

Is There an Impact of Social Factors and Food on Early Childhood Caries? A Cross-Sectional Study

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Abstract

This study aimed to investigate the impact of dietary habits on early childhood caries (ECC) in preschool children. We recruited 153 children between 30 and 71 months of age who applied to a state hospital dental clinic in Ankara, Turkey. The decayed-missing-filled teeth (dmft) index was calculated with a questionnaire that investigated the number of decayed, missing, and/or filled milk teeth. Participants formed three separate groups according to their caries history (Group 1: caries-free children, Group 2: children with ECC, Group 3: children with severe ECC [S-ECC]). The mean dmft score was 4.0 ± 3.9 , and 20.2% of children were in caries-free group ($n = 31$), 45.8% were in ECC group ($n = 70$), and 34.0% were in S-ECC group ($n = 52$). The carbonated beverage consumption and the dmft index score was directly proportional ($p < .05$). Besides, there was a significant correlation between anti-cariogenic foods such as milk and eggs and dmft index score ($p < .05$). S-ECC was associated with higher consumption of French fries ($\beta = .052$; 95% CI $-0.141, 1.827$) and lower consumption of egg ($\beta = -0.052$; 95% CI $-0.103, 0.001$). Consequently, the fast-food-style Western diet was closely related to tooth decay, and healthy dietary habits such as the Mediterranean-style diet may provide crucial protection against dental caries in preschool children.

Keywords

anti-cariogenic food, cariogenic food, dental caries, preschool children, social factors

Introduction

Early childhood dental caries is an infectious disease with multifactor etiology, and it is one of the most common chronic diseases affecting children worldwide (Mulu et al., 2014). The most common isolated bacterial agent is *Streptococcus mutans* (Bae et al., 2018). The World Health Organization (WHO, 2015) targets 80% of caries and periodontal disease-free children in the 5 to 6 years age population. Despite the successful trends of reduced dental caries in developed countries' reports (Moynihan & Kelly, 2014), Republic of Turkey Ministry of Health et al. (2014) reported dental caries as one of the three most common diseases in preschool children. An Oral Health Survey in Turkey revealed that the prevalence of dental caries was 69.8% and the dmft was 3.7 ± 3.9 (Güçüz & Kuvvetli, 2014). The rate was higher compared with the developed countries such as England, Germany, and Denmark (Grund et al., 2015; Pitts et al., 2007; Wang et al., 2018).

Dental caries is a multifactorial disease, and several risk factors were described for its initiation and progression (Elamin et al., 2018). These risk factors are associated with nutritional habits, socioeconomic status, and oral hygiene

(Hong et al., 2014; Mulu et al., 2014). Particularly, high consumptions of sucrose and carbonated beverages, high sugar intake between meals, and frequent snack habits were reported to be associated with tooth decay formation in preschool children (Kowash, 2015; Kowash et al., 2017). Moreover, a national survey revealed that the children aged 2 to 5 years in Turkey consume under the recommended amounts of dairy products and meat, and over the recommended amounts of added sugar (Republic of Turkey Ministry of Health et al., 2014). Sugar, especially sucrose, promotes the colonization of certain oral microorganisms and increases the viscosity of the bacterial plaque, which enhances the adhesion on teeth (Soliman et al., 2017; Tinanoff, 2005). Frequent consumption of sugar causes a decrease in the pH of the bacterial plaque, enabling the interaction of the substrate and microorganisms

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to reduce extracellular glucans. A continuous increase in acidogenic bacteria causes an imbalance in mineralization and demineralization of dental tissues (Zaki et al., 2015). Moreover, the quality of oral hygiene practices, and the amount and frequency of cariogenic snacks were also associated with dental caries (Hong et al., 2014). Although the results were inconsistent, few previous studies mentioned the relationship between toothbrushing and caries prevalence (Elidrissi & Naidoo, 2016; Kowash et al., 2017). Sociodemographic variables were also involved in the preservation of oral health in preschool children. Socioeconomic factors such as income and education level of the family and the number of family members were reported to affect the prevalence of the disease (Congiu et al., 2014; Elamin et al., 2018; Tanaka et al., 2013). Particularly, the children in urban areas of developing countries, ethnic minorities, and disadvantaged social groups in industrialized countries were found to have a higher prevalence of dental caries (Edelstein et al., 2006).

