The relationship between healthy eating index-2015 and dental caries in preschool children.

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Abstract

Objective: To determine the relationship between the Healthy Eating Index (HEI-2015) and tooth decay in children aged 3-6 years in Karaj, 2020.

Design: cross-sectional. Dietary information was estimated from a 24-hour food recall questionnaire and analyzed for nutrient composition. Dietary quality was determined using HEI-2015, a standard according to the 2015 US Dietary Guidelines. The total number of decayed, missing, and filled teeth (dmft) was assessed through clinical examination and according to WHO standard criteria for caries diagnosis. General information and other variables were collected during the interview.

Setting: Karaj, Iran.

Subjects: A random sample available from one hundred and eighty-two children (girls and boys, mean age 60.4 months) from a specialized pediatric dental clinic.

Results: The Nutritional quality assessment showed that HEI-2015 had a negative correlation with tooth decay (r=-0.177, P=0.017). Overweight / obese children had more decayed teeth (r=0.32, P<0.001). Direct and significant Relationship between tooth decay index with total energy (Kcal/d) consumption (X2=9.78, P=0.002), total fat intake (g/d) (X2=12.19, P<0.001) and inverse and the significant Relationship between fiber (g/d) consumption and tooth decay was observed (X2=5.11, P=0.024). But there was no significant relationship between dmft index and protein and carbohydrate (g/d) consumption as well as age (P>0.05).

Conclusions: There is a relationship between tooth decay and the quality of nutrition in children.

Keywords: Diet quality, Healthy eating index, Tooth decay index, dmft, Children.

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Introduction

Dental caries is the most common chronic disease in the world and that is commonly considered a disease of children [1,2]. Dental decay depends directly on plaque bacteria that metabolize fermentable carbohydrates: the acids that are thus formed lead to the demineralization of teeth [3]. The World Health Organization (WHO) has identified dental caries in childhood as a global problem with a prevalence of 60 to 90% [4]. Baby teeth play an effective role in meeting the nutritional and developmental needs of children and maintaining the necessary space for the growth of permanent teeth. Tooth decay is a complex health condition that is influenced by a number of biological, behavioural, environmental, genetic, nutritional status, fluoride exposure, and personal factors [5,6]. Despite improved trends in levels of dental caries in developed countries, dental caries remains prevalent and is increasing in some developing countries undergoing nutrition transition. Oral health problems impact on individuals and society includes pain, discomfort, social and functional limitation and handicap, and effects on the quality of life so the financial impact is relatively high [7]. There is some evidence that an impaired dentition can affect individuals by causing dietary restrictions via chewing difficulty, possibly compromising nutritional status and well-being [8,9]. The treatment of dental diseases costs 5-10% of total health expenditure in industrialized countries, with WHO estimating oral diseases as the fourth most expensive diseases to treat in most industrialized countries [1-11]. Despite the extensive repeated dental care and use of fluoride toothpaste, caries persisted and progressively increased with age in the majority of subjects. It seems that the main way to further reduce the level of caries is to modify the diet.

Oral health is related to diet in many ways, for example, nutritional influences on craniofacial development, oral cancer, and oral infectious diseases [12]. Nutrition affects the teeth during development and malnutrition may exacerbate periodontal and oral infectious diseases. However, the most significant effect of nutrition on teeth is the local action of diet in the mouth on the development of dental caries and enamel erosion. Foods rich in starch, without the addition of sugars, play a small role in coronal dental caries. Sugars, particularly sucrose, are the most important dietary etiological cause of caries. By examining the totality of the diet through diet indices or scores to measure adherence to pre-established criteria, insight may be gained into the combined effects of foods, nutrients, and other dietary components on various health outcomes [13]. About to nutrition and dental health, it is very important to set and present a nutritional pattern that, in addition to meeting the nutritional needs of individuals, has the least cariogenic properties.

The Healthy Eating Index (HEI) is one such tool originally developed in 1995 by the United States Department of Agriculture's (USDA) Center for Nutrition Policy and Promotion (CNPP) to monitor and evaluate changes in diet quality among the US population [14]. There is strong evidence that the HEI is a reliable measure and an alternative approach is to examine the overall diet quality to reflect the complexity of food intake patterns and dietary exposure [15]. Among individuals, the HEI is inversely related to the risk of major chronic disease, overweight and obesity, and all-cause mortality [16,17].

