

A STUDY OF THE RELATIONSHIP BETWEEN DIET AND OBESITY WITH DENTAL CARIES IN CHILDREN

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ABSTRACT

One of the most common infectious diseases related to nutrition is tooth decay. In this study, the relationship between diet and obesity with tooth decay in children was investigated. This descriptive-analytical study was conducted on children. Tooth decay was determined by the DMFT index. Also, BMI (Body Mass Index) was used to evaluate obesity, and a semi-quantitative FFQ (Food Frequency Questionnaire) was utilized to evaluate food intake. The results showed that the frequency of caries index in overweight and obese children was significantly higher than in other children ($P < 0.05$). The results of the frequency of food consumption showed that all children, except for the milk and dairy group, used fruits and vegetables from other food groups. An inverse correlation was observed between tooth decay and the average consumption of milk and dairy products, fruits, and vegetables, and a significant positive correlation was observed between BMI and the frequency of consumption of sweets. In the current study, obesity, consumption of carious snacks, and reduction in consumption of vegetables, fruits, and dairy products have been proposed as risk factors for dental caries in children. Due to the importance of teeth in children's general health, it seems necessary to educate parents and children about following a balanced diet.

Key words: Children, Diet, Obesity, Dental caries.

Introduction

Dental caries is one of the most common chronic childhood diseases [1-4] and a practical health problem in developing countries [5-7]. Various factors such as genetic factors, nutritional status, obesity, dental anatomy, oral hygiene, use and absorption of fluoride, age, gender, composition and amount of saliva secretion, parental education level, and socio-economic status have been suggested in causing tooth decay [4-8]. Studies have shown that childhood nutrition is related to most diseases in adulthood [9, 10]. At the same time, research shows that diet has an effective role in the occurrence of obesity, premature loss of teeth, gum problems, and bad breath [11, 12].

Carbohydrates are a suitable substance for bacteria that cause tooth decay. Sucrose-rich foods and the frequency of food consumption cause the microbes in the mouth to break down sugary substances. For this reason, the acid caused by the bacterial fermentation of simple carbohydrates lowers the pH of saliva and provides the basis for caries. The longer the contact time of sugary substances with the oral environment, the more damage occurs. Therefore, sticky sweet substances such as raisins, dried berries, and chocolate have more destructive effects [13, 14]. This is especially important in children [5, 6].

Correct and appropriate nutrition from the beginning of life not only improves the physical growth and development of the child [9] but also has a major effect on the optimal health of the oral cavity and the general health of the child [15, 16]. Sweetening children's food makes the child's sense of taste accustomed to sugary substances, and this shows a greater interest in consuming sweet substances at an older age. Improper nutritional patterns among children and adolescents, especially sweet snacks, most of which are taken outside the home, lead to this age group being more at risk of obesity, overweight, and tooth decay [3, 4].

Obesity is one of the most common nutritional disorders associated with dental caries in children [4-6]. In some research, a positive and significant relationship between obesity and dental caries has been reported [4]. However, in some studies, an inverse relationship has been reported [8] and in some studies, no relationship has been reported [3, 5]. Considering the importance of healthy nutrition and the possible role of obesity in causing tooth decay, this study was conducted to determine the relationship between food intake and obesity with tooth decay in children.

Materials and Methods

The current study was cross-sectional and descriptive and was conducted on 79 children (47 girls and 32 boys). The

sample size was estimated based on the formula used in cross-sectional studies, taking into account the prevalence of tooth decay of 82%, maximum error of 8%, and alpha of 0.05. First, the purpose of the research was explained to the mothers of the investigated children, and if the children agreed, they were included in the plan.

Tooth decay was determined using the DMFT (Decayed, Missing, and Filled Teeth) index, which is a sign of restored and extracted decayed teeth. For this purpose, the teeth were examined by dentists based in the pediatric dental clinic using a dental unit, a probe, and a flat dental mirror. To classify the severity of tooth decay, DMFT methods of zero (no decay), 1-3 (low decay group), and DMFT ≥ 4 (high decay group) were considered.

