

**Research Article**

**Poor Self-Perceived Oral Health and Associated Factors among  
13 Years old Adolescents Using Chi-Squared Automatic  
interaction Detection Decision Tree Analysis**

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**ABSTRACT**

**Aim:** The purpose of the present study is to use Chi-squared Automatic Interaction Detection Decision Tree Analysis to determine the associated factors of poor perception of oral health among 13 years old adolescents, Iran, 2016: This cross-sectional study was carried out on 519 adolescents in Qazvin, Iran, in 2015. Self-administered Questionnaire contained parts about oral health behaviors (frequency of tooth brushing, dental visit, snacking and use of fluoride toothpaste); socio-demographic status, self-perceived of oral health, gum bleeding and halitosis. The clinical status was assessed by simplified oral hygiene index. Descriptive statistics, Chi-squared Automatic Interaction Detection Decision Tree Analysis (CHAID), Chi-square and independent sample t test, binary and multiple logistic regressions were performed for the statistical analysis. The overall accuracy of prediction of both analysis was tested by ROC curve.

**Result:** Of all participants only 23% of adolescents brush their teeth every day twice or more and 35% never used toothpaste. The mean score of knowledge and attitude were respectively (4.2±1.5) and (4.6±1.2). The CHAID decision tree analysis revealed that tooth brushing frequency, malodor, dental visit and knowledge score were affecting the adolescent's perception of oral health. Adolescents that had a last dental visit more than 2 years ago, were more likely to report poor self-perceived oral health (OR= 1.79, 95% CI 1.10-2.92 P = 0.02).

**Conclusion:** poor self-perceived oral health and tooth brushing frequency, oral malodor, dental visit, and oral health knowledge were associated in a hierarchical structure. In designing and conducting effective oral health promotion programs for adolescents, consideration of such subjective measurements are essential.

**Key world:** Adolescence, Self-perceived oral health, Oral health behaviors, Dental visit, Malodor

**INTRODUCTION**

Indeed remarkable efforts have been made in the field of public health to solve the oral health problems, however oral health still remains a

public health issue in both developed and developing countries(1, 2). The importance of the problem is highlighted when evaluating oral

health disparities among children and adolescents, who constitute approximately 20% of the world's population(3, 4).Adolescence is referred to as the period in which lifelong health habits are created and consolidation of health behavior occurs(5).It is suggested that even school performance is related with oral healthstatus. Adolescents with poorer oral health status were more likely to experience school absence for dental pain(6, 7)In addition routine preventive oral checkup is required for establishing and maintaining good and stable oral health status(8, 9).

Such periodic screening can lead to early diagnosis and treatment which result in reduction of disparities in the society (10, 11). In economic constrained communities, the cost of such oral and dental screening visits are comparatively high, therefore subjective measurements could be used as summary indicator of overall oral health status(12, 13).

Subjective perception provides a valid, cost-effective way to understand an individual's oral health condition and to estimate clinical status, especially in large population studies(14, 15). Moreover, studies in different country settings have identified several clinical conditions associated with self-perceived oral health, such as dental caries, number of untreated teeth, symptoms of temporo-mandibular disorders (TMD), and stomatitis(16, 17).

For better understanding of self-perceived oral health, recognizing the association between explanatory factors is critical. A recent analytical method used in the medical fields, the decision tree model technique, provides reliable, accurate explanation for medical and health issues (18) Decision trees are reliable algorithms that provide high accurate classification including chance of events and outcomes that illuminate their possible consequences (19).

To the best of our knowledge there are few studies measuring self-perceived oral health among adolescents and also estimates associated factors with such rigorous epidemiological methods.

The aim of present study is to use Chi-squared Automatic Interaction Detection Decision Tree Analysis (CHAID) to determine the correlates of poor self-perceived oral health among 13 years old adolescents in Qazvin, Iran.

## METHODS

### Design and Sampling

This cross-sectional study was conducted in Qazvin the capital of province of Qazvin, among 13-year-old adolescents whom studying at public schools in 2015. The city is located in south-west of capital Tehran (about 150 km distance) with a population of 380,000. Approximately 17500 adolescents studied in both private and public schools. To reach a sample with homogenous socio-demographic background, participants selected from public schools.