The HEI-2015 has been developed to measure adherence to the most recently published federal dietary guidelines, the 2015 Dietary Guidelines for Americans (DGA) [18]. The Healthy Eating Index, according to the latest revision in 2015, emphasizes the consumption of fruits and vegetables, as well as limiting the consumption of added sugars and saturated fats. The total HEI score provides a picture of overall dietary quality, while the component scores used to calculate the total HEI score offer an opportunity to study important components of dietary intake and their relationship to dental caries [19,20].

Some studies have assessed the diet of individuals and populations in terms of single foods, food groups, nutrients, or other individual dietary components [21,22]. But, are problematic when trying to understand the impact of the overall diet, since nutrients or food items are not consumed in isolation. However, there is a lack of information in the literature about the influence of nutritional status on tooth wear. Furthermore, information on the general properties of the diet with respect to the balance of macronutrients is important to ensure oral health programs are compatible with general health needs. Thus present study aims to evaluate the quality of diet and determine its relationship with dental caries in children aged 3-6 years referred to the paediatric dental clinic in Karaj. The outcome could be useful in planning public health policies for prioritization of care and evaluating outcomes from treatment strategies and initiatives [23,24].

Methods

Study design and population sample

This study involves examining the relationship between feed quality and tooth decay in preschool children. The study plan was cross-sectional and conducted during the period 2020-2019.

To calculate the sample size, the following parameters were used: the prevalence of tooth decay was 72%, SE, 8%, 95% CI, and add 10% for a Missing sample [25]. The minimum sample size required for the present study was 130 people. With the available random sample, the final study sample consisted of 182 children of both sexes (118 boys and 64 girls), from 3 to 6 years old, where referred to the specialized paediatric dental clinic in Karaj, in North of Iran. A specialized paediatric dental clinic was selected to cover all areas of the city, providing a sample that shows the socio-economic status of the entire resident population. Necessary permits for entering the clinic and ethical approval were obtained from the Humanities Research Committee of the Azad University, Science and Research Branch of Tehran. Before starting work, a visit to the clinic, and initial coordination was done by the researcher.

Inclusion criteria: Willingness to participate in the study-Reside in Karaj for at least five years. Exclusion criteria: (I) children or parents who are not allowed to participate in the epidemiological survey, and (II) children who have previously used certain medications or diets and have the widespread systemic disease.

Prior to the study, positive consent was obtained from the legal guardians of the participants on the day of the clinical examination and in accordance with the declaration of the World Medical Association of Helsinki. At the time of implementation, the parents received the necessary information about the objectives of the research. Steps were performed as follows: Complete the demographic questionnaire and Food recall questionnaire by parents, Measurement of anthropometric indices (Height and weight), specialized dental examination.

Detailed information on the amount of food and nutrients consumed by children, both indoors and outdoors, was collected using a 24-hour food reminder questionnaire. Participants had access to posters showing pictures of cups, spoons, bowls, and other common foods to help estimate their size. Participants underwent a dental examination by a paediatric dentist. Other data, standard interviews, and physical examinations were also performed at the clinic. Based on this, we gathered complete information about children's diet and dental examinations. A detailed description of the study plan, methods, and participation are provided by Sharif.

Dietary assessment

The Healthy Eating Index is an indicator for assessing and monitoring the dietary status of people over 2 years of age. The Healthy Nutrition Index 2015 (HEI) is based on the consumption of the following components: total fruits, whole fruits, total vegetables, greens and beans, whole grains, dairy products, total protein foods, seafood and plant proteins, MUFA + ratio PUFA to SFA, refined grains, sodium, Added Sugars and saturated fats [14].

The steps for determining the overall score are as follows: (1) each person's food intake was extracted from a 24-hour food recall questionnaire asked by a nutritionist, (2) Each food item was assigned a code using tables and food combinations, entered into a computer, and nutrient composition was determined, (3) The total amount of food consumed by the participants was determined and the reported household amounts were converted to grams, (4) Food grams were converted to serving using the food guide pyramid. The values were measured on a scale of cup or ounce (Oz) and recorded with caloric content, i.e. in 1000 kcal or in proportion to the total calories, (5) Each of the HEI-2015 components was scored using the relevant standard. The minimum score for the Healthy Eating Index can be zero and the maximum score is 100, and it is ranked in three levels (0-50 poor diet, 51- 80 need improvement, above 80 good diets, (6) Energy and nutrient intake were automatically calculated from the recorded food intake.