Body mass index was used to evaluate obesity. For this purpose, the weight of children with minimal clothes and without shoes was measured with a Bascoli scale (Seca/Germany) with an accuracy of 100 grams and height with a Seca caliper with an accuracy of 0.5 cm. Body mass index (BMI) is calculated from the division of weight (kilograms) by the square of height (square meters), calculated using the percentiles of body mass index, for age and sex, set by the US Centers for Disease Control and Prevention (CDC) [17]. Due to the small number of samples in this study, children were classified into 3 groups based on BMI percentiles: children with BMI less than 5th percentile, as underweight; between 5-85th percentiles were considered as normal, and children with a percentile above 85th were considered overweight and obese. Semi-quantitative food frequency questionnaire (FFQ) to evaluate children's food intake based on the main food groups included A list of 142 food items in the groups of grains, dairy products, proteins, fruits, and vegetables, as well as other foods, including

sweets (sugar, honey, jam, biscuits, cakes, cookies, sweets, chocolate, and candies), snacks and other low-value food items (chips, pretzels, pretzels) and sweet and carbonated drinks (carbonated drinks, desserts, and industrial fruit juices) were completed by nutrition experts through face-to-face interviews with mothers. The validity and reliability of the food frequency questionnaire were done in a previous study.

Data analysis was done using SPSS version 23 statistical software. Considering the normality of the data, the χ^2 test was used to analyze the qualitative variables, and the one-way ANOVA test was used to analyze the quantitative variables related to tooth decay. Also, to determine the correlation between the DMFT index with background variables and food groups, Pearson's correlation test was used. $P < 0.05$ was considered as a significant level.

Results and Discussion

79 children (47 girls and 32 boys) aged 6 to 11 years with an average age of 9 ± 1.9 years were studied. The results showed that in all the samples, 20 children (25.3%) had normal weight, 20 children (25.3%) were underweight, and 39 children (49.4%) were overweight and obese. The average DMFT index in all samples was 3.97 ± 1.6 . 71 (89.9%) of the studied children had tooth decay. 8 (10.1%) of the children had zero DMFT (no decay), 37 (46.8%) had DMFT 1-3 (low decay), and 34 (43.1%) had DMFT 4 and above (high decay). The highest percentage of fathers were employees (57%) and had a diploma and higher education (65.8%) and the highest percentage of mothers were housewives (69.6%) and had a diploma and higher education (54.4%). The average size of the household was 5.3 ± 1.3 people.

Table 1. Frequency distribution of body mass index and severity of dental caries in the studied children.

BMI \ DMFT	0		1-3		≥ 4		Total	
	N	%	N	%	N	%	N	%
Low weight	2	25	11	29.7	7	20.6	20	25.3
Normal	3	37.5	11	29.7	6	17.6	20	25.3
Overweight/Obese	3	37.5	15	40.6	21	61.8	39	49.4
Total	8	100	37	100	34	100	79	100

As shown in **Table 1**, caries severity showed a significant relationship with body mass index ($p = 0.05$; $X^2 = 7.2$), so that 21 (8.61%) of the children who were overweight or obese had DMFT greater than or equal to 4. The average food groups consumed and their relationship with the

severity of tooth decay are summarized in **Table 2**. The results showed that the average consumption of milk and dairy products ($P = 0.02$) as well as fruits and vegetables ($p = 0.04$) had a significant relationship with the severity of tooth decay.

Table 2. The average food groups consumed and the severity of tooth decay in the studied children.

The severity of tooth decay \ Food groups	0 (Mean ± SD)	1-3 (Mean ± SD)	≥ 4 (Mean ± SD)	P
Milk and dairy products	2.3 ± 1.8	1.5 ± 1.2	0.7 ± 0.09	0.02

Fruits and vegetables	2.6 ± 1.5	2.4 ± 1.7	1.9 ± 1	0.04
Bread and cereals	5.7 ± 2.3	5.8 ± 1.9	5.6 ± 2.1	0.55
Meats, legumes, and eggs	2.3 ± 0.9	2.3 ± 1.3	2.1 ± 0.9	0.35

Tables 3 and 4 show the frequency of consumption of milk and dairy products, fruits and vegetables, and decay-causing foods (including sweets, snacks, and sweet and carbonated drinks) in the studied children. As can be seen, most children (65.8%) only used milk and dairy products ($P = 0.03$; $\chi^2 =$

15.2), fruits and vegetables ($P = 0.02$; $\chi^2 = 11.3$) 1-2 times a week, while the consumption of sweets ($P = 0.03$; $\chi^2 = 23.2$), sweet and carbonated drinks ($P = 0.06$; $\chi^2 = 19.7$), and snacks ($P = 0.055$; $\chi^2 = 32.3$), were more and equal to 5 times a week in most children.

Table 3. Frequency distribution of consumption of milk and dairy products, fruits, and vegetables in the studied children.

