Iran J Public Health, Vol. 45, No.3, Mar 2016, pp.353-361

Original Article

Effect of Nutritional Habits on Dental Caries in Permanent Dentition among Schoolchildren Aged 10-12 Years: A Zero-Inflated Generalized Poisson Regression Model Approach

Afshin ALMASI [1], ****Abbas RAHIMIFOROUSHANI*** [2], ***Mohammad Reza ESHRAGHIAN*** [2], ***Kazem MOHAMMAD*** [2], ***Yahya PASDAR*** [3], ***Mohammad Javad TARRAHI*** [4], ***Abbas MOGHIMBEIGI*** [5], ***Touraj AHMADI JOUYBARI*** [6]

1. *Dept. of Biostatistics and Epidemiology, School of Public Health, Kermanshah University of Medical Sciences, Kermanshah, Iran*
2. *Dept. of Epidemiology and Biostatistics, School of Public Health, Tehran University of Medical Sciences (TUMS), Tehran, Iran*
3. *Dept. of Nutritional Sciences, Kermanshah University of Medical Sciences, Kermanshah, Iran*
4. *Dept. of Epidemiology and Biostatistics, School of Public Health, Lorestan University of Medical Sciences, Khorramabad, Iran*
5. *Modeling of Non-Communicable Disease Research Center, Dept. of Biostatistics and Epidemiology, School of Public Health, Hamadan University of Medical Sciences, Hamadan, Iran*
6. *Substance Abuse Prevention Research Center, Kermanshah University of Medical Sciences, Kermanshah, Iran*

***Corresponding Author:** Email: rahimifo@tums.ac.ir

(Received 11 Apr 2015; accepted 15 Sep 2015)

Abstract

Background: The aim of this study was to assess the associations between nutrition and dental caries in permanent dentition among schoolchildren.

Methods: A cross-sectional survey was undertaken on 698 schoolchildren aged 10 to 12 yr from a random sample of primary schools in Kermanshah, western Iran, in 2014. The study was based on the data obtained from the questionnaire containing information on nutritional habits and the outcome of decayed/missing/filled teeth (DMFT) index. The association between predictors and dental caries was modeled using the Zero Inflated Generalized Poisson (ZIGP) regression model.

Results: Fourteen percent of the children were caries free. The model was shown that in female children, the odds of being in a caries susceptible sub-group was 1.23(95% CI: 1.08-1.51) times more likely than boys (P=0.041). Additionally, mean caries count in children who consumed the fizzy soft beverages and sweet biscuits more than once daily was 1.41(95% CI: 1.19-1.63) and 1.27 (95% CI: 1.18-1.37) times more than children that were in category of less than 3 times a week or never, respectively.

Conclusions: Girls were at a higher risk of caries than boys were. Since our study showed that nutritional status may have significant effect on caries in permanent teeth, we recommend that health promotion activities in school should be emphasized on healthful eating practices; especially limiting beverages containing sugar to only occasionally between meals.

Keywords: Nutritional habits, Dental caries, Zero inflated generalized poisson regression model, Schoolchildren

Introduction

Dental caries is considered a major public health problem and oral health can play an important role in nutritional intake and general status of health (1). Some diseases like dental caries, asthma, diabetes,

and obesity are very common among children. Dental caries are the most common disease and up to eight times more prevalent than asthma ranked the second among all the common diseases (2). The consumption of some foods, like sweets and ice cream which have highly fermentable carbohydrates may lead to an increased risk of dental caries (3, 4), nevertheless, some other studies have not confirmed this relationship (5, 6).

According WHO, the unhealthy dietary messages to children must be limited and prevented because the advertisements aimed to promote the consumption of sugary foods and beverages play an important role in the increased level of sugar intake in developing countries (7). Radio and/or television usually broadcast some advertisements promoting unhealthy dietary habits and under the influence of such advertisements people may use an increased level of unhealthy ingredients and food in their children die; for instance, they may use more sweets for feeding the children, and even they may use sweets as rewards. Additionally, people may use more sugar while preparing foods and hence they spend more money on sweets (7-9). Moreover, carious lesions are more prevalent in children of school age because they usually do not have proper dietary habits and they do not practice oral hygiene effectively and regularly (10). In addition, pain, dental abscess, and severe local and systemic infections may occur because of tooth decays which are not treated (11). Furthermore, dental caries are among the chronic illnesses which can prevent children to attend schools, hence the children may have a poor school performance because of this group of diseases (12, 13). Children with poor oral health, compared with their counterparts, are about three times more prone to miss school when they are suffering from dental pain (14). Furthermore, caries have been experienced by about 60-90% of children of school age all around the world, and Asian and Latin American countries have reported higher prevalence rates (15).