Caries assessment

Dental examinations with the recommendations of the World Health Organization WHO, It was performed by an experienced dentist in a paediatric clinic under standard conditions [26]. The Examination was performed on the dental unit using unit light,

mirror, and dental catheter. Enamel decay has been reported, but no radiographs have been taken. From this information, the total number of damaged, missing, or filled permanent teeth (dmft index) per person was calculated. Therefore, if the smooth surface of the teeth (the enamel is empty) or the grooves are damaged, or the floor and surrounding area are softened and this softness is felt with the catheter, tooth decay is considered. Also, if a tooth has been repaired with fillings, but is still decayed, it is considered decayed. But White spots are not considered caries. A tooth that has one or more surfaces that are permanently filled and has no old or new caries is called a restored tooth. Teeth that are lost only due to decay have considered lost teeth. Teeth that are not available due to orthodontics, accidents, etc., are not considered lost teeth [27].

The severity of tooth decay in the community (according to the guidelines of the World Health Organization) is without caries, low caries, and high caries, (dmft 0, dmft 1-3, dmft ≥ 4) [28].

Anthropometric and socio-demographic

Anthropometric measurements, including height, weight, and body mass index at the time of examinations were performed by a nutritionist using standard methods and portable equipment in the dental clinic. In order to weigh the participants, a digital scale with an accuracy of 100 grams was used, which was done with minimal clothing and without shoes to increase the accuracy of the quantities. Participants' height was measured using standard portable Stadiometers with an accuracy of 0.5 cm (while participants were standing, without shoes and heels and shoulders facing the wall and face forward. BMI (kg\m^2) was classified based on the WHO (2006) reference, which defines BMI percentiles for age and sex [29]. The international classification of BMI into low weight (15th percentile), normal weight (15th-15th percentile), overweight (97th percentile), and obesity (97th percentile) was performed with special tables for children.

Eligible participants completed a general questionnaire to collect detailed information on sociological, health, and anthropometric characteristics and eating habits. The general questionnaire included a set of information, mother's age, duration of breastfeeding, number of toothbrushes per week, and household economic status.

Statistical analysis

Data were analysed using Stata statistical software package version 13 and IBM SPSS Statistics Version 23.0. Key socio-demographic and nutritional variables were combined with dental data. Nutritional characteristics and tooth status were summarized and presented using mean (or median) for continuous variables, frequencies, and percentages for classified variables. The Correlation coefficient and Chi-square were used to determine the relationships between a classified or continuous dependent variable. The Kruskal Wallis test was used to evaluate the significant difference between the mean dmft scores for energy consumption and macronutrients and to determine the relationship between dmft and population indices in the study group. The relationship between dmft and total HEI score and its components was determined by the Pearson correlation coefficient. The odds ratio of tooth decay (dmft) and HEI-2015 score were calculated based on logistic regression. The results were considered significant at P<0.05.

Results

The sample size of the present study was 182 cases, of which approximately 64.8% were boys and 35.2% were girls with an average age of 63 months. A one-sample Kolmogorov–Smirnov Z test showed that data relating to the Social, demographic characteristics were not normally distributed.

Characteristics of participants and their relationship to dental caries status are reported in **Table 1**. In terms of gender, 60.9% of girls have more than 4 decayed teeth and 46.6% of boys have 1-3 number of decayed teeth. The Median weight for the unfavourable position (dmft ≥ 4) was 21 (IQR 6), and the median weight for the absence of tooth decay was18) IQR 6). So, with weight gain, more decayed teeth are seen in children (r=0.20, P=0.005). The anthropometric index (BMI) was divided into 4 classes, underweight, normal, overweight, and obese. Tooth decay is more common in overweight and obese children (r=0.32, P<0.001). So that the frequency of high caries (dmft ≥ 4) in obese people is 84%, and the frequency of non-caries in obese people is 8%. The number of decayed teeth was higher in children whose mothers were younger (r=-0.32, P<0.001). So that the median age of mothers, 30 (IQR 4), It is observed in children with the unfavourable dental condition. The number of decayed teeth was higher in children who had never breastfed (72.9%) and the lowest number of decayed teeth was observed in children who were breastfed from 12 to 24 months (7.6%). Also, children who brushed three times a week had more decayed teeth. So, 80% of children who brushed three times a week had an unfavourable index of tooth decay (dmft ≥ 4). Although the frequency of decayed teeth was higher in low economic status, it was not statistically significant. Also, there was no significant relationship between age and height variables with DMFT (P>0.05).

