different stages of cancer diagnosis and treatment. For example, some of these include a challenging decision making on chemotherapy protocols for a patient,<sup>36</sup> supported the nurses' decision-making process about patients' needs and preparation of individual care plans.<sup>37</sup> Another example of CDSS application is to help with the diagnosis within a gastroenterology room during real endoscopy examinations with human-computer interaction (HCI) support methodologies in order to identify interaction opportunities,<sup>38</sup> and precise selection of meningioma brain histopathological image classification.<sup>39</sup> Also, it is used as a practical tool to improve the selection of protocols for monitoring, diagnosing, and treating cervical cancer in women and the patient-specific follow-up decision making for them.<sup>40</sup> Some

decision support systems have examined drug interactions of various diseases and may lead to undesirable and sometimes life-threatening reactions.<sup>41</sup>

Furthermore, cancer screening programs have been run in different countries as a primary preventive measures in order to reduce damage and focus on the high-risk groups of cancer.<sup>7</sup> In the screening process and to manage the cases with a positive test, especially for the patients at risk of developing cancer, presenting the report of the follow-up referral with the aim of providing therapeutic suggestions can be very effective. CDSSs have an important role in this context and upgrade the quality of the screening programs significantly. Moreover, the time saving of 1 minute and 39 seconds per patient consultation for providers has been calculated.<sup>42</sup>

Few studies have examined the application of machine learning methods in OSCC. Only a multiparametric decision support system formulated for the prediction of OSCC reoccurrence. In this system, collected different type of data have included

clinical data, imaging and gene expression data in order to identify the factors that have potential involvement in OSCC progression and subsequently predict the possibility of a recurrence of the disease.<sup>43</sup> Table 2 shows some of the different applications of CDSS in the stages of cancer.

## Discussion

The advent of information technology in the field of medicine, and in particular the application of artificial intelligence, has led to significant progress in the data management especially in chronic diseases such as cancer. Discovering the patterns and relationships between them from the multiple and complex data sets have facilitated the effective prediction of future outcomes of cancer.<sup>44</sup> In recent years, many studies have used molecular, clinical or population-based data to predict cancer susceptibility,<sup>45</sup> recurrence<sup>43</sup> and survival.<sup>46,47</sup>

Due to the nature of medical data, the success of any intelligent system largely depends on the input data optimality; therefore, using data mining approaches are essential in order to reduce the data dimension, optimal choice and Increase in accuracy.<sup>48</sup>

Understanding of tumorigenesis can have a positive effect on the diagnosis and treatment process and also designing the more effective CDSSs. Different studies indicated that the following stages are required for cancer to form: 1- Acquisition of autonomous proliferative signaling, 2- Inhibition of growth inhibitory signals, 3- Evasion of programmed cell death, 4- Immortalization, 5- Acquisition of a nutrient blood supply (angiogenesis) and 6- Acquisition of the ability to invade tissue.<sup>44,49,50</sup>

Although significant progress has been made in the treatment of cancer, survival rate remains unchanged and oral cancer remains a life-threatening illness with a poor prognosis.<sup>51</sup>

OSCC is a rapidly progressive disease, although it can be a slower process by using several mechanisms, including defective

antigen presentation, interference with tumor-T cell interaction and production of immunosuppressive factors.<sup>52</sup>

Various studies have been conducted about the potentials and limitations of microarrays for the prediction of OSCC outcome, based on gene expression signatures.<sup>53,54</sup> The bioinformatics method that can be used to distinguish OSCC and normal tissues is gene ontology (GO). GO analysis was used to investigate the critical genes in the progression of OSCC and protein-protein interaction (PPI) networks. Moreover, pathway enrichment analysis was performed to estimate the significant pathways.<sup>55</sup> Studies that examine the impact of proteins on development and metastasis of OSCC through regulation of transcriptional responses, differentiation, angiogenesis, proliferation, and apoptotic programs can help researchers identify crucial targets for the prevention and treatment of OSCC.<sup>56</sup>

The importance of early diagnosis, the prognosis of cancer type, classifying cancer patients into high or low-risk groups, also an improvement in screening uptake by a combination of risk factors including genetic, environmental and behavioral risk factors in primary care led to an interest in the use of information technology and artificial intelligence in this area.<sup>57</sup>

Various surveys on the system development process have indicated the significant evolutions toward an effective improvement with regards to the patient, attention to organizational and economic issues and use of standard models for knowledge representation.<sup>58</sup> Dentists positive attitudes at the outset of a system change can help organizational administrators with the adoption of evidence-based dentistry tools such as a CDSS system.<sup>59</sup>

Efficiency and usability in CDSSs have a significant impact on users' adoption,<sup>60</sup> but designing a system with a multitude of warnings and suggestions and alarms is misleading and ambiguous.<sup>61</sup> Therefore, special attention has to be paid to these

points to design a convenient and functional system. Obviously, artificial intelligence analysis of health data and clinical decision support system must be employed along with clinicians.<sup>62,63</sup> Improving the capabilities of the CDSS and presenting it as an intelligent web service and providing access to dentists, as well as medical researchers, is an effective step in managing new and tracking past patients.

### Conclusion

With the advent of information technologies in the field of medicine, especially computer-based decision aids with embedded algorithms, there have been significant developments in the diagnosis and treatment of diseases.

Clinical decision support system can have an effective role in classifying the patients with OSCC into the higher/lower risk of reoccurrence groups and determine the optimal treatment protocols in a cost-effective manner at the point of caregiver.

Furthermore, the significant performance of the CDSS in improving the accuracy of early detection can play a vital role in reducing invasive treatments.

The trend of diagnostic techniques of the oral cavity towards non-invasive methods and identification of reliable biological tumor markers for OSCC produces a large amount of data. CDSS can manage data intelligently and improve in diagnostic accuracy

Obviously, several studies can be programmed on the application of the CDSS in susceptibility and survivability prediction in OSCC patient.

### Conflict of Interests

Authors have no conflict of interest.

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### References

1. Krishna Rao SV, Mejia G, Roberts-Thomson K, Logan R. Epidemiology of oral cancer in Asia in the past decade-an update (2000-2012). *Asian Pac J Cancer Prev* 2013; 14(10): 5567-77.
2. Sahebamee M, Mansourian A, Etemad-Moghadam S, Shamshiri AR, Derakhshan S. Conventional versus Papanicolaou-stained cytobrush biopsy in the diagnosis of oral squamous cell carcinoma. *Oral Health Dent Manag* 2014; 13(3): 619-22.
3. Durr ML, van Zante A, Li D, Kezirian EJ, Wang SJ. Oral tongue squamous cell carcinoma in never-smokers: Analysis of clinicopathologic characteristics and survival. *Otolaryngol Head Neck Surg* 2013; 149(1): 89-96.
4. Soudry E, Preis M, Hod R, Hamzany Y, Hadar T, Bahar G, et al. Squamous cell carcinoma of the oral tongue in patients younger than 30 years: Clinicopathologic features and outcome. *Clin Otolaryngol* 2010; 35(4): 307-12.
5. Carreras-Torras C, Gay-Escoda C. Techniques for early diagnosis of oral squamous cell carcinoma: Systematic review. *Med Oral Patol Oral Cir Bucal* 2015; 20(3): e305-e315.
6. Cheng YS, Rees T, Wright J. Updates regarding diagnostic adjuncts for oral squamous cell carcinoma. *Tex Dent J* 2015; 132(8): 538-49.
7. Tian X, Chen Z, Shi S, Wang X, Wang W, Li N, et al. Clinical diagnostic implications of body fluid MiRNA in oral squamous cell carcinoma: A meta-analysis. *Medicine (Baltimore)* 2015; 94(37): e1324.
8. Mendonca EA. Clinical decision support systems: Perspectives in dentistry. *J Dent Educ* 2004; 68(6): 589-97.
9. Lee SJ, Lee S, Lim J, Ahn SJ, Kim TW. Cluster analysis of tooth size in subjects with normal occlusion. *Am J Orthod Dentofacial Orthop* 2007; 132(6): 796-800.
10. Hwang HS, Youn IS, Lee KH, Lim HJ. Classification of facial asymmetry by cluster analysis. *Am J Orthod Dentofacial Orthop* 2007; 132(3): 279-6.
11. de Veld DC, Skurichina M, Witjes MJ, Duin RP, Sterenborg DJ, Star WM, et al. Autofluorescence characteristics of healthy oral mucosa at different anatomical sites. *Lasers Surg Med* 2003; 32(5): 367-76.
12. Saudi H. A periodontal expert system as an aid in periodontal treatment planning. *Egypt Dent J* 2002; 48: 1087.
13. Shankarapillai R, Mathur K, Nair MA, Rai N, Mathur A. Periodontitis risk assessment using two artificial neural networks-a pilot study. *International Journal of Dental Clinics* 2010; 2(4): 36-40.



14. Allahverdi N, Akcan T. A Fuzzy Expert System design for diagnosis of periodontal dental disease. Proceedings of the 5<sup>th</sup> International Conference on Application of Information and Communication Technologies (AICT); 2011 Oct 12-14; Baku, Azerbaijan.
15. Yagi M, Ohno H, Takada K. Decision-making system for orthodontic treatment planning based on direct implementation of expertise knowledge. *Conf Proc IEEE Eng Med Biol Soc* 2010; 2010: 2894-7.
16. Pegon-Machat E, Decerle N, Tubert-Jeannin S. Development and evaluation of a triage tool for patients in a dental emergency unit. *Sante Publique* 2015; 27(1): 79-88. [In French].
17. Thanathornwong B, Suebnukarn S, Ouivirach K. Decision support system for predicting color change after tooth whitening. *Comput Methods Programs Biomed* 2016; 125: 88-93.
18. Welch BM, Kawamoto K. Clinical decision support for genetically guided personalized medicine: a systematic review. *J Am Med Inform Assoc* 2013; 20(2): 388-400.
19. Abernethy AP, Samsa GP, Matchar DB. A clinical decision and economic analysis model of cancer pain management. *Am J Manag Care* 2003; 9(10): 651-64.
20. Finlayson SG, Levy M, Reddy S, Rubin DL. Toward rapid learning in cancer treatment selection: An analytical engine for practice-based clinical data. *J Biomed Inform* 2016; 60: 104-13.
21. Mi H, Petitjean C, Dubray B, Vera P, Ruan S. Robust feature selection to predict tumor treatment outcome. *Artif Intell Med* 2015; 64(3): 195-204.
22. Cakir A, Demirel B. A software tool for determination of breast cancer treatment methods using data mining approach. *J Med Syst* 2011; 35(6): 1503-11.
23. Bury J, Hurt C, Roy A, Bradburn M, Cross S, Fox J, et al. A quantitative and qualitative evaluation of LISA, a decision support system for chemotherapy dosing in childhood acute lymphoblastic leukaemia. *Stud Health Technol Inform* 2004; 107(Pt 1): 197-201.
24. Gerbert B, Bronstone A, Maurer T, Hofmann R, Berger T. Decision support software to help primary care physicians triage skin cancer: A pilot study. *Arch Dermatol* 2000; 136(2): 187-92.
25. Emery J, Morris H, Goodchild R, Fanshawe T, Prevost AT, Bobrow M, et al. The GRAIDS Trial: A cluster randomised controlled trial of computer decision support for the management of familial cancer risk in primary care. *Br J Cancer* 2007; 97(4): 486-93.
26. Ozanne EM, Howe R, Omer Z, Esserman LJ. Development of a personalized decision aid for breast cancer risk reduction and management. *BMC Med Inform Decis Mak* 2014; 14: 4.
27. Javan Amoli AH, Maserat E, Safdari R, Zali MR. Electronic Risk Assessment System as an Appropriate Tool for the Prevention of Cancer: A Qualitative Study. *Asian Pac J Cancer Prev* 2015; 16(18): 8595-8.
28. Shelton JB, Ochotorena L, Bennett C, Shekelle P, Kwan L, Skolarus T, et al. Reducing PSA-based prostate cancer screening in men aged 75 years and older with the use of highly specific computerized clinical decision support. *J Gen Intern Med* 2015; 30(8): 1133-9.
29. Hills RL, Kulbok PA, Clark M. Evaluating a quality improvement program for cervical cancer screening at an urban safety net clinic. *Health Promot Pract* 2015; 16(5): 631-41.
30. Maserat E, Seied Farajollah SS, Safdari R, Ghazisaeedi M, Aghdaei HA, Zali MR. Information engineering and workflow design in a clinical decision support system for colorectal cancer screening in Iran. *Asian Pac J Cancer Prev* 2015; 16(15): 6605-8.
31. Lundin J, Lundin M, Isola J, Joensuu H. Evaluation of a web-based system for survival estimation in breast cancer. *Stud Health Technol Inform* 2003; 95: 788-93.
32. Sidiropoulos K, Glotsos D, Kostopoulos S, Ravazoula P, Kalatzis I, Cavouras D, et al. Real time decision support system for diagnosis of rare cancers, trained in parallel, on a graphics processing unit. *Comput Biol Med* 2012; 42(4): 376-86.
33. Exarchos KP, Goletsis Y, Fotiadis DI. A multiscale and multiparametric approach for modeling the progression of oral cancer. *BMC Med Inform Decis Mak* 2012; 12: 136.
34. Nguyen AN, Lawley MJ, Hansen DP, Bowman RV, Clarke BE, Duhig EE, et al. Symbolic rule-based classification of lung cancer stages from free-text pathology reports. *J Am Med Inform Assoc* 2010; 17(4): 440-5.
35. Nguyen AN, De J, Nguyen J, Padula A, Qu Z. A teaching database for diagnosis of hematologic neoplasms using immunophenotyping by flow cytometry. *Arch Pathol Lab Med* 2008; 132(5): 829-37.
36. Righi LV. Oncotherapy: A system for requesting chemotherapy protocols. *Stud Health Technol Inform* 2015; 216: 1121.
37. Yilmaz AA, Ozdemir L. Development and implementation of the clinical decision support system for patients with cancer and nurses' experiences regarding the system. *Int J Nurs Knowl* 2017; 28(1): 4-12.
38. Abrantes D, Pimentel-Nunes P, Dinis-Ribeiro M, Coimbra M. Identifying technology interaction opportunities within a gastroenterology exam room. *Stud Health Technol Inform* 2015; 210: 652-6.
39. Al-Kadi OS. A multiresolution clinical decision support system based on fractal model design for classification of histological brain tumours. *Comput Med Imaging Graph* 2015; 41: 67-79.

40. Bountris P, Haritou M, Pouliakis A, Margari N, Kyrgiou M, Spathis A, et al. An intelligent clinical decision support system for patient-specific predictions to improve cervical intraepithelial neoplasia detection. *Biomed Res Int* 2014; 2014: 341483.
41. Rasoolimoghadam M, Safdari R, Ghazisaeidi M, Maharanitehrani M, Tahmasebiyan S. Designing decision support system to detect drug interactions type 2 diabetes. *Acta Inform Med* 2015; 23(6): 336-8.
42. Walker JG, Licqurish S, Chiang PP, Pirota M, Emery JD. Cancer risk assessment tools in primary care: a systematic review of randomized controlled trials. *Ann Fam Med* 2015; 13(5): 480-9.
43. Exarchos KP, Goletsis Y, Fotiadis DI. Multiparametric decision support system for the prediction of oral cancer reoccurrence. *IEEE Trans Inf Technol Biomed* 2012; 16(6): 1127-34.
44. Kourou K, Exarchos TP, Exarchos KP, Karamouzis MV, Fotiadis DI. Machine learning applications in cancer prognosis and prediction. *Comput Struct Biotechnol J* 2015; 13: 8-17.
45. Ayer T, Alagoz O, Chhatwal J, Shavlik JW, Kahn CE, Jr., Burnside ES. Breast cancer risk estimation with artificial neural networks revisited: Discrimination and calibration. *Cancer* 2010; 116(14): 3310-21.
46. Park K, Ali A, Kim D, An Y, Kim M, Shin H. Robust predictive model for evaluating breast cancer survivability. *Eng Appl Artif Intell* 2013; 26(9): 2194-205.
47. Holt TA, Thorogood M, Griffiths F, Munday S, Friede T, Stables D. Automated electronic reminders to facilitate primary cardiovascular disease prevention: Randomised controlled trial. *Br J Gen Pract* 2010; 60(573): e137-e143.
48. Gilutz H, Novack L, Shvartzman P, Zelingher J, Bonneh DY, Henkin Y, et al. Computerized community cholesterol control (4C): Meeting the challenge of secondary prevention. *Isr Med Assoc J* 2009; 11(1): 23-9.
49. Hanahan D, Weinberg RA. The hallmarks of cancer. *Cell* 2000; 100(1): 57-70.
50. Hanahan D, Weinberg RA. Hallmarks of cancer: The next generation. *Cell* 2011; 144(5): 646-74.
51. Pasini FS, Maistro S, Snitcovsky I, Barbeta LP, Rotea Mangone FR, Lehn CN, et al. Four-gene expression model predictive of lymph node metastases in oral squamous cell carcinoma. *Acta Oncol* 2012; 51(1): 77-85.
52. Fang L, Sun L, Hu FF, Chen QE. Effects of FasL expression in oral squamous cell cancer. *Asian Pac J Cancer Prev* 2013; 14(1): 281-5.
53. Randhawa V, Acharya V. Integrated network analysis and logistic regression modeling identify stage-specific genes in Oral Squamous Cell Carcinoma. *BMC Med Genomics* 2015; 8: 39.
54. Tang XH, Urvalek AM, Osei-Sarfo K, Zhang T, Scognamiglio T, Gudas LJ. Gene expression profiling signatures for the diagnosis and prevention of oral cavity carcinogenesis-genome-wide analysis using RNA-seq technology. *Oncotarget* 2015; 6(27): 24424-35.
55. Jiang Q, Yu YC, Ding XJ, Luo Y, Ruan H. Bioinformatics analysis reveals significant genes and pathways to target for oral squamous cell carcinoma. *Asian Pac J Cancer Prev* 2014; 15(5): 2273-8.
56. Liu Y, Liu CX, Wu ZT, Ge L, Zhou HM. Mining proteins associated with oral squamous cell carcinoma in complex networks. *Asian Pac J Cancer Prev* 2013; 14(8): 4621-5.
57. Mehrotra R, Gupta DK. Exciting new advances in oral cancer diagnosis: Avenues to early detection. *Head Neck Oncol* 2011; 3: 33.
58. Quaglioni S, Sacchi L, Lanzola G, Viani N. Personalization and patient involvement in decision support systems: current trends. *Yearb Med Inform* 2015; 10(1): 106-18.
59. Mertz E, Bolarinwa O, Wides C, Gregorich S, Simmons K, Vaderhobli R, et al. Provider attitudes toward the implementation of clinical decision support tools in dental practice. *J Evid Based Dent Pract* 2015; 15(4): 152-63.
60. Meulendijk MC, Spruit MR, Willeboordse F, Numans ME, Brinkkemper S, Knol W, et al. Efficiency of clinical decision support systems improves with experience. *J Med Syst* 2016; 40(4): 76.
61. Kesselheim AS, Cresswell K, Phansalkar S, Bates DW, Sheikh A. Clinical decision support systems could be modified to reduce 'alert fatigue' while still minimizing the risk of litigation. *Health Aff (Millwood)* 2011; 30(12): 2310-7.
62. Mohammadzadeh N, Safdari R, Baraani A, Mohammadzadeh F. Intelligent data analysis: The best approach for chronic heart failure (CHF) follow up management. *Acta Inform Med* 2014; 22(4): 263-7.
63. Safdari R, Kadivar M, Langarizadeh M, Nejad AF, Kermani F. Developing a Fuzzy Expert System to predict the risk of neonatal death. *Acta Inform Med* 2016; 24(1): 34-7.

## The association between growth factors and blood factors with early childhood caries

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### Original Article

#### Abstract

**BACKGROUND AND AIM:** Early childhood caries (ECC) is a specific form of rampant dental caries affecting infants and young children. ECC is still a problem that threatens the health of the community and its management is important. It is believed that the majorities of children with ECC also suffer from malnutrition, anemia, low weight and altered physical growth patterns. This study was undertaken to compare blood indices [mean corpuscular volume (MCV), hemoglobin and serum ferritin] in a population of children in Kerman, Iran, and the association between growth factors, blood parameters, and ECC.

**METHODS:** In this cross-sectional study, 240 children were selected from Afzalipour Hospital of Kerman. The subjects consisted of 2 to 6-year children, who needed blood sampling for different diagnostic reasons. Data were collected through clinical oral examinations, anthropometric measures, blood indices measurement (MCV, hemoglobin and serum ferritin) and structured questionnaire in order to assess demographic characteristics, nutritional habits and the presence or absence of systemic conditions. Data were analyzed using SPSS software.

**RESULTS:** The mean age of subjects was 50.79 months. Of 240 children included in this study, 124 (52.1%) were girls and the rest (47.9%) were boys. Statistical test revealed that there were statically significant differences in weight as well as the height of children in experimental and control groups ( $P < 0.050$ ). No significant differences were detected in the frequencies of low hematocrit levels between the groups with and without dental caries ( $P > 0.050$ ).

**CONCLUSION:** No significant association was observed between ECC and blood indices (MCV, hemoglobin and serum ferritin), but the mean height and weight in the caries-free group were significantly higher.