Sample size was calculated, using data from previous similar study in Iran that, the prevalence of poor self-perceived among adolescents was 24%, at a 5% level of significance, and with precision of 4%, and with adding 10% non-respondent the a minimum sample size of 482 was required for the study(15).The following formula used:

$$n = \frac{Z^2 P(1-P)}{d^2}$$

Proportional to the size of the population of adolescents in 2 educational areas, a multistage cluster sample was selected. Gender was the second stratum due to single educational system of Iran, in this way 24 schools (cluster) were included the study. Eventually (528) students were recruited in the study. Nine students refused to participate thus, the overall response rate was 98%. The final sample was consisted of 260 male and 259 female adolescents (total of 519).

### Data collection and questionnaire

A self-administered questionnaire was applied for data collection. The questionnaire had been validated and utilized in a previous study in Tehran(20). Initially To determine the reliability of the questionnaire, it was completed twice by a small number of students (n = 25), with a two-

week interval between sessions, (Cronbach's  $\alpha = 0.929$ ). the questionnaire obtained information on the demographic characteristics of adolescents, associated oral health behavior, subjective measures of oral health conditions (self-perceived oral health and halitosis), the use of water pipe or smoking, knowledge and attitude of oral health. Knowledge assessment section included questions on the definition of dental plaque, relation of sugar and tooth decay, relation of fluoride and tooth decay, effect of brushing, flossing, and use of fluoride tooth paste. Attitude of each respondent's towards oral health was explored by questions of appropriate oral practices, effect of oral health problem on school appearance, and correlation of oral health problems and general health, the importance of maintaining a healthy mouth throughout life, preference of having natural teeth or denture. The variables "knowledge" and attitude took a value of 0 - 6 depending on the answers to the six related questions.

#### **Clinical measurements**

The Simplified Oral Hygiene Index (OHI-S) was used to assess the participants' oral health (21). The OHI-S involves the examination of six tooth surfaces (the four permanent first molars, and the upper right and lower left central incisors) representing the anterior and posterior segments of the mouth. A score was only given to tooth surfaces covered with plaque and/or calculus. The scoring system was applied to index teeth covered with plaque and calculus as follows:

- A score of 0: The absence of any plaque or calculus on the tooth.
- A score of 1: Plaque or calculus on some, but not all, of the interproximal and gingival surfaces.
- A score of 2: Plaque or calculus covering more than one-third but not more than two-third of the entire clinical crown.
- A score of 3: Plaque or calculus covering more than two-third of the entire clinical crown.

To compute the relevant plaque/calculus index scores, the sum of all the scores were divided by the number of examined teeth (six in total). The

final OHI-S score for each participant was determined by calculating the sum of the plaque and calculus index scores. Subsequently, the OHI-S score was categorized as good (a score of 0.0–1.2), fair (a score of 1.3–3.0), or poor (a score of 3.1–6.0). The "poor" and "fair" score categories were subsequently merged and renamed as a "poor" category to account for wide differences in the distribution of the data. All clinical examination was performed by two qualified in calibration dentists (one male and one female) ( $\kappa = 0.87$ ).

Lighting headlamp, disposable dental mirrors and a standard World Health Organization-approved ball-ended probe were used for all oral examinations.

#### **Statistical analysis**

Descriptive statistics, Chi-squared Automatic Interaction Detection Decision Tree Analysis (CHAID), Chi-square for categorical variables, independent sample t-test for continuous variables, binary and multiple logistic regressions (Backward method) were performed for the statistical analysis. We used two multivariate logistic regression models to estimate the factors related to the outcome variables "poor self-perceived oral health with odds ratios. Chi-square automatic interaction detection analysis was carried out to identify potential factors and determine their relationship with poor perception of oral health. Chi-squared Automatic Interaction Detection Decision Analysis is a diagnostic tool to present chances of the occurrence of outcomes using multiple Bonferroni tests. The overall accuracy of prediction of both analysis was expressed by percentage and tested by ROC curve. The area under the ROC curve (AUC) is a measure of how well a parameter can distinguish between two prediction methods of CHAID and Logistic regression. Significance was set at 0.05 for splitting of decision tree and logistic regression. SPSS version 22, for Windows (SPSS Inc., Chicago, IL, USA) used for all analysis.