Table 2 shows the median, mean, and standard deviation (SD) of total energy intake and macronutrients (carbohydrates, fiber, protein, and total fat) associated with tooth decay. The mean energy and total fat intake in the unfavourable position of the tooth (dmft ≥ 4) were higher than the optimal position of the tooth (dmft 0). While the average fiber consumption in favourable conditions of tooth decay was higher than unfavourable conditions of tooth decay. Statistical analysis showed that there is a significant difference between the average total energy consumption (X2=9.78, P=0.002), fiber (X2=5.11, P=0.024), and total fat intake (X2=12.19, P<0.001) with dmft. So that with increasing tooth decay, energy consumption and total fat increase, and fiber consumption decrease. The mean of Protein in unfavourable tooth position (dmft ≥ 4) was higher than the optimal tooth position (dmft 0). While the average carbohydrate intake in favourable conditions of tooth decay was more than unfavourable conditions of tooth decay. But the relationship was not statistically significant (P>0.005).

Table 3 shows the mean and standard deviation (SD) of the HEI-2015 component scores and total scores associated with tooth decay (dmft). The mean total score of the HEI-2015 for participants was significantly less than the maximum total score of the index. The score for the HEI-2015 (of 100), was (54.7(SD 10.7), P=0.01), with a range of 31.6-79.8. The mean scores of fatty acids 0.9 (SD 1.9), refined grains 1.3(SD 2.6), added sugars 4.5 (SD 2.8) and saturated fats 3.8 (SD 3.7) were all significantly

Table 1. *Socio-demographic characteristics of DMFT degrees in 182 children aged 6-3 years (Karaj, Iran), 2020.*

dmft degrees								
Characteristics (n =182)	**dmft 0 (n 19)**		**dmft 1-3 (n 72)**		**dmft ≥4 (n 91)**			
	Median	**IQR**	**Median**	**IQR**	**Median**	**IQR**	**P value***	**r ****
Age(months)	65.0	21.0	61.0	15.0	70.0	24.0	0.180	0.10
Sex (%) female male							**0.031**	
	12.5 9.3		26.6 46.6		60.9 44.1			
Anthropometrics Body weight (kg)	18.0	6.0	19.0	4.1	21.0	6.0	**0.005**	0.20
BMI according to age (%)							**<0.001**	0.32
<15. percentile (thin) ≥15-<85. Percentile (normal) ≥85-<97. Percentile (over weight) ≥97. Percentile (obese)	0.0 11.0 8.0 14.3		100.0 44.5 8.0 14.3		0.0 44.5 84.0 71.4			
Height (Cm)	109.0	12.0	110.0	11.5	110.0	12.0	0.425	0.06
Mother's age (years)	32.0	7.0	33.0	6.0	30.0	4.0	**<0·001**	-0.32
Breast fed status (%)							**0.004**	
Not breast fed ≤ 6 month 6-12 months 12-24 months ≥ 24 months	8.3 13.3 23.1 7.6 0.0		18.8 53.3 30.8 50.0 100.0		72.9 33.3 46.2 42.4 0.0			
Frequency of tooth brushing (%)							**0.044**	
Never Once a week Twice times a week three times a week	20.0 10.4 7.4 5.0		45.0 39.1 55.6 15.0		35.0 50.4 37.0 80.0			
Socioeconomic status (%)							0.474	
High Middle low	4.2 10.7 13.5		33.3 43.0 32.4		62.5 46.3 54.1			

Note: dmft: decayed, missing and filled teeth

Values are presented means and standard deviations or percentages. IQR, interquartile range.

*P values obtained from Kruskal Wallis test for continuous variables and X2 tests for categorical variables.

** Spearman correlation test Significant at the 0.05 level.

Table 2. *Daily energy and macronutrient intake (median, mean and SD) by dmft degrees for 182 Children aged 6-3 years (Karaj, Iran), 2020, Kruskal-Wallis test Results are shown (df=1).*