**KEYWORDS:** Dental Caries; Iron Deficiency; Anemia; Preschool Child; Growth Factors; Blood Factors; Early Childhood Caries

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Dental caries is a transmissible infectious disease and its initiation and progression are affected by various factors.<sup>1</sup> It has been demonstrated that children with higher counts of *Streptococcus mutans* and *Lactobacilli* are 5 times more prone to have early childhood caries (ECC) as compared to those with lower

counts of these bacterial species.<sup>2</sup>

The American Academy of Pediatric Dentistry (AAPD) has defined ECC as the presence of one or several tooth surfaces (cavitated or non-cavitated) which have been lost or restored due to caries in any of the primary teeth in 71-month or younger children.<sup>3</sup> It has been shown that children of

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families with low socioeconomic status, irrespective of culture and ethnicity, suffer from this condition more than other groups. In general and based on the studies carried out in almost all the countries, varying prevalence rates have been reported in different age groups.

ECC has been reported to be the most common chronic disease in children in the United States. Dental caries is five times more common than asthma and seven times more common than hay fever.<sup>4</sup> Furthermore, the prevalence of ECC in Iran has been reported to be 3-44% in different parts of the country,<sup>5-7</sup> which necessitates further research about the condition and evaluation of techniques to deal with it. The current knowledge on the effects of ECC on the nutritional status of children is not sufficient and it is believed that the majorities of children with ECC also suffer from malnutrition, anemia, low weight and altered physical growth patterns.<sup>8</sup>

Despite the epidemic nature of dental caries and iron deficiency, limited studies are available on the association between these two entities. ECC is still a problem that threatens the health of the community and its management is important. ECC might lead to the malocclusion of permanent teeth, phonetic problems, and low self-confidence. Continuous and unbearable pain in young children, such as a toothache, have serious and sometimes irreversible effects on the growth and development of children.<sup>9</sup> Moreover, caries is more prevalent in deciduous teeth. This phenomenon itself is one of the most important factors in shifting caries to newly erupted permanent teeth.<sup>10</sup> The children's health affects their nutrition, sleep, smile, speech, and socialization. In addition, the facial appearance affects the children's mental health and, subsequently the establishment of social relationships.<sup>11</sup> Furthermore, clinicians have also found that an attractive appearance and social acceptance can help the person in achieving social success.<sup>12</sup> Based on a research, weight gain and other parameters related to the

growth and development of children are normal when the teeth are healthy, which might be attributed to the efficacy of mastication and proper nutrition.<sup>13</sup>

ECC predisposes more severe dental conditions in future,<sup>14</sup> and increases the sensitivity of children to somatic pains. Limitations in selecting food, decreased appetite, anorexia and a decrease in food enjoyment are complications that associate dental caries with weight loss, delayed growth and poor development.<sup>15-17</sup> On the other hand, it has been demonstrated that the weight loss is compensated after the dental health has been improved.<sup>18</sup> Therefore, identification of malnutrition risk factors results in a decrease in its occurrence, which in turn improves the children's health-related indices.

The present study was undertaken to evaluate growth and blood factors in children with ECC.<sup>19</sup> Therefore, the possible role of some factors relevant to malnutrition in this type of dental caries would be elucidated.

## Methods

This cross-sectional study was undertaken using clinical examination. A checklist, including demographic characteristics (age, sex) and the presence or absence of systemic conditions, was completed by an examiner (a trained pedodontist) on 240 children. All the 2 to 6-year children in the pediatric department of Afzalipour Hospital of Kerman, south-east of Iran, who needed blood sampling for different diagnostic reasons, were included in this study through random sampling. The parents were asked about children's feeding pattern during infancy and birth weight. The ethical code (K/88/07) was allocated to this study by the Oral Diseases Research Center of Kerman. The parents signed an informed consent form for the participation of their children in the study.

Children with ECC were compared with a control group of caries-free children. Two groups of children were included in this study. The inclusion criteria were as follows: no specific physical or systemic condition related

to ECC or iron deficiency as reported by the parents, absence of severe renal insufficiency and hypothyroidism (anemia is one of the complications of these two medical conditions), an age range of 2 to 6 years. Children with systemic disease, severe renal insufficiency and hypothyroidism were excluded.

The children underwent a clinical examination under a 100-W light using disposable dental mirrors and explorers and placed in one of the following groups. G1: caries-free, G2: decalcification on the maxillary incisors, G3: cavity on the maxillary incisors, and G4: decalcification on some maxillary incisors and cavities on some others.<sup>20</sup>

The clinical evaluation of the nutritional status involves several tests to correctly determine the presence of malnutrition. The clinical parameters of children including height, weight and the upper mid-arm circumference (MAC) were measured. The MAC was measured on the right side. A tape measure, with no capacity to be stretched, was used for such measurement. To this end, the examiner measured the distance between the acromion process of the scapula and the elbow, determined the middle point, and then measured the circumference of the arm at this point without exerting any pressure on the arm.<sup>21</sup> The most important blood tests that might indicate iron deficiency are hemoglobin, ferritin sodium and to a lesser extent mean corpuscular volume (MCV),<sup>22</sup> which were

evaluated in the present study. Based on a definition by World Health Organization (WHO), a hemoglobin level under 11 or a hematocrit value under 33% in 6 to 59-month children, and hemoglobin levels under 11.5 or hematocrit levels under 34% in 5 to 11-year children indicate anemia.<sup>23</sup> If iron deficiency anemia is assessed based on serum ferritin levels, at ages under 5 and ages between 5 to 15 years, ferritin levels under 12 and 15 are considered abnormal, respectively.<sup>24</sup>

Data were analyzed using SPSS software (version 20, IBM Corporation, Armonk, NY, USA). Mean  $\pm$  standard deviation (SD) and number (percentage) were used for data description. Analysis of variance (ANOVA), Student's independent t-test, and chi-square or Fisher's exact tests were used for data analysis. Statistical significance was set at  $P < 0.050$ .

## Results

A total of 240 children were included in this cross-sectional study. 124 subjects (52.1%) were girls and the rest (47.9%) were boys. Table 1 shows frequency distribution of the children according to sex, feeding pattern, caries status, birth weight, and blood parameters. Demographic characteristics and selected blood tests between ECC and control groups have been shown in table 2. ANOVA test outcomes showed that only the mean height in the caries-free group was significantly higher than that in other groups (Table 3).

**Table 1.** Distribution of the children according to sex, feeding pattern, caries, birth weight, and blood parameters

Parameter		n (%)
Sex	Female	124 (51.7)
	Male	116 (48.3)
Feeding pattern	Breastfeeding	166 (69.2)
	Bottle feeding	36 (15.0)
	Both	38 (15.8)
Blood test	Normal	84 (35.0)
	Decreased	156 (65.0)
Weight at birth time	Normal	220 (91.7)
	Low birth weight	20 (8.3)
Caries	Caries free	83 (34.6)
	Decalcification of anterior upper teeth	18 (7.5)
	Cavity on anterior upper teeth	126 (52.5)
	Decalcification in some teeth and cavity in others	13 (5.4)

**Table 2.** Demographic characteristics and selected laboratory tests among 2 to 6-year Iranian children

Characteristic	Caries	
	No (n = 83)	Yes (n = 159)
Ferritin (ng/ml) (mean ± SD)	34.63 ± 19.16	34.39 ± 24.93
Hb (g/dl) (mean ± SD)	12.37 ± 1.02	12.50 ± 2.48
Height (cm) (mean ± SD)	99.53 ± 14.15	96.94 ± 9.97
MAC (mean ± SD)	15.09 ± 2.74	14.98 ± 1.66
MCV (mean ± SD)	77.61 ± 4.59	76.80 ± 5.64
Weight (kg) (mean ± SD)	16.34 ± 4.24	15.22 ± 3.29
Age (month) (mean ± SD)	51.87 ± 16.45	50.23 ± 14.42

SD: Standard deviation; Hb: Hemoglobin; MAC: Mid-arm circumference; MCV: Mean corpuscular volume

The 4 groups were converted to two groups, with and without caries, and re-analyzed. Student's independent t-test analysis showed that only the mean weight of children who had no caries was significantly higher than children with any type of caries.

In addition, Fisher's exact test did not exhibit any significant differences in the frequencies of low hematocrit values and low birth weight between the different age groups with caries. Similarly, chi-square test did not show any significant differences in the frequencies of low hematocrit values and low birth weight between the two groups (Table 4).

Based on the results, the mean height of caries-free children was significantly higher than the children with caries. The mean weight of caries-free children was significantly higher than that of children with caries. There were no significant differences in the frequencies of low hematocrit levels between groups with and without caries. The frequencies of low birth weight were not significantly different between groups with different caries rates. There were no

significant differences in the frequencies of low birth rates between groups with and without caries.

### Discussion

At present, there are insufficient data on the relationship between caries and iron deficiency. Meanwhile, the available data are contradictory. In this study, children with ECC and caries-free children were included to evaluate the relationship between MCV, hemoglobin, and serum ferritin levels and dental caries. Height, weight and MAC of all participants were measured.

To date, only a limited number of studies have assessed the nutritional status of young children with ECC. In a study, the clinical criterion used for the diagnosis of ECC was the presence of smooth surface caries on 4 maxillary incisors.<sup>25</sup> In the present study, the clinical criterion for the diagnosis of ECC was the presence of smooth surface caries with cavities or decalcification on 4 maxillary incisors. Initial studies have shown that children with ECC might have lower mean weight, compared to caries-free children.

**Table 3.** The comparison of measured parameter between four groups according to caries stages

Parameter	Caries free (n = 83)	Decalcification of anterior upper teeth (n = 18)	Cavity on anterior upper teeth (n = 126)	Decalcification in some teeth and cavity in others (n = 13)	P*
Weight (kg) (mean ± SD)	16.34 ± 4.25	14.07 ± 2.33	15.41 ± 3.26	15.03 ± 4.47	0.060
Height (cm) (mean ± SD)	99.54 ± 14.15	93.28 ± 11.99	97.98 ± 9.43	91.65 ± 10.32	0.040
MAC	15.09 ± 2.74	14.36 ± 0.92	15.08 ± 1.66	15.00 ± 2.11	0.570
Hb (g/dl) (mean ± SD)	12.38 ± 1.02	12.52 ± 1.04	12.27 ± 1.12	12.46 ± 0.95	0.710
Ferritin (ng/ml) (mean ± SD)	34.63 ± 19.10	24.39 ± 13.93	35.62 ± 26.51	38.66 ± 18.78	0.240
MCV	77.61 ± 4.59	77.92 ± 6.28	76.58 ± 5.74	77.47 ± 3.87	0.480

\*Analysis of variance (ANOVA)

SD: Standard deviation; MAC: Mid-arm circumference; Hb: Hemoglobin; MCV: Mean corpuscular volume

**Table 4.** The comparison of measured parameters between two groups [with and without early childhood caries (ECC)]

Parameter	Caries		P*
	No (n = 83)	Yes (n = 157)	
Weight (kg) (mean ± SD)	16.35 ± 4.25	15.23 ± 3.29	0.040
Height (cm) (mean ± SD)	99.54 ± 14.16	96.91 ± 9.99	0.130
MAC	15.09 ± 2.75	14.99 ± 1.64	0.740
Hb (g/dl) (mean ± SD)	12.38 ± 1.02	12.31 ± 1.10	0.660
Ferritin (ng/ml) (mean ± SD)	34.63 ± 19.16	34.58 ± 25.01	0.980
MCV	77.61 ± 4.59	76.81 ± 5.66	0.260

\*Student's independent t-test

SD: Standard deviation; Hb: Hemoglobin; MAC: Mid-arm circumference; MCV: Mean corpuscular volume

Therefore, it has been suggested that these children might not have received adequate calories.<sup>26,27</sup> In this study, only the weight of children, who were caries-free, was significantly higher than that in children with caries.

Thomas and Primosch compared the weight of children with ECC, with the reference norms for children, and concluded that children with ECC had no noticeable weight loss.<sup>27</sup> The limitation of that study and similar studies is the fact that they have used only the children's weight as a criterion for the evaluation of their nutritional status, which is not sufficient for the evaluation of the clinical nature of nutrition. On the other hand, Bagherian and Sadeghi evaluated the relationship between body mass index (BMI) and dental caries in preschool children, where they showed a higher rate of dental caries in overweight children. They attributed this problem to the possible relationship between a higher intake of high-calorie foodstuffs deficient in nutritive materials by these children.<sup>28</sup> Several studies support these findings.<sup>29-32</sup>

Similar to our results, Gaur and Nayak suggested that severe ECC negatively influenced the children weights. Awareness and parents' education may help in improving their weights.<sup>33</sup> Clarke et al.<sup>22</sup> evaluated the nutritional status of children with ECC using different clinical criteria. The clinical measurements consisted of height, weight and MAC. In addition, they evaluated the blood samples of the subjects for hemoglobin, MCV and serum albumin and

ferritin levels. These measurements were compared with those in a control group. The results of the study suggested that ECC might be a risk maker for iron deficiency anemia. In their study, 80% of the subjects exhibited low serum levels of ferritin and in 28% of children, the hemoglobin levels were lower than the standard levels. Interestingly, after rendering dental treatments to children with ECC, their ferritin and hemoglobin levels were improved.<sup>22</sup>

Shaoul et al. showed a significant relationship between ECC and low serum levels of ferritin.<sup>34</sup> However, the mechanism of the relationship between iron deficiency and dental caries is unknown. Several hypotheses have been proposed in this regard to date. A hypothesis, based on a study by Gaur and Nayak,<sup>33</sup> suggests that a decrease in hemoglobin levels can be associated with inflammatory responses in the human body. The inflammatory responses in ECC might result in the production of cytokines that inhibit the synthesis of erythrocytes and decrease hemoglobin levels. A decrease in hemoglobin levels is common in many chronic diseases. Furthermore, severe ECC (S-ECC) is known as a chronic disease.

Schroth et al. reported that children with ECC have altered dietary habits that can predispose them to nutritional deficiencies such as iron deficiency.<sup>3</sup> Fretham hypothesized that iron deficiency in children leads to a decrease in mental capacities, a decrease in motor skills and an increase in anxiety levels. Early diagnosis of such

deficiency, for example by detecting ECC in children, might result in the early initiation of treatment.<sup>35</sup> Unlike these studies, our result did not depict any association between ECC and blood parameters.

One of the shortcomings of the present study was the inability to match the samples completely. Although a consistent age range was considered for all the samples and the subjects were evaluated separately in relation to their sex, socioeconomic matching was not possible. S-ECC is more prevalent in children with lower socioeconomic status<sup>36</sup> and it is more difficult to find caries-free subjects in these socioeconomic levels. According to the important role of various factors in the induction of S-ECC, such as family income and the parents' educational levels, it is not possible to extend the results of this study to the whole community. Despite the limitations of this study, our results added the association

investigation between ECC and blood parameters and developmental indices to the literature and provided additional evidence for the complexity of this relationship.

### Conclusion

No significant associations between ECC and blood parameters were observed. However, lower height and weight were significant determinants of caries experience. Finally, it is suggested that height, weight, and diet of children with ECC should be more precisely evaluated periodically.

### Conflict of Interests

Authors have no conflict of interest.

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### References

1. Casamassimo PS, Thikkurissy S, Edelstein BL, Maiorini E. Beyond the DMFT: The human and economic cost of early childhood caries. *J Am Dent Assoc* 2009; 140(6): 650-7.
2. Ramos-Gomez FJ, Weintraub JA, Gansky SA, Hoover CI, Featherstone JD. Bacterial, behavioral and environmental factors associated with early childhood caries. *J Clin Pediatr Dent* 2002; 26(2): 165-73.
3. Schroth RJ, Levi J, Kliewer E, Friel J, Moffatt ME. Association between iron status, iron deficiency anaemia, and severe early childhood caries: A case-control study. *BMC Pediatr* 2013; 13: 22.
4. Filstrup SL, Briskie D, da Fonseca M, Lawrence L, Wandera A, Inglehart MR. Early childhood caries and quality of life: Child and parent perspectives. *Pediatr Dent* 2003; 25(5): 431-40.
5. Askarizadeh N, Siyonat P. The prevalence and pattern of nursing caries in preschool children of Tehran. *J Indian Soc Pedod Prev Dent* 2004; 22(3): 92-5.
6. Bargrizan M, Rahimi M, Moghadam B. Nursing caries in 2-4 years old children in Tehran. An epidemiologic survey. *J Dent Sch Shahid Beheshti Univ Med Sci* 2001; 18(4): 9-15. [In Persian].
7. Poureslami H, Adhemi SH. Relationship between ECC and feeding habits among a group of babies & toddlers in Kerman. *Journal of Islamic Dental Association of Iran* 2001; 17: 47-55. [In Persian].
8. Schroth RJ, Jeal NS, Kliewer E, Sellers EA. The relationship between vitamin D and severe early childhood caries: A pilot study. *Int J Vitam Nutr Res* 2012; 82(1): 53-62.
9. Larson K, Russ SA, Crall JJ, Halfon N. Influence of multiple social risks on children's health. *Pediatrics* 2008; 121(2): 337-44.
10. Jahanimoghadam F, Poureslami H, Shamsaddin H, Horri A, Khazaeli P, Mahvi AH. Effect of ER: Yag laser on sodium fluoride varnish uptake by primary tooth enamel: An in-vitro study. *Research Report Fluoride* 2016; 49(4 Pt 2): 538-48.
11. Yusuf H, Gherunpong S, Sheiham A, Tsakos G. Validation of an English version of the Child-OIDP index, an oral health-related quality of life measure for children. *Health Qual Life Outcomes* 2006; 4: 38.
12. Jahanimoghadam F, Momenidanayee S, Karimifshar M. Correction of severe tooth rotation by using two different orthodontic appliances: Report of two cases. *J Oral Health Oral Epidemiol* 2016; 5(1): 46-51.
13. Monse B, Duijster D, Sheiham A, Grijalva-Eternod CS, van Palenstein Helderma W, Hobdell MH. The effects of extraction of pulpally involved primary teeth on weight, height and BMI in underweight Filipino children. A cluster randomized clinical trial. *BMC Public Health* 2012; 12: 725.
14. Greenwell AL, Johnsen D, DiSantis TA, Gerstenmaier J, Limbert N. Longitudinal evaluation of caries patterns from the primary to the mixed dentition. *Pediatr Dent* 1990; 12(5): 278-82.



15. Miller J, Vaughan-Williams E, Furlong R, Harrison L. Dental caries and children's weights. *J Epidemiol Community Health* 1982; 36(1): 49-52.
16. Ayhan H, Suskan E, Yildirim S. The effect of nursing or rampant caries on height, body weight and head circumference. *J Clin Pediatr Dent* 1996; 20(3): 209-12.
17. Benzian H, Monse B, Heinrich-Weltzien R, Hobdell M, Mulder J, van Palenstein, Helderma W. Untreated severe dental decay: A neglected determinant of low Body Mass Index in 12-year-old Filipino children. *BMC Public Health* 2011; 11: 558.
18. Ribeiro NM, Ribeiro MA. Breastfeeding and early childhood caries: A critical review. *J Pediatr (Rio J)* 2004; 80(5 Suppl): S199-S210.
19. Sullivan DH. The role of nutrition in increased morbidity and mortality. *Clin Geriatr Med* 1995; 11(4): 661-74.
20. Shivakumar K, Prasad S, Chandu G. International caries detection and assessment system: A new paradigm in detection of dental caries. *J Conserv Dent* 2009; 12(1): 10-6.
21. Committee on Nutrition AaOP. Appendix I. Procedures for measuring growth parameters. Elk Grove Village, IL: American Academy of Pediatrics; 1998. p. 168-74
22. Clarke M, Locker D, Berall G, Pencharz P, Kenny DJ, Judd P. Malnourishment in a population of young children with severe early childhood caries. *Pediatr Dent* 2006; 28(3): 254-9.
23. Scott SP, Chen-Edinboro LP, Caulfield LE, Murray-Kolb LE. The impact of anemia on child mortality: An updated review. *Nutrients* 2014; 6(12): 5915-32.
24. Jose B, King NM. Early childhood caries lesions in preschool children in Kerala, India. *Pediatr Dent* 2003; 25(6): 594-600.
25. Acs G, Lodolini G, Kaminsky S, Cisneros GJ. Effect of nursing caries on body weight in a pediatric population. *Pediatr Dent* 1992; 14(5): 302-5.
26. Miller J, Vaughan-Williams E, Furlong R, Harrison L. Dental caries and children's weights. *J Epidemiol Community Health* 1982; 36(1): 49-52.
27. Thomas CW, Primosch RE. Changes in incremental weight and well-being of children with rampant caries following complete dental rehabilitation. *Pediatr Dent* 2002; 24(2): 109-13.
28. Bagherian A, Sadeghi M. Association between dental caries and age-specific body mass index in preschool children of an Iranian population. *Indian J Dent Res* 2013; 24(1): 66-70.
29. Norberg C, Hallstrom SU, Matsson L, Thorngren-Jerneck K, Klingberg G. Body mass index (BMI) and dental caries in 5-year-old children from southern Sweden. *Community Dent Oral Epidemiol* 2012; 40(4): 315-22.
30. Trikaliotis A, Boka V, Kotsanos N, Karagiannis V, Hassapidou M. Short communication: Dmfs and BMI in preschool Greek children. An epidemiological study. *Eur Arch Paediatr Dent* 2011; 12(3): 176-8.
31. Vazquez-Nava F, Vazquez-Rodriguez EM, Saldivar-Gonzalez AH, Lin-Ochoa D, Martinez-Perales GM, Joffre-Velazquez VM. Association between obesity and dental caries in a group of preschool children in Mexico. *J Public Health Dent* 2010; 70(2): 124-30.
32. Willershausen B, Moschos D, Azrak B, Blettner M. Correlation between oral health and body mass index (BMI) in 2071 primary school pupils. *Eur J Med Res* 2007; 12(7): 295-9.
33. Gaur S, Nayak R. Underweight in low socioeconomic status preschool children with severe early childhood caries. *J Indian Soc Pedod Prev Dent* 2011; 29(4): 305-9.
34. Shaoul R, Gaitini L, Kharouba J, Darawshi G, Maor I, Somri M. The association of childhood iron deficiency anaemia with severe dental caries. *Acta Paediatr* 2012; 101(2): e76-e79.
35. Fretham SJ, Carlson ES, Georgieff MK. The role of iron in learning and memory. *Adv Nutr* 2011; 2(2): 112-21.
36. Costa LR, Daher A, Queiroz MG. Early childhood caries and body mass index in young children from low income families. *Int J Environ Res Public Health* 2013; 10(3): 867-78.