The prevalence of caries is rising in Iran which is similar to the trend observed in other developing countries (4). During the last 10 years, several studies have been conducted on primary schoolchildren in Iran where the prevalence of caries is about 35–85% in children (16-19). In fact, both obesity and dental caries are under the influence of several factors and they may affect the health and psychosocial development of children (2, 20, 21). Because of the effects of common, modifiable, influences such as diet and lifestyle (22), the relationship between these items have not been clearly defined yet (23, 24). Developed countries, all around the world, have reported a decline in the prevalence of caries in the past 20 yr, however, there are still many debates on the role of diet and nutrition in this decline and it has remained controversial (24). Researchers have not reported any direct relationship between the decrease in caries and an increase in nutritional status (25-27). Nowadays, many studies in different countries are aiming to evaluate dental caries indices and influencing factors.

The aim of this study was to collect updated data on caries-inducing and caries-preventing dietary habits; it also aimed to evaluate the association between foods and dental caries in schoolchildren living in suburb of Kermanshah, a city in the west of Iran, in 2014.

Materials and Methods

This cross sectional study was conducted using the cluster random sampling procedure. Six hundred ninety eight children were selected from 16 public schools in the suburb of Kermanshah, Iran, from Nov 2013 to Feb 2014. Eight schools were selected from thirty-two schools for girls and eight schools were selected from thirty-seven schools for boys. As the inclusion and exclusion criteria, only children fulfilling the following conditions were included in this study: Age between 10 to 12 yr and no history of congenital and genetic problems.

This study was approved by Kermanshah University of Medical Sciences Ethics Committees (No. 90061) and all subjects' parents gave their informed consent for participation.

Outcome Measures: Dental Caries

The amount of decayed, missing, and filled surfaces of the permanent teeth is indicated by the

DMFT index: 'D' stands for decayed tooth; 'M' denotes missing tooth due to decay, and 'F' represents filled tooth. Each patient underwent a dental caries assessment for the DMFT index according to the WHO recommendation form carried out by two trained and calibrated examiners (student of dentistry) using disposable dental mirrors, intra-oral LED lights, and ball-ended WHO CPI probes (28).

Determinants of Children's Oral Health

It is generally a challenging task to collect data from young children about their dietary habits (as the exposure variable), because the 12-yr-old children have a limited cognitive ability to recall and record snacks and beverage intake and they also have a limited knowledge of food and food preparation (29). However, children older than eight years of age, with increasing their age have a rapid increase in their ability to report food intake (30). The dietary habits of the children were measured using a Food Frequency Questionnaires (FFQ) focused on a general pattern. Using the questionnaire, each child was interviewed individually and asked 'How often do you consume [each item]?' A part of this questionnaire consisted of 13 dental caries-inducing or caries-preventing foods, in which the 'frequency of intake' of each item was scored on a four items 'Likert' scale as follows: more than once daily (4 points); once daily (3 points); three or four times a week (2 points); less than three times a week or never (1 points) (31, 32).

Several confounding variables were measured. Weight and height, as anthropometric features, were measured. Height was measured to the nearest 0.1 cm by a stadiometer. Weight was measured to the nearest 0.1 kg using a digital scale while the child was wearing minimum clothing. Each school children's BMI (Body Mass Index), which is widely used as a surrogate measure for obesity, was calculated as weight in kilograms divided by the square of the height in meters (kg/m^2). Standardized percentile curves of BMI in Iran were used. Based on these curves underweight condition is defined as under the 5th percentile curve, normal as between the 5th and 85th percentile, at risk of being overweight as higher than the 85th and lower than the 95th percentile, and overweight as higher or equal to the 95th percentile (33).