Although the relationship between sugar consumption in childhood and dental caries is well known (Giacaman, 2018), a healthy diet model consisting of anti-cariogenic foods may also prevent its development (Morikava et al., 2018). However, the Mediterranean-style diet may even fail in developed and/or developing countries such as Turkey due to the adoption of a Western-style diet and increased sugar consumption (İnan-Eroğlu et al., 2009; Sahingoz & Sanlier, 2011). On the other hand, Zaki et al. (2015) reported that preschool children consuming healthy vegetables and dairy products face fewer tooth decays compared with those who lack these foods in their meals.

Most of the previous studies evaluated the effect of sugary and starchy meals on dental caries (Moynihan & Kelly, 2014; Peres et al., 2015; Sheiham & James, 2015; Watanabe et al., 2014). However, only a few studies investigated the effect of anti-cariogenic foods so far (Dowidar & El Tantawi, 2008; Morikava et al., 2018; Zaki et al., 2015). Therefore, this study assessed (a) the prevalence, severity, and contributing factors of early childhood caries (ECC) in preschool children in Ankara, Turkey, and (2) the effect of both cariogenic and anti-cariogenic foods on dental caries formation. Thus, we aimed to evaluate the effects of the sociodemographic status of the family, oral hygiene practices, and cariogenic and anti-cariogenic food consumption on dental caries among preschool children.

Materials and Methods

Study Plan

This cross-sectional study was performed on 153 children (58.2% boys, 41.8% girls) aged between 30 and 71 months, living in Ankara, the capital city of Turkey. Subjects were randomly selected from healthy children who were admitted to the dentistry outpatient clinic of a state hospital. The

parents or caregivers of the voluntary participants were informed about the objectives and methods of the study, and their written informed consent was obtained prior to the study. All researchers agreed to adhere to the tenets of the Declaration of Helsinki (World Medical Association). Children aged between 30 and 71 months who had no physical and/or mental disorders affecting oral health and had no previous history of antibiotic treatment in the past 2 weeks were included in the study. Data were collected with face-to-face interviews between January and August 2016. The study was approved by the Ethical Review Committee of University of Health Sciences, Ankara Child Health and Diseases, Hematology-Oncology, Training and Research Hospital.

The questionnaire was administered to the parents/caregivers of participants which consisted of questions to obtain general demographic data of the child and family (age of the child, monthly income of the family and educational background, etc.), and a food frequency questionnaire (FFQ) to assess the positive or negative effects of dietary habits on dental health. Household income was analyzed as a numerical value based on the Turkish monthly minimum wage, which was 1,300 Turkish Liras (US\$450) at the time of data collection.

Evaluation of ECC

Each child underwent an oral examination, and dental caries was diagnosed using WHO recommendations for oral health surveys (WHO, 2013). The dental examination was performed by the same pediatric dentist using a noninvasive technique (mirror, dental probe, cotton roll). Caries was determined visually with the optimal illumination of the oral cavity; no X-rays were used. Caries lesions were recorded as present when a carious cavity was apparent upon visual inspection. The prevalence of caries was obtained by calculating the number of decayed (d), missing teeth (m), filled teeth (f), teeth (t), or surfaces (s). The decayed, missing, and filled teeth (dmft) scores for each individual were calculated by excluding teeth lost due to trauma or exfoliation. ECC and severe ECE (S-ECC) terms were previously described by the American Academy of Pediatric Dentistry (AAPD, 2008). The ECC is the presence of one or more decayed (with or without cavity), missing (due to caries), or filled tooth surface in a child aged 71 months or younger. S-ECC is defined as a dmft decayed score greater than 3 in children between 3 and 6 years old with prevalent, acute, and progressive characteristics (AAPD, 2008).