The authors declare that they have no conflict of interest. The study participants were asked to

provide written consent form. Adolescents were aware that they could withdraw from the study at any time. The study was approved by the Ethics Committee of Tehran University of Medical Sciences, Tehran, Iran (Number IR.tums.REC.1394.988).

## RESULTS

Of all participants 50.1% were boys, about 90% of the fathers were occupied and 198 of the mothers achieved university degree, more than sixty percent of participants living in their own house.

41% of adolescents expressed they didn't had their dental visits in two years. Only 23% of adolescents brush their teeth every day twice or more and 35% never used toothpaste. Among all participants about 60% stated they never consume snacks between meals. About 78% of adolescents had poor perception of their oral health. More than half of participants' clinical oral status were categorized as poor or medium. The mean score of knowledge and attitude were respectively  $(4.2 \pm 1.5)$  and  $(4.6 \pm 1.2)$ .

<b>Table 1</b> : Distribution of socio demographic factors, oral health behaviors, and mean score of knowledge and attitude among 13 years adolescents of Qazvin (N=521), 2016			
<i>variable</i>		<b>N</b>	<b>(%)</b>
<b>Gender</b>	Boy	265	50.9
	Girl	256	49.1
<b>Father occupation</b>	With Job	471	90.9
	Without Job	47	9.1
<b>Mother occupation</b>	With Job	125	24.0
	Without Job	395	76.0
<b>Father education</b>	Illiterate and primary school	208	40.2
	Diploma	121	23.4
	University	189	36.5
<b>Mother education</b>	Illiterate and primary school	205	39.9
	Diploma	111	21.6
	University	198	38.5
<b>House ownership</b>	Free house	43	8.3
	Tenant	122	23.5
	Own house	355	68.3
<b>Dental visit</b>	Under 2 year	305	58.7
	Above 2 year	215	41.3
<b>Frequency of tooth brushing</b>	Never, sometime in week	196	37.5
	Everyday	208	39.8
	More than once a day	119	22.8
<b>Use of toothpaste</b>	Never or sometimes	179	34.6
	Most of the times	169	32.6
	Always	170	32.8
<b>Frequency of Snacking</b>	3times and more in a day	66	12.7
	Once or twice a day	154	29.7
	Never between meals	299	57.6
<b>Self-report of Malodor</b>	Never seldom	266	51.2
	Sometime	132	25.4
	Always	122	23.5
<b>Self-perceived oral health</b>	Poor	411	78.7
	Good	111	21.3
<b>OHI</b>	Poor	12	2.4
	Medium	271	54.4
	Good	215	43.2
<b>Knowledge*</b>	4.2(1.5)		
<b>Attitude*</b>	4.6( 1.2)		
<b>* Mean (SD)</b>			

**Table 2** denotes the univariate analysis of poor self-perceived oral health with associated factors among 13 years old adolescents of Qazvin. It has

been revealed that 26% of the adolescents who had poor perception of their oral health also reported low educational attainment of their

fathers ( $p = 0.03$ ). Regarding oral health characteristics, the last visit of individuals to the dentist over two years, frequency of tooth brushing and self-report of malodor were significantly different among adolescents with poor and good perception of oral health.

Table 3 presents the univariate analysis of means knowledge and attitude scores and their

association with self-perceived oral health among participating adolescents in Qazvin. The mean knowledge score of adolescent who classified their oral health as poor was ( $3.7 \pm 1.6$ ) which was significantly different from other counterparts ( $p < 0.001$ ).

**Table 2:** Univariate analysis of influencing factors of self-perceived oral health among 13 years old of adolescents of Qazvin, IRAN, 2016.