## A retrospective study of children and adolescents oral and maxillofacial lesions over a 20-year period in Kerman, Iran

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### Original Article

#### Abstract

**BACKGROUND AND AIM:** Oral and maxillofacial lesions vary in different geographic regions based on their clinical features. Until now, few investigations have studied these lesions in children and adolescents in Iran. The aim of this research was to study the clinicopathological manifestations of biopsied oral and maxillofacial lesions among children and adolescents in the south of Iran.

**METHODS:** In this retrospective cross-sectional study, all the cases referred to the Department of Pathology, Kerman faculty of Dentistry, and two treatment centers of Kerman University of Medical Sciences, Kerman, Iran during 1996-2015 were included. All demographic information including age, gender, anatomic location and histopathologic diagnosis of the oral and maxillofacial biopsies in patients under 18 years was extracted from patients' chart fields. SPSS was used for the data analysis.

**RESULTS:** Of 3196 oral and maxillofacial lesions, 326 cases (10.2%) occurred in the age group under 18 years. The most common group was inflammatory/reactive lesions (36.8%). The most common lesions were pyogenic granuloma (9.20%), peripheral giant cell granuloma (8.89%), and dentigerous cyst (8.28%). Gingiva was the main involved area and the female to male ratio was 1.1 to 1.

**CONCLUSION:** Our study revealed that almost 10.2% of oral and maxillofacial lesions occurred in children and adolescents. The majority of lesions were benign, and malignant lesions were rarely observed in the sample. The most prevalent biopsied lesions were inflammatory/reactive lesions. Unlike other studies, lower rates of mucocele were observed in this study. These findings can improve patient's management among dentists and surgeons.

**KEYWORDS:** Adolescent; Child; Oral Pathology; Biopsy; Prevalence

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Children and adolescents may show different oral lesions with different clinical features, signs and symptoms, behavior and prevalence compared to the adults.<sup>1-4</sup> Although few investigations have been performed on the prevalence of these lesions among children and adolescents but these studies are mostly limited to epidemiological surveys on dental and

periodontal diseases like dental caries, periodontal disease, malocclusion, and dental traumas.<sup>3,5,6</sup> In addition, there are some studies that only have identified and reported certain groups of diseases such as odontogenic lesions, bone diseases, and salivary gland lesions.<sup>1-3</sup>

Because of environmental and racial characteristics and lifestyle of the population, there are significant differences between

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prevalence of oral and maxillofacial lesions in different populations. In addition, the other important factor is lack of age range classification standards for classifying patients in children and adolescents group.<sup>1-7</sup>

The main aim of the study on the prevalence of oral and maxillofacial lesions in this age group is to determine the most common lesions in this population. In addition, the age ranges, signs and symptoms, and the sites more affected by these lesions in this population are different from common lesions in adults.<sup>7</sup> There are few studies with large sample that have analyzed the results of oral and maxillofacial biopsies in children and adolescents.<sup>8</sup> In Iran, few studies have investigated oral lesions of this age range.<sup>9-11</sup> Therefore, the aim of this retrospective study was to evaluate the clinicopathologic features of oral and maxillofacial lesions diagnosed in children and adolescents (0-18 years).

### Methods

In this retrospective cross-sectional study, of 134722 cases diagnosed during 1996-2015 in pathology laboratory of Kerman faculty of Dentistry and two treatment centers of Kerman University of Medical Sciences, Kerman, Iran including Bahonar and Shafa hospitals, about 3196 cases were diagnosed in oral and maxillofacial region. Among these cases, 326 cases (10.2%) were diagnosed in patients less than 18 years. Clinical data such as age, gender, site of involvement, and clinical diagnosis were extracted from patients' chart fields. The study was confirmed by the Ethics Committee of Kerman University of Medical Sciences (Ethics code: IR.KMU.REC.1394.51). All slides were reviewed by an oral pathologist for definitive diagnosis. Since there were some cases that were not properly stained due to long-term filing or were not definitely diagnosed, new slides were prepared from paraffin-embedded tissue blocks and examined. Immunohistochemical staining reaction in cases where it was necessary to

reach a final diagnosis was performed.

The histopathological diagnoses were categorized in 9 groups as follows:

Inflammatory/reactive lesions, odontogenic cysts and tumors, pulp and periapical inflammatory lesions, salivary gland pathology, benign soft tissue lesions, benign epithelial lesions, non-odontogenic cysts, benign bone lesions, and premalignant and malignant lesions.

Data were analyzed using SPSS software (version 20, IBM Corporation, Armonk, NY, USA) and chi-square and t-test ( $P$ -value  $< 0.05$  was considered statistical significant).

### Results

The results of this study showed that in 20-year period (1996-2015), 3262 cases of oral and maxillofacial lesions were diagnosed in children and adolescents with 0-18 years of age. Of 326 cases, 154 cases (47.2%) were male with the average age of  $12.5 \pm 4.3$  and 172 (52.8%) were female with the average age of  $13.1 \pm 4.7$ . The female to male ratio was 1.1 to 1 and was not statistically significant ( $P > 0.05$ ). Chi-square test showed no significant statistical relationship between genders in the 9 lesion categories ( $P = 0.20$ ). The overall incidence of lesions in the permanent dentition was significantly higher than primary and mixed dentitions ( $P = 0.01$ ). The frequency of lesions considering their group is demonstrated in table 1.

The most prevalent group was Inflammatory/reactive lesions, and then, odontogenic cysts and tumors, and pulp and periapical inflammatory lesions were the most prevalent ones. The most prevalent lesion in this study was pyogenic granuloma (9.20%), and then peripheral giant cell granuloma (8.89%), dentigerous cyst (8.28%), and mucocele (7.97%). The frequency of lesions in inflammatory/reactive lesions and odontogenic cysts and tumors categories are listed in tables 2 and 3, respectively.

The frequency of pulp and periapical inflammatory lesions and salivary gland pathology are shown in table 4.

**Table 1.** Distribution of the lesions according to diagnosis categories

Categories	Gender		Age (year) (mean $\pm$ SD)	n (%)
	Female	Male		
Inflammatory/reactive lesions	68	52	14.34 $\pm$ 3.62	120 (36.80)
Odontogenic cysts and tumors	30	31	13.07 $\pm$ 3.88	61 (18.71)
Pulp and periapical inflammatory lesions	15	22	13.44 $\pm$ 3.37	37 (11.34)
Salivary gland pathology	21	15	11.85 $\pm$ 4.72	36 (11.04)
Benign soft tissue lesions	8	11	13.90 $\pm$ 3.58	19 (5.82)
Benign epithelial lesions	10	7	12.29 $\pm$ 3.61	17 (5.21)
Non-odontogenic cysts	8	5	12.54 $\pm$ 3.81	13 (3.98)
Malignant lesions	6	6	11.51 $\pm$ 2.27	12 (3.68)
Bone lesions	6	5	10.27 $\pm$ 2.18	11 (3.37)

SD: Standard deviation

The most common lesions in these two groups were radicular cyst (6.74%) and mucocele (7.97%), respectively.

Benign soft tissue lesions were the fifth common category in this study. Hemangioma with 8 cases (2.45%) was the most prevalent lesion in this category followed by lipoma with 4 cases and granular cell tumor and vascular malformation each with 2 cases. Neuroma, chondromyxoid fibroma and neurofibroma each were diagnosed in 1 case.

In this study, benign epithelial lesions were found in 17 cases. Among them, squamous papilloma diagnosed in 10 cases (3.06%) was the most common lesion and then verruca vulgaris and multifocal epithelial hyperplasia (Heck disease), each with 2 cases and, compound nevus, blue nevus and white sponge nevus each with 1 case were the most common lesions.

Non-odontogenic cysts (3.98%) were the next common group in this study. Thyroglossal duct cyst (n = 7), epidermoid cyst (n = 3), dermoid cyst (n = 2), and traumatic bone cyst (n = 1) were the most

prevalent lesions in this category.

Bone lesions were diagnosed in 3.37% and central giant cell granuloma and fibrous dysplasia were diagnosed in 5 and 6 cases, respectively.

In this study, 3.68% of lesions (n = 12) were malignant tumors that burkitt lymphoma (n = 4), rhabdomyosarcoma, mucoepidermoid carcinoma, and Langerhans cell histiocytosis (n = 2) and esthesioneuroblastoma and fibrosarcoma (n = 1) were observed.

## Discussion

Most studies on the prevalence of oral and maxillofacial lesions in children and adolescents have shown that 5.5% to 24.8% of all cases referred to the histopathology services were in patients under 18 years old.<sup>1-3,5,7-13</sup> In this study, 10.2% of oral and maxillofacial lesions were observed in ages 0-18 years and the prevalence of these lesions was less than similar studies in other parts of Iran (13.9% and 19.3%)<sup>9,10</sup> and Thailand (15%),<sup>13</sup> and higher than Taiwan (6% and 6.6%).<sup>3,14</sup>

**Table 2.** Number of cases and the most common location of the inflammatory/reactive lesions

Inflammatory/reactive lesions	Number of cases	Percentage in relation to the group	Percentage in relation to the total	Most common location
Pyogenic granuloma	30	25.00	9.20	Gingiva
Peripheral giant cell granuloma	29	24.16	8.89	Gingiva
Irritation fibroma	22	18.33	6.74	Buccal mucosa
Peripheral ossifying fibroma	18	15.00	5.52	Gingiva
Acute and chronic inflammatory process	8	6.66	2.45	Gingiva
Unspecific ulcer	5	4.16	1.53	Tongue
Inflammatory gingival hyperplasia	4	3.33	1.22	Gingiva
Foreign body reaction	2	1.66	0.61	Gingiva
Idiopathic gingival fibromatosis	1	0.83	0.30	Gingiva
Fibro-epithelial hyperplasia	1	0.83	0.30	Buccal mucosa

**Table 3.** Number of cases and the most common location of the odontogenic cysts and tumors

Odontogenic cysts and tumors	Number of cases	Percentage in relation to the group	Percentage in relation to the total	Most common location
Dentigerous cyst	27	44.26	8.28	Mandible
Follicular hyperplasia	9	14.75	2.76	Mandible
Keratocystic odontogenic tumor	7	11.47	2.14	Mandible
Odontoma	5	8.19	1.53	Maxilla
Ameloblastoma	4	6.54	1.22	Mandible
Ameloblastic fibroma	3	4.91	0.92	Mandible
Ameloblastic fibro-odontoma	2	3.27	0.61	Mandible
Adenomatoid odontogenic tumor	2	3.27	0.61	Maxilla
Orthokeratinized odontogenic cyst	1	1.63	0.30	Mandible
Calcifying odontogenic cyst	1	1.63	0.30	Maxilla

Other studies have reported that the prevalence of these lesions in other countries were 6.6% and 13% in Brazil,<sup>5,7,8</sup> 8.2% in the United Kingdom,<sup>1</sup> 25% in Nigeria,<sup>2</sup> and 12% in America.<sup>15,16</sup> The observed differences in the results of various studies may be due to using different inclusion criteria. For example, several studies have been performed on children with different age ranges (under 15, 16, 18 and 19 years old). In addition, study period, location of lesions (oral/oral and maxillofacial), geographical region, genetic background of population, and the institute in which the study was performed could have affected the results of the studies.<sup>1,7,8,15,16</sup>

In current study, the prevalence of the lesions was a little more in girls than boys (ratio 1.1 to 1) that is similar to the results of the studies of Vale et al.,<sup>7</sup> Melo Mouchrek et al.,<sup>17</sup> and Krishnan et al.<sup>18</sup> Some studies have reported no sex predilection<sup>1,3,9,10,12,13</sup> while others reported more prevalence in boys.<sup>2,5,9,14,19</sup>

Most of the lesions in this study were found in the permanent dentition period. Studies that examined oral and maxillofacial lesions in long-term, suggested that by increasing the age, the frequency of lesions increases as well.<sup>1,18-20</sup> In similar studies in Thailand<sup>13</sup> and Turkey,<sup>19</sup> the highest prevalence of the lesions was found in mixed dentition period. Although the prevalence of these lesions in children and adolescents in some studies was approximately equal and it was 52% and 48%, respectively in the study of Jones and Franklin<sup>1</sup> and 48.2% and 51.8%, respectively in the study of Chen et al.<sup>14</sup>

Similar to the most studies, inflammatory/reactive lesions (36.8 %) were the most common category in this study.<sup>3,7,9,10,14,16,19</sup> However, similar studies conducted in oral pathology laboratories in the UK<sup>1</sup> and Thailand<sup>13</sup> have reported that dental pathologies (22%) and cystic lesions (35%) were the most prevalent ones in children and adolescents, respectively.

**Table 4.** Number of cases and the most common location of the pulp and periapical inflammatory lesions and salivary gland pathology

Lesion	Number of cases	Percentage in relation to the group	Percentage in relation to the total	Most common location
Radicular cyst	22	59.45	6.74	Maxilla
Periapical granuloma	12	32.43	3.68	Mandible
Osteomyelitis	2	5.40	0.61	Mandible
Residual cyst	1	2.70	0.30	Maxilla
Mucocele	26	72.22	7.97	Lower lip
Sialadenitis	6	16.66	1.84	Parotid
Pleomorphic adenoma	3	8.33	0.92	Parotid
Warthin tumor	1	2.77	0.30	Parotid

On the other hand, as most of the neoplasms can be treated in medical hospital, a study in a surgical pathology service in Africa showed that benign neoplasms were the most prevalent lesions in this age range.<sup>2</sup> Other studies in Thailand,<sup>13</sup> Nigeria,<sup>2</sup> and Uganda<sup>21</sup> have reported inflammatory/reactive lesions as the second most common category.

Similar to the study of Saravani et al.<sup>9</sup> and Kamulegeya and Lakor,<sup>21</sup> we observed most of the inflammatory/reactive lesions in the permanent dentition period; while Dhanuthai et al.<sup>13</sup> Gultelkin et al.,<sup>19</sup> and Wang et al.,<sup>3</sup> reported these lesions more often in mixed dentition period. In this study, these lesions were more frequent in female while some studies have reported higher prevalence in male.<sup>3,7,9,13,19</sup>

In most studies on the occurrence of oral lesions in pediatric, mucocele have been reported as the most prevalent oral lesion.<sup>1,3,5,7,9,14</sup> In this study, pyogenic granuloma was reported as the most prevalent oral lesion (9.20%). Pyogenic granuloma was mostly observed in maxilla and more frequent in female. After that, peripheral giant cell granuloma (8.89%), dentigerous cyst (8.28%), and mucocele (7.97%) were the next more frequent lesions in this study. In the studies of Jaafari-Ashkavandi and Ashraf<sup>10</sup> and Saravani et al.<sup>9</sup> in Iran, peripheral giant cell granuloma and pyogenic granuloma were reported as the most prevalent lesions, respectively. Poor oral hygiene, abnormal tooth development, and taking certain medications have been reported as the etiologic factors of pyogenic granuloma. In addition, these lesions are seen more often in women and in the second decade of their life due to the increased vascular effects of female hormones.<sup>22</sup> Dhanuthai et al.<sup>13</sup> In their study in Thailand reported dentigerous cyst, mucocele, and pyogenic granuloma as the most prevalent lesions. Maia et al.<sup>23</sup> in Brazil, reported dentigerous cyst and fibrous hyperplasia as the most common lesions. The difference between the results of this study with other

studies can be due to including 0-18 year-old children and adolescents while other studies included adolescents under 14 or 15 year-old. It also can be due to the type of institution in which the study is performed. In this study, most of the samples were obtained from the pathology laboratory of medical hospital.

Odontogenic cysts and tumors were the second most common category (18.71%) in this study. The prevalence reported in this study is lower than those reported in Africa, Thailand, and Taiwan (23%-25%),<sup>2,13,14</sup> but more than those reported in Turkey (12%).<sup>19</sup> Similar to most studies, dentigerous cyst was the most prevalent lesion in this category.<sup>18,24,25</sup> However, studies in the UK, Turkey, and North of Iran reported radicular cyst as the most cystic lesion in children.<sup>1,11,19</sup> In the study of Lei et al.<sup>26</sup> that was performed in 2014 in Taiwan on head and neck lesions, of 298 cases with dentigerous cyst, 28 cases were observed in 0-10 year-old children and 65 cases in 10-19 year-old adolescents and dentigerous cyst was most common in ages 0-19 years. Similar to the study of Saravani et al.,<sup>9</sup> Al Yamani et al.,<sup>27</sup> Kamulegeya and Lakor,<sup>21</sup> and Wang et al.,<sup>3</sup> most of these lesions were observed in permanent dentition period but Dhanuthai et al.<sup>13</sup> and Gultelkin et al.<sup>19</sup> reported higher prevalence of cystic lesions in mixed dentition period.

Several studies have reported sexual predominance for cystic lesions<sup>18,19,25</sup> but the present study showed equal prevalence in both genders which is consistent with the study of Saravani et al.<sup>9</sup> and Bodner<sup>24</sup> Similar to the other studies, mandible was the most involved area in this study.<sup>7,9,19,25</sup>

Among odontogenic tumors, odontoma and ameloblastoma were the most prevalent lesions involving the maxilla and mandible, respectively. Consistent with other studies, these lesions have been reported as the first and second most common odontogenic tumors.<sup>1,5,10,13,23</sup>

In this study, pulp and periapical inflammatory lesions (11.34%) were the third most prevalent category, and similar to the

study of Jaafari-Ashkavandi and Ashraf<sup>10</sup> and Maia et al.,<sup>23</sup> radicular cyst was the most prevalent lesion in this group which occurred more frequently in the maxilla. Lima et al.<sup>5</sup> also reported radicular cyst (6.88%) as the most common cyst after dentigerous cyst. In the study of Siadati et al.<sup>11</sup> in Iran, radicular cyst was the most prevalent cystic lesion and the third most prevalent lesion in this study after mucocele and central giant cell granuloma. Many studies have classified radicular cyst in odontogenic cysts category, and have identified it as the second most prevalent cyst after dentigerous cyst.<sup>24</sup>

In salivary gland pathology, mucocele was the most prevalent lesion which involved more frequently the lower lip and female gender. Nico et al.<sup>28</sup> and Jaafari-Ashkavandi and Ashraf<sup>10</sup>, also found a female predominance for this lesion. Most studies have classified mucocele in the inflammatory/reactive group and have reported it as the most prevalent lesion in pediatrics but its prevalence was lower in this study. Lima et al.<sup>5</sup> reported that of 128 salivary lesions, 108 cases were mucocele but Shulman<sup>29</sup> in a study on patients under 17 years of age reported only 5 cases of mucocele.

In this study, hemangioma was the most prevalent soft tissue tumor (2.45%). In studies done by Wang et al.,<sup>3</sup> Dhanuthai et al.,<sup>13</sup> and Lima et al.<sup>5</sup> the prevalence rates of 0.08%, 0.72%, and 0.96% were reported for hemangioma, respectively. Despite different classifications, hemangioma has been reported as the most common soft tissue tumor in most studies.<sup>3,5,12</sup>

In this study, only 17 cases of benign epithelial lesions were found. Although verruca vulgaris is known as a lesion that mostly occurs in children but the prevalence of this lesion was only 0.61%. Other studies have also revealed the prevalence of 0.19-2.04%.<sup>1,8,26</sup> Consistent with the study of Jaafari-Ashkavandi and Ashraf<sup>10</sup> squamous papilloma was the most prevalent benign epithelial lesion in this study and gingiva was reported as the most frequently affected site. Lima et al.<sup>5</sup> and Vale et al.<sup>7</sup> reported the

prevalence rate of 1.44% and 3.81% for this lesion, respectively which is consistent with the results of our study. Consistent with the study of Jaafari-Ashkavandi and Ashraf<sup>10</sup> and Jones and Franklin<sup>1</sup>, the present study showed female predilection for these lesions. In contrast, Wang et al.<sup>3</sup> reported higher prevalence in male. However, due to the small sample size, these differences are reliable.

In this study, 13 cases of non-odontogenic cysts (3.98%) were observed. The occurrence of odontogenic cysts in this study was almost 3.6 times higher than non-odontogenic cysts. Most of the studies have reported that the prevalence of odontogenic cysts was higher than non-odontogenic cysts;<sup>1,13,19,25</sup> however, Kamulegeya and Lakor<sup>21</sup> have reported similar prevalence of these lesions in their study.