Evaluation of Food Consumption

The 30-item semi-quantitative FFQ investigates cariogenic and anti-cariogenic food. The cariogenic foods are fermented products that may cause caries by decreasing the pH of the saliva under 5.5 when they contact with microorganisms in the mouth, and anti-cariogenic foods protect the tooth

surface after consuming acidic foods. The questionnaire is an adapted version of the FFQ developed by Willett et al. (2015), and it was previously used and validated in the Turkish population (Güneş et al., 2016). Cariogenic foods include crackers, bread, cereals, potato crisps, bakery, cookies, cake, French fries, banana, dried fruit, fruit juice, carbonated drinks, and sweets (Tinanoff, 2005). The anti-cariogenic foods are milk, yogurt, cheese, meat, chicken, egg, fish, peanut, carrots, apple, and raw vegetables (Dowidar & El Tantawi, 2008). “A Photographic Atlas of Food Portions Sizes” developed for the Turkish population was used to precisely assess the amounts of the food consumed (Rakicioglu et al., 2014).

Statistical Analysis of the Data

Research data were statistically analyzed by using the SPSS 22.0 program. A χ^2 test was used to compare the demographic data of the participants with or without dental caries. The normality of continuous variables was tested using the Kolmogorov–Smirnov test. Spearman correlation analysis was used to assess the correlation between two variables. A linear regression model was used to compare the cariogenic and anti-cariogenic foods in both caries groups. An adjusted model was performed to detect the potential confounders associated with cariogenic and anti-cariogenic foods. Multivariable-adjusted linear regression was used to identify the correlation between cariogenic and anti-cariogenic foods in the caries group based on the adjusted model. The level of significance was set at a probability of less than 5% ($p < .05$).

Results

Of the participants, 52.2% of them were boys and 41.8% were girls. The mean age was 57.3 ± 10.6 months, and 22.2% of children were aged between 30 and 47 months, 24.8% between 48 and 59 months, and 52.9% between 60 and 71 months. The mean dmft score was 4.0 ± 3.9 , and 20.2% of children were in caries-free group ($n = 31$), 45.8% were in ECC group ($n = 70$), and 34.0% were in S-ECC group ($n = 52$).

The demographic and oral hygiene practice data of the participants are presented in Table 1. The S-ECC was significantly more common in boys ($p < .05$). Besides, the most common age group for S-ECC was 60 and 71 months of age ($p < .05$). There was a significant association between the maternal education level and dental caries groups ($p < .05$). However, there was no significant association between the paternal education level and dental caries ($p > .05$). The majority of children 35 (67.3%) with S-ECC reported less than 2 min of teeth brushing time, but the relation between brushing time and dental caries was not statistically significant. Teeth brushing frequency of parents was also significantly associated with dental caries ($p > .05$). Furthermore,

around half of the children with ECC and S-ECC had no previous dental visit history and only very few (8.6% and 11.6%, respectively) of them had visited for a routine check-up.

Correlation between the amount of cariogenic food consumption and dmft score is given in Table 2. A positive correlation was determined between the consumption amount of French fries and dmft index score ($r = .174$; $p < .05$). Moreover, as the consumption of carbonated drinks increased, dmft index score was increased, as well ($r = .236$; $p < .01$). However, a weak positive correlation was found between fast-food consumption and dmft index score ($r = .205$; $p < .05$). Similarly, there was a weak correlation between the added sugar consumption and dmft index ($r = .186$; $p < .05$).

A negative correlation was obtained between yogurt, milk, egg, and red meat consumption and dmft index score ($r = -.161$; $p < .05$; $r = -.234$; $p < .01$; $r = -.223$, $p < .01$; $r = -.244$, $p < .01$, respectively) (Table 3). The consumption of dairy products, meat, and their alternatives and dmft index score was inversely proportional ($r = -.275$; $p < .01$; $r = -.230$, $p < .01$, respectively), but there was no significant correlation between vegetables and fruit consumption and dmft index ($r = -.036$; $p > .05$).

Multiple-adjusted linear regression models were developed in bivariate analyses to predict caries risk of consuming significant cariogenic and anti-cariogenic foods. After adjustments for age and gender, the amount of carbonated drinks consumption was significantly higher in S-ECC group than the caries-free group ($\beta = 0.843$; 95% CI 0.008, 0.095). Meat consumption was found lower in the ECC group compared with the caries-free group and that was statistically significant after the adjustments for age and gender (Table 4).