Food intake	Frequency of consumption		Never		1-2 times a week		3-4 times a week		≥ 5 times a week		χ^2	P
	N	%	N	%	N	%	N	%				
Milk and dairy products	10	12.7	52	65.8	9	11.4	8	10.1	15.2	0.05		
Fruits and vegetables	14	17.7	50	63.3	10	12.7	5	6.3	11.3	0.02		

Also, the results of the correlation test between tooth decay and food consumption pattern showed that there is a positive and significant correlation between tooth decay and BMI ($P = 0.001$; $r = 0.94$), and the frequency of consumption of sweets ($P = 0.02$; $r = 0.84$), as well as a significant inverse

correlation between tooth decay and the average consumption of milk and dairy products ($P = 0.016$; $r = -0.89$) and fruits and vegetables ($P = 0.01$; $r = -0.78$) but no significant correlation was observed among other cases with tooth decay.

Table 4. Distribution of the frequency of consumption of sweets, sweet and carbonated drinks, and snacks in the studied children.

Abundance of decaying food	Frequency of consumption		Never		1-2 times a week		3-4 times a week		≥ 5 times a week		χ^2	P
	N	%	N	%	N	%	N	%				
Sweets	4	5.1	4	51.1	28	35.4	43	54.4	33.2	0.03		
Sweet and carbonated drinks	14	17.7	14	17.7	29	37.8	22	27.8	19.7	0.06		
Snacks	21	26.5	6	7.6	10	12.7	42	53.2	32.3	0.055		

Several factors affect the development of tooth decay. Tooth decay is a known multi-cause disease related to nutrition [17-20]. Considering the importance of oral and dental hygiene in childhood, the role of factors affecting it is also important. Today, special attention has been paid to the relationship between eating habits and obesity with oral health status [17-19]. In this study, the relationship between tooth decay and nutritional status based on body mass index and food intake of children was investigated.

The relationship between childhood obesity and tooth decay is very complex and is related to various factors such as age, sex, race, and family income [8]. The results of studies by Narksawat *et al.* [17] in urban and rural children of Thailand and Parshnath *et al.* [8] in India indicated a negative relationship between body mass index and tooth decay. In the present study, a positive and significant correlation was obtained between body mass index and DMFT. It has been suggested that probably an inappropriate eating pattern, especially excessive consumption of foods containing

carbohydrates and sugars, exposes children to the risk of caries and being overweight at the same time [4, 5].

The results of the frequency of food consumption showed that the studied children used other main food groups, except for dairy products, fruits, and vegetables. In children with $DMFT \geq 4$, the average consumption of milk and dairy products and fruits and vegetables was significantly lower than in other children, which indicates the direct effect of the child's diet on tooth decay. The presence of mineral salts, including calcium and phosphorus, vitamins A and D, as well as protein components in milk and dairy products, play an important role in preventing tooth decay [21, 22]. Calcium strengthens bones and teeth with the help of vitamin D and phosphorus. The lack of these minerals can lead to changes in the structure of teeth and gum tissues and increase the basis for tooth decay. It should be noted that incorrect and insufficient nutrition aggravates these complications in the long term [23, 24].

Regarding the relationship between food intake and tooth decay in children, many studies with different results have been reported. In some studies [25], an inverse relationship between the consumption of milk and dairy products with the condition of the gums and tooth wear was observed. The results of these studies confirm the results of the current research. Similar to the findings of our study, Stewart *et al.* [26] also reported that the prevalence of caries in children whose main diet was vegetables is lower than in other children. Even though fruits and vegetables contain natural sugar, due to the presence of a lot of water in them, their sugar is diluted, and as a result, they have little decay power. Also, due to the presence of fiber in them when chewing, they neutralize the action of fermenting bacteria and help to clean the teeth. More secretion of saliva when eating fresh fruits and vegetables neutralizes the amount of acid caused by the fermentation of simple carbohydrates, balances the pH of the mouth, and helps to maintain and restore tooth enamel. On the other hand, the presence of vitamins, including vitamins C and A found in many fruits and vegetables, is beneficial for the health of the gums. Sugar and other fermentable carbohydrates such as candy, biscuits, and cookies are also considered one of the most important factors of caries [27, 28].

Studies have shown that repeated consumption of snacks, especially sweet foods during the day with a decrease in the pH of oral saliva is an effective factor in tooth decay. The amount of acid produced by the fermentation of food by oral bacteria depends on the amount of sugar in that material. Especially the relationship between the consumption of food containing sugary substances that have a greater adhesive power on the surface of the teeth [29].