Nutrient intakes	**dmft**			
		Dmft 0 (n 19)	**dmft 1-3 (n 72)**	**dmft ≥4 (n 91)**
Total energy (kcal/d)	X^2 =9.78, **P=0.002***			
Median		1628.9	1698.2	1772.3
Mean		1680.5	1659.5	1739.1
SD		201.3	186.3	186.0
Carbohydrate (g/d)	X^2 =0.07, P=0.78			
Median		223.8	220.9	218.4
Mean		225.7	222.2	220.3
SD		31.3	40.7	34.8
Fiber (g/d)	X^2 =5.11, **P=0.024***			
Median		20.7	20.9	14.3
Mean		21.0	20.0	17.7
SD		8.1	8.0	7.0
Protein (g/d)	X^2 =1.64, P=0.20			
Median		53.5	65.6	61.1
Mean		58.8	65.8	65.3
SD		13.8	14.2	21.9
total fat (g/d)	x^2 =12.19, **P<0.001**			
Median		60.5	57.0	63.8
Mean		62.4	58.4	63.3
SD		12.3	14.9	17.5

Note: * Kruskal-Wallis test was used to test for significant differences between DMFT degrees. Significant P values are highlighted in bold. Significant at the 0.05 level.

lower than the maximum values (10 points). Other components did not show significant differences with their maximum values. The Pearson correlation tests showed that there is a negative correlation with a dmft between the components of dairy (r=-0.17, P=0.017), fatty acids (r=-0.15, P=0.04), refined grains (r=-0.15, P=0.03), sodium (r=-0.18, P=0.01), saturated fat (r=-0.17, P=0.02) and the total HEI-2015 score. So that with increasing the score of the mentioned components, the amount of tooth decay decreases. There was a negative correlation between the components of Total fruit (r=-0.06), whole fruit (r=-0.07), total protein foods (r=-0.11) and total seafood and plant foods (r=-0.05) with tooth decay, but it was not statistically significant (P>0.05).

Table 4 shows the odds ratio of tooth decay (dmft>0) with increasing HEI-2015 score and its components. According to the first regression model, which is a raw model, there is no significant relationship between HEI-2015 components and total score with the chance of having decayed teeth (P>0.05). The results show that in model 2: (adjustment based on variables for Age, Sex, Anthropometrics, Mother's age, Breastfed status, Frequency of tooth brushing, socioeconomic status) the ratio of chance of tooth decay in children who followed the recommendations for dairy and whole protein foods, relative to the base (non-compliance), Significance is less, respectively (OR=0.46, (CI 0.24-0.87), P=0.017), (OR=0.07, (CI 0.08-0.60), P=0.016). As the total score increases, the chances of tooth

Table 3. *Healthy Eating Index-2015 (HEI-2015) total and component scores† by dmft in children aged 3-6 years (Karaj, Iran), 2020 (n=182).*

Component	Tooth decay index (dmft)					Maximum possible	Qualifications for maximum
	Score Mean	SD	Range	Significance	r		
Total Fruits	3.5	2.0	0-5	0.41	- 0.06	5	≥ 0.8 c equivalents/1,000 kcal
Whole Fruits	3.6	2.1	0-5	0.33	- 0.07	5	≥ 0.4 c equivalents/1,000 kcal
Total vegetables	4.2	1.4	0-5	0.54	0.04	5	≥ 1.1 c equivalents/1,000 kcal
Greens and Beans	4.3	1.5	0-5	0.18	0.09	5	≥ 0.2 c equivalents/1,000 kcal
Whole grains	4.3	4.7	0-10	0.60	0.03	10	≥ 1.5 Oz equivalents/1,000 kcal
Dairy	7.9	3.3	0-10	0.01*	- 0.17	10	≥ 1.3 c equivalents/1,000 kcal
Total protein foods	4.3	1.1	0-5	0.12	- 0.11	5	≥ 2.5 Oz equivalents/1,000 kcal
Seafood and Plant Proteins	3.4	2.1	0-5	0.44	- 0.05	5	≥ 0.8 c equivalents/1,000 kcal
Fatty acids	0.9	1.9	0-10	0.04*	- 0.15	10	(PUFAs[a]+MUFAs[b])/SFAs[c] ≥ 2.5
Refined grains	1.3	2.6	0-10	0.03*	- 0.15	10	≤ 1.8 Oz equivalents/1,000 kcal
Sodium	8.2	2.1	0-10	0.01*	- 0.18	10	≤ 1.1 g/1,000 kcal
Added Sugars	4.5	2.8	0-10	0.12	0.11	10	≤ 6.5% of energy
Saturated fats	3.8	3.7	0-10	0.02*	- 0.17	10	≤ 8% of energy
Total HEI score	54.7	10.7	31.6-79.8	0.01*	- 0.17	100	Obtain maximum score in all components

Note: HEI-2015, Healthy Eating Index-2015.
†Intakes between the minimum and maximum standards are scored proportionately. a PUFAs¼polyunsaturated fatty acids.
b MUFAs¼monounsaturated fatty acids.
c SFAs¼saturated fatty acids.
*Significant difference (P < 0•05) obtained from the Pearson correlation test.