Discussion

This cross-sectional study assessed preschool children in Ankara Turkey and demonstrated that socioeconomic factors, oral hygiene, and dietary habits significantly affect the development of dental caries in preschool children. Besides, we only detected 20.2% of the children to have no caries. Dental caries severity was significantly associated with the mother's education level, frequency of parent's toothbrushing, and previous history of a dental visit. Moreover, carbonated drinks and french fries were associated with increased dental caries risk; on the other hand milk, yogurt, eggs, and meat may reduce the risk.

We detected dental caries in more than two thirds of the children in this study. Similarly, other studies conducted in Turkey (İnan-Eroğlu et al., 2017; Ozler et al., 2018) and other developing countries reported a high prevalence of dental caries in children (Elamin et al., 2018; Shaghaghian et al., 2018). However, the prevalence in developed countries was lower (Grund et al., 2015; Pitts et al., 2007). Besides, the mean score of the dmft index in the 3- to 6-year-old children of our study was similar to that in Turkey National Oral

Table 1. Demographic Characteristics of Children and Caries Groups.

Variables ^a	Caries groups			p value
	Caries-free n (%)	ECC n (%)	S-ECC n (%)	
Gender				
Girl	14 (45.2)	37 (52.9)	13 (25.0)	.008**
Boy	17 (54.8)	33 (47.1)	39 (75.0)	
Age (months)				
30–47	13 (41.9)	11 (15.7)	34 (19.2)	.024*
48–59	5 (16.1)	16 (22.9)	38 (32.7)	
60–71	13 (41.9)	43 (61.4)	81 (48.1)	
Family income category				
≤1,300 TL	43.3	36.2	50.0	.096
>1,300–≥4,714 TL	43.3	56.5	50.0	
>4,714 TL	13.3	7.2	–	
Mother's education level				
Illiterate	1 (3.2)	2 (2.8)	9 (17.3)	.005**
Primary School	11 (35.5)	21 (30.0)	23 (44.2)	
Secondary School	6 (19.4)	15 (21.4)	11 (21.2)	
High school	6 (19.4)	22 (41.4)	8 (15.4)	
College	7 (22.6)	10 (14.3)	1 (1.9)	
Father's education level				
Illiterate	–	1 (1.4)	2 (3.8)	.443
Primary School	7 (22.6)	15 (21.4)	18 (34.6)	
Secondary School	7 (22.6)	17 (24.3)	13 (25.0)	
High school	10 (32.3)	27 (38.6)	15 (28.8)	
College	7 (22.6)	10 (14.3)	4 (7.7)	
Frequency of children teeth brushing				
>One time/day	9 (29.0)	19 (27.1)	19 (36.5)	.470
1 One time/day	7 (22.6)	17 (24.3)	16 (30.8)	
≥Two times/day	15 (48.4)	34 (48.6)	17 (32.7)	
Frequency of mother's teeth brushing				
>One time/day	14 (45.2)	24 (34.3)	5 (9.6)	.001**
1 One time/day	7 (22.6)	26 (37.1)	18 (34.6)	
≥Two times/day	10 (32.3)	20 (28.6)	29 (55.8)	
Frequency of father's teeth brushing				
>One time/day	11 (35.5)	24 (34.3)	7 (13.5)	.001**
1 One time/day	7 (22.6)	27 (38.6)	11 (21.2)	
≥Two times/day	13 (41.9)	19 (27.1)	34 (65.4)	
Dental visits				
No dental visits	3 (9.7)	30 (42.8)	28 (53.8)	.002**
For check-up	4 (12.9)	6 (8.6)	6 (11.6)	
For dental pain	24 (77.4)	34 (48.6)	18 (34.6)	

Note. ECC = early childhood caries; S-ECC = severe early childhood caries.

^aChi-square test was used to compare gender, age groups, family income categories, mother and father's education levels and oral hygiene habits between caries groups.

* $p < .05$. ** $p < .01$.

Health Survey (Güçiz & Kuvvetli, 2014) and other developing countries (Grund et al., 2015; Nishi et al., 2002; Pitts et al., 2007).

Several previous studies reported higher dental caries rates in girls, opposed to that observed in this study; Shaffer et al., 2015). The higher prevalence of caries among girls was mostly explained by the earlier tooth eruption of girls.