In this study, the prevalence of bone lesions was 3.37%. The prevalence of these lesions have been reported from 3.2% to 4.8% in other studies.<sup>1,5</sup> In the study of Jaafari-Ashkavandi and Ashraf<sup>10</sup> this category constituted 10.3% of all lesions. Similar to many studies, this study also reported central giant cell granuloma and fibrous dysplasia as the most prevalent lesions of this category, and mandible and maxilla were the most involved areas.<sup>2,10</sup> However, Maia et al. reported that both of these lesions mostly occurred in the mandible.<sup>23</sup>

In this study, most of the diagnosed lesions were benign and only 3.68% were malignant. Albright et al.<sup>30</sup> showed that in a 23-year period, the prevalence of head and neck cancer in children under 15 years was increased. Sousa et al.<sup>12</sup> and Lima et al.<sup>5</sup> in their studies on 0-14 year-old children in Brazil found malignancy in 1.3% and 1.2% of all studied cases, respectively. Jones and Franklin<sup>1</sup> and Wang et al.<sup>3</sup> reported that the frequency of these lesions were 1% and 5%, respectively.

## Conclusion

The results revealed that about 10.2% of oral and maxillofacial lesions involved patients under 18 years. Inflammatory/reactive lesions were the most prevalent ones. Similar

to other studies, most of the diagnosed lesions were benign. However, comparing to the other studies, there were some differences and the frequency of mucocele in this study was lower than those reported in other studies. These findings can help dentists and surgeons for better management of their patients. However, similar studies in different patient groups should be designed to determine the exact prevalence and to get more accurate demographic information for

oral lesions.

### Conflict of Interests

Authors have no conflict of interest.

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### References

1. Jones AV, Franklin CD. An analysis of oral and maxillofacial pathology found in children over a 30-year period. *Int J Paediatr Dent* 2006; 16(1): 19-30.
2. Lawoyin JO. Paediatric oral surgical pathology service in an African population group: A 10 year review. *Odontostomatol Trop* 2000; 23(89): 27-30.
3. Wang YL, Chang HH, Chang JY, Huang GF, Guo MK. Retrospective survey of biopsied oral lesions in pediatric patients. *J Formos Med Assoc* 2009; 108(11): 862-71.
4. Majorana A, Bardellini E, Flocchini P, Amadori F, Conti G, Campus G. Oral mucosal lesions in children from 0 to 12 years old: Ten years' experience. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2010; 110(1): e13-e18.
5. Lima Gda S, Fontes ST, de Araujo LM, Etges A, Tarquinio SB, Gomes AP. A survey of oral and maxillofacial biopsies in children: A single-center retrospective study of 20 years in Pelotas-Brazil. *J Appl Oral Sci* 2008; 16(6): 397-402.
6. Rioboo-Crespo Mdel R, Planells-del Pozo P, Rioboo-Garcia R. Epidemiology of the most common oral mucosal diseases in children. *Med Oral Patol Oral Cir Bucal* 2005; 10(5): 376-87.
7. Vale EB, Ramos-Perez FM, Rodrigues GL, Carvalho EJ, Castro JF, Perez DE. A review of oral biopsies in children and adolescents: A clinicopathological study of a case series. *J Clin Exp Dent* 2013; 5(3): e144-e149.
8. Cavalcante RB, Turatti E, Daniel AP, de Alencar GF, Chen Z. Retrospective review of oral and maxillofacial pathology in a Brazilian paediatric population. *Eur Arch Paediatr Dent* 2016; 17(2): 115-22.
9. Saravani S, Kadeh H, Amirabadi F, Keramati N. Clinical and Histopathological Profiles of Pediatric and Adolescent Oral and Maxillofacial Biopsies in a Persian Population. *Int J Pediatr* 2015; 3(1): 381-90.
10. Jaafari-Ashkavandi Z, Ashraf MJ. A clinico-pathologic study of 142 orofacial tumors in children and adolescents in southern Iran. *Iran J Pediatr* 2011; 21(3): 367-72.
11. Siadati S, Seyedmajidi M, Sharbatdaran M. Frequency of different oral lesions in children and adolescents in Babol, Northern Iran. *Caspian J Intern Med* 2013; 4(4): 773-6.
12. Sousa FB, Etges A, Correa L, Mesquita RA, de Araujo NS. Pediatric oral lesions: A 15-year review from Sao Paulo, Brazil. *J Clin Pediatr Dent* 2002; 26(4): 413-8.
13. Dhanuthai K, Banrai M, Limpanaputtajak S. A retrospective study of paediatric oral lesions from Thailand. *Int J Paediatr Dent* 2007; 17(4): 248-53.
14. Chen YK, Lin LM, Huang HC, Lin CC, Yan YH. A retrospective study of oral and maxillofacial biopsy lesions in a pediatric population from southern Taiwan. *Pediatr Dent* 1998; 20(7): 404-10.
15. Skinner RL, Davenport WD Jr, Weir JC, Carr RF. A survey of biopsied oral lesions in pediatric dental patients. *Pediatr Dent* 1986; 8(3): 163-7.
16. Das S, Das AK. A review of pediatric oral biopsies from a surgical pathology service in a dental school. *Pediatr Dent* 1993; 15(3): 208-11.
17. Melo Mouchrek MM, Gonçães LM, Bezerra-Júnior JR, de Cássia Silva Maia E, da Silva RA, Nogueira da Cruz MC. Oral and maxillofacial biopsied lesions in Brazilian pediatric patients: A 16-year retrospective study. *Rev odonto ciênc* 2011; 26(3): 222-6.
18. Krishnan R, Ramesh M, Paul G. Retrospective evaluation of pediatric oral biopsies from a dental and maxillofacial surgery centre in Salem, Tamil Nadu, India. *J Clin Diagn Res* 2014; 8(1): 221-3.
19. Gultelkin SE, Tokman B, Turkseven MR. A review of paediatric oral biopsies in Turkey. *Int Dent J* 2003; 53(1): 26-32.
20. Shah SK, Le MC, Carpenter WM. Retrospective review of pediatric oral lesions from a dental school biopsy service. *Pediatr Dent* 2009; 31(1): 14-9.



21. Kamulegeya A, Lakor F. Oral maxillofacial tumors and tumor-like conditions: A Ugandan survey. *Pediatr Surg Int* 2011; 27(9): 925-30.
22. Jafarzadeh H, Sanatkhani M, Mohtasham N. Oral pyogenic granuloma: A review. *J Oral Sci* 2006; 48(4): 167-75.
23. Maia DM, Merly F, Castro WH, Gomez RS. A survey of oral biopsies in Brazilian pediatric patients. *ASDC J Dent Child* 2000; 67(2): 128-31, 83.
24. Bodner L. Cystic lesions of the jaws in children. *Int J Pediatr Otorhinolaryngol* 2002; 62(1): 25-9.
25. Urs AB, Arora S, Singh H. Intra-osseous jaw lesions in paediatric patients: A retrospective study. *J Clin Diagn Res* 2014; 8(3): 216-20.
26. Lei F, Chen JY, Lin LM, Wang WC, Huang HC, Chen CH, et al. Retrospective study of biopsied oral and maxillofacial lesions in pediatric patients from Southern Taiwan. *J Dent Sci* 2014; 9(4): 351-8.
27. Al Yamani AO, Al Sebaei MO, Bassyoni LJ, Badghaish AJ, Shawly HH. Variation of pediatric and adolescents head and neck pathology in the city of Jeddah: A retrospective analysis over 10 years. *Saudi Dent J* 2011; 23(4): 197-200.
28. Nico MM, Park JH, Lourenco SV. Mucocele in pediatric patients: Analysis of 36 children. *Pediatr Dermatol* 2008; 25(3): 308-11.
29. Shulman JD. Prevalence of oral mucosal lesions in children and youths in the USA. *Int J Paediatr Dent* 2005; 15(2): 89-97.
30. Albright JT, Topham AK, Reilly JS. Pediatric head and neck malignancies: US incidence and trends over 2 decades. *Arch Otolaryngol Head Neck Surg* 2002; 128(6): 655-9.

## Human gingival fibroblasts culture in an autologous scaffold and assessing its effect on augmentation of attached gingiva in a pilot clinical trial

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### Original Article

#### Abstract

**BACKGROUND AND AIM:** An important goal of periodontal plastic surgery is the creation of attached gingiva around the teeth. In this study, the aims were to culture gingival fibroblasts in a biodegradable scaffold and measure the width of attached gingiva after the clinical procedure.

**METHODS:** This study was carried out on 4 patients (8 sites), with inadequate attached gingiva next to at least two teeth in contralateral quadrants of the same jaw. A biopsy of attached gingiva (epithelial + connective tissue) was taken using a surgical blade. Following culture of gingival fibroblasts,  $250 \times 10^3$  cells in 250  $\mu$ l nutritional medium were mixed with platelet-rich in growth factor (PRGF). Periosteal fenestration technique was done on one side (control) and tissue-engineered mucosal graft (test) was carried out on the contralateral side in each patient. The width of keratinized tissue, probing depth (PD) and width of attached gingiva were recorded at baseline and 3 months after the operation.

**RESULTS:** An increased width of keratinized and attached tissue on all operated sites after 3 months was observed. These results showed the increased mean of the width of keratinized and attached gingiva to be 4.17 mm and 4.14 mm in test and 1.10 mm and 1.10 mm in control sites, respectively. The difference of keratinized and attached gingiva width between test and control sites was significant ( $P = 0.030$ , and  $P = 0.010$  respectively).

**CONCLUSION:** According to the results of this study, PRGF can be used as a scaffold to transfer gingival fibroblasts to recipient sites with significant clinical results.

**KEYWORDS:** Tissue Engineering; Gingiva; Blood Platelet; Scaffold

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An important goal of periodontal plastic surgery is the regeneration of attached gingiva.<sup>1</sup> Several surgery techniques such as denudation,<sup>2</sup> periosteal retentions,<sup>3</sup> periosteal fenestration,<sup>4,5</sup> apically positioned flap,<sup>6</sup> connective tissue grafts,<sup>7</sup> free gingival grafts,<sup>8</sup> and acellular dermal matrix allografts<sup>9</sup> were proposed to increase the attached gingiva. At the present

time, connective tissue and free gingival grafts are usually used to augment the gingiva, because of the predictability of these procedures. However, some disadvantages are existed about masticatory mucosal grafts such as postoperative pain at the donor site, morbidity, reducing the size of a donor site, formation of exocytosis, poor color matching to the surrounding tissue, and increased

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procedure duration.<sup>9-11</sup> Therefore, a technique with fewer disadvantages is preferred by the patients and clinicians. Tissue engineering technology is already being developed and applied in different medical fields to replace cartilage, bone, cardiovascular components, pancreas, and skin.<sup>12</sup> According to this fact, tissue engineering could also be useful in periodontology. Cells, scaffolds and growth factors are the three principal components for preparation of a tissue-engineered construct.<sup>12</sup> Epithelial cells and fibroblasts are used to develop the tissue engineered gingival grafts (TEGG).<sup>13-21</sup> Benzyl ester hyaluronic acid, collagen, polyglactin mesh, and chitosan are the scaffolds used in periodontology aiming at gingival augmentation.<sup>15,19,20,22</sup>

Platelet-rich plasma (PRP) is an autogenous concentration of platelets in which platelet counts should be 5 times more than the baseline number of platelets in whole blood.<sup>23</sup> PRP has been used clinically in human since the 1970s for its healing properties.<sup>24</sup> PRP is also called plasma rich in growth factors (PRGF), platelet concentrates (PCs), and autologous platelet gel (APG).<sup>25</sup> Platelet activation in PRP results in releasing of growth factors such as platelet-derived growth factor (PDGF), vascular endothelial growth factor (VEGF), transforming growth factor- $\beta$  (TGF- $\beta$ ), and insulin-like growth factor (IGF).<sup>25</sup> All of which are proven beneficial to wound healing.<sup>26</sup> PRP as a biogenic scaffold for tissue engineering have not been applied in the reconstruction of the oral mucosa. We used PRP as a scaffold in tissue engineering, because of the safety, low preparation cost, and existence of fibrin and growth factors in it.<sup>26</sup>

The aim of our research was to culture the human gingival fibroblasts in PRGF as a scaffold and investigate its influence on gingival augmentation.

## Methods

This study was a pilot randomized controlled clinical trial. Four woman patients (8 sites), aged 32 to 46 years, with less than enough

attached gingiva surrounding at least two teeth in contralateral quadrants of the same jaw were included in this study. They were selected from the patients referred to Department of Periodontology of Kerman Dental School, Iran.

Inclusion criteria in this study were no pregnancy and lactation, no medication affecting on periodontium, no smoking, no periodontal diseases, no systemic diseases affecting on periodontium or contraindicating periodontal surgery, full mouth plaque index and full mouth bleeding index < 20% at the time of surgery.

Explanation regarding the aim and course of the study was given to patients and informed consent was obtained. This study was ethically approved by Ethics Committee of Kerman School of Medical and Dental Sciences, Iran. Kerman University approved the consent form and design of the present study with ethical code 96/86/K. This clinical trial was registered in IRCT website with number IRCT201108135305N2.

**Clinical measurements:** At baseline and 3 months after surgery, probing depth (PD), the width of keratinized and attached gingiva were measured and recorded. Williams's periodontal probe was used to measure the width of keratinized gingiva from the gingival margin to the mucogingival junction to the nearest millimeter. Roll test was used for detection of mucogingival junction. The PD was subtracted from the width of keratinized gingiva, and the width of attached gingiva was specified in the mid-buccal region for each involved teeth. One clinician who was blind to this study measured all of the clinical parameters at baseline and 3 months after surgery and also allocated surgery sites. Another clinician who was not blind to the study performed all of the surgical procedures.

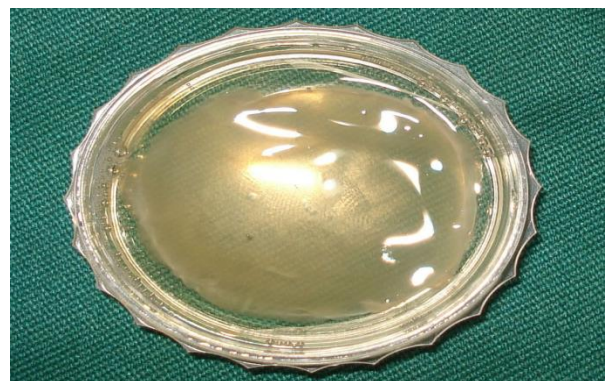
**Biopsy and cell culturing:** At the first visit, a biopsy ( $\sim 3 \times 2 \times 1$  mm) was taken from a site with adequate attached gingiva under local anesthesia. The gingival biopsy (connective tissue and epithelium) in a

nutritional medium [Roswell Park Memorial Institute (RPMI) 1640], (Gibco, Paisley, Scotland, UK) containing antibiotics [penicillin (Sigma- Aldrich, USA), 100 IU/ml, and streptomycin (Sigma- Aldrich, USA), 100 µg/ml] was sent to the laboratory. The patients were required to use chlorhexidine digluconate 0.2% mouthwash for several days.

Each gingival biopsy was washed three times in phosphate buffered saline (PBS) (Sigma- Aldrich, USA), and then transferred to a Petri dish. A scalpel was used to cut each sample into small pieces under sterile conditions. These pieces in a petri dish containing 0.25% trypsin (Sigma- Aldrich, USA) were incubated at 37 °C, 5% CO<sub>2</sub> for 1 hour. After incubation, the gingival epithelium was separated from the gingival connective tissue and washed with PBS. A solution of 80 µl/ml type I collagenase (Sigma- Aldrich, USA) was added to digest the gingival connective tissue pieces in order to obtain gingival fibroblasts. After one night incubation, RPMI 1640 was added to the Petri dish and the suspension was centrifuged for 5 minutes to eliminate the collagenase enzyme. The fibroblasts were cultured in nutritional medium (RPMI 1640) containing 10% fetal bovine serum (FBS) (Gibco, Paisley, Scotland, UK), and antibiotics (penicillin 100 IU/ml and streptomycin 100 µg/ml). The cells were cultured in a CO<sub>2</sub> incubator at 37 °C and the nutritional medium was changed twice a week. When the culture reached 80-90% confluence for fibroblasts, trypsin-EDTA was used to detach the cells for 5 minutes. Then, detached fibroblasts were used to produce tissue engineered gingival graft (TEGG).

**Preparation of TEGG:** PRGF was used as a scaffold for production of TEGG. For the preparation of PRGF, 10 ml blood was taken from the patients. The blood was poured into two 5 ml tubes containing trisodium citrate 3.8% (BTI, Vitoria, Spain) and was centrifuged at 2600 rpm for 5 minutes. 0.5 ml of plasma which was in the red blood cell (RBC) layer (PRGF) in each of the tubes was gathered with

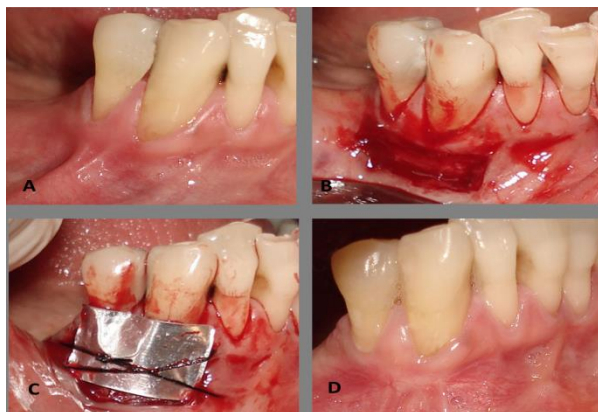
a micropipettor. 1 ml PRGF was poured into a 5 ml Petri dish. For activation of platelets in PRGF and neutralization of the effect of trisodium citrate, 50 µl 10% calcium chloride (BTI, Vitoria, Spain) was added. Then, 250 × 10<sup>3</sup> cells in 250 µl RPMI 1640 medium (count with hemocytometer) was added to PRGF. In order to set initially, it was put under the hood at room temperature for 10 minutes. After that, the TEGG was incubated for 30 minutes. After incubation, nutritional medium RPMI 1640 was added and incubated overnight to use in the clinic. Before transferring the graft to the clinic, it was rinsed with PBS several times (Figure 1). It was transferred to the dental clinic in a sterile situation, filled with RPMI 1640, and sealed with parafilm.



**Figure 1.** Plasma rich in growth factors (PRGF) containing the patient's cultured fibroblasts after 24 hours

**Surgery and postoperative instructions:** In this study, control (no graft) and test (TEGG) sites were selected randomly by a coin toss in each patient (simple randomization). The recipient bed preparation in control and test sites was the same. In order to prepare the recipient bed, after a local anesthesia with lidocaine 2% and epinephrine 1/80000, the mucogingival junction was horizontally incised (a submarginal incision) and two vertical releasing incisions were created apically for ~ 10 mm. The length of horizontal incision was about 15 mm. The bed was prepared by sharp dissection with a scalpel. Then, a periosteal fenestration was done about

7 mm apical to the horizontal incision. At the control site, on the partial thickness prepared bed, a gauze and aluminum foil in an appropriate size were placed on the bed, respectively. These components were stabilized with a 4-0 silk criss-cross horizontal mattress suture (Figure 2).



**Figure 2.** Control site A) Preoperative photograph, B) Periosteal fenestration technique is performed, C) A Vaseline gauze is placed on the recipient bed and a foil is adapted and fixed with a criss-cross horizontal mattress suture and D) At 3 months, tissue augmentation is obtained

At the test sites, after the TEGG was cut to an appropriate size, it was placed on the partial thickness bed. Gauze and aluminum foils in an appropriate size were adapted on the surface of the graft, respectively.<sup>20</sup> A 4-0 silk criss-cross horizontal mattress suture was used to fix these components (Figure 3).

During the first two weeks, the patients were asked not to use chlorhexidine mouthwash to prevent damage to the fibroblasts and discontinue toothbrush. After 2 weeks following surgery, sutures were removed. After the surgery, supragingival

tooth cleaning along with oral hygiene instructions were carried out once a week for the first 6 weeks and continued as once a month for up to 3 months post-surgery.



**Figure 3.** Test site A) Preoperative photograph, B) After preparation of bed tissue-engineered gingival graft is adapted to the recipient area, C) Vaseline gauze and foil are adapted and fixed with a criss-cross horizontal mattress suture and D) At 3 months, tissue augmentation is obtained

One-sample Kolmogorov-Smirnov test was used to check the normal distribution of data. Because of the abnormal distribution of the data, Wilcoxon signed-rank test was utilized to compare the results before and after the surgery in the control and test groups.

## Results

The results of this study revealed that the healing process took place without any complication in both control (4 sites) and test (4 sites) sites.

The data related to the probing pocket depth, the width of keratinized gingiva and width of attached gingiva at baseline and 3 months after surgery are presented in table 1.