		POOR	GOOD	$\chi^2$	P
variable		n (%)	n (%)		
<b>Gender</b>	Boy	66(25.0)	198(75.0)	5.3	<b>0.02</b>
	Girl	43(16.8)	213(83.2)		
<b>Father occupation</b>	With Job	94(20.0 )	376(80.0)	1.5	0.21
	Without Job	13(27.7)	34(72.3)		
<b>Mother occupation</b>	With Job	20(16.0)	105(84.0)	2.3	0.12
	Without Job	88(22.3)	306(77.7)		
<b>Father education</b>	Illiterate and primary school	55(26.6)	152(73.4)	7.12	<b>0.03</b>
	Diploma	23(19.0)	98(81.0)		
	University	30(15.9)	159(84.1)		
<b>Mother education</b>	Illiterate and primary school	49( 24.0)	155( 76.0)	2.9	0.23
	Diploma	22( 19.8)	89( 80.2)		
	University	34(17.2)	164( 82.8)		
<b>House ownership</b>	Free house	9( 20.9)	34( 79.1)	0.04	0.9
	Tenant	26(21.5)	95(78.5)		
	Own house	73( 20.6 )	282( 79.4)		
<b>Dental visit</b>	Under 2 year	48( 15.8 )	256( 84.2)	12.01	<b>0.001</b>
	Above 2 year	61( 28.4 )	154( 71.6)		
<b>Frequency of tooth brushing</b>	Never, sometime in week	63( 32.1)	133( 67.9)	22.02	<b>&lt;0.001</b>
	Everyday	31( 15.0)	176( 85.0)		
	More than once a day	17( 14.3 )	102( 85.7)		
<b>Use of toothpaste</b>	Never or sometimes	46(25.7)	133(74.3)	5.62	0.06
	Most of the times	36(21.3)	133(78.7)		
	Always	26(15.4)	143(84.6)		
<b>Frequency of Snacking</b>	3times and more in a day	20(30.3)	46(69.7)	5.57	0.06
	Once or twice a day	25(16.2)	129(83.8)		
	Never between meals	63(21.1)	235(78.9)		
<b>Self-report of Malodor</b>	Never seldom	36(13.5)	230(86.5)	18.49	<b>&lt;0.001</b>
	Sometime	36(27.3)	96(72.7)		
	Always	37(30.3)	85(69.7)		
<b>OHI</b>	Poor	38(17.7)	177(82.3)	4.76	0.09
	Medium	60(22.1)	211(77.9)		
	Good	5(41.7)	7(58.3)		

**Table 3 :** The univariate analysis of mean knowledge and attitude scores and their association with self-perceived oral health among participating adolescents of Qazvin, IRAN, 2016.

	Self-perceived oral health	N	Mean (SD)	P
<b>Knowledge</b>	Poor	104	3.7(1.6)	<b>&lt;0.001</b>
	Good	397	4.4(1.4)	
<b>Attitude</b>	Poor	108	4.5(1.35)	0.16
	Good	405	4.74(1.2)	

**Table 4** demonstrates the results from multivariate logistic regression analysis of poor self-perceived oral health and associated factors among participants. Age and father’s educational level that were significantly associated with poor self-perceived oral health in the univariate model. This was not confirmed in the multivariate model after adjusting for other variables. Adolescents that had dental visit above 2 years were more likely to report poor self-perceived oral health (OR= 1.79,

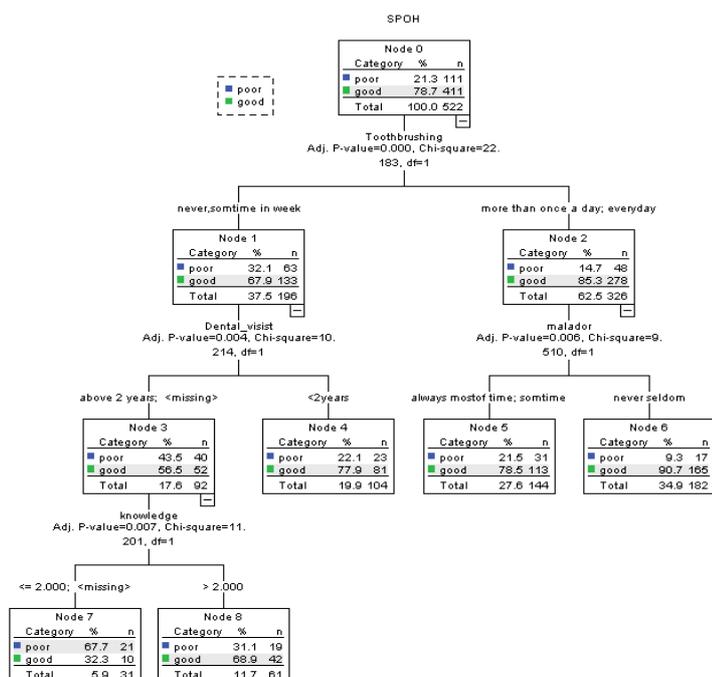
95% CI 1.10-2.92 P = 0.02). The likelihood of reporting a poor self-perceived oral health was 2 times more among participants that they always had malodor (OR=1.92, 95% CI 1.06-3.5 P = 0.03). The probability of having a poor self-perceived oral health was higher among those who reported fewer brushing their teeth (OR= 2.14, 95% CI 1.07-4.27 P = 0.03).