Reliability and validity

To evaluate and control the likely bias of the examiners in dental examinations, two trained examiners and 24 school children from four schools were randomly selected. Examinations were carried out on all the 24 subjects by each of the examiners. The subjects were reexamined after two weeks by the same examiner. Wilcoxon signed rank test showed no statistically significant difference between the results of the two examinations in terms of the scores of FFQ, dental caries, weight, and height. Besides, using Intraclass Correlation Coefficient (ICC) Intra-examiner reproducibility was assessed for dental caries scores, dietary habits (measured by FFQ), weight and height was the results were satisfactory (0.76, 0.69, 0.97, 0.96 respectively). In addition, to assure the validity of the examiners findings about DMFT, a dentist conducted dental examinations on the same 24 school children. Then, the results were compared with those reported by school nurses (ICC= 0.98).

Statistical analysis

Since the outcome variable, DMFT, is a count variable; which may have zero values for many subjects, thus the association between predictors and dental caries was modeled by using the Zero Inflated Generalized Poisson (ZIGP) regression model to account for highly frequented zeroes. In this two-part model (i.e. ZIGP model), probability of being at risk of caries (susceptible subgroup) and mean caries count in susceptible subgroup can be modeled simultaneously.

In univariate analysis, each factor that was significant at the level of $P \leq 0.2$ was candidate to enter into multiple zero-inflated generalized Poisson regression. This late model shows the effect of each factor adjusted for others. The final model contained only factors that were significant at the level of $P \leq 0.05$. The adjusted effect of each caries risk factors in having a higher mean caries count (in susceptible subgroup), and odds ratios of being in susceptible subgroup along with its 95% confidence interval were estimated by the two parts of the model. Also, some interactions between dietary

habits and confounder were studied. Among 706 questionnaires, 698 cases were included in the analysis.

Data were analyzed by programming in R 3.0.2 software downloaded from *cran.r-project.org*.

Results

Among the 698 schoolchildren in this study, 51.6% were girl. Body Mass Index calculations showed the representative prevalence as follows: underweight school children (16.7%), normal (65.3%), those at risk of becoming overweight (13.6%) and those overweight (4.4%). 14% of the children were caries free.

Univariate analysis

Findings of univariate analysis are presented in Table 1. The relationship between gender and DMFT was significant (P=0.027), i.e. mean caries count of girls were 1.11 times higher than boys. Girls were 1.18 times more susceptible to caries than boys. In addition, the consumption of following food materials showed as significant predictors (P≤0.2) of dental caries: sweet biscuits as snack, ice cream, apple, canned fruits or jams, fizzy soft beverages.

Multivariable analysis

Dispersion parameter was estimated 0.12 (P=0.027), thus generalized Poisson was proper than Poisson. In addition, according to Likelihood Ratio (LR) test, ZIGP model was proper than GP model (P=0.014). The results of fitting multiple ZIGP regression showed that consumption of sweet biscuits as snack and fizzy soft beverages related to both of increasing in mean caries count and susceptibility of caries in children. This final model shows the effect of two factors adjusted for gender. Other factors, not presented in that table such as interaction effects, were not significant (P>0.05). As has been shown in Table 2, mean caries count in girls was 1.22 times more than boys. Mean caries count in children who consumed sweet biscuits more than once daily was 1.16 (95% CI: 1.05-1.25) and once daily was 1.27 (95% CI: 1.18-1.37) times more than those that were in category of less than 3 times a week or never.

Additionally, mean caries count in children who were in category with consumption of fizzy soft beverages more than once daily and once daily was 1.41(95% CI: 1.19-1.63) and 1.63 (95% CI: 1.49-1.78) times more than children that were in category of less than 3 times a week or never respectively. Finally, in girls the odds of being in a caries susceptible subgroup was 1.23 (95% CI: 1.08-1.51) times more likely than boys (P=0.041). In addition, the odds of being in caries susceptible subgroup of children which consumed sweet biscuits more than once daily was 1.51 (95% CI: 1.05-1.25) times more likely than those children that had less than 3 times a week or never (P=0. 046). The odds of being in susceptible to caries subgroup of children which consumed fizzy soft beverages more than once daily and once daily was respectively, 1.35 (95% CI: 1.06-1.75, P=0.042) and 1.39 (95% CI: 1.17-1.55, P=0.042) times more likely than those children that had less than 3 times a week or never .