Table 4. *Odds ratios of tooth decay per unit increase in total HEI score and HEI component scores: Children 3-6 years old (Karaj, Iran), 2020 (n=182).*

Risk of tooth decay (dmft> 0)		Model 1		Model 2		
	OR	95 % CI	P-value*	OR	95% CI	P-value*
Total HEI score	1.03	0.98-1.08	NS	0.37	0.20-0.66	<0.001
HEI component scores Total Fruits **(cups)**	0.83	0.31-2.23	NS	0.83	0.42-1.64	NS
Whole Fruits **(cups)**	0.90	0.32-2.51	NS	0.61	0.21-1.79	NS
Total vegetables **(cups)**	0.82	0.25-2.61	NS	0.73	0.16-3.32	NS
Greens and Beans (cups)	0.81	0.25-2.62	NS	1.07	0.17-6.50	NS
whole grains **(Oz)**	0.58	0.20-1.69	NS	0.86	0.27-2.72	NS
Dairy **(cups)**	0.75	0.27-2.08	NS	0.46	0.24-0.87	0.017
Total protein foods **(Oz)**	0.92	0.34-2.47	NS	0.07	0.08-0.60	0.016
Seafood and Plant Proteins **(cups)**	0.87	0.33-2.27	NS	0.20	0.03-1.11	NS
Fatty acids	1.35	0.84-2.17	NS	1.14	0.45-2.92	NS
Refined grains **(Oz)**	1.02	0.84-1.24	NS	0.30	0.08-1.07	NS
Sodium **(g)**	0.75	0.50-1.08	NS	1.20	0.31-4.64	NS
Added Sugars **(% energy)**	1.17	0.96-1.42	NS	0.99	0.25-3.85	NS
Saturated fats **(% energy)**	0.59	0.07-4.76	NS	1.66	0.76-3.64	NS

Note: HEI, Health Eating Index; dmft, decay, missing filling teeth.
Total HEI score range, 0–100; HEI component score range, 1–10.
Risk of tooth decay: For children who follow the nutritional recommendations compared to children who do not.
Logistic regression models were employed to calculate odds ratios and 95% confidence intervals. Two separate logistic regression models were implemented: raw regression model 1 and regression model 2 for HEI component components. Model 2 was adjusted for age, Sex, Anthropometrics, Mother's age, Breast fed status, Frequency of tooth brushing, socioeconomic status.
*Significant at the (P < 0•05) level. NS – not significant (P>0.05).

decay decrease (OR=0.37, (CI 0.20-0.66), P<0.001). Among children who matched other HEI-2015 components (total fruits, whole fruits, total vegetables, whole grains, seafood, and plant proteins, and refined grains, and added sugars, tooth decay decreased but, was not statistically significant (p>0.05).

Discussion

Since the aim of this study was to determine the association between the healthy eating index and tooth decay, special attention was paid to describing the quality of diet as the sum of food or beverages consumed simultaneously, according to the latest federal diet guidelines, DGA-2015, In order to obtain an accurate picture of the combined effects of food on the teeth. Because, among the many multifactorial etiological factors, the diet has been identified as a particular risk factor for caries development in children [30]. This is also the first study to report the quality of diet in terms of HEI-2015 index with dental health in Karaj preschool children (from Iran).

The findings of this study showed that there is a positive relationship between weight, BMI, total fat, and total energy intake, as well as between mother's age and the amount of fiber intake with tooth decay. There was also a significant relationship between sex, frequency of brushing, and duration of breastfeeding with tooth decay. On the other hand, the economic level of the household did not show a significant relationship with tooth decay.

Our results show that participants with higher dental caries in primary teeth, on average, had significantly higher weight and BMI. These findings are consistent with other studies that have reported a direct relationship between weight and BMI with dental caries [31]. In addition, the results of a study in Bangladesh on 1699 children aged 6-12 years, also in an Iranian study on 1482 children aged 3-6 years, tooth decay was inversely related to weight and BMI [32,33]. The difference in results seems to be due to different races and different age groups. The change in dietary patterns and consumption of foods with erosive potential can trigger this change in overweight children.