		P value	OR	(CI95%)
<b>Dental visit</b>	Under 2 year		1	
	Above 2 year	<b>0.02</b>	<b>1.79</b>	<b>(1.10-2.92)</b>
<b>Frequency of tooth brushing</b>	More than once a day		1	
	Everyday	<b>0.02</b>	<b>1.94</b>	<b>(1.12-3.34)</b>
	Never, sometime in week	<b>0.03</b>	<b>2.14</b>	<b>(1.07-4.27)</b>
<b>Self-report of Malodor</b>	Never seldom		1	
	Sometime	0.6	0.85	(0.46-1.58)
	Always	<b>0.03</b>	<b>1.92</b>	<b>(1.06-3.5)</b>
<b>Knowledge</b>	One score change	<b>0.02</b>	<b>1.22</b>	<b>(1.03-1.45)</b>

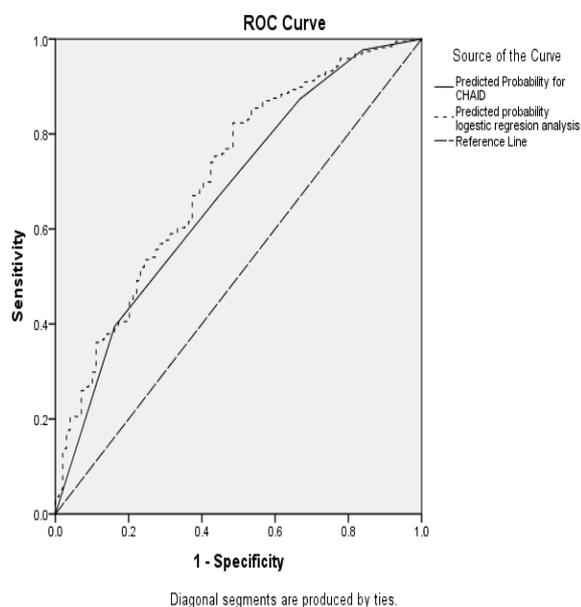
Figure 1 presents the CHAID decision tree analysis for self-perceived oral health of 13 years old adolescents in Qazvin. As shown in figure the model contained a total of 9 nodes with 5 terminal nodes. There were 4 variables affecting the adolescent’s perception of oral health in each category that the population of participants differed significantly (all  $P < 0.05$ ). The first variable was split on tooth brushing frequency , those who followed standard pattern of brushing and those whom brushed less than twice a day .The next important factor among those who brush their teeth every day more than once , was malodor ( $P = 0.006$ ). On the other arm the next important factor among the participants with less than recommended pattern of tooth brushing was dental visit ( $P = 0.004$ ). Another split was occurred in this step, participants who declared to had dental visit longer than two years were also divided to those with knowledge score above 2 and less than that (as automatic cut point) ( $P = 0.007$ ). Other variables included in the model such as gender, parent’s educational level and occupational status, use of tooth paste, oral hygiene status, frequency of snacking and attitude score did not reach the significance level. The

estimated error of risk of the model was 0.19, and the standard error was 0.017. The total prediction of the model was 80.8%.

**Figure 1:** Represents the CHAID decision tree analysis for self-perceived oral health of 13 years old adolescents of Qazvin.