Discussion

This cross-sectional study demonstrated a positive relationship between some nutritional habits and dental caries among the schoolchildren aged 10-12 yr old. In the present study, gender was an effective factor influencing caries severity. Considering the odds of being susceptible to caries, the mean number of dental caries in girls was higher than that in boys. This finding is in line with results of the majority of other studies in Iran and other countries (34-39). This finding might be justified by considering the fact that girls' experience permanent dentition eruption two to 10 months earlier than boys (27, 40, 41). Therefore, girls are in need of more dental care services.

Furthermore, children who consumed soft drinks more than once daily or once daily were more likely at risk of dental caries. These results were in agreement with past studies which have reported associations between soft drinks and dental caries (42-44). Consumption of high carbonated soft drink in the US seemed to be more common among children aged 6-10 years old (45).

Table 1: Estimated mean caries count ratios and odds ratios from zero-inflated Generalized Poisson regression Models in 10- 12 yr-old schoolchildren

Variables†	Generalized Poisson part			Zero-inflation part	
	Ratio of means§	95% CI for the ratio	*P*-value of model	OR (susceptible to caries)	95% CI for OR
Gender			0.027		
Boy(ref)	1	-		1	-
Girl	1.24	1.05-1.46		1.15	1.04-1.27
BMI			0.24		
Normal (ref)	1	-		1	-
Underweight	0.99	0.88-1.12		1.07	0.39-2.88
At risk overweight	0.86	0.74- .99		0.83	0.24-2.85
Overweight	0.94	0.75- 1.2		0.65	0.2-2.18
Bread			0.55		
1(ref)	1	-		1	-
2	1.02	0.88-1.18		0.86	0.25-2.91
3	0.95	0.72-1.032		0.66	0.21-2.02
4	0.95	0.74-1.23		1.02	0.28-3.71
Sweet biscuits			0.041		
1(ref)	1	-		1	-
2	1.006	0.89-1.12		1.05	0.57-3.55
3	1.46	1.15-1.82		1.25	1.09-1.44
4	1.51	1.23-1.89		1.47	1.16-1.87
Confectionery cookies and cakes			0.79		
1(ref)	1	-		1	-
2	0.92	0.79-1.07		0.48	0.2-1.12
3	0.98	0.75-1.27		1.75	0.96-3.19
4	0.96	0.69-1.32		1.43	0.82-2.48
Sweetenedhotmilk			0.65		
1(ref)	1	-		1	-
2	0.93	0.83-1.05		0.68	0.28-1.7
3	0.99	0.88-1.12		0.92	0.33-2.5
4	1.01	0.85-1.19		1.07	0.24-4.6
Soft drink			0.44		
1(ref)	1	-		1	-
2	1.02	0.93-1.16		1.36	0.36-5.3
3	0.94	0.8-1.1		1.46	0.14-4.5
4	0.82	0.59-1.14		1.58	0.6-4.3
Ice cream			0.19		
1(ref)	1	-		1	-
2	0.97	0.86-1.08		0.93	0.4-2.18
3	0.85	0.74-0.99		1.08	0.33-3.4
4	1.04	0.79-1.38		2.05	0.91-3.2
Cheese as snack			0.7		
1(ref)	1	-		1	-
2	0.98	0.85-1.14		0.5	0.17-1.4
3	1.04	0.93-1.15		1.58	0.94-2.6
4	1.08	0.9-1.3		1.6	0.89-2.9
Apple			0.18		
1(ref)	1	-		1	-
2	0.89	0.79-0.99		1.78	0.71-4.48
3	0.95	0.82-1.1		0.81	0.58-1.12
4	0.89	0.69-1.16		0.76	0.49-1.18
Dry fruit			0.46		
1(ref)	1	-		1	-
2	0.93	0.82-1.05		0.71	0.31-1.6
3	1.04	0.85-1.27		1.6	0.84-3.1
4	0.89	0.73-1.09		1.33	0.62-2.85
Cannedfruits/jams			0.04		
1(ref)	1	-		1	-
2	1.05	0.92-1.21		1.01	0.34-3.1
3	0.97	0.72-1.31		1.2	0.8-1.78
4	0.71	0.56-0.91		1.28	0.86-1.94
Chocolates			0.302		
1(ref)	1	-		1	-
2	1.01	0.88-1.14		1.03	0.83-1.25
3	0.77	0.55-1.07		1.11	0.65-1.87
4	0.9	0.75-1.08		1.32	0.74-2.3
Nuts(walnut and almond)			0.336		
1(ref)	1	-		1	-
2	1.01	0.89-1.15		0.86	0.34-2.1
3	0.85	0.71-1.02		1.2	0.24-5.9
4	0.98	0.72-1.34		2	0.9-4.4
Fizzysoftbeverages			0.045		
1(ref)	1	-		1	-
2	0.92	0.8-1.07		1.21	1.03-1.4
3	1.31	1.05-1.58		2.03	2.05-3.9
4	1.86	1.44-1.88		2.24	1.76-2.8