In the present study, a significant correlation was observed between the frequency of consumption of sweets and tooth decay. Similar to the results of the present study, Eronat *et al.* [30] studied children in Turkey, and Amin *et al.* Gives Grenby's study [29] on British students also showed that almost all children consumed cakes, biscuits, and chips. In our study, 43 people (54.4%) of children used snacks such as chocolate sweets and candies more than 5 times a week, of which 21 people (48.8%) had excess underweight and obese, and the DMFT index ($DMFT \geq 4$) in this group was significantly higher than other children. The results showed that in children whose parents had secondary and higher education, the average DMFT was lower than other children. Probably, more awareness of educated parents about oral and dental problems and their attention to children's health plays an important role in dental care for children [1-4]. Therefore, the level of education of parents can also be considered as one of the influential factors in the incidence of tooth decay.

Conclusion

The results showed that the frequency of caries index in overweight and obese children was significantly higher than

in other children. The results of the frequency of food consumption showed that all children, except for the milk and dairy group, used fruits and vegetables from other food groups. An inverse correlation was observed between tooth decay and the average consumption of milk and dairy products, fruits, and vegetables, and a significant positive correlation was observed between BMI and the frequency of consumption of sweets. In the present study, obesity, consumption of carious snacks, and reduction in consumption of dairy products, fruits, and vegetables have been proposed as risk factors for dental caries in children. Considering the importance of teeth in children's general health, it seems necessary to educate parents and children about following a balanced diet.

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References

1. Özel İÇ, Erbaş Ünverdi G, Serdar Eymirli P, Yabancı Ayhan N. The relationship between dental caries, dietary intake and body composition in school-age children. *Egypt Pediatr Assoc Gaz.* 2024;72(1):14. doi:10.1186/s43054-024-00255-5
2. Esin K, Ballı-Akgöl B, Sözlü S, Kocaadam-Bozkurt B. Association between dental caries and adherence to the Mediterranean diet, dietary intake, and body mass index in children. *BMC Oral Health.* 2024;24(1):297. doi:10.1186/s12903-024-04020-3
3. Kotha SB, Terkawi SA, Mubarak SA, Saffan ADA, Kotha SL, Mallineni SK. Association between body mass index (BMI) and dental caries among 6-12-year-old school children. *Children (Basel).* 2022;9(5):608. doi:10.3390/children9050608
4. Talluri D, Panga GSK, Shaik PS, Pavani NPM, Yaddanapalli SC, Bommireddy VS, et al. Correlation of dental caries status with BMI in school children of age 3-16 years- An institutional study. *J Family Med Prim Care.* 2023;12(4):649-53. doi:10.4103/jfmpc.jfmpc_2021_21
5. Aljafari A, ElKarmi R, Nasser O, Atef AA, Hosey MT. Oral health status and practices of 6-to 7-year-old children in Amman, Jordan: A cross-sectional study. *BMC Oral Health.* 2022;22(1):307. doi:10.1186/s12903-022-02342-8
6. Babaei A, Pakdaman A, Hessari H, Shamshiri AR. Oral health of 6-7 year-old children according to the caries assessment spectrum and treatment (CAST) index. *BMC Oral Health.* 2019;19(1):20. doi:10.1186/s12903-018-0709-x
7. Selmani A, Coenen M, Voss S, Jung-Sievers C. Health indices for the evaluation and monitoring of health in