**Figure 2:** The overall accuracy of prediction of both analysis in Roc curve.



**Figure 2** illustrates the Receiver Operating Characteristic (ROC) curve of prediction of influencing factors on poor perception of oral health by two analysis of CHAID and logistic regression. The index of area under the curve (AUC) is widely used for assessment of accuracy of methods and comparison of performances of different diagnostic systems in many fields including studies of human perception(22). As shown in figure 2, the area under the ROC curve of CHAID decision tree was almost the same as logistic regression model (0.67 vs. 0.70,  $p=0.001$ ), both of which were away from reference line.

## DISCUSSION

To the best of our knowledge, studies on subjective measurements of oral health among adolescents with emphasis on oral health determinants have rarely been reported in Iran. Using Chi-squared Automatic Interaction Detection Decision Tree Analysis has demonstrated a multilevel interaction model in a hierarchical order that empower us to detect more clear relation between dependent and independent variables. The present study indicates that among

participating adolescents, the frequency of tooth brushing was the most important predictor in perception of oral health. Oral malodor was the next predicting variable in the group that stated they brush twice a day and more. Furthermore, among group with infrequent tooth brushing the next predictor was dental visits. At this level of the analysis, the variable divided to groups of having dental visits above two years and less than two years. The next predictor refers to association of oral health knowledge among group with fewer dental visit. All the results were confirmed by the logistic regression analysis.

It is important to mention that the social desirability bias should be considered among the limitations of a study while using a self-administered questionnaire and the rebellious nature of adolescents. In addition, establishing causality is difficult due to the cross-sectional design of the study.

Our study detected tooth brushing frequency as the first layer of predictor in the decision tree. In other words, the most important factor in having poor perception of oral health among adolescents was infrequent tooth brushing, which is in line with previous studies in Iran (23, 24). According to multiple studies daily twice tooth brushing (mechanical removal of plaque from the teeth) has an impact on caries development and is critical in preventing gum disease and maintaining good oral health (25-27). Another study mentioned that participants with good perception of oral health are more likely brush their teeth and have regular dental visit, which is in line with our findings.(28).

Schoolchildren who rated their oral health as poor, have less frequently used dental services. This is also in agreement with our results. Routine preventive oral checkup is required for establishing and maintaining good and stable oral health status. In fact, such periodic screening can lead to early diagnosis and treatment which results in reduction of disparities in the society. Finally new oral health promoting strategies are required

for reorientation of services that facilitate dental access for adolescents (10, 11, 29, 30).

The results of this study revealed that malodor is an important factor that could lead to poor perception of oral health among adolescents. The prevalence of malodor was considerably high among adolescents and should not be neglected (31). It has been suggested that there is strong link between periodontitis and oral malodor (32, 33). Also, the perception of halitosis, specifically in adolescents, is related to psychosocial factors, such as a poor self-image and low self-esteem. An impaired self-image leads to poor subjective perceptions about oral health and halitosis. According to previous findings, a significant relationship between adolescent risk and benefit perceptions and oral health behavior and perception exists (33). Moreover, it has been suggested that oral malodor (halitosis or bad breath) might be used as a motivation tool for improving oral health in adolescents. In contrast, some studies declared the clinical halitosis and self-perceived oral malodor are not identically the same. Hence, just relying on one's perception might be an invalid method of assessment of oral malodor. However, oral malodor preventive education could role as effective intervention for oral health promotion among adolescents (34, 35). In our study, clinical measurement (simplified oral hygiene index) was not associated with self-perceived oral health neither was not in line with some previous studies (14, 15). Such results reflects low awareness of adolescents that may influence care seeking behaviors and highlight the value of oral health education program in this period of life (36, 37).

In conclusion, the new socio-dental approach is necessary to plan for assessing oral health needs and also overcome the inadequacies of the sole use of clinical evaluation of oral health needs. Besides, we believe that it is essential to combine the clinical evaluation measures with subjective measurements of the individuals' perceptions. Accordingly, effective oral health care and

appropriate oral health education lead to ideal oral health status among adolescents.