**Table 1.** Baseline and post-surgery clinical parameters

Clinical parameter		Baseline (mm) (mean ± SD)	Post-surgery (mm) (mean ± SD)	P*
Probing pocket depth	Test	1.00 ± 0	1.00 ± 0	-
	Control	1.00 ± 0	1.00 ± 0	-
Width of keratinized gingiva	Test	0.83 ± 0.75	5.00 ± 0.63	0.001
	Control	1.50 ± 0.54	2.60 ± 1.50	0.030
Width of attached gingiva	Test	0.16 ± 0.40	4.30 ± 0.51	0.001
	Control	0.50 ± 0.54	1.60 ± 1.50	0.030

SD: standard deviation

\*Wilcoxon signed-rank test

**Table 2.** Comparison of post-surgery clinical parameters between test and control groups

Clinical parameter	Post-surgery (mm) (mean $\pm$ SD)		P*
	Test	Control	
Probing pocket depth	1.00 $\pm$ 0	1.00 $\pm$ 0	-
Width of keratinized gingiva	5.00 $\pm$ 0.63	2.60 $\pm$ 1.50	0.030
Width of attached gingiva	4.30 $\pm$ 0.51	1.60 $\pm$ 1.50	0.010

SD: standard deviation

\*Wilcoxon signed-rank test

Also, the post-surgery clinical parameters of test and control groups are compared and shown in table 2. According to these results, mean of the increased width of keratinized and attached gingiva was 4.17 mm and 4.14 mm in test and 1.10 mm and 1.10 mm in control sites, respectively, 3 months after surgery. The difference between the width of keratinized gingiva in test and control sites was significant ( $P = 0.030$ ). Likewise, the comparison of attached gingiva width between control and test site was also statistically significant ( $P = 0.010$ ) (Table 2). The comparison between the width of keratinized and attached gingiva before and after surgery showed a significant difference in both test and control groups ( $P = 0.001$ , and  $P = 0.030$  respectively) (Table 1).

### Discussion

In dentistry, the culture of epithelial cells for regeneration of oral soft tissue was performed, at the first.<sup>13,14</sup> During the healing, the epithelial sheets are weak against mechanical trauma, and manipulation of them during surgery is difficult.<sup>14</sup> Because of these disadvantages, culture of fibroblasts for preparation of tissue-engineered soft tissue grafts was indicated.<sup>15,16,19-21</sup> According to the study carried out by Karring et al., the morphogenetic stimuli of the underlying connective tissue control the keratinization of gingival epithelium.<sup>27</sup> Therefore, culture of the fibroblasts was performed to produce tissue-engineered soft tissue grafts in several studies.<sup>15,19,20,22</sup> In this study, we used fibroblasts and an autologous scaffold (PRGF) to augment the gingiva. Both control and test sites showed a significant increase of keratinized and attached gingiva width, 3 months after surgery. The average increase

in keratinized and attached gingiva was 4.17 mm and 4.14 mm, respectively. At control sites, the average increased width of keratinized and attached gingiva was 1.10 mm which was statistically significant. The difference between the control and test groups in regard to the width of keratinized and attached gingiva was 3.06 mm and 3.04 mm, respectively. In a study done by Prato et al., benzyl ester of hyaluronic acid was introduced as a scaffold.<sup>15</sup>

Gingival fibroblasts were cultured and seeded onto this scaffold and this prepared tissue was grafted onto a periosteal bed. The average increased keratinized tissue was 2.00  $\pm$  0.41 mm. In this study, the keratinized gingiva increased about 2.17 mm more than aforementioned study. The difference between the type of scaffold and bed preparation (marginal incision in Prato et al. study and sub-marginal incision in our study) can explain this result. Another study evaluated a living human fibroblast-derived dermal substitute (HF-DDS) and compared it to a gingival autograph (GA).<sup>19</sup> McGuire and Nunn used an absorbable polyglactin scaffold and allogeneic dermal fibroblasts. The average of increased keratinized gingiva around the teeth with inadequate attached gingiva was 2.72 mm after 3 months post-surgery. In this study, although the amount of increased keratinized tissue was less in test sites, the esthetic result was better than control sites.

Mohammadi et al. in a study, used a collagen type I (Zyderm) as a scaffold which human gingival fibroblasts were seeded into it.<sup>20</sup> Results showed mean increased width of keratinized and attached gingiva to be 2.8 mm in test (TEGG) and 1.9 and 2 mm in control sites (periosteal fenestration

technique), respectively, 3 months after surgery. When test and control groups were compared, the width of keratinized and attached gingiva clinically increased (0.9 mm and 0.8 mm, respectively). In the present study, about 1.37 mm keratinized gingiva and 1.34 mm attached gingiva was obtained more than the results of Mohammadi et al.<sup>21</sup> study. In these two studies, bed preparation (periosteal fenestration), dimensions of recipient bed, incisions, cells (fibroblast) were similar. Only, the difference between the scaffolds can infer these results. Mohammadi et al. in a case report, showed that using a cultured gingival graft (fibroblasts + collagen scaffold) can increase the width of pre-implant keratinized tissue.<sup>21</sup>

In an animal study, chitosan was used as a carrier for transporting fibroblasts to the recipient bed prepared in the mouth of dogs, in order to gingival augmentation.<sup>22</sup> At test sites (chitosan + fibroblasts), the width of keratinized gingiva showed a 2.13 mm increase in mid-buccal surface of teeth. At control sites (chitosan), the width of keratinized gingiva increased about 1 mm. The difference between test and control sites was not statistically significant. Scheyer et al. showed that application of living cellular sheet in the treatment of mucogingival defects resulted in better color, absence of scar, and better mucogingival junction alignment in comparison with free gingival graft.<sup>28</sup>

The present study showed the most increased keratinized and attached gingiva width among the studies performed in the field of soft tissue engineering. The reason which can explain this difference is the type

of scaffold used in this study (PRGF). As we know, PRGF is a combination of fibrin and platelets growth factors. Platelet growth factors existed in  $\alpha$ -granules become activated after preparation of PRGF. Growth factors can affect angiogenesis, proliferation of fibroblasts, mutagenesis, extracellular matrix (fibronectin, glycosaminoglycan) and collagen synthesis which have key roles in regeneration of soft tissue.<sup>27</sup>

The use of tissue-engineered gingival grafts has several advantages including requiring a small donor site, obtaining enough keratinized tissue, less complaint and discomfort emerges for patients, and being safe and less costly because an autologous scaffold is used. According to this study, these tissue-engineered materials effectively create keratinized gingiva. Of course, further controlled clinical trial is needed.

### Conclusion

Results of this investigation show that the tissue-engineered gingival graft is able to generate keratinized tissue safely and with little complication. Our suggestions are using PRGF alone at control sites in the next studies, and increasing the sample size for enhancing the power of the study.

### Conflict of Interests

Authors have no conflict of interest.

### Acknowledgments

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### References

1. Newman MG, Takei H, Klokkevold PR, Carranza FA. Carranza's clinical periodontology-e-book: Expert consult: Online. 12<sup>th</sup> ed. Philadelphia, PA: Elsevier Health Sciences; 2014. p. 628.
2. Ochsenein C. Newer concepts of mucogingival surgery. *J Periodontol* 1960; 31(3): 175-85.
3. Staffileno H, Wentz F, Orban B. Histologic study of healing of split thickness flap surgery in dogs. *J Periodontol* 1962; 33(1): 56-69.
4. Corn H. Periosteal separation-its clinical significance. *J Periodontol* 1962; 33(2): 140-53.
5. Robinson RE, Agnew RG. Periosteal fenestration at the mucogingival line. *J Periodontol* 1963; 34(6): 503-12.
6. Friedman N. Mucogingival surgery: The apically repositioned flap. *J Periodontol* 1962; 33(4): 328-40.

7. Edel A. Clinical evaluation of free connective tissue grafts used to increase the width of keratinised gingiva. *J Clin Periodontol* 1974; 1(4): 185-96.
8. Bjorn H. Free transplantation of gingiva properia. *Swed Dent J* 1963; 22: 684-9.
9. Silverstein L, Callan D. An acellular dermal matrix allograft and a palatal graft for tissue augmentation. *Periodontal Insights* 1996; 6: 3-6.
10. Pack AR, Gaudie WM, Jennings AM. Bony exostosis as a sequela to free gingival grafting: two case reports. *J Periodontol* 1991; 62(4): 269-71.
11. Brasher WJ, Rees TD, Boyce WA. Complications of free grafts of masticatory mucosa. *J Periodontol* 1975; 46(3): 133-8.
12. Knight MA, Evans G. Tissue engineering: Progress and challenges. *Plast Reconstr Surg* 2004; 114(2): 26e-37e.
13. Raghoobar GM, Tomson AM, Scholma J, Blaauw EH, Witjes MJ, Vissink A. Use of cultured mucosal grafts to cover defects caused by vestibuloplasty: an in vivo study. *J Oral Maxillofac Surg* 1995; 53(8): 872-8.
14. Ueda M, Hata KI, Sumi Y, Mizuno H, Niimi A. Peri-implant soft tissue management through use of cultured mucosal epithelium. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 1998; 86(4): 393-400.
15. Prato GP, Rotundo R, Magnani C, Soranzo C, Muzzi L, Cairo F. An autologous cell hyaluronic acid graft technique for gingival augmentation: A case series. *J Periodontol* 2003; 74(2): 262-7.
16. Pini Prato GP, Rotundo R, Magnani C, Soranzo C. Tissue engineering technology for gingival augmentation procedures: A case report. *Int J Periodontics Restorative Dent* 2000; 20(6): 552-9.
17. Lauer G, Schimming R. Tissue-engineered mucosa graft for reconstruction of the intraoral lining after freeing of the tongue: A clinical and immunohistologic study. *J Oral Maxillofac Surg* 2001; 59(2): 169-75.
18. Okuda K, Momose M, Murata M, Saito Y, Inoue M, Shinohara C, et al. Treatment of chronic desquamative gingivitis using tissue-engineered human cultured gingival epithelial sheets: A case report. *Int J Periodontics Restorative Dent* 2004; 24(2): 119-25.
19. McGuire MK, Nunn ME. Evaluation of the safety and efficacy of periodontal applications of a living tissue-engineered human fibroblast-derived dermal substitute. I. Comparison to the gingival autograft: A randomized controlled pilot study. *J Periodontol* 2005; 76(6): 867-80.
20. Mohammadi M, Shokrgozar MA, Mofid R. Culture of human gingival fibroblasts on a biodegradable scaffold and evaluation of its effect on attached gingiva: A randomized, controlled pilot study. *J Periodontol* 2007; 78(10): 1897-903.
21. Mohammadi M, Mofid R, Shokrgozar MA. Peri-implant soft tissue management through use of cultured gingival graft: A case report. *Acta Med Iran* 2011; 49(5): 319-24.
22. Lotfi G, Shokrgozar MA, Mofid R, Abbas FM, Ghanavati F, Bagheban AA, et al. A clinical and histologic evaluation of gingival fibroblasts seeding on a chitosan-based scaffold and its effect on the width of keratinized gingiva in dogs. *J Periodontol* 2011; 82(9): 1367-75.
23. Brass L. Understanding and evaluating platelet function. *Hematology Am Soc Hematol Educ Program* 2010; 2010: 387-96.
24. Sanchez-Gonzalez J, Méndez-Bolaina E, Trejo-Bahena NI. Platelet-rich plasma peptides: Key for Regeneration. *Int J Pept* 2012; 2012: 532519.
25. Sanchez AR, Sheridan PJ, Kupp LI. Is platelet-rich plasma the perfect enhancement factor? A current review. *Int J Oral Maxillofac Implants* 2003; 18(1): 93-103.
26. Carter CA, Jolly DG, Worden CE, Sr., Hendren DG, Kane CJ. Platelet-rich plasma gel promotes differentiation and regeneration during equine wound healing. *Exp Mol Pathol* 2003; 74(3): 244-55.
27. Karring T, Cumming BR, Oliver RC, Loe H. The origin of granulation tissue and its impact on postoperative results of mucogingival surgery. *J Periodontol* 1975; 46(10): 577-85.
28. Scheyer ET, Nevins ML, Neiva R, Cochran DL, Giannobile WV, Woo SB, et al. Generation of site-appropriate tissue by a living cellular sheet in the treatment of mucogingival defects. *J Periodontol* 2014; 85(4): e57-e64.



## Dental care satisfaction among adult population in Isfahan, Iran and its influencing factors

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### Original Article

#### Abstract

**BACKGROUND AND AIM:** The aim of this study was to assess the level of dental care satisfaction among Iranian adult population and to identify socio-demographic factors and factors related to dental service that affect satisfaction.

**METHODS:** A self-administrated valid and reliable 21-item questionnaire was designed and distributed among 1360 adult population living in Isfahan, Iran, using multi-stage proportional cluster sampling. It consisted of 5 main sections including demographic questions, perceived oral health status, oral health behaviors, barriers in receiving the demanded care and some 5-point Likert scale questions to assess the satisfaction level. Chi-square and analysis of variance were used to compare variables. People were classified as satisfied/dissatisfied based on their total score with score of 26 as the cut-off point. A logistic regression model was used to identify the factors affecting the level of satisfaction and to estimate their effect size.

**RESULTS:** The mean age of participants was  $31.2 \pm 11.3$  and they mostly reported to have dental visits during the last year. The mean satisfaction score was 3.34 out of 5 (53% were satisfied) and the least and the most satisfaction was in regard to waiting time and the convenience to access, respectively. Logistic regression showed that participants in lower age group [odds ratio (OR) = 0.7], those who reported their oral health status as poor (OR = 0.8) and those who had to spend more time to reach dental care setting (OR = 0.6) and those who had to wait more (OR = 0.5) were less satisfied.

**CONCLUSION:** About 53% of participants were satisfied which was much lower than percentage of satisfied people in developed countries and the level of satisfaction was associated with socio-demographic, behavioral and also dental service.

**KEYWORDS:** Patient Satisfaction; Dental Care; Adult; Iran

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Patient satisfaction is becoming an important field of research recently with the introduction of the concept of 'consumerism'.<sup>1</sup> Evaluating the patient satisfaction with health care could be considerable way of evaluating the quality of care and provider-patient relationships and has been considered an important indicator of the efficient utilization of health services. This concept assesses an individual's attitude to the health services received and, is progressively being used in dentistry like

other fields of medicine.<sup>2,3</sup>

Measuring patient satisfaction is a useful measure for evaluation of health systems, particularly evaluating the "process" of care or the professional activities associated with providing care.<sup>4</sup> Patient satisfaction is believed to have dramatic influence on compliance and consequently treatment quality.<sup>2</sup> Dissatisfaction might be a reason for switching dental providers and to influence health-related behavior, health status and health outcomes of patients.<sup>5,6</sup> Furthermore,

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dissatisfaction may result in raising complaints with dental care and inducing considerable levels of stress on dentists.<sup>7</sup>

Patient satisfaction is a multidimensional concept including the technical aspects of care or those related to the process of diagnosis and treatment, interpersonal, accessibility/availability, financial access, efficacy/outcomes, continuity of care, facilities, and general attitudes about overall care.<sup>7</sup>

In developing countries, ensuring adequate access to oral health care services and improving the level of oral health status are the major concerns for health policymakers.<sup>1</sup> In Iran, private practices provide more than 80% of dental services in cities (including about 60% of the population). Only a limited number of dentists (about 10% of 25000) are employed by the public sector, offering service to 45% of the population.<sup>8</sup> Currently, national reports reveal that the dentist to population ratio is about 30 dentist per 100000 populations.<sup>9</sup>

In different parts of the world, the concerns and satisfaction of adult population about dental health care services have been studied. In a study conducted in Nigeria, high level of satisfaction was reported in 53% of patients which was related mostly to the communication skills and rapport of staff with the patients.<sup>10</sup> In another study to determine dental care satisfaction among UK adult population, most of people (89%) were satisfied with the quality of care delivered to them and only 2% had raised complained.<sup>11</sup>

Studies assessing adults' concerns regarding dental care services in Iran are scarce. Some limited sporadic studies have been undertaken to assess dental care satisfaction provided mostly by public providers which revealed a low level of satisfaction.<sup>12</sup>

Having information about public opinions and concerns about the oral health services provided to them is vital for planning an efficient and responsive dental health service.<sup>13</sup> Therefore, this study aimed to determine the level of dental care satisfaction among the Iranian adult population with regards to public and private dental services,

and also to identify socio-demographic and some of the factors related to dental service that might have a predictable effect on satisfaction with dental care.

## Methods

This study was a cross-sectional study carried out in Isfahan, Iran, in 2014. This study was approved by the ethics committee of Isfahan University of Medical Sciences (registration number 390045). Isfahan is the second biggest city in the country with about 900 active dentists and a lot of private and public dental clinics. Participants also signed informed consent to participate.

A self-administrated 21-item questionnaire was designed which consisted of 5 main sections: demographic questions (age, educational level, sex, region of living), perceived oral health status of the participants, oral health behaviors (such as their dental visits pattern, the site at which dental service were rendered to them, self-care behaviors), barriers and difficulties in receiving the demanded care (travel time, appointment and office waiting time, emergency waiting time, dental fears, insurance coverage, cost of services, ease to select a dentist) and finally 8 questions to assess the level of their satisfaction. Satisfaction was considered as a multi-dimensional concept including the quality of care, interpersonal relationship, accessibility, waiting time, office working time and distance to the care delivery sites (one question for each domain). Participants were asked to determine their level of satisfaction with each of these domains using a 5-point Likert scale (ranging from 1 = strongly dissatisfied to 5 = strongly satisfied) resulting in a total score between 0-40 for each of the participants. The cut-off point of 26 was considered for separating the satisfied and dissatisfied groups based on the sum of satisfaction scores. This cut-off score was defined based on the recommendations about defining cut-off scores for Likert scales<sup>14</sup> and also the opinions of the main investigators of this study.

Items for the questionnaire were

developed based on literature review of previous studies and the specific characteristics of oral health care system in Iran.<sup>8,15,16</sup> A group of experts including two experts in oral public health, one in community medicine and five in health care centers confirmed the content validity of questionnaire; Experts were asked to give score to each question based on the relevance of questions with goals (questions with high relevancy = 1, moderate = 2 and low or uncertain = 3). Questions that scored 2 or 3 were deleted or were modified accordingly. For assuring the reliability of questions, a pilot study was carried out on a group of 100 persons. The Cronbach's alpha coefficient was above 0.7. The face validity of questionnaire was also assured in the pilot study based on the opinion of participants.

According to sampling formula and considering 50% (maximum percent) for the percentage of satisfied patients with regards to dental services and considering 27% as the maximum error, it was estimated to need 1360 patients for the survey.

The included samples were patients between 15-64 years old living in Isfahan. Method of sampling was multi-stage proportional clustering; from the 17 geographic regions (clusters) in Isfahan (according to the available clustering map in Vice Chancellery of Health Affairs, Isfahan) and according to their average sex and age distribution, 80 participants were randomly selected in

each cluster. In each cluster, 13 women and 13 men in the age range 15-24 and 25 women and 27 men in the age range 25-64 years were considered.

Questionnaires were distributed among participants in selected clusters during August-October 2014 by 4 calibrated interviewers. Participants were chosen from population at social places such as parks, mosques, shopping centers and thoroughfares. They were asked to fill-out the questionnaires and return them in the place and not to consult with anyone else.

SPSS software (version 18, SPSS Inc., Chicago, IL, USA) was used to summarize the main results using descriptive and analytical statistical tests. The frequency of responses for each questions were calculated. Chi-square and analysis of variance (ANOVA) tests were used to compare variables. A logistic regression model was used to identify the potential factors affecting the level of satisfaction with dental services and to estimate their effect size. Statistical significant was set at 0.05 level for all the tests.

## Results

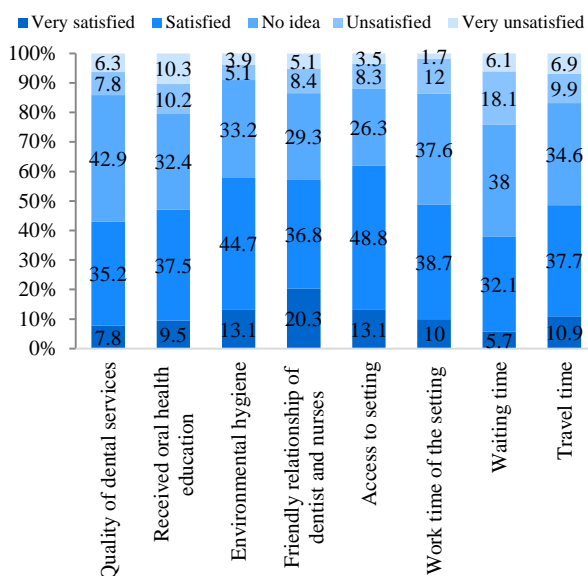
Among the 1630 participants in this study, the mean age was  $31.2 \pm 11.3$  and they were mostly in age range 25-64 years. About 12% had academic degrees and majority had diploma (i.e. graduated from high school) (Table 1). Women consisted 51.3% of participants (n = 697).

**Table 1.** Distribution (frequency and percentage) of participants and comparison between male and female according to socio-demographic and dental visit scheme

Variables		Total [n (%)]	Men [n (%)]	Women [n (%)]	P
Age group (year)	15-24	442 (32.5)	221 (50.0)	221 (50.0)	0.280
	25-64	918 (67.5)	442 (48.1)	476 (51.9)	
Sex			663 (48.8)	697 (51.3)	< 0.001
Education	Illiterate	26 (1.9)	24 (23.5)	78 (76.5)	
	Under diploma	519 (38.1)	260 (58.7)	183 (41.3)	
	Diploma	651 (47.9)	295 (45.3)	356 (54.7)	
Last dental visit	University degree (BSc, MSc and PhD)	164 (12.1)	84 (51.2)	80 (48.8)	0.060
	< 1 years ago	683 (50.3)	314 (47.4)	369 (52.9)	
	1-2 years ago	333 (24.5)	163 (48.9)	170 (51.1)	
	> 2 years ago	265 (19.5)	138 (52.7)	127 (51.1)	
Reason for last visit	Never	78 (5.7)	47 (60.3)	31 (39.7)	0.320
	Regular visit for examination	203 (15.1)	100 (49.3)	103 (50.7)	
	Visit upon pain and discomfort	920 (68.6)	438 (47.6)	482 (52.4)	
	Visit for other reasons (orthodontics, ulcers)	218 (16.3)	116 (53.2)	102 (46.8)	

Most of the participants reported to have dental visits during the last year and the most common reason was to receive treatment for pain and other discomforts not regular examination. There was no significant difference between men and women regarding their scheme of visits (Table 1).