†-Scores were used as following: 4- more than once daily ; 3- once daily ; 2- 3 or 4 times a week ; 1- less than 3 times a week or never/ §- i.e. mean caries count

Table 2: Adjusted effects of dietary habits according to ZIGP regression model

	Generalized Poisson part			Zero-inflation part		
Variables†	**Ratio of means**	**95% CI for the ratio**	***P*-value**	**OR (susceptible to caries)**	**95% CI for OR**	***P*-value**
Gender						
Boy(ref)	1	-	-	1	-	-
Girl	1.22	1.03-1.42	0.035*	1.23	1.08-1.51	0.041*
Sweet biscuits						
1(ref)	1	-	-	1	-	-
2	0.99	0.88-1.11	0.93	1.44	0.54-3.8	0.57
3	1.16	1.05-1.25	0.042*	1.77	0.8-2.9	0.43
4	1.27	1.18-1.37	0.031*	1.56	1.13-1.98	0.046*
Fizzy soft beverages						
1(ref)	1	-	-	1	-	-
2	0.96	0.8-1.13	0.35	1.29	0.83-1.93	0.36
3	1.41	1.19-1.63	0.039*	1.35	1.06-1.75	0.042*
4	1.63	1.49-1.78	0.028*	1.39	1.17-1.55	0.028*

* *P*-value≤ 0.05

†-Scores were used as following: 4- more than once daily ; 3- once daily ; 2- 3 or 4 times a week ; 1- less than 3 times a week or never

However, the results of previous research are not convincing (46). Consumption of drinks containing sugars leads to a drop in the PH of dental plaque. Saliva flow and salivary components can neutralize this acid and usually within 20-30 minutes the pH of plaque reaches its resting level (47). However, the consumption of such drinks becomes dangerous when they are used frequently for a long time (30). In addition, sweet biscuits were identified as a factor increasing on the incidence of dental caries. It is very important to consider the consumption of this type of snacks, because they are widely available to all children in schools and can remain on the surface of tooth for hours in school time. Generally, this type of snack does not have much nutritional value and even can reduce food intake at the mealtime. According to the results of a longitudinal study on primary dentition, higher intake of food sugar and starch at mealtime was associated with a decreased risk of caries, however when people are more exposed to sugar from snacks, they are more at risk of caries (48). Moreover, nowadays people use fluoride products more than ever which shows that people underestimate the impact of dietary habits on dental caries. On the other hand, the recurrent use of acidogenic and erosive drinks can enhance the risk of caries (47). Because of the increased rate of acidic, sugar-rich soft drinks intake, children are more vulnerable to the risk of acid demineralization which can finally cause caries and dental erosion (30).

In this study, no significant relationship was found between BMI, as a measure of current general nutritional status, and dental caries. There is not enough evidence indicating the association between underweight/obesity and dental caries. According to some cross-sectional studies, there is a positive relationship between obesity and dental caries (19, 48, 49), however some other studies have reported a weak or no association between BMI and dental caries (23, 50). According to a cross-sectional study on schoolchildren, being overweight was negatively correlated with the DMF/dmf index (51). A direct relationship between obesity and dental caries was only reported in one out of seven studies with strong levels of evidence (52). Considering BMI as a measure of current general nutritional status, it has been shown that nutrition does not have an impact on the post-eruptive tooth stage (53, 54).