- children and adolescents in prevention and health promotion: A scoping review. *BMC Public Health*. 2021;21(1):2309. doi:10.1186/s12889-021-12335-x
8. Parshnath ST, Babu V, Kumar VD, Amitha HA. Comparison of association of dental caries in relation with body mass index (BMI) in government and private school. *J Dent Sci Res*. 2011;2(2):22-6.
 9. Haque S, Al Rafi DA, Zaman N, Salman M, Al Noman MA, Hoque MN, et al. Nutritional status of under-five aged children of ready-made garment workers in Bangladesh: A cross-sectional study. *PLoS One*. 2023;18(4):e0284325. doi:10.1371/journal.pone.0284325
 10. Khan DSA, Das JK, Zareen S, Lassi ZS, Salman A, Raashid M, et al. Nutritional status and dietary intake of school-age children and early adolescents: Systematic review in a developing country and lessons for the global perspective. *Front Nutr*. 2022;8:739447. doi:10.3389/fnut.2021.739447
 11. Moynihan P, Peterson PE. Diet, nutrition and the prevention of dental diseases. *Public Health Nutr*. 2004;7(1A):201-6.
 12. Chan AKY, Tsang YC, Jiang CM, Leung KCM, Lo ECM, Chu CH. Diet, nutrition, and oral health in older adults: A review of the literature. *Dent J*. 2023;11(9):222. doi:10.3390/dj11090222
 13. Shaket S, Zhang J, VanHoute J. Accumulation of fermentable sugars and metabolic acids in food particles that become entrapped on the dentition. *J Dent Res*. 1996;75(11):1885-91.
 14. Mobley CC. Nutrituin and dental caries. *Dent Clin North*. 2003;47(2):319-36.
 15. Innes NP, Chu CH, Fontana M, Lo EC, Thomson WM, Uribe S, et al. A century of change towards prevention and minimal intervention in cariology. *J Dent Res*. 2019;98(6):611-7. doi:10.1177/0022034519837252
 16. George A, Sousa MS, Kong AC, Blinkhorn A, Patterson Norrie T, Foster J, et al. Effectiveness of preventive dental programs offered to mothers by non-dental professionals to control early childhood dental caries: A review. *BMC Oral Health*. 2019;19:1-9. doi:10.1186/s12903-019-0862-x
 17. Narksawat K, Tonmukayakul U, Boonthum A. Association between nutritional status and dental caries in permanent dentition among primary school children aged 12-14 years, Thailand. *Southeast Asian J Trop Med Public Health*. 2009;40(2):338-44.
 18. Adeniyi AA, Oyapero OA, Ekekezie OO, Braimoh MO. Dental caries and nutritional status of school children in lagos, nigeria - A preliminary survey. *J West Afr Coll Surg*. 2016;6(3):15-38.
 19. Dimaisip-Nabuab J, Duijster D, Benzian H, Heinrich-Weltzien R, Homsavath A, Monse B, et al. Nutritional status, dental caries and tooth eruption in children: A longitudinal study in Cambodia, Indonesia and Lao PDR. *BMC Pediatr*. 2018;18(1):300. doi:10.1186/s12887-018-1277-6
 20. Nadeeshani H, Kudagammana ST, Herath C, Jayasinghe R, Liyanage R. Early childhood caries and nutritional status of children: A review. *Food Nutr Bull*. 2023;44(4):249-64. doi:10.1177/03795721231209358
 21. Bhanbhro S, Kamal T, Diyo RW, Lipoeto NI, Soltani H. Factors affecting maternal nutrition and health: A qualitative study in a matrilineal community in Indonesia. *PLoS One*. 2020;15(6):e0234545. doi:10.1371/journal.pone.0234545
 22. Gebremichael MA, Belachew Lema T. Dietary diversity, nutritional status, and associated factors among pregnant women in their first trimester of pregnancy in ambo district, Western Ethiopia. *Nutr Metab Insights*. 2023;16:11786388231190515. doi:10.1177/11786388231190515
 23. Roberts M, Tolar-Peterson T, Reynolds A, Wall C, Reeder N, Rico Mendez G. The effects of nutritional interventions on the cognitive development of preschool-age children: A systematic review. *Nutrients*. 2022;14(3):532. doi:10.3390/nu14030532
 24. Calcaterra V, Verduci E, Magenes VC, Pascuzzi MC, Rossi V, Sangiorgio A, et al. The role of pediatric nutrition as a modifiable risk factor for precocious puberty. *Life*. 2021;11(12):1353. doi:10.3390/life11121353
 25. O'Sullivan EA, Curzon ME. A comparison of acidic dietary factors in children with and without dental erosion. *ASDC J Dent Child*. 2000;67(3):186-92.
 26. Stewart R, Barber T, Troutman K, Wei S. *Pediatric Dentistry*. 1sted .st. Louis: Mosby Co; 1982. 541.
 27. Sheiham A, Steele JG, Marcenes W, Finch S, Walls AW. The impact of oral health on stated ability to eat certain foods; Findings from the national diet and nutrition survey of older people in great Britain. *Gerodontology*. 1999;16(1):11-20. doi:10.1111/j.1741-2358.1999.00011.x
 28. Watson S, McGowan L, McCrum LA, Cardwell CR, McGuinness B, Moore C, et al. The impact of dental status on perceived ability to eat certain foods and nutrient intakes in older adults: Cross-sectional analysis of the UK national diet and nutrition survey 2008–2014. *Int J Behav Nutr Phys Act*. 2019;16:43. doi:10.1186/s12966-019-0803-8
 29. Grenby TH. Snack foods and dental caries: Investigations using laboratory animals. *Br Dent J*. 1990;168(9):353-61.
 30. Eronat N, Koparal E. Dental caries prevalence, dietary habits, tooth-brushing, and mother's education in 500 urban Turkish children. *J Marmara Univ Dent Fac*. 1997;2(4):599-604.