## CONCLUSION

The most recognizable finding that emerged from this study is that adolescents' perception of oral health is formed by a combination of variables from different behavioral practices. Among adolescents' poor self-perceived oral health and tooth brushing frequency, oral malodor, dental visit, and oral health knowledge were correlates in a hierarchical structure. In designing and conducting effective oral health promotion programs for adolescents, consideration of such subjective measurements is essential.

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## REFERENCES

1. Petersen PE. The World Oral Health Report 2003: continuous improvement of oral health in the 21st century—the approach of the WHO Global Oral Health Programme. *Community Dentistry and oral epidemiology*. 2003;31(s1):3-24.
2. Petersen PE. World Health Organization global policy for improvement of oral health-World Health Assembly 2007.

- International dental journal. 2008;58(3):115-21.
3. Edelstein BL, Chinn CH. Update on disparities in oral health and access to dental care for America's children. *Academic pediatrics*. 2009;9(6):415-9.
  4. Petersen PE, Bourgeois D, Ogawa H, Estupinan-Day S, Ndiaye C. The global burden of oral diseases and risks to oral health. *Bulletin of the World Health Organization*. 2005;83(9):661-9.
  5. Diclemente RJ, Hansen WB, Ponton LE. *Handbook of adolescent health risk behavior*: Springer Science & Business Media; 2013.
  6. Jackson SL, Vann WF, Jr., Kotch JB, Pahel BT, Lee JY. Impact of poor oral health on children's school attendance and performance. *Am J Public Health*. 2011;101(10):1900-6.
  7. Piovesan C, Antunes JL, Mendes FM, Guedes RS, Ardenghi TM. Influence of children's oral health-related quality of life on school performance and school absenteeism. *J Public Health Dent*. 2012;72(2):156-63.
  8. Carballido Fernandez M, Povedano MP, Gonzalez-Nieto VS, Marquez-Calderon S. [Screening for health problems in school-aged children and adolescents: a review of clinical practice guidelines]. *Gac Sanit*. 2011;25(1):87-8.
  9. Okunseri C, Gonzalez C, Hodgson B. Children's Oral Health Assessment, Prevention, and Treatment. *Pediatr Clin North Am*. 2015;62(5):1215-26.
  10. Dye BA, Li X, Thornton-Evans G. Oral health disparities as determined by selected healthy people 2020 oral health objectives for the United States, 2009-2010. *NCHS Data Brief*. 2012(104):1-8.
  11. Mouradian WE, Wehr E, Crall JJ. Disparities in children's oral health and access to dental care. *Jama*. 2000;284(20):2625-31.
  12. Locker D. Applications of self-reported assessments of oral health outcomes. *J Dent Educ*. 1996;60(6):494-500.
  13. Locker D, Maggiri J, Quinonez C. Income, dental insurance coverage, and financial barriers to dental care among Canadian adults. *J Public Health Dent*. 2011;71(4):327-34.
  14. Blizniuk A, Ueno M, Zaitsev T, Kawaguchi Y. Association between self-reported and clinical oral health status in Belarusian adults. *J Investig Clin Dent*. 2016.
  15. Yazdani R, Vehkalahti MM, Nouri M, Murtomaa H. Validity of self-assessment of oral health among 15-year-olds in Tehran, Iran. *Oral Health Prev Dent*. 2008;6(4):263-9.
  16. Kojima A, Ekuni D, Mizutani S, Furuta M, Irie K, Azuma T, et al. Relationships between self-rated oral health, subjective symptoms, oral health behavior and clinical conditions in Japanese university students: a cross-sectional survey at Okayama University. *BMC Oral Health*. 2013;13:62.
  17. Pattussi MP, Peres KG, Boing AF, Peres MA, da Costa JS. Self-rated oral health and associated factors in Brazilian elders. *Community Dent Oral Epidemiol*. 2010;38(4):348-59.
  18. Podgorelec V, Kokol P, Stiglic B, Rozman I. Decision trees: an overview and their use in medicine. *J Med Syst*. 2002;26(5):445-63.
  19. Babic SH, Kokol P, Podgorelec V, Zorman M, Sprogar M, Stiglic MM. The art of building decision trees. *J Med Syst*. 2000;24(1):43-52.
  20. Yazdani R, Vehkalahti MM, Nouri M, Murtomaa H. School-based education to improve oral cleanliness and gingival health in adolescents in Tehran, Iran. *International Journal of Paediatric Dentistry*. 2009;19(4):274-81.
  21. Greene JC, Vermillion JR. THE SIMPLIFIED ORAL HYGIENE INDEX. *J Am Dent Assoc*. 1964;68:7-13.
  22. Bandos AI, Rockette HE, Gur D. Exact Bootstrap Variances of the Area Under ROC Curve. *Communications in Statistics - Theory and Methods*. 2007;36(13):2443-61.