Conclusion

Taking into account the sampling method used in this study, i.e. two-stage cluster sampling, our result has a sufficient power to be generalized to the whole population. As we know, the main limita-

tion of cross-sectional studies is acknowledged in inferring results from simultaneous measurement of risk indicators and disease, which limits the chance to identify causative factors. Since caries is a progressive disease, past dietary habits, adopted several years ago, may have resulted in the present disease; such an element cannot be captured in a cross-sectional study. Consequently, when feasible, it is better to investigate the association between diet and dental caries via longitudinal study designs examining the changes in dietary habits and their impacts on the development of caries.

Carbonated soft drinks and sugar-sweetened snacks such as biscuits, which are usually available at school, are not only nutritious, but also can lead to decreased food intake at the main mealtime and thus they are associated with caries. As a result, health promotion activities in school should emphasize healthy eating practices, for instance the consumption of soft drinks containing sugar must be reduced (so they would be used only occasionally between meals), and an appropriate amount of food containing sugar and starch must be consumed only at the main mealtime. Furthermore, girls need more dental care than boys.

Ethical considerations

Ethical issues (including plagiarism, obtaining informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

Acknowledgments

This paper is a part of a research towards a PhD degree at School of Public Health, Tehran University of Medical Sciences (TUMS) and was financially supported by this university. We would like to appreciate their support. The authors would like to express their sincere appreciation to the staffs working in school of public health in Kermanshah University of Medical Sciences (KUMS), especially for their helps in data collection. The authors declare no conflict of interests.

References

1. Benzian H, Monse B, Heinrich-Weltzien R, Hobdell M, Mulder J, van Palenstein Helderman W (2011). Untreated severe dental decay: a neglected determinant of low Body Mass Index in 12-year-old Filipino children. *BMC Public Health*, 11(1): 558.
2. Health UDo, Services H (2008). Oral health in America: A report of the Surgeon General, Rockville, MD: US Department of Health and Human Services, National Institute of Dental and Craniofacial Research, National Institutes of Health; 2000. *NIH Publication no 00-4713*.
3. Johansson I, Lif Holgerson P, Kressin N, Nunn M, Tanner A (2010). Snacking habits and caries in young children. *CARIES RES*,44(5): 421-30.
4. Vadiakas G (2008). Case definition, aetiology and risk assessment of early childhood caries (ECC): a revisited review. *Eur Arch Paediatr Dent,* 9(3): 114-25.
5. Kiwanuka S, Åstrøm A, Trovik T (2004). Dental caries experience and its relationship to social and behavioural factors among 3–5-year-old children in Uganda. *Int J Paediatr Dent*,14(5): 336-46.
6. Matee M, Hof M, Maselle S, Mikx F, Helderman WvP (1994). Nursing caries, linear hypoplasia, and nursing and weaning habits in Tanzanian infants. *Community Dent Oral Epidemiol*,22(5PT1): 289-93.
7. Hawkes C (2006). Uneven dietary development: linking the policies and processes of globalization with the nutrition transition, obesity and diet-related chronic diseases. *Global Health*, 2(1): 4.
8. Kumarihamy SL, Subasinghe LD, Jayasekara P, Kularatna SM, Palipana PD (2011). The prevalence of Early Childhood Caries in 1-2 yrs olds in a semi-urban area of Sri Lanka. *BMC Res Notes*,4(1): 336.
9. Wamani H, Åstrøm AN, Peterson S, Tylleskär T, Tumwine JK (2005). Infant and young child feeding in western Uganda: knowledge, practices and socio-economic correlates. *J Trop Pediatr*, 51(6): 356-61.
10. Kemparaj U, Chavan S, Shetty NL (2014). Caries Risk Assessment Among School Children in