**Satisfaction with dental care:** The mean score of satisfaction with dental care was 3.34 out of 5. The distribution of participants' satisfaction with different domains is shown in figure 1. Considering "strongly satisfied" and "satisfied" as one category, and "strongly dissatisfied" and "dissatisfied" as another category, it was revealed that the least satisfaction was regarding waiting time for receiving dental services and the most satisfaction was about the convenience to access and followed by satisfaction about the hygiene of dental settings. Regarding the quality of received care, 43% were satisfied. Considering the cut-off point of 26 in sum of satisfaction scores as the threshold for satisfaction/dissatisfaction, 53% were satisfied.



**Figure 1.** Distribution of participants' level of satisfaction with different domains of dental care satisfaction

**Factors related to satisfaction with dental care:** The frequency and distribution of factors with probable effects on participants'

satisfaction with dental services are shown in table 2. Most of the participants reported their oral health status as "excellent" and 12.9% reported it as "poor". The most common setting for receiving dental care was public clinics and private offices. Almost 30% of the participants determined that they could reach the dental services delivery centers in less than 15 minutes. Among the respondents, 70% identified the mean waiting time to receive non-emergency care less than 1 month and 86% reported that they encountered no problem in their transportation to dental care centers. Almost 52.6% of the population was covered by dental insurance and 58.0% reported to have a recognized dentist for their dental care.

**Table 2.** Distribution of self-perceived oral health status, dental service factors, dental fear and insurance coverage among participants (probable factors affecting dental satisfaction)

Probable factors	n (%)
Self-perceived oral health status	
Poor	176 (12.9)
Moderate	574 (40.2)
Well	463 (34.1)
Very well	124 (9.2)
Excellent	49 (6.10)
Setting of care receive	
Public clinic	425 (32.3)
Private clinic	250 (19.0)
Charity clinic	32 (2.40)
Private offices	427 (32.4)
Dental school clinic	19 (1.40)
Travel time	
< 15 min	389 (29.1)
15-29 min	588 (43.9)
30-59 min	318 (23.7)
> 1 hour	44 (3.30)
Need to emergency care	349 (25.7)
Waiting time to receive care	
< 1 month	882 (69.4)
1-3 month	251 (19.8)
> 3 month	137 (10.8)
Facing time limitation to set dental visit	556 (40.9)
Having dental fear	323 (23.8)
Having problems in payment (high costs of dental treatments)	823 (60.5)
Insurance coverage	715 (52.7)

A multivariate regression model was designed to determine the factors with significant effect and the level of their association with level of satisfaction of

participants (satisfied/dissatisfied). The binary satisfaction variable was considered as the dependent variable.

The prerequisite condition for factors to be considered in the regression model was their significant association with satisfaction level through Chi-square test. People with higher educational level ( $P = 0.001$ ,  $\chi^2 = 18.6$ ) and those who evaluated their perceived oral health as good or excellent ( $P < 0.001$ ,  $\chi^2 = 41$ ), participants reported to have insurance coverage ( $P = 0.039$ ,  $\chi^2 = 4.3$ ) and older participants ( $P = 0.017$ ,  $\chi^2 = 59.1$ ) were more satisfied.

More travel time ( $P = 0.001$ ,  $\chi^2 = 140.4$ ), more waiting time ( $P < 0.001$ ,  $\chi^2 = 108$ ), facing time limitation ( $P < 0.001$ ,  $\chi^2 = 68.8$ ), having payment problems ( $P = 0.001$ ,  $\chi^2 = 25$ ) and having transportation problem ( $P = 0.001$ ,  $\chi^2 = 15$ ) resulted in less satisfaction.

Also, setting of care ( $P < 0.001$ ,  $\chi^2 = 159.6$ ), reason for last visit ( $P$ -value  $< 0.001$ ,  $\chi^2 = 14.5$ ), and having personal willingness to receive dental care ( $P < 0.001$ ,  $\chi^2 = 35.5$ ) were significantly correlated with level of satisfaction. People who received their care in private settings and those whose reason for the last visit was regular examinations were more satisfied compared with those who attended for treatment. Gender, need for emergency care and sense of dental fear were not significantly associated with satisfaction.

By inputting the above potential factors in the logistic regression model (Backward

Wald,  $R^2 = 0.28$ ), it was revealed that participants in lower age group [Odds ratio (OR) = 0.7], those who reported their oral health status as poor (OR = 0.8) and those who had to spend more time to reach dental care setting (OR = 0.6) and had to wait more (OR = 0.5) were dissatisfied (Table 3). On the other hand, participants who were personally more willing to receive care (OR = 1.5) and those who reported to have no time limitation (OR = 2.4) were satisfied. Also, people who regularly attended private clinics were more satisfied (OR = 3.13,  $n = 108$ ) compared to the individuals who attended public clinics.

## Discussion

This study assessed the satisfaction with dentistry and its determinants among general population in Isfahan. Patient satisfaction is usually defined as healthcare users' reaction to main aspects of their health care service experience including context, process and outcomes of the services.<sup>17</sup> In our study, 53% were satisfied with provided services which was much lower than percentage of satisfied people in developed countries.<sup>5,11</sup> The most satisfaction among 8 domains was with access and environmental hygiene which is in agreement with other studies.<sup>18-20</sup> In a study conducted in Greece<sup>21</sup> the patients' top priority about their expectations of the dental services was adherence to the protocols of antisepsis and sterilization.

**Table 3.** Multiple logistic regression model for factors related to being satisfied with dental care

Variables	OR	P	95% CI	
Age group	0.71	0.030	0.5	0.9
Perceived oral health	0.83	0.020	0.7	0.9
Travel time	0.60	< 0.001	0.5	0.7
Waiting time	0.52	< 0.001	0.4	0.6
Willingness to receive care	1.5	0.020	1.1	2.2
Setting of care*				
Private clinic vs. public clinic	3.30	< 0.001	2.3	4.9
Charity vs. public clinic	0.30	0.030	0.1	0.9
Private office vs. public clinic	1.80	< 0.001	1.3	2.5
Dental school vs. public clinic	4.10	0.012	1.4	12.5
Facing time limitation	2.40	< 0.001	1.8	3.3
Reason for last visit	1.50	0.070	0.9	2.2

OR: Odds ratio; CI: Confidence interval

\*Public clinic was considered as the reference category

The level of satisfaction in our study was also associated with socio-demographic (age), behavioral (perceived oral health status and their self-motivation to receive dental care) and also dental service factors (waiting and travel time and setting of care). Some other factors such as reason for attendance were correlated with satisfaction when assessed separately by bivariate analysis.

In a similar study that evaluated satisfaction with the quality of dental care conducted on the adult population in UK,<sup>11</sup> about 90% of people were satisfied with the quality of care. Dissatisfaction was more frequent among younger participants [OR = 1.75, 95% confidence interval (CI) 1.24, 2.48,  $P = 0.002$ ], problem motivated (OR = 2.24, 95% CI 1.64, 3.05,  $P < 0.001$ ) and irregular attendees. In our study, older population was more satisfied. However, Lahti et al. found that older patients were less satisfied since the oral health status of older people is usually lower than younger people that might result in negative experiences or that elderly might believe that their dentist was not as supportive as they expected.<sup>22</sup>

In some of the studies gender of participants were correlated with satisfaction. In these studies, women were generally more satisfied with dental care than men.<sup>23-25</sup> It is suggested that such result could be due to their greater exposure to dental services that could likely moderate the expectations of women and increase the chance of being met by the providers.<sup>24</sup> However, in our study there was no significant difference between men and women that could be described by the similar scheme of dental visits among them.

In a study conducted in 23 years old people in Norway, 14.6% of them were very satisfied with dental care and the gender difference was not also statistically significant. Multivariate linear regression showed that positive beliefs of the dentist, low/moderate dental anxiety, availability of dentists, and their last dental visit being not very painful/unpleasant explained 57.5% of

the variance of satisfaction.<sup>7</sup> In another study conducted in Uganda on 1146 subjects (mean age 15.8 years) those who had painless experience in their dental visit attended dentistry more than once dentistry, evaluated their oral status positively, and those who were satisfied with their dentist's communication, expressed greater levels of satisfaction with the oral health services provided to them.<sup>26</sup>

A national survey in Swiss including of 15-74 aged residents ( $n = 1129$ ) showed that 47.9 % of participants were satisfied and 47.6% were very satisfied. In their study, women and those with higher education were more satisfied. The most common reasons inducing satisfaction with dentists were interpersonal communication skills of the dentist and the staff. Dental fear was also a significant predicting factor for dissatisfaction with the dentist.<sup>5</sup>

It seems dental fear and anxiety could influence the level of satisfaction negatively, however in our study dental fear was not significantly related to dissatisfaction. This difference could be explained by firstly small percentage of people who were afraid and secondly the overwhelming dental visit behavior of our participants. Most of them (about 70%) reported to visit dentists in case of pain and discomfort which could mask the real effects of dental fear. Armfield et al. indicated that the patterns of dental visit are significantly affected by dental fear; people with higher levels of dental fear are more likely to postpone their visits until they feel serious problems and dental pain.<sup>27</sup>

In other studies the reason for last dental visit in more than 50% of people was regular examination.<sup>28</sup> On the other hand, attendance for receiving care instead of regular check-ups could itself affect dental service satisfaction negatively. In a study conducted recently in Lithuania,<sup>29</sup> the logistic regression model showed that higher satisfaction with dental care level was more likely for those who were recognized as check-up-based regular dental attenders (OR = 1.7). In our

study also (bivariate analysis), people who reported their reason for last dental visit as "regular check-ups" were more satisfied.

Although the cost of health care services seems to be an important barrier to the health service utilization, some investigators have indicated that 'knowing in advance what the fee will be' and 'believing that the fees are appropriate' are among the two less-important factors.<sup>30</sup> Newsome and Wright,<sup>2</sup> based on their literature review, mentioned cost as the least important issue considered by patients when selecting a dentist. In our study, cost and payment problems were not significantly correlated to level of patients' satisfaction, although in bivariate analysis people who thought dental costs were high were less satisfied.

One of the other effective factors in predicting the satisfaction of participants in our study was the setting of care delivery; those attending private settings were 1.8 to 3.3 times more likely to be satisfied. It was clarified that about 51% of participants preferred to attend private clinic and offices versus 32% who preferred public clinics. In the study conducted in Lithuania,<sup>29</sup> stronger satisfaction was also reported by those visiting private practices ( $P < 0.001$ ). In Iran, just about 10% of dentists are working in public settings<sup>8</sup> and therefore the amount of attendance might be more than their capacity which could explain a part of this lower level of satisfaction.

In our study those who evaluated their perceived oral health as good or excellent

were more satisfied. Ntabaye et al. showed that perceived oral health status was considered as an important predictive factor for satisfaction as all those who perceived their oral health status to be very good were satisfied with the provided care.<sup>31</sup>

## Conclusion

In conclusion, in our study about half of the participants were satisfied with their received services which was much lower than percentage of satisfied people in developed countries and the level of satisfaction was associated with socio-demographic, behavioral and also dental service factors. This study represents one of the few documents to show variations in satisfaction with dental services by different levels of contributing factors in Iran. Some of these factors could be improved by considering appropriate policies such as educating public about the importance of regular check-up and improving the service quality in public dental care settings.

## Conflict of Interests

Authors have no conflict of interest.

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## References

1. Shrestha A, Doshi D, Rao A, Sequeira P. Patient satisfaction at rural outreach dental camps-a one year report. *Rural Remote Health* 2008; 8(3): 891.
2. Newsome PR, Wright GH. A review of patient satisfaction: 1. Concepts of satisfaction. *Br Dent J* 1999; 186(4): 161-5.
3. Mascarenhas AK. Patient satisfaction with the comprehensive care model of dental care delivery. *J Dent Educ* 2001; 65(11): 1266-71.
4. Sitzia J, Wood N. Patient satisfaction: A review of issues and concepts. *Soc Sci Med* 1997; 45(12): 1829-43.
5. Armfield JM, Enkling N, Wolf CA, Ramseier CA. Dental fear and satisfaction with dental services in Switzerland. *J Public Health Dent* 2014; 74(1): 57-63.
6. Skaret E, Berg E, Raadal M, Kvale G. Factors related to satisfaction with dental care among 23-year olds in Norway. *Community Dent Oral Epidemiol* 2005; 33(2): 150-7.
7. Kress GC Jr. Patient satisfaction with dental care. *Dent Clin North Am* 1988; 32(4): 791-802.
8. Tahani B, Khoshnevisan MH, Yazdani S, Ebn Ahmady A, Dugdale P. Stewardship of National Oral Health system in

- Iran: Its strengths and weaknesses. *Arch Iran Med* 2013; 16(12): 717-24.
9. Hoseinpour R, Safari HR. A review of statistics and information about the dentistry section of the country. Tehran, Iran: Iranian Dental Association; 2013.
  10. Orenuga OO, Sofola OO, Uti OO. Patient satisfaction: A survey of dental outpatients at the Lagos University Teaching Hospital, Nigeria. *Nig Q J Hosp Med* 2009; 19(1): 47-52.
  11. Bedi R, Gulati N, McGrath C. A study of satisfaction with dental services among adults in the United Kingdom. *Br Dent J* 2005; 198(7): 433-7.
  12. Seyedi Andi S, Shojaeizadeh D, Batebi A, Hoseini M, Rezai R. Client satisfaction with health system services offered by urban health care centers of Shahid Beheshti University of Medical Sciences, Tehran, Iran. *J Babol Univ Med Sci* 2009; 10(6): 80-7. [In Persian].
  13. Franco LM, Franco C, Kumwenda N, Nkhoma W. Methods for assessing quality of provider performance in developing countries. *Int J Qual Health Care* 2002; 14(Suppl 1): 17-24.
  14. Sharifi HP. Principles of validity and analysis of validation. Tehran, Iran: Roshd Publications; 2011. p. 419. [In Persian].
  15. New York State Department of Health Office of Managed Care. Dental care survey Medicaid managed care members [Online]. [cited 2007]; Available from: URL: [https://www.health.ny.gov/health\\_care/managed\\_care/reports/dental/docs/pdf/final\\_report\\_dental\\_care.pdf](https://www.health.ny.gov/health_care/managed_care/reports/dental/docs/pdf/final_report_dental_care.pdf)
  16. Stewart JF, Spencer AJ. Dental satisfaction survey 2002 [Online]. [cited 2005]; Available from: URL: <https://www.adelaide.edu.au/arc poh/downloads/publications/reports/working-papers/2002-satisfaction.pdf>
  17. Gurdal P, Cankaya H, Onem E, Dincer S, Yilmaz T. Factors of patient satisfaction/dissatisfaction in a dental faculty outpatient clinic in Turkey. *Community Dent Oral Epidemiol* 2000; 28(6): 461-9.
  18. Holt VP, McHugh K. Factors influencing patient loyalty to dentist and dental practice. *Br Dent J* 1997; 183(10): 365-70.
  19. Al-Hussyeen AJ. Factors affecting utilization of dental health services and satisfaction among adolescent females in Riyadh City. *Saudi Dent J* 2010; 22(1): 19-25.
  20. Dewi FD, Sudjana G, Oesman YM. Patient satisfaction analysis on service quality of dental health care based on empathy and responsiveness. *Dent Res J (Isfahan)* 2011; 8(4): 172-7.
  21. Karydis A, Komboli-Kodovazeniti M, Hatzigeorgiou D, Panis V. Expectations and perceptions of Greek patients regarding the quality of dental health care. *Int J Qual Health Care* 2001; 13(5): 409-16.
  22. Lahti S, Tuutti H, Hausen H, Kaarlanen R. Patients' expectations of an ideal dentist and their views concerning the dentist they visited: Do the views conform to the expectations and what determines how well they conform? *Community Dent Oral Epidemiol* 1996; 24(4): 240-4.
  23. Bamise C, Bada T, Bamise F, Ogunbodede E. Dental care utilization and satisfaction of residential university students. *Libyan J Med* 2008; 3(3): 140-3.
  24. Hill CJ, Garner SJ, Hannafin ME. What Dental Professionals Should Know About Dental Consumers. *Health Mark Q* 1990; 8(1-2): 45-57.
  25. Ekback G, Ordell S, Stahlacke K. Satisfaction with dental care and life-course predictors: A 20-year prospective study of a Swedish 1942 birth cohort? *Acta Odontol Scand* 2016; 74(3): 194-201.
  26. Okullo I, Astrom AN, Haugejorden O. Influence of perceived provider performance on satisfaction with oral health care among adolescents. *Community Dent Oral Epidemiol* 2004; 32(6): 447-55.
  27. Armfield JM, Stewart JF, Spencer AJ. The vicious cycle of dental fear: Exploring the interplay between oral health, service utilization and dental fear. *BMC Oral Health* 2007; 7: 1.
  28. Tamaki Y, Nomura Y, Teraoka K, Nishikahara F, Motegi M, Tsurumoto A, et al. Characteristics and willingness of patients to pay for regular dental check-ups in Japan. *J Oral Sci* 2004; 46(2): 127-33.
  29. Sakalauskiene Z, Machiulskiene V, Murtomaa H, Vehkalahti MM. Satisfaction with dental care and its role in dental health-related behaviour among lithuanian university employees. *Oral Health Prev Dent* 2015; 13(2): 113-21.
  30. Kress GC Jr, Silversin JB. The role of dental practice characteristics in patient satisfaction. *Gen Dent* 1987; 35(6): 454-7.
  31. Ntabaye MK, Scheutz F, Poulsen S. Patient satisfaction with emergency oral health care in rural Tanzania. *Community Dent Oral Epidemiol* 1998; 26(5): 289-95.



## Sesame extraction gel as an agent for prevention of dental caries: An in-vitro study

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### Original Article

#### Abstract

**BACKGROUND AND AIM:** Sesame has a high content of calcium. Regarding to the lack of adequate data about its remineralizing potential, we conducted this study to evaluate the surface hardness of enamel exposed to sesame extraction gel in comparison to artificial saliva and fluoride.

**METHODS:** After mounting and polishing twenty-four caries-free human premolars, the baseline microhardness was recorded. Subsequently, decalcification was accomplished by immersing into cola, after which the surface hardness was recorded again. Ultimately, the samples were divided into three groups, which were treated by either the sesame gel (SG), artificial saliva (AS) or the fluoride gel (FG). The final microhardness was assessed again. The repeated measure analysis of variance (ANOVA) was employed for comparison of baseline (B), decalcified (R) and remineralized (R) hardness while the one-way ANOVA followed by least significant difference test was used for comparison of different remineralizing agents.

**RESULTS:** There was significant difference among the teeth at baseline, after decalcification and after treatment by experimental solutions ( $P < 0.001$  and  $P = 0.002$  for pair wise comparison of B/D and D/R, respectively). Moreover, after remineralizing treatment, there was no significance difference between the solutions ( $P = 0.350$ ,  $P = 0.150$  and  $P = 0.610$  for pair-wise comparisons of SG-FG, SG-AS, FG-AS, respectively). However, the mean microhardness value was increasing in that order.

**CONCLUSION:** Although treating the decalcified enamel by sesame extraction enhanced its microhardness, there was no significant difference between sesame, fluoride and artificial saliva when they were applied for just 15 min.

**KEYWORDS:** Sesame; Dental Enamel; Hardness

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Dental caries, which is still a major public health problem and is the most frequent infectious disease in the human society, could lead to high morbidity rate.<sup>1</sup> Dental treatments are often costly and painful which shift both practitioners and patients toward prevention instead of restoration of tooth caries.<sup>2</sup> Carious lesion, which represents as cavitation, is the result of mineral loss from the tooth structure

due to production of acid by cariogenic bacteria.<sup>3</sup> Therefore, any remineralizing agent that exposes the tooth surface to mineral rich saliva,<sup>4</sup> could compensate and even prevent this process.<sup>3</sup> Although fluoride has a rich successful history and serves as an inexpensive topical agent in dental clinics,<sup>2</sup> many investigations were accomplished seeking for new remineralizing materials to eliminate the drawbacks of fluoride including

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its toxicity.<sup>5-8</sup> Accordingly, some innovative calcium phosphate materials such as bioactive glass, milk-derived protein and amorphous calcium phosphate were introduced recently.<sup>9,10</sup> However, in view of their high cost and essential modern technology vehicles, their application is still limited in dental clinics despite their enormously proved remineralizing efficacy.<sup>2,6,8</sup>

In recent years, the increased interest in alternative and complementary medicine has encouraged the dental researchers to explore the influence of various natural products against tooth caries,<sup>11-13</sup> particularly due to their lack of side effects on body tissues beside their economic features.<sup>14</sup> The oil pulling therapy has been extensively documented in traditional remedy in order to strengthen the tooth, jaw and gums as well as a useful management for prevention of tooth decay.<sup>15</sup> While several herbal oils were prescribed for this therapeutic purpose in folk medicine, sesame oil was one of the most famous ones.<sup>15</sup> Nonetheless, contemporary investigations revealed that sesame is one of the most reliable herbal sources of calcium.<sup>16-19</sup> Consequently, some studies provided scientific evidence demonstrating that oil pulling therapy by sesame oil could be applied as a preventive strategy against dental caries.<sup>16,20,21</sup> However, to the best of our knowledge, there is no available data about the remineralizing capacity of sesame oil on tooth structure. Therefore, this study was conducted to evaluate the surface hardness of enamel exposed to sesame extraction gel in comparison to artificial saliva and fluoride gel.