23. Naghibi Sistani MM, Yazdani R, Virtanen J, Pakdaman A, Murtomaa H. Determinants of Oral Health: Does Oral Health Literacy Matter? *ISRN Dentistry*. 2013;2013:249591.
24. Yazdani R, Vehkalahti MM, Nouri M, Murtomaa H. Smoking, tooth brushing and oral cleanliness among 15-year-olds in Tehran, Iran. *Oral Health Prev Dent*. 2008;6(1):45-51.
25. Damle SG, Patil A, Jain S, Damle D, Chopal N. Effectiveness of supervised toothbrushing and oral health education in improving oral hygiene status and practices of urban and rural school children: A comparative study. *J Int Soc Prev Community Dent*. 2014;4(3):175-81.
26. Gibson S, Williams S. Dental caries in pre-school children: associations with social class, toothbrushing habit and consumption of sugars and sugar-containing foods. Further analysis of data from the National Diet and Nutrition Survey of children aged 1.5-4.5 years. *Caries Res*. 1999;33(2):101-13.
27. Polk DE, Geng M, Levy S, Koerber A, Flay BR. Frequency of daily tooth brushing: predictors of change in 9- to 11-year old US children. *Community dental health*. 2014;31(3):136-40.
28. Agostini BA, Machry RV, Teixeira CR, Piovesan C, Oliveira MD, Bresolin CR, et al. Self-perceived oral health influences tooth brushing in preschool children. *Braz Dent J*. 2014;25(3):248-52.
29. Ardenghi TM, Vargas-Ferreira F, Piovesan C, Mendes FM. Age of first dental visit and predictors for oral healthcare utilisation in preschool children. *Oral Health Prev Dent*. 2012;10(1):17-27.
30. Piovesan C, Antunes JL, Guedes RS, Ardenghi TM. Influence of self-perceived oral health and socioeconomic predictors on the utilization of dental care services by schoolchildren. *Braz Oral Res*. 2011;25(2):143-9.
31. Patil PS, Pujar P, Poornima S, Subbareddy VV. Prevalence of oral malodour and its relationship with oral parameters in Indian children aged 7-15 years. *Eur Arch Paediatr Dent*. 2014;15(4):251-8.
32. Morita M, Wang HL. Association between oral malodor and adult periodontitis: a review. *J Clin Periodontol*. 2001;28(9):813-9.
33. Roditis M, Delucchi K, Cash D, Halpern-Felsher B. Adolescents' Perceptions of Health Risks, Social Risks, and Benefits Differ Across Tobacco Products. *J Adolesc Health*. 2016;58(5):558-66.
34. Pham TA, Ueno M, Shinada K, Kawaguchi Y. Comparison between self-perceived and clinical oral malodor. *Oral Surg Oral Med Oral Pathol Oral Radiol*. 2012;113(1):70-80.
35. Yokoyama S, Ohnuki M, Shinada K, Ueno M, Wright FA, Kawaguchi Y. Oral malodor and related factors in Japanese senior high school students. *J Sch Health*. 2010;80(7):346-52.
36. Biesbrock AR, Walters PA, Bartizek RD. Initial impact of a national dental education program on the oral health and dental knowledge of children. *J Contemp Dent Pract*. 2003;4(2):1-10.
37. Jessri M, Jessri M, Rashidkhani B, Kimiagar SM. Oral health behaviours in relation to caries and gingivitis in primary-school children in Tehran, 2008. *East Mediterr Health J*. 2013;19(6):527-34.