Davangere City Using Cariogram. *Int J Prev Med*, 5(5): 664.
11. Chu C-H, Ho P-L, Lo EC (2012). Oral health status and behaviours of preschool children in Hong Kong. *BMC Public Health*, 12(1): 767.
12. Wolfe BL (1985). The influence of health on school outcomes: a multivariate approach. *Med Care*, 23(10): 1127-38.
13. Fowler M, Johnson M, Atkinson S (1985). School achievement and absence in children with chronic health conditions. *J Pediatr*, 106(4): 683-7.
14. Jackson SL, Vann Jr WF, Kotch JB, Pahel BT, Lee JY (2011). Impact of poor oral health on children's school attendance and performance. *Am J Public Health*, 101(10): 1900.
15. Petersen PE, Bourgeois D, Ogawa H, Estupinan-Day S, Ndiaye C (2005). The global burden of oral diseases and risks to oral health. *Bull World Health Organ*, 83(9): 661-9.
16. Kazerouni K, Mohammadi N, Ansari G, Kamali Z (2005). The effects of socio-economic status on dental caries incidence in a group of primary school children, Tehran-2000. *J Dent Sch*, 22 (4): 51-9.
17. Motlagh MG, Khaniki GRJ, Adiban H (2007). Investigation of Dental Caries Prevalence among 6-12 year old Elementary School Children in Andimeshk, Iran. *J Med Sci,* 7(1): 116-20.
18. Momeni A, Mardi M, Pieper K (2005). Caries prevalence and treatment needs of 12-year-old children in the Islamic Republic of Iran. *Med Princ Pract*, 15(1): 24-8.
19. Sadeghi M, Lynch C, Arsalan A (2011). Is there a correlation between dental caries and body mass index-for-age among adolescents in Iran?. *Community Dent Health*, 28(2): 174-7.
20. Wake M, Nicholson JM, Hardy P, Smith K (2007). Preschooler obesity and parenting styles of mothers and fathers: Australian national population study. *Pediatrics*, 120(6): e1520-7.
21. Primosch RE (1982). Effect of Family Structure on the Dental Caries Experience of Children. *J Public Health Dent*, 42(2): 155-68.
22. Hooley M, Skouteris H, Boganin C, Satur J, Kilpatrick N (2012). Body mass index and dental caries in children and adolescents: a systematic review of literature published 2004 to 2011. *Syst Rev*, 1:57.
23. Gerdin EW, Angbratt M, Aronsson K, Eriksson E, Johansson I (2008). Dental caries and body mass index by socio-economic status in Swedish children. *Community Dent Oral Epidemiol*, 36(5): 459-65.
24. Reifsnider E, Mobley C, Mendez D (2004). Childhood obesity and early childhood caries in a WIC population. *J Multicult Nurs Health*, 10.2.
25. Sadeghi M, Alizadeh F (2007). Association between dental caries and body mass index-for-age among 6-11-year-old children in Isfahan in 2007. *J Dent Res Dent Clin Dent Prospects*, 1(3): 119-24.
26. Dye BA, Shenkin JD, Ogden CL, Marshall TA, Levy SM, Kanellis MJ (2004). The relationship between healthful eating practices and dental caries in children aged 2-5 years in the United States, 1988-1994. *J Am Dent Assoc*, 135(1): 55-66.
27. Sánchez-Pérez L, Irigoyen M, Zepeda M (2010). Dental caries, tooth eruption timing and obesity: a longitudinal study in a group of Mexican schoolchildren. *Acta Odontol Scand*, 68(1): 57-64.
28. Organization WH (1997). *Oral health surveys: basic methods*. World Health Organization. Geneva, Switzerland.
29. Livingstone M, Robson P (2000). Measurement of dietary intake in children. *Proc Nutr Soc*, 59(02): 279-93.
30. Nazik M, Malde M, Ahmed M, Trovik T (2013). Correlation between caries experience in Sudanese school children and dietary habits, according to a food frequency questionnaire and a modified 24-hr recall method. *Afr J Food, Agri Nutr Develo*,13(2).
31. Dean JA, Avery DR, McDonald RE (2010). *McDonald and Avery dentistry for the child and adolescent*. Elsevier Health Sciences.
32. Kristal AR, Abrams BF, Thornquist MD, Disogra L, Croyle RT, Shattuck AL, et al. (1990). Development and validation of a food use checklist for evaluation of community nutrition interventions. *Am J Public Health*, 80(11): 1318-22.
33. Hosseini M, Carpenter R, Mohammad K (1999). Body mass index reference curves for Iran. *Ann Hum Biol*, 26(6): 527-35.
34. Huew R, Waterhouse PJ, Moynihan PJ, Maguire A (2011). Prevalence and severity of dental