In the present study, the average energy intake was 1739.1 Kcal/d in dmft ≥ 4. The average daily fiber intake among children without dental caries was 21g. Our findings show that higher energy intake and lower fiber intake are associated with tooth decay. Similarly, Mac et al.'s study of 1,639 children aged 1-5 years in South Africa found that tooth decay was directly related to energy intake [34]. These results are inconsistent with other studies that show an inverse relationship between fat and protein intake and dmft, and conflicting results can be attributed in part to the different methods used to assess macronutrient intake or incorrect reporting of ratios [35]. However, more studies are needed to clarify the relationship between macronutrients and tooth decay. Because some experts support a higher percentage of energy intake of total fat and others support lower fat intake.

In a study by Amiri et al., it was shown that tooth decay decreases with increasing maternal age and in our study the result was similar [35]. The inverse relationship between maternal age and child dmft seems to be due to mothers' greater knowledge and experience about children's teeth. We found no association between child age and tooth decay. But the fact is that several studies have reported a higher risk of tooth decay with age because exposure to caries risk factors, including foods, increases with age, and mixed results may indicate that Age was not a major confounding variable in the present study [36-38].

In our study, no correlation was found between dmft and child height, which is consistent with some studies, such as the study of Masoom Misha et al. In Bangladesh and Elif et al. in Ankara [32-37]. The lack of a link between height and dmft can be attributed in part to the hereditary nature of height and its lesser impact on nutrition.

In our study, more girls than boys were classified into unfavourable groups based on dmft. However, the results of studies examining the relationship between gender and the prevalence of dental caries are contradictory, as some studies have reported high dmft levels in boys [33]. However, in some studies, no relationship was found between sex and tooth decay [37]. Inequality in the number of boys and girls participating in the study may cause this difference in results.

Several studies have analysed the impact of household economic status on the experience of tooth decay in children. In these studies, a significant correlation was found, and it was reported that low socioeconomic status is associated with an increased prevalence of dmft [39-41]. However, this study did not confirm the association between socioeconomic status and increased dmft risk. Lack of connection is possible the data on socioeconomic status recorded according to the declaration of the parents and the classification was not based on an objective assessment.

In our study, there was a significant relationship between breastfeeding duration and tooth decay, so That children who were breastfed for less than 6 months had less tooth decay than children who were never fed or fed for more than 6 months. In a study by Julian et al. To investigate the effect of nutritional methods on tooth decay on 285 children aged 36-60 months in Sri Lanka, the relationship between exclusive breastfeeding for 6 Months and breastfeeding for more than 24 months with tooth decay there were positives [42]. The results of studies show a discrepancy between breast milk Intake and tooth decay, which may be related to frequent tooth contact with food and acid production, as well as oral habits. On the other hand, antibodies in Breast milk or nutrients play a protective role.

There was an almost direct relationship between the frequency of brushing and tooth decay, with children brushing three times a week, having a higher incidence of tooth decay, as a study of eating habits associated with tooth decay in 2880 children aged 3 to 5 years in China. Zeng et al, showed that there is a direct relationship between the frequency of brushing and tooth decay [36]. But the inverse relationship between brushing frequency and tooth decay is evident in the study of Ghasemianpour et al, in Iran. This difference in results may be related to differences in the quality of brushing and the importance of the time spent doing so compared to more brushing.

The data show a relationship between nutritional quality and tooth decay in children. Our results show that participants with higher dental caries had significantly lower HEI-2015 scores. In fact, a poor diet is associated with an increased risk of tooth decay. This study showed a statistically significant difference

Related to dental caries in children with or without more favourable dietary intake according to HEI classification. Our approach revealed an average score of 57.4 out of 100. This represents a score of needing improvement'. In context, a score of over 80 represents 'good' and a score of less than 51 is 'poor' [15]. In parallel with the results of previous studies, a higher percentage for dmft was obtained in children with a lower total HEI-2015 score in this study.

Higher scores on milk and dairy products, fatty acids, refined grains, sodium, and saturated fats are associated with a reduced risk of tooth decay in children. The high score of HEI components for fat indicates that participants are in line with or close to the recommendations. Therefore, high scores of refined grains, sodium, and saturated fat indicate low consumption of these Nutrients is associated with a more favourable caries status.