## Methods

This is an experimental in vitro study in which the blinded operators accomplished all process of preparing the samples and testing. All the teeth as well as solutions were coded and at the end of the statistical analysis, they were de-coded by the same person.

**Preparation of sesame extract gel:** The sesame gel was prepared by an expert professor at the Pharmacology School of the

Shahid Beheshti University of Medical Sciences, Tehran, Iran.

In order to prepare the extract, 200 gr of black sesame seed (which was purchased locally) were immersed in boiled water for 4 hours. Subsequently, they were filtrated, the solvent was evaporated and the residues were weighed that was roughly 20 g. Finally, it was admixed with 80 g of Carbomer 934 to produce an applicable 20% gel.

**Preparation of the teeth:** Twenty-four healthy human premolars extracted for orthodontic reasons were used in this study. The tap water was used as storage liquid and was replaced twice a week. In order to exclude unacceptable samples, the teeth were firstly cleaned with a low speed hand piece using brushes and slurry of pumice. At the next step, stereomicroscope was employed (40x magnification, Carton Optimal Industries Ltd, Thailand). The teeth that had crack were excluded and caries-free teeth were included. Thereafter, epoxy resin was used to mount the teeth before flattening and wet polishing of enamel by 5000-grit silicone paper.

**Microhardness test:** The baseline microhardness was assessed using a Vickers indenter (Shimadzu M g5037, Japan) at 50 g load. We made three indentations on each specimen.

It is noteworthy that all the microhardness tests (at the baseline, after de- and remineralization) were accomplished by a single operator at Amir-Kabir University of Industrial Sciences, Tehran.

**Demineralization process:** All of the specimens were exposed to an acidic cola based drink (Khoshgovar, Tehran, Iran) for 8 min that was replaced every 2 min in order to stabilize the PH (4.7). Thereafter, the microhardness of every sample was recorded again.

**Remineralization process:** The samples were randomly divided into three groups those were exposed to either artificial saliva (AS) (Hypozalix spray, Biocodex, France), fluoride gel (FG) (acidulated phosphate fluoride, Pascadental, USA) and the experimental sesame gel (SG) for 15 min.

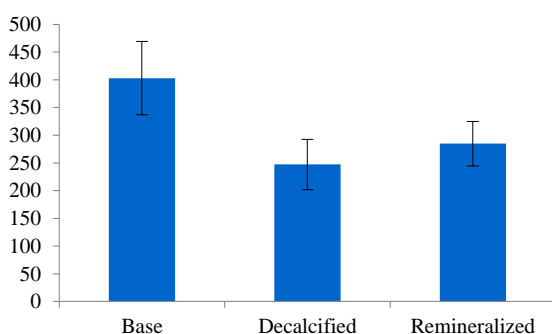
Ultimately, the final microhardness value was measured.

After exploring the normal distribution of the data (Kolmogorov-Smirnov), the average hardness of the teeth at the baseline, and after demineralization and remineralization were compared using repeated measure analysis of variance (ANOVA) test. Moreover, for comparison of the experimental solutions after remineralizing treatment, the one-way ANOVA test was incorporated followed by least significant difference and post hoc tests. The level of significance was determined as  $P = 0.05$ .

## Results

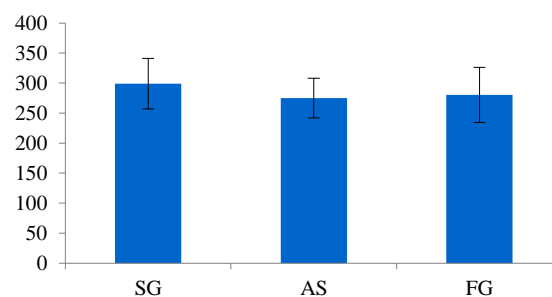
Our analysis revealed that the microhardness value was diminished after soaking in the demineralizing solution while it was increased again roughly similar after incorporation of all remineralizing agents.

Figure 1 shows the mean value of microhardness related to all of the samples at the baseline, after immersing in acidic cola drink (decalcified) and after remineralization by experimental solutions (incorporating either AS, FG or SG). The baseline microhardness was significantly diminished after 8 min exposure to cola drink ( $P < 0.001$ ) while it was significantly increased after 15 min treatment by remineralizing solutions ( $P = 0.002$ ). Therefore, it was proved that the acidic cola drink had an adverse effect on the human enamel. However, all the three remineralizing solutions compensated this damage.



**Figure 1.** The mean value of microhardness  $\pm$  Standard deviation (SD) related to all tested teeth

On the other hand, figure 2 represents the mean microhardness value of three remineralizing sub-groups. Obviously, the highest microhardness was recorded in SG followed by FG whereas the least was regarded to AS. However, statistical analysis revealed no significant difference among these subgroups ( $P = 0.35, 0.15$  and  $0.61$  for pair-wise comparisons of SG-FG, SG-AS, FG-AS, respectively). Therefore, it was demonstrated that 15 min treatment by either AS, FG or SG would increase the microhardness of demineralized human enamel. Although the results were roughly similar to each other, the sesame was the most effective one.



**Figure 2.** The mean value of microhardness  $\pm$  Standard deviation (SD) related to remineralizing subgroups

## Discussion

The results of the current study revealed that sesame extraction could increase the surface hardness of tooth enamel after exposure to cola based drinks. This finding may prove the remineralization ability of sesame on tooth enamel.

Since most tooth remineralizing materials consist of calcium and phosphate,<sup>5-8</sup> and sesame is rich in these minerals, it could be assumed that sesame could be used as tooth mineralizing agent. This theory is in consistent with Abebe et al.<sup>16</sup> and Kamchan et al.<sup>18</sup> who measured the mineral fractions of different foods and they reported the highest amount of calcium in sesame. In fact, in many previous publications, sesame was reported as one of the most drastic sources of calcium in nutrition.<sup>16-18</sup> However, despite this

calcium enrichment, the bioavailability of sesame's calcium is quite limited.<sup>16,18</sup> This fact is related to other ingredients of sesame such as phytate, oxalate and dietary fiber content that inhibit the absorption of calcium in human gastrointestinal system.<sup>16,18</sup> It has been documented that these three compounds, especially the oxalate, has prompt negative effect on the calcium dialysability.<sup>18</sup>

However, our investigation hypothesized that the sesame's calcium could precipitate on the tooth surface leading to enhancement of surface hardness and it is the first time that the surface hardness of human tooth enamel is reported after incorporation of sesame extraction.

Nonetheless, the benefits of sesame oil have been frequently proved in oil pulling therapy for prevention of plaque formation. Actually, some studies were carried on the anti-cariogenic potential of sesame oil<sup>15,20,21</sup> and they proposed two mechanisms. Firstly, sesame oil was introduced as an effective agent against biofilm formation on tooth surface that could be attributed to its oily structure, which is the base of oil pulling theory for prevention of dental plaque.<sup>15,20,21</sup> Moreover, sesame has anti-bacterial potential against main cariogenic bacteria including *Streptococcus mutans*. Thaweboon et al. claimed that sesame could significantly inhibit the growth of *S. mutans*.<sup>21</sup> Therefore, sesame could be quite favorable in dentistry especially that this natural gift does not have any side effect on human body. Moreover, it could be considered as an economic material.

It should be noted that we did not use fresh sesame seed in our experiment because in previous documentations it was reported that different ingredients of sesame are resistance to oxidation and their stability over time is trustable.<sup>17</sup>

The surface hardness test was incorporated in many articles as a quite reliable test exploring the mineral content of tooth surface. In fact, as the calcium substance of the enamel increase, its surface

hardness would increase dramatically. Among various hardness tests including Vickers, Barcol's, Knoop, etc., the Vickers is frequently used in enamel investigations due to the brittle structure of enamel.

According to our statistical analysis comparing the Vickers surface hardness, after remineralizing procedure, there was no significant difference among either of the groups. It means that in statistical point of view, there was no significant difference between artificial saliva, sesame gel and fluoride gel. However, the exact mean value was highest in sesame group followed by fluoride and the least one was in artificial saliva. Thus, this lack of significant difference could be possibly explained by the short exposure time, which was 15 min in all subgroups. Therefore, prolonged treatment intervals are strongly suggested in future studies.

Sesame extraction had the potential of increasing the surface hardness of human enamel that was decalcified by an acidic beverage. Hence it could be assumed that the incorporated gel had possible remineralizing effect.

### Conclusion

It was revealed that exposing the human enamel to an acidic cola based drink would diminish its surface hardness while treating with the sesame or fluoride gel would enhance this property. However, by 15 min incorporation of experimental gels, no statistically significant difference was obtained among the groups compared to artificial saliva.

### Conflict of Interests

Authors have no conflict of interest.

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## References

1. Moses J, Nammalwar RB, Gurunathan D. Prevalence of dental caries, socio-economic status and treatment needs among 5 to 15 year old school going children of chidambaram. *J Clin Diagn Res* 2011; 5(1): 146-51.
2. Karlinsey RL, Mackey AC, Walker ER, Frederick KE. Surfactant-modified beta-TCP: Structure, properties, and in vitro remineralization of subsurface enamel lesions. *J Mater Sci Mater Med* 2010; 21(7): 2009-20.
3. Reynolds EC. Calcium phosphate-based remineralization systems: Scientific evidence? *Aust Dent J* 2008; 53(3): 268-73.
4. Peters MC. Strategies for noninvasive demineralized tissue repair. *Dent Clin North Am* 2010; 54(3): 507-25.
5. Cai F, Shen P, Morgan MV, Reynolds EC. Remineralization of enamel subsurface lesions in situ by sugar-free lozenges containing casein phosphopeptide-amorphous calcium phosphate. *Aust Dent J* 2003; 48(4): 240-3.
6. Karlinsey RL, Mackey AC, Walker ER, Frederick KE. Preparation, characterization and in vitro efficacy of an acid-modified beta-TCP material for dental hard-tissue remineralization. *Acta Biomater* 2010; 6(3): 969-78.
7. Manton DJ, Walker GD, Cai F, Cochrane NJ, Shen P, Reynolds EC. Remineralization of enamel subsurface lesions in situ by the use of three commercially available sugar-free gums. *Int J Paediatr Dent* 2008; 18(4): 284-90.
8. Walker GD, Cai F, Shen P, Bailey DL, Yuan Y, Cochrane NJ, et al. Consumption of milk with added casein phosphopeptide-amorphous calcium phosphate remineralizes enamel subsurface lesions in situ. *Aust Dent J* 2009; 54(3): 245-9.
9. Attin T, Paque F, Ajam F, Lennon AM. Review of the current status of tooth whitening with the walking bleach technique. *Int Endod J* 2003; 36(5): 313-29.
10. Cunha AG, De Vasconcelos AA, Borges BC, Vitoriano Jde O, Alves-Junior C, Machado CT, et al. Efficacy of in-office bleaching techniques combined with the application of a casein phosphopeptide-amorphous calcium phosphate paste at different moments and its influence on enamel surface properties. *Microsc Res Tech* 2012; 75(8): 1019-25.
11. Aparna S, Srirangarajan S, Malgi V, Setlur KP, Shashidhar R, Setty S, et al. A comparative evaluation of the antibacterial efficacy of honey in vitro and antiplaque efficacy in a 4-day plaque regrowth model in vivo: preliminary results. *J Periodontol* 2012; 83(9): 1116-21.
12. Bosio K, Avanzini C, D'Avolio A, Ozino O, Savoia D. In vitro activity of propolis against *Streptococcus pyogenes*. *Lett Appl Microbiol* 2000; 31(2): 174-7.
13. Nassar HM, Li M, Gregory RL. Effect of honey on *Streptococcus mutans* growth and biofilm formation. *Appl Environ Microbiol* 2012; 78(2): 536-40.
14. Moussa A, Saad A, Nouredine D, Aboud B, Meslem A, Baghdad K. The influence of starch of ginger on the antibacterial activity of honey of different types from algeria against *escherichia coli* and *staphylococcus aureus*. *Int J Microbiol Res* 2011; 2(3): 258-62.
15. Asokan S, Rathinasamy TK, Inbamani N, Menon T, Kumar SS, Emmadi P, et al. Mechanism of oil-pulling therapy-in vitro study. *Indian J Dent Res* 2011; 22(1): 34-7.
16. Abebe Y, Bogale A, Hambidge KM, Stoecker BJ, Bailey K, Gibson RS. Phytate, zinc, iron and calcium content of selected raw and prepared foods consumed in rural Sidama, Southern Ethiopia, and implications for bioavailability. *J Food Compos Anal* 2007; 20(3): 161-8.
17. Elleuch M, Besbes S, Roiseux O, Blecker C, Attia H. Quality characteristics of sesame seeds and by-products. *Food Chem* 2007; 103(2): 641-50.
18. Kamchan A, Puwastien P, Sirichakwal PP, Kongkachuichai R. In vitro calcium bioavailability of vegetables, legumes and seeds. *J Food Compos Anal* 2004; 17(3): 311-20.
19. Poneros-Schneier AG, Erdman Jr JW. Bioavailability of calcium from sesame seeds, almond powder, whole wheat bread, spinach and nonfat dry milk in rats. *J Food Sci* 1989; 54(1): 150-3.
20. Saravanan D, Ramkumar S, Vineetha K. Effect of oil pulling with sesame oil on plaque-induced gingivitis: A microbiological study. *J Orofac Res* 2013; 3(3): 175-80.
21. Thaweboon S, Nakaparksin J, Thaweboon B. Effect of oilpulling on oral microorganisms in biofilm models. *Asia J Public Health* 2011; 2(2): 62-6.

## Association between clinical and cone-beam computed tomography findings in patients with temporomandibular disorders

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### Original Article

#### Abstract

**BACKGROUND AND AIM:** The aim of this study was to assess the association between the clinical and cone-beam computed tomography (CBCT) findings in relation to bony changes in patients with temporomandibular disorders (TMD).

**METHODS:** According to the research diagnostic criteria for temporomandibular disorder (RDC/TMD), forty-one patients with type II TMD (42 TM joints) and type III TMD (40 TM joints) were recruited for this study. Condylar position and bony changes including flattening, sclerosis, osteophytes, resorption, and erosion of joint were evaluated by CBCT and compared with clinical findings. Data were analyzed by SPSS software.

**RESULTS:** Condylar flattening, sclerosis, resorption, and erosion were not significantly associated with joint/masticatory muscles pain or crepitus sound. The vertical or horizontal position of the condyle showed no significant relationship with the clinical findings. Condylar osteophyte was significantly associated with pain in masticatory muscles and crepitus ( $P = 0.030$  and  $P = 0.010$ , respectively). There was no association between the condylar range of motion and pain in joint or masticatory muscles.

**CONCLUSION:** Condylar osteophyte was significantly associated with both masticatory muscles pain and crepitus sound. No significant relationship was found between the other temporomandibular joint (TMJ) radiographic and clinical findings in patients with TMD.

**KEYWORDS:** Cone-Beam Computed Tomography; Mandibular Condyle; Temporomandibular Joint Disorders

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Temporomandibular disorder (TMD) is the term used to include all functional disturbances of the masticatory system. TMDs are identified by a triad of clinical symptoms such as pain, jaw sounds and limitation/deviation on mouth opening.<sup>1</sup> TMDs are diagnosed as frequently as 33%, with a predilection for women.<sup>2</sup> This disorder

has been found to be associated with psychosocial factors such as depression and anxiety disorders and parafunctional activities such as clenching and bruxism.<sup>3</sup>

Both clinical and radiographic examinations of temporomandibular joint (TMJ) are needed to diagnose TMD. A comprehensive clinical examination should be performed based on the research

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diagnostic criteria for TMD (RDC/TMD) considering both physical and psychological etiologic factors of TMD. The RDC/TMD criteria are based on the physical symptoms including three categories of muscular disorders (group 1), disk displacement (group 2), and arthralgia, osteoarthritis or osteoarthrosis (group 3). Group-2 includes disk displacement with and without reduction.<sup>4</sup> The RDC/TMD criteria for disk displacement with reduction are known as reciprocal clicking (click on vertical opening and closing that happens at 5 mm greater interincisal space on opening than closing and is omitted on protrusive opening), repeatable on 2 out of 3 sequential attempts, or clicking on vertical range of motion (either opening or closing), repeatable on 2 out of 3 sequential attempts, and click during lateral movement or protrusion which are reproducible on 2 out of 3 consecutive trials. The RDC/TMD criteria for disk displacement without reduction are known as a considerable limitation in the opening, maximum unassisted opening  $\leq 35$  mm, passive stretching increasing opening by  $\leq 4$  mm more than the maximum unassisted opening, contralateral excursion  $< 7$  mm and/or uncorrected deviation to the same side on opening. The RDC/TMD criteria for TMD type III include pain on palpation for one or two joints, coarse crepitus and self-reported pain of the joints or radiographic signs of arthritis.<sup>5</sup>

Radiographic examination of TMJ is usually necessary to differentiate these pathologic conditions. Advanced radiographic methods, such as magnetic resonance imaging (MRI), are used to evaluate the soft tissue of disk and its dislocation, whereas Cone-Beam computed tomography (CBCT) is the gold standard method to assess the bony changes of TMJ.<sup>6,7</sup>

There are few number of studies evaluating the relationship between clinical and radiographic findings of TMD by CBCT.<sup>3</sup> Among these, an association was found between functional pain and radiographic

bony changes on the articular surface of condyle by Kurita et al.<sup>2</sup> However, several other studies have found no relationship between the intensity of pain and range of mandibular motion on the one hand and the degree of condylar bony changes on the other.<sup>3,8-10</sup>

Considering the divergent results in this field, the current study was conducted to assess the association between clinical and radiographic findings in patients with TMJ disk displacement and osteoarthritis.

## Methods

All patients with symptoms of type II and III TMD attending the Prosthodontics Department of Mashhad Dental School, Iran, from April 2013 to April 2014, were recruited for this cross-sectional study. The inclusion criteria were considered based on RDC/TMD. The exclusion criteria were congenital craniofacial disorders, history of TMJ therapeutic interventions (surgery, laser therapy, and medication), those receiving orthodontic treatment, pregnancy, systemic diseases involving TMJ (e.g. rheumatoid arthritis) and pyogenic arthritis.<sup>5</sup>

The research protocol was approved by the Ethics Committee of Mashhad University of Medical Sciences (Code: 920112) and written consent was obtained.

Clinical examination was performed by an expert prosthodontist and history of TMJ trauma or parafunctional habits were also recorded.

The maximum mouth opening was assessed by a tape measure and patients were classified into normal (35-50 mm) and limited ( $< 35$  mm) groups.<sup>4</sup> Myofascial pain was characterized by any symptom of ache in the jaw, face, temples, preauricular region or inside the ear during rest or function. Moreover, the pain on palpation of masseter or temporalis muscles, posterior region of the mandible, submandibular site, lateral pterygoid and tendon of temporalis was also registered. Additionally, TMJ pain elicited by palpation at rest or during function alongside

jaw sounds including click and crepitus was recorded.<sup>5</sup>

Bilateral CBCT images were taken by Promax 3D (Planmeca, Helsinki, Finland) from the TMJ in opened and closed mouth states [field of view (FOV) = 80 × 80 mm, kilovoltage peak (kVP) = 64-68, mA = 6-10, slice thickness = 0.16 mm, slice interval = 1 mm].

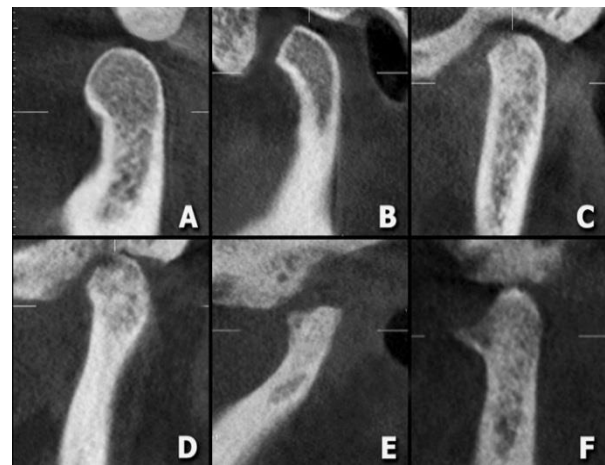
Three-dimensional images of coronal, sagittal and axial planes were constructed by multi-planar reconstructions of CBCT, using Romexis 3.1.1 (Planmeca, Helsinki, Finland). The sagittal slices were reconstructed perpendicular to the panoramic line that was drawn on the axial plane. The slice corresponding to the center of the condyle was considered as the reference.<sup>11</sup> All of the images were interpreted by two expert oral and maxillofacial radiologists under blinded condition. Divergent interpretations were discussed and the final agreement was reached in all cases.