caries in Libyan schoolchildren. *Int Dent J,* 61(4): 217-23.
35. Gatou T, Koletsi Kounari H, Mamai-Homata E (2011). Dental caries prevalence and treatment needs of 5-to 12-year-old children in relation to area-based income and immigrant background in Greece. *Int Dent J*, 61(3): 144-51.
36. Moghimbeigi A, Eshraghian MR, Mohammad K, Mcardle B (2008). Multilevel zero-inflated negative binomial regression modeling for over-dispersed count data with extra zeros. *J Appl Stat*, 35(10): 1193-202.
37. Saied-Moallemi Z, Virtanen J, Tehranchi A, Murtomaa H (2006). Disparities in oral health of children in Tehran, Iran. *Eur Arch Paediatr Dent,* 7(4): 262-4.
38. Al-Darwish M, El Ansari W, Bener A (2014). Prevalence of dental caries among 12–14year old children in Qatar. *Saudi Dent J*, 26(3): 115-25.
39. Krzywiec E, Zalewska M, Wójcicka A, Jabłoński R, Olejnik B, Grabowska S, et al. (2012). Selected eating habits and caries occurrence in adolescents. *Przegl Epidemiol*, 66(4): 713-21.
40. Parner ET, Heidmann JM, Væth M, Poulsen S (2001). A longitudinal study of time trends in the eruption of permanent teeth in Danish children. *Arch Oral Biol*, 46(5): 425-31.
41. Wedl J, Danias S, Schmelzle R, Friedrich R (2005). Eruption times of permanent teeth in children and young adolescents in Athens (Greece). *Clin Oral Investig*, 9(2): 131-4.
42. Levy S, Warren J, Broffitt B, Hillis S, Kanellis M (2003). Fluoride, beverages and dental caries in the primary dentition. *Caries Res*, 37(3): 157-65.
43. Sohn W, Burt B, Sowers M (2006). Carbonated soft drinks and dental caries in the primary dentition. *J Dent Res*, 85(3): 262-6.
44. Stevens A, Hamel C, Singh K, Ansari MT, Myers E, Ziegler P, et al. (2014). Do sugar-sweetened beverages cause adverse health outcomes in children? A systematic review protocol. *Syst Rev*, 3(1): 96.
45. Tahmassebi J, Duggal M, Malik-Kotru G, Curzon M (2006). Soft drinks and dental health: a review of the current literature. *J Dent*, 34(1): 2-11.
46. Meurman J, Rytömaa I, Kari K, Laakso T, Murtomaa H (1987). Salivary pH and glucose after consuming various beverages, including sugar-containing drinks. *Caries Res*, 21(4): 353-9.
47. Ismail AI, Burt BA, Eklund SA (1984). The cariogenicity of soft drinks in the United States. *J Am Dent Assoc*, 109(2): 241-5.
48. Marshall S, Burrows T, Collins C (2014). Systematic review of diet quality indices and their associations with health-related outcomes in children and adolescents. *J Hum Nutr Diet*, 27(6):577-98.
49. Hayden C, Bowler JO, Chambers S, Freeman R, Humphris G, Richards D, et al. (2013). Obesity and dental caries in children: a systematic review and meta-analysis. *Community Dent Oral Epidemiol*, 41(4): 289-308.
50. Chiu S-H, DiMarco MA, Prokop JL (2013). Childhood obesity and dental caries in homeless children. *J Pediatr Health Care*, 27(4): 278-83.
51. Markovic D, Ristic-Medic D, Vucic V, Mitrovic G, Nikolic Ivosevic J, Peric T, et al. (2014). Association between being overweight and oral health in Serbian schoolchildren. *Int J Paediatr Dent*, 25(6): 409-17.
52. McDowell I (2006). *Measuring health: a guide to rating scales and questionnaires*. Oxford University Press.
53. Rugg-Gunn AJ (1993). Nutrition, diet and dental public health. *Community Dent Health*, 10 Suppl 2: 47-56.
54. Balay JL (2007). Nutrition for dental health. *Diabetes Self Manag*, 24(2): 6-8.