Therefore, they are exposed to the cariogenic oral environment for a longer period (Lukacs & Largaespada, 2006). On the contrary, two studies found no sex difference in caries prevalence (Ferraro & Vieira, 2010), and one found caries to be more frequent in males than in females (Holst et al., 1999). Differences in results may be due to sociocultural reasons, dietary behaviors, and access and utilization of oral

Table 2. Correlations Between Cariogenic Food Consumption and DMFT Index Score.

Variables	1	2	3	4	5	6	7	8	9	10	11	12
1. dmft	–	.127	.060	–.40	.91	.119	.174*	.055	–.032	.024	.236**	.134
2. Cracker (g)		–	.031	.107	.151	.172*	.189*	.074	–0.40	.048	.035	.02
3. Bread (g)			–	–.042	–.048	.081	.012	.013	.048	–.104	–.108	–0.98
4. Cereals (g)				–	–.013	.022	–.227**	.038	.081	0.008	.071	.01
5. Potato crisps (g)					–	.101	.316**	–0.11	–.147	.187*	.338**	.217**
6. Bakery-cookies-cake (g)						–	.215**	.202*	.044	–.006	.012	.085
7. French fries (g)							–	.105	–.093	.032	.195*	.049
8. Banana (g)								–	.126	–.001	–.132	.076
9. Dried fruit (g)									–	–.053	–.056	–.070
10. Fruit juice (mL)										–	.201*	.237**
11. Carbonated drinks (mL)											–	.184*
12. Sweets												–

Note. DMFT = decayed-missing-filled teeth.

* $p < .05$. ** $p < .01$.

Table 3. Correlations Between Anticariogenic Foods (g) and DMFT Index Score.

Variables	1	2	3	4	5	6	7	8	9	10	11	12
1. DMFT	–	–.234**	–.161*	–.098	–.244**	–.116	–.223**	–.044	.095	–.074	.040	–.80
2. Milk		–	.141	–.085	.187*	.131	.204*	.032	–.004	.034	.058	.139
3. Yogurt			–	.135	.072	.172*	.131	.106	.058	.123	.069	–.037
4. Cheese				–	.186*	–.071	.228**	.107	–.036	.025	.101	.011
5. Meat					–	.314**	.166*	.407**	.029	.112	.216**	.078
6. Chicken						–	.146	.324**	.051	.218**	.311**	.182*
7. Egg							–	.169*	–.203*	.193*	.099	.032
8. Fish								–	.157	.185*	.148	.086
9. Peanut									–	.065	.049	.179*
10. Carrots										–	.239**	.143
11. Apple											–	.204*
12. Raw vegetables												–

Note. DMFT = decayed-missing-filled teeth.

* $p < .05$. ** $p < .01$.

health care, and some of these factors may differ among populations. The older children had higher caries prevalence, consistent with other previous studies (Bae et al., 2018; Shaghaghian et al., 2018). As the child grows up, the teeth expose to cariogenic factors such as the cariogenic environment more, and eventually the risk increases.

According to the results of this study, growing in a higher socioeconomic family was related to less risk for dental caries. Similarly, Hoffmeister et al. (2016) and Bae et al. (2018) reported significantly better dental health status in children of parents with higher socioeconomic status. That can be explained by the higher budgets spend on dental preventive and restorative care in families with higher income. The difference between the mother's education level and caries groups was significant but no statistically significant association was observed between the father's education level and dental caries of children. These findings support the results which presented the socioeconomic level of parents as an

important predictor of caries risk among children (Bae et al., 2018; Tanaka et al., 2013; Yazdani et al., 2020). Generally, men are more involved in public duties, and the women participate more in household chores and look after the children in developing countries such as Turkey. Therefore, mothers spend more time on the care of their children's oral hygiene and eating habits. Furthermore, higher household income and higher education could be related to the availability and accessibility of healthy foods and dental care services (Bae et al., 2018).

We found a nonsignificant relationship between the frequency of children's toothbrushing and their dental caries status. However, in this study, parents who brush their teeth more than twice a day have a lower risk of caries. Contrarily, it was reported that children brushing their teeth at least twice a day were associated with reduced caries risk (Hoffmeister et al., 2016; Morikava et al., 2018). Although there are several oral health educational programs for

Table 4. Amount of Food Consumption of ECC and S-ECC Groups Compared with the Reference Group.