To assess the vertical condylar position, the distance between the uppermost region of the condyle and deepest area of the joint fossa was measured. The distance between 1.5-4 mm was considered as normal.<sup>12</sup> In order to evaluate the horizontal position of the condyle, anterior and posterior joint spaces were determined by the method of Kinzinger et al.<sup>13</sup> The shortest distance between the most anterior region of the condyle to the articular eminence (anterior joint space) and the most posterior region of the condyle to the tympanic process of the temporal bone (posterior joint space) were measured. The joint space index (JSI) was estimated as follows:  $JSI = [(Post - Ant) / (Post + Ant)] \times 100$ , where Ant is anterior joint space, and Post is posterior joint space. The index values were interpreted as follows, 0: central location of the condyle, > 0: anterior location of the condyle, and < 0: posterior location of the condyle.

If the most superior region of condyle was located around 5 mm posterior and 8 mm anterior to the most inferior region of articular eminence, it was considered normal.

If the condyle moved posteriorly more than this range, it was considered a limitation in motion and anteriorly, out of this range, was named hypermobility or subluxation.<sup>14</sup>

Bony changes, including flattening, sclerosis, osteophytes, resorption, and erosion were also identified in at least two consecutive cross-sections of CBCT images (Figure 1).



**Figure 1.** The sagittal CBCT (Cone-Beam computed tomography) appearance of normal mandibular condyle (A), flattening of condylar head (B), sclerosis (C), erosion (D), resorption (E) and osteophyte (F)

The Fisher's exact test was used to assess the association between the clinical and CBCT findings using SPSS (version 18, SPSS Inc., Chicago, IL, USA) and the significance level was set at  $P < 0.050$ .

## Results

A total of 41 patients (22 women and 19 men) fulfilled the inclusion and exclusion criteria. The mean age of the patients was  $42.5 \pm 27.5$  years. The sex did not have any influence on the study parameters. The association between clinical and CBCT findings were evaluated as follows:

### *Erosive changes and TMJ/muscular pain:*

Of 82 joints evaluated, 1 joint was characterized by pain and erosive changes of the glenoid fossa. 8 joints were identified with erosive changes in the region of articular eminence, and 3 joints were reported as joint pain. Among 44 cases with the erosion of the



**Table 1.** Association between temporomandibular joint (TMJ) pain and bony changes of joint

Bony change		TMJ pain		P*
		Yes [n (%)]	No [n (%)]	
Erosion of condylar head	Yes (n = 44)	21 (47.8)	23 (52.2)	> 0.999
	No (n = 38)	19 (50.0)	19 (50.0)	
Sclerosis of condylar head	Yes (n = 3)	2 (66.7)	1 (33.3)	> 0.999
	No (n = 37)	21 (56.8)	16 (43.2)	
Osteophyte of condylar head	Yes (n = 12)	9 (75.0)	3 (25.0)	0.179
	No (n = 28)	14 (50.0)	14 (50.0)	
Resorption of condylar head	Yes (n = 1)	1 (100)	0 (0)	> 0.999
	No (n = 39)	22 (56.4)	65 (43.6)	
Fattening of condylar head	Yes (n = 12)	8 (66.7)	4 (33.3)	0.505
	No (n = 28)	15 (53.6)	13 (46.4)	

\*Fisher's exact test

TMJ: Temporomandibular joint

condylar head, 11 cases were identified with disk displacement signs and 33 cases with osteoarthritis. There was no significant association between condylar erosion and joint or masticatory muscles pain (Tables 1 and 2).

**Sclerosis and TMJ/muscular pain:** 3 of 82 joints exhibited sclerosis of the glenoid fossa, 2 of which had joint pain but none of them had pain in masticatory muscles. In addition, 4 joints had articular eminence sclerosis with joint pain, but only 1 of them showed pain in masticatory muscles. No significant association was found between condylar sclerosis and joint or muscular pain (Tables 1 and 2).

**Osteophyte and TMJ/muscular pain:** No osteophyte was found in the region of glenoid fossa or articular eminence in the patients with type III TMD. 12 joints showed condylar osteophyte. There was no

significant association between condylar osteophyte and joint pain; however, the relationship between condylar osteophyte and masticatory muscles pain was significant ( $P = 0.039$ ) (Tables 1 and 2).

**Resorption and TMJ/muscular pain:** No joint exhibited resorption of the glenoid fossa or articular eminence in the subjects with type III TMD. Condylar resorption was observed in only one joint. There was no association between condylar resorption and joint or masticatory muscles pain (Tables 1 and 2).

**Flattening and TMJ/muscular pain:** No flattening was detected in the region of glenoid fossa or articular eminence. However, 66 cases of condylar flattening were detected. No significant association was found between condylar flattening and joint or masticatory muscles pain (Table 1).

**Condylar erosion/sclerosis/osteophyte/resorption/flattening and crepitus:** No

**Table 2.** Association between muscular pain and bony changes of joint

Bony changes		Muscular pain		P*
		Yes [n (%)]	No [n (%)]	
Erosion of condylar head	Yes (n = 44)	9 (20.4)	35 (79.6)	0.605
	No (n = 38)	10 (26.3)	28 (73.7)	
Sclerosis of condylar head	Yes (n = 3)	0 (0)	3 (100)	> 0.999
	No (n = 37)	8 (21.6)	29 (78.4)	
Osteophyte of condylar head	Yes (n = 12)	5 (41.7)	7 (58.3)	0.039
	No (n = 28)	3 (10.7)	25 (89.3)	
Resorption of condylar head	Yes (n = 1)	0 (0)	1 (100)	> 0.999
	No (n = 39)	8 (20.5)	31 (79.5)	
Fattening of condylar head	Yes (n = 66)	14 (21.2)	52 (78.8)	0.509
	No (n = 16)	5 (31.2)	11 (68.8)	

\*Fisher's exact test

**Table 3.** Association between crepitus and bony changes of joint

Bony changes		Crepitus		P*
		Yes [n (%)]	No [n (%)]	
Erosion of condylar head	Yes (n = 40)	29 (72.5)	11 (27.5)	0.170
	No (n = 42)	37 (88.1)	5 (11.9)	
Sclerosis of condylar head	Yes (n = 3)	2 (66.7)	1 (33.3)	0.090
	No (n = 79)	14 (17.7)	65 (82.3)	
Osteophyte of condylar head	Yes (n = 12)	6 (50.0)	6 (50.0)	0.010
	No (n = 70)	10 (14.3)	60 (85.7)	
Resorption of condylar head	Yes (n = 1)	0 (0)	1 (100)	> 0.999
	No (n = 81)	16 (19.8)	65 (80.2)	
Fattening of condylar head	Yes (n = 66)	13 (19.7)	53 (80.3)	> 0.999
	No (n = 16)	3 (18.7)	13 (81.3)	

\*Fisher's exact test

association was found between crepitus sound and condylar head erosion, sclerosis, resorption, and flattening. A significant relationship was established between crepitus and condylar osteophytes ( $P = 0.010$ ) (Tables 1 and 3).

**Condylar position in closed mouth and TMJ/muscular pain:** The horizontal position of condyle was centric in 23 patients, whereas in 18 and 41 subjects it was located anteriorly and posteriorly, respectively. The vertical position of condyle was normal in 55 cases. However, 27 subjects exhibited increased vertical joint space. There was no association between the horizontal or vertical position of condyle and pain in joint or masticatory muscles (Tables 4 and 5).

**Condylar range of motion and TMJ/muscular pain:** From the 82 evaluated joints, 48 condyles were in the normal range on mouth opening. Limitation in motion was noticed in 25 joints, whereas 9 ones showed hypermobility. There was no association between the condylar range of motion and pain in joint or masticatory muscles (Table 6).

## Discussion

This study was designed to evaluate the relationship between clinical and CBCT findings in patients with TMD according to the RDC/TMD criteria. The efficacy of CBCT has been demonstrated by previous studies.<sup>12,15,16</sup>

Larheim et al. reported that 35% of patients with disk displacement had no pain.<sup>17</sup> Some authors proposed pain as a multi-dimensional experience, the origin of which, joints or muscles, might not be identified by patients.<sup>18,19</sup> Joint pain was not significantly associated with TMD in the current study. This finding was consistent with other studies.<sup>3,20-22</sup>

In a CBCT study on a symptomatic TMD group of Korean children and adolescents, multiple cases of erosion and posterior position of condyle were reported. Sclerosis was the most frequent finding in the asymptomatic group.

Erosion occurred more frequently in patients with pain and limited mouth

**Table 4.** Association of the horizontal position of the condyle and pain in joint or masticatory muscles

Pain		Horizontal position of condyle			P*
		Anterior [n (%)]	Centric [n (%)]	Posterior [n (%)]	
Jaw pain	Yes (n = 40)	13 (32.5)	7 (17.5)	20 (50.0)	0.060
	No (n = 42)	5 (11.9)	16 (38.1)	21 (50.0)	
Masticatory muscle pain	Yes (n = 19)	4 (21.0)	5 (26.3)	10 (52.7)	0.885
	No (n = 63)	14 (22.2)	18 (28.6)	31 (49.2)	

\*Fisher's exact test

**Table 5.** Association of the vertical position of the condyle and pain in joint or masticatory muscles

Pain		Vertical position of condyle			P*
		High [n (%)]	Normal [n (%)]	Low [n (%)]	
Jaw pain	Yes (n = 40)	12 (30.0)	28 (70.0)	0 (0)	0.582
	No (n = 42)	15 (35.8)	27 (64.3)	0 (0)	
Masticatory muscle pain	Yes (n = 19)	5 (26.3)	14 (73.7)	0 (0)	0.484
	No (n = 63)	22 (34.9)	41 (65.1)	0 (0)	

\*Fisher's exact test

opening.<sup>23</sup> In another study, patients with erosive changes reported more pain and dysfunction.<sup>24</sup> The present results showed no association between erosive changes and pain. The different clinical and radiological approaches may justify the difference.

Palconet et al. demonstrated a weak association between radiographic findings of condyle (erosion, flattening and osteophyte) in CBCT and pain in joint or masticatory muscles or other clinical findings.<sup>3</sup> These findings were similar to the current results. However, a significant association was found between osteophytes and pain in masticatory muscles. This might be due to the fact that the presence of osteophytes and pain upon function gradually leads to limited function and consequently splinting and fatigue of muscles.

Wiese et al. found no association between bony changes in TMJ tomograms and pain-related variables, including pain in joint and masticatory muscles upon palpation, duration of pain perception and chronic pain.<sup>25</sup> Clinical symptoms may appear 6 months prior to the appearance of radiologic bony changes and radiographic images may seem normal in the early stages of osteoarthritis. When the radiographic structural changes appear, but the patients have no pain, osteoarthritis is probably present. In this case, the inflammatory reactions and pain gradually abate, the suitable range of motion is restored, and joint

sounds decrease, but the regenerative processes continue in the condyle and fossa.<sup>26</sup>

Kurita et al. demonstrated a positive relationship between pain and radiographic evidence of osteoarthritis.<sup>2</sup> This incoherence might be explained by different case selection, pain determination criteria and radiographic methods.

In the present study, condylar flattening was found in patients with signs of disk displacement. However, some authors found no association between osteophytes, erosion, flattening and disk displacement.<sup>27</sup> In addition, in Sener and Akganlu's study, degenerative changes in joints were not suggested as a special finding of disk displacement.<sup>28</sup>

Joint sounds are often considered as an indicator of internal derangement of TMJ. However, it should be noted that the absence of joint sounds is not essentially associated with normality.<sup>29</sup> In the present study, consistent with the Wiese's et al. study,<sup>26</sup> crepitus was shown to be associated with osteophytes. Moreover, similar to another survey, crepitus was not associated with other radiographic changes.<sup>27</sup>

In the present research, no association was found between the horizontal or vertical position of condyle and pain in the TMJ or muscles. The condyles were commonly observed in the posterior position.

The clinical significance of the horizontal position of the condyle is controversial. Many

**Table 6.** Association between maximum mouth opening and pain in joint or masticatory muscles

Pain		Maximum mouth opening		P*
		Limited [n (%)]	Normal [n (%)]	
Jaw pain	Yes (n = 40)	17 (42.5)	23 (57.5)	0.550
	No (n = 42)	17 (40.5)	25 (59.5)	
Masticatory muscle pain	Yes (n = 19)	8 (42.1)	11 (57.9)	0.550
	No (n = 63)	26 (41.3)	37 (58.7)	

\*Fisher's exact test

researchers found no association between the horizontal position of the condyle and clinical findings.<sup>26,30,31</sup> However, several studies showed that the posterior position of the condyle was common in TMD patients.<sup>32,33</sup>

No association was found between the vertical position of condyle and pain in joint or masticatory muscles. The association of vertical position of the condyle with clinical findings was not previously studied. The current results showed an insignificant association between the condylar position in opened mouth and pain. In the study by de Senna et al., no association was found between the position of the condyle and disk with clinical symptoms.<sup>34</sup> In agreement with us, Hirsch and John did not find any changes in the jaw motion with the presence of TMD symptoms.<sup>35</sup>

Future studies could replicate the current results using a larger sample, MRI assessment,

and quantitative clinical evaluations.

### Conclusion

Condylar osteophyte was significantly associated with both masticatory muscles pain and crepitus sound. No significant relationship was found between the radiographic and clinical findings in patients with type II and type III TMD.

### Conflict of Interests

Authors have no conflict of interest.

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### References

1. Fernandez-de-las-Penas C, Svensson P. Myofascial temporomandibular disorder. *Curr Rheumatol Rev* 2016; 12(1): 40-54.
2. Kurita H, Kojima Y, Nakatsuka A, Koike T, Kobayashi H, Kurashina K. Relationship between temporomandibular joint (TMJ)-related pain and morphological changes of the TMJ condyle in patients with temporomandibular disorders. *Dentomaxillofac Radiol* 2004; 33(5): 329-33.
3. Palconet G, Ludlow JB, Tyndall DA, Lim PF. Correlating cone beam CT results with temporomandibular joint pain of osteoarthritic origin. *Dentomaxillofac Radiol* 2012; 41(2): 126-30.
4. Al-Riyami S. Temporomandibular joint disorders in patients with skeletal discrepancies [PhD Thesis]. London, UK: UCL Eastman Dental Institute; 2010. 2017.
5. Manfredini D, Guarda-Nardini L, Winocur E, Piccotti F, Ahlberg J, Lobbezoo F. Research diagnostic criteria for temporomandibular disorders: A systematic review of axis I epidemiologic findings. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2011; 112(4): 453-62.
6. Liu XM, Zhang SY, Yang C, Chen MJ, Cai Y, Haddad MS, et al. Correlation between disc displacements and locations of disc perforation in the temporomandibular joint. *Dentomaxillofac Radiol* 2010; 39(3): 149-56.
7. Alkhader M, Kuribayashi A, Ohbayashi N, Nakamura S, Kurabayashi T. Usefulness of cone beam computed tomography in temporomandibular joints with soft tissue pathology. *Dentomaxillofac Radiol* 2010; 39(6): 343-8.
8. Celic R, Jerolimov V, Zlataric DK. Relationship of slightly limited mandibular movements to temporomandibular disorders. *Braz Dent J* 2004; 15(2): 151-4.
9. Helenius LM, Hallikainen D, Helenius I, Meurman JH, Kononen M, Leirisalo-Repo M, et al. Clinical and radiographic findings of the temporomandibular joint in patients with various rheumatic diseases. A case-control study. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2005; 99(4): 455-63.
10. Helenius LM, Tervahartiala P, Helenius I, Al-Sukhun J, Kivisaari L, Suuronen R, et al. Clinical, radiographic and MRI findings of the temporomandibular joint in patients with different rheumatic diseases. *Int J Oral Maxillofac Surg* 2006; 35(11): 983-9.
11. Tsiklakis K, Syriopoulos K, Stamatakis HC. Radiographic examination of the temporomandibular joint using cone beam computed tomography. *Dentomaxillofac Radiol* 2004; 33(3): 196-201.
12. Alexiou K, Stamatakis H, Tsiklakis K. Evaluation of the severity of temporomandibular joint osteoarthritic changes related to age using cone beam computed tomography. *Dentomaxillofac Radiol* 2009; 38(3): 141-7.
13. Kinzinger G, Kober C, Diedrich P. Topography and morphology of the mandibular condyle during fixed functional

- orthopedic treatment -a magnetic resonance imaging study. *J Orofac Orthop* 2007; 68(2): 124-47.
14. White SC, Pharoah MJ. *Oral radiology: Principles and interpretation*. Philadelphia, PA: Elsevier Health Sciences; 2013.
  15. Scrivani SJ, Keith DA, Kaban LB. Temporomandibular disorders. *N Engl J Med* 2008; 359(25): 2693-705.
  16. Honda K, Larheim TA, Maruhashi K, Matsumoto K, Iwai K. Osseous abnormalities of the mandibular condyle: Diagnostic reliability of cone beam computed tomography compared with helical computed tomography based on an autopsy material. *Dentomaxillofac Radiol* 2006; 35(3): 152-7.
  17. Larheim TA, Westesson P, Sano T. Temporomandibular joint disk displacement: Comparison in asymptomatic volunteers and patients. *Radiology* 2001; 218(2): 428-32.
  18. Schmitter M, Kress B, Rammelsberg P. Temporomandibular joint pathosis in patients with myofascial pain: A comparative analysis of magnetic resonance imaging and a clinical examination based on a specific set of criteria. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2004; 97(3): 318-24.
  19. Laskin DM, Greene CS, Hylander WL. *Temporomandibular disorders: An evidence-based approach to diagnosis and treatment*. Hanover Park, IL: Quintessence Publishing Co, Inc; 2006. p. 201-58.
  20. Ohlmann B, Rammelsberg P, Henschel V, Kress B, Gabbert O, Schmitter M. Prediction of TMJ arthralgia according to clinical diagnosis and MRI findings. *Int J Prosthodont* 2006; 19(4): 333-8.
  21. Crow HC, Parks E, Campbell JH, Stucki DS, Daggy J. The utility of panoramic radiography in temporomandibular joint assessment. *Dentomaxillofac Radiol* 2005; 34(2): 91-5.
  22. Emshoff R, Innerhofer K, Rudisch A, Bertram S. Relationship between temporomandibular joint pain and magnetic resonance imaging findings of internal derangement. *Int J Oral Maxillofac Surg* 2001; 30(2): 118-22.
  23. Cho BH, Jung YH. Osteoarthritic changes and condylar positioning of the temporomandibular joint in Korean children and adolescents. *Imaging Sci Dent* 2012; 42(3): 169-74.
  24. Zhao YP, Zhang ZY, Wu YT, Zhang WL, Ma XC. Investigation of the clinical and radiographic features of osteoarthritis of the temporomandibular joints in adolescents and young adults. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2011; 111(2): e27-e34.
  25. Wiese M, Svensson P, Bakke M, List T, Hintze H, Petersson A, et al. Association between temporomandibular joint symptoms, signs, and clinical diagnosis using the RDC/TMD and radiographic findings in temporomandibular joint tomograms. *J Orofac Pain* 2008; 22(3): 239-51.
  26. Wiese M, Wenzel A, Hintze H, Petersson A, Knutsson K, Bakke M, et al. Osseous changes and condyle position in TMJ tomograms: Impact of RDC/TMD clinical diagnoses on agreement between expected and actual findings. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2008; 106(2): e52-e63.
  27. Goodarzi Pour D, Rajae E, Golestan B. Association between magnetic resonance imaging, temporomandibular joint scanographic findings and clinical manifestations of joint pain and sounds in temporomandibular disorders. *Iran J Radiol* 2010; 7(4): 245-9.
  28. Sener S, Akganlu F. MRI characteristics of anterior disc displacement with and without reduction. *Dentomaxillofac Radiol* 2004; 33(4): 245-52.
  29. Poveda Roda R, Diaz Fernandez JM, Hernandez BS, Jimenez SY, Margaix M, Sarrion G. A review of temporomandibular joint disease (TMJD). Part II: Clinical and radiological semiology. Morbidity processes. *Med Oral Patol Oral Cir Bucal* 2008; 13(2): E102-E109.
  30. Robinson de Senna B, Marques LS, Franca JP, Ramos-Jorge ML, Pereira LJ. Condyle-disk-fossa position and relationship to clinical signs and symptoms of temporomandibular disorders in women. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2009; 108(3): e117-e124.
  31. Vasconcelos Filho JO, Menezes AV, Freitas DQ, Manzi FR, Boscolo FN, de Almeida SM. Condylar and disk position and signs and symptoms of temporomandibular disorders in stress-free subjects. *J Am Dent Assoc* 2007; 138(9): 1251-5.
  32. Imanimoghaddam M, Madani AS, Mahdavi P, Bagherpour A, Darijani M, Ebrahimnejad H. Evaluation of condylar positions in patients with temporomandibular disorders: A cone-beam computed tomographic study. *Imaging Sci Dent* 2016; 46(2): 127-31.
  33. Pereira LJ, Gavião MB, Bonjardim LR, Castelo PM. Ultrasound and tomographic evaluation of temporomandibular joints in adolescents with and without signs and symptoms of temporomandibular disorders: A pilot study. *Dentomaxillofac Radiol* 2007; 36(7): 402-8.
  34. de Senna BR, dos Santos Silva VK, França JP, Marques LS, Pereira LJ. Imaging diagnosis of the temporomandibular joint: Critical review of indications and new perspectives. *Oral Radiology* 2009; 25: 86.
  35. Hirsch C, John MT, Lautenschlager C, List T. Mandibular jaw movement capacity in 10-17-yr-old children and adolescents: Normative values and the influence of gender, age, and temporomandibular disorders. *Eur J Oral Sci* 2006; 114(6): 465-70.