The mechanisms behind the protective effects of milk, dairy, and fatty acids are still unclear, perhaps due to the presence of Essential fatty acids, vitamin E, and minerals in milk such as phosphorus and calcium. However, it is hypothesized that increasing the consumption of dairy products and fatty acids and reducing the intake of refined grains, sodium and saturated fats play a role in reducing tooth decay. These results are similar to other studies, for example, in a study by Vundavalli et al. To determine the relationship between healthy eating index and body mass index and early childhood caries in 350 children aged 5-6 years in Saudi Arabia [21]. In the study of bread and colleagues with the aim of determining the relationship between the healthy eating index and tooth decay in 3912 children aged 2-5 years, also in the study of Priyadarshini et al., with the aim of investigating the role of diet in children with ECC affected by HEI in 2005, in 3-6-year-old children in India, tooth decay index (dmft) was inversely related to healthy eating index (HEI) [38,43]. These results show that with increasing the score of HEI components, the prevalence of tooth decay decreases significantly.

Similarly, in the logistic regression model, we found that the risk of tooth decay was lower in children who followed the dairy and total protein foods diet recommendations. Studies conducted in the United States from 2011 to 2014 on adults by Kay et al. Showed that higher rates of total fruits, whole fruits, beans and vegetables, and added sugar were associated with fewer caries. In a study of 3-6-year-old children in India, which aimed to investigate the role of diet in children with ECC under the influence of HEI 2005, it was reported that in children without caries, recommendations for dark vegetables, legumes, milk, and pure calories (Saturated fats and added sugars) were more observed than other groups [38]. However, the present study failed to establish a significant relationship between dmft at 95% confidence level with a total fruit score, whole fruit score, total vegetable score, bean and vegetable score, whole grain score, seafood and vegetable score, fatty acid, refined grains Create sodium and added sugar points. The difference in findings may be due to greater access to vegetables and legumes, as well as differences in children's race, sample size, and nutritional and demographic information collection. To better understand these relationships and differences, more research is needed to identify foods that are specifically associated with a reduced risk of tooth decay in children.

This population-based study shows that dental status in children is associated with the intake of certain foods, including dairy and total protein foods. The anti- cariogenic characteristics of some food groups, including dairy products in particular cheese, whole grains, and fruits rich in fiber have been documented in previous studies [44]. Several factors may have contributed to increasing the risk of dental decay in children. Increasing the well-being and availability of sugary products such as soft drinks, industrial juices that have more marketing, all may cause children's teeth to be exposed to large amounts of acid at older ages [45]. As a result, it seems reasonable to recommend consuming more dairy and protein products.

In particular, the use of the HEI-2015 for dietary quality evaluation is a strength of the present study. This index measures how compliant one is with national dietary guidelines. The food diary method is not only suited to providing a good estimate of the mean intake of a group, but it also provides more accurate and detailed information about the quantity, time, and pattern of consumption of foods and drinks which is important when investigating dietary patterns of relevance to dental health. HEI-2015 is a useful tool that reflects the overall dietary intake [46,47]. The findings of the present study show that not only the quality of the diet but also the specific components of the HEI score can have beneficial effects on the condition of the teeth. Studies showed that children with better dietary intake were less likely to have a risk of dmft compared with children with the worse dietary intake [48]. So precise preventive and therapeutic measures for tooth decay and control of nutritional status are necessary to avoid increasing clinical problems.

However, it must be considered that a limitation of our study is its cross-sectional design, making it difficult to draw the relationship regarding causes and effects. Therefore, further longitudinal studies are needed to better understand and interpret the tooth decay measures and associated risk factors in children. It seems that a healthy diet and a high-quality diet are essential to prevent tooth decay in preschool children. But, further studies are needed to develop dietary strategies to prevent tooth decay that examines the role of various dietary components in early childhood tooth decay.

Conclusion

The present data show that there is a relationship between children's nutritional status and tooth decay. Children with a low Healthy Eating Index had more tooth decay. Tooth decay in primary teeth is considered as a predictor of increased risk of general caries in permanent teeth, so careful preventive measures are essential for tooth decay and control of nutritional statusn [49,50]. To prevent the increase of clinical problems, providing periodic scores of the total and component HEI components to the authorities can be used to train and assist in future decisions and priorities. The risk of tooth decay in primary teeth may be related to nutritional status. Therefore, children need more nutritional supervision and dietary counselling. Since even small changes in diet quality can lead to a better nutritional status, further steps should focus on increasing the quality of the diet in this high-risk group.

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