Foods (g)	Caries-free ^a		ECC		S-ECC		
	X ± SE	X ± SE	Crude β (95% CI)	Adjusted β ^b (95% CI)	X ± SE	Crude β	Adjusted β ^b (95% CI)
Carbonated drinks	19.1 ± 50.4	23.9 ± 52.3	-0.69 (-0.368, 0.329)	-0.082 (-0.359, 0.194)	32.2 ± 42.4	0.751 (-0.239, 1.742)	0.843 (0.008, 0.095)
French fries	13.4 ± 17.1	18.8 ± 18.9	0.02 (-0.015, 0.19)	0.001 (-0.015, 0.017)	24.1 ± 23.8	0.057 (0.013, 0.101)	0.052 (-0.141, 1.827)
Milk	284.7 ± 165.5	231.6 ± 150.0	-0.001 (-0.003, 0.001)	0.000 (-0.002, 0.002)	179.3 ± 145.0	-0.005 (-0.011, 0.001)	-0.003 (-0.009, 0.004)
Yogurt	142.9 ± 89.1	126.6 ± 89.1	-0.001 (-0.004, 0.003)	0.000 (-0.004, 0.003)	103.4 ± 98.2	-0.009 (-0.019, 0.001)	-0.007 (-0.017, 0.003)
Egg	38.7 ± 21.9	39.7 ± 25.8	-0.001 (-0.014, 0.012)	-0.002 (-0.014, 0.011)	25.3 ± 17.9	-0.054 (-0.104, 0.003)	-0.052 (-0.103, 0.001)
Meat	16.6 ± 21.9	12.7 ± 12.3	-0.016 (-0.036, 0.005)	-0.025 (-0.045, 0.005)	9.3 ± 21.3	-0.015 (-0.062, 0.32)	-0.022 (-0.069, 0.025)

Note. X = mean; β = coefficient; SE = standard error; ECC = early childhood caries; S-ECC = severe early childhood caries.

^aCaries-free group = reference group.

^bAdjusted for age and sex.

Bold indicates $p < .05$.

preschool children in Turkey, these results indicate that may not be sufficient and/or adequate. Therefore, new strategies and updated practical educational programs on dental health should be discussed for developing countries such as Turkey. Besides, about half of the children in the ECC and S-ECC groups of this study had never visited a dentist before, and only 10% of them had undergone a routine dental check-up. These rates may clearly explain the high prevalence of dental caries in participants. The impact of dental check-ups to decrease dental caries risk was previously pointed out (Armfield et al., 2007), and the future strategies to decrease dental caries prevalence in preschool term children should include routine check-up programs. Besides parents should pay attention to the restorative needs of children as well as protective approaches. Moreover, joyful advertisements to invite children to dental clinics may help to overcome dentist phobia, and brochures for regular dental check-ups of preschool children may increase the awareness of parents.

Cariogenic foods such as sugary drinks and foods, carbonated beverages, and fast food are among the features of the Western-style diet. This diet type leads to the formation of organic acids through microorganisms in the mouth and saliva and decreases the pH below 5.5 which accelerates the formation of caries (Giacaman, 2018). It was reported that there is a positive correlation between sugar or soft drink consumption and decay (Ollila & Larmas, 2007; Tsai et al., 2006) and between carbonated soft drinks and cavitated caries (Marshall et al., 2003; Sohn et al., 2006). In this study, we determined that carbonated beverages affected caries formation, similar to other studies. Acidic carbonated drinks directly cause demineralization in teeth. Moreover, the consumption of carbonated drinks by children damages the teeth enamel and causes caries (Masson et al., 2010). We also found that the dmft index score of children elevates as the

french fries consumption of the children increases. Chankanka et al. (2011) stated that the consumption of foods with processed starch, such as cake, fries, potato chips, and crackers, increases the risk of caries formation. In another study, it was found that children who frequently consumed cake and fries had an increased risk of dental lesions and enamel cavitations (Giacaman, 2018). Refined and processed cereals contain modified starch and maltose which are sensitive to saliva amylase. As a result of the fermentation of maltose, the pH of the plaque decreases and leads to demineralization of the teeth. Furthermore, recently women in Turkey participate more in working life which may diminish cooking habits at home, and also the influences on lifestyle may lead to more fast food consumption and Western-style diet even in families that mothers do not participate in working life. Therefore, we found out that a Western-style diet was related to dental caries formation, and future studies may evaluate the cooking habits of working and nonworking women to better understand the effect of cooking habit alterations in society.

Oral health is positively affected by the consumption of vegetables and fruits with high fiber content, which are typical contents of a Mediterranean-style diet (Lacatuşu et al., 2019). Although increased apple, carrot, and raw vegetable consumption was related to decreased dmft index in participants, we could not detect a significant correlation between them. Interestingly, İnan-Eroğlu et al. (2017) reported high dmft scores in children with high Mediterranean diet scores. However, the findings were statistically insignificant. According to the Healthy Eating Index-2010 score, children with good diet quality had significantly lower dmft index scores. Similarly, Healthy Eating Index-2005 was used by Zaki et al. (2015) and the total vegetable intake score showed no significant relationship with the caries formation. Dowidar

and El Tantawi (2008) did not detect a statistically significant relevance between mean vegetable portion between caries-free and caries affected children. Due to the increase in fiber intake with hard fruits such as raw vegetables and apples, the saliva flow rate increases as they require more chewing activity which may also have a positive impact on dental caries (Tinanoff, 2005). However, it is known that starchy foods such as potatoes and bananas are finely ground, heat-treated, and may cause caries with frequent consumption. These starchy vegetables are divided into simple sugars that are metabolized by saliva amylase and bacteria that cause tooth decay (Moynihan & Petersen, 2004). The multivariate analysis revealed that the consumption of french fries increases the risk of S-ECC approximately 6 times more compared with those without carries.

Anti-decay substances in several nutrients show their effect either by preventing demineralization or by reducing the acid formation at the plaque (Zaki et al., 2015). The dmft index score of the participants significantly decreased as the milk and yogurt consumption increased. Milk and milk-based cheeses are known to have a protective effect on teeth. A high level of phosphorus and calcium and the strong taste of cheese induce the secretion of saliva, which neutralizes the acidity of the plaque and also diminishes oral bacteria colonization (Rugg-Gunn, 2001).

Meat and egg consumption was found lower in the ECC group than the caries-free group ($p < .05$). The preventive effect of protein-rich foods on caries formation may be explained by the urea released during their metabolism that neutralizes the acidic environment, thus suppressing the demineralization (Dowidar & El Tantawi, 2008). Consumption of protein-rich foods in meals may be suggested to decrease the formation of caries in preschool children.

This study had a few limitations. First, the absence of radiographic examination to determine the prevalence of dental caries may lead to a lower detection of decayed teeth. Also, the examinations were performed once. Thus, undiagnosed proximal carious lesions may not be detected. As many different foods and beverages are taken together at different times, the relationships between the frequency of consumption of certain types of foods or beverages, and the results of caries may interfere with each other. As it is a cross-sectional study, it does not reflect the whole society, and therefore population-based studies with larger sample sizes may better explain the relationship between caries formation and certain food consumption. Nevertheless, we believe that interventions involving the preschool-aged population are crucial for constructing a healthier generation, and the results of this study may have an impact on social policies to organize necessary precautions. Finally, a selection bias may occur due to voluntary participation, and randomized, prospective design studies are recommended for future research.

Conclusion

In this study, we determined that low-carbonated beverages, starchy food consumption, and high protein-containing beverages (milk and dairy products), and foods (meat, eggs) had a positive effect on dental health. Dental caries is a multifactorial disease and is related to other risk factors. To reduce dental caries, it is necessary to spread protective dentistry services and to inform children and families about healthy nutrition. Longitudinally designed future research is needed to investigate the risk factors for noncavitated caries as a subgroup and to define potential protective nutrients in preschool childhood.

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Author Contributions

N.N.A.Ç. and H.Y. formulated the research question and design of the study. N.N.A.Ç. recruited participants and all measurements; N.N.A.Ç. analyzed data, N.N.A.Ç. and H.Y. wrote the manuscript, and N.N.A.Ç., H.Y., and A.O.O. approved the final manuscript.

Declaration of Conflicting Interests

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Ethical Standards Disclosure

Approval of the Ethics Committee was received from Ankara Children's Hematology-Oncology Hospital, Ankara, Turkey, and the Helsinki Declaration principles were followed in the research.

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