

Role of Foods in Caries Among Preschool-Children: A Cross-Sectional Study

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Abstract. *Introduction:* Early childhood caries (ECC) is a chronic infectious disease that affects children and is a serious public health problem. Proper and balanced nutrition is important for preventing caries and developing immunity against infections. The aim of this study is to evaluate the relation between childhood caries and consumption of cariogenic and anti-cariogenic foods among children 30-78 months old. *Materials and Methods:* The study was carried out with 200 children between 30-78 months old. The questionnaire form was included sociodemographic characteristics, nutritional habits and frequency of consumption of food groups. Presence of decayed, extracted or filled teeth was recorded from dentist files and decayed-missed-filled teeth (dmft) index was calculated. Patients were divided into two groups according to dmtf index as children with and without caries. The data was evaluated with proper statistical methods. *Results:* During the study, 200 children (116 male, 84 female) were evaluated. Mean age was 61.4±11.9 months. Educational status of parents was related to presence of caries (p<0.05). Presence of caries was related to regular consumption of breakfast and lunch but there was not a significant relation for dinner. Consumption of potato crisps, fizzy drinks, and sweets was more frequent among children with caries (p<0.05) whereas consumption of anti-cariogenic animal oriented foods was more frequent among children without caries (p<0.05). Frequency of milk, yogurt and chicken consumption was higher among caries-free children (p<0.05). *Conclusions:* Consumption of cariogenic foods has an important role in the occurrence of early caries among children. Longitudinal cohort studies are recommended to determine causal mechanisms.

Key words: anti-cariogenic food, cariogenic food, children, dental caries

Introduction

Foods are important for the healthy growth and development of children (1). Unhealthy nutritional habits developed during early childhood causes many health problems including dental and oral health. Childhood caries are accepted as a pandemic disease characterized by untreated cavities causing pain, discomfort, and functional restriction (2).

Dental problems are among the most frequent health problems in almost every part of the world (3). Early childhood caries (ECC) is a chronic infectious disease that affects children and is a serious public

health problem (4). ECC is defined as the presence of one or more decayed (non-cavitated or cavitated lesions), missing (due to caries) or filled tooth surfaces in any primary tooth in a preschool-age child between birth and 71 months of age (5). Like with other forms of dental caries, ECC is a multifactorial condition. Caries are formed due to the interaction of sugar and microorganisms on tooth surface in time (6). Social and behavioral risk factors due to unhealthy life habits are shown to be related to dental caries (7). The incidence and prevalence of dental caries are reported to be stable between 1990 and 2010 (8) and economic burden is supposed to be nearly 442 billion dollars only in 2010

(9). World Health Organization (WHO) claimed a target for caries and periodontal disease of children 5-6 years of age as 80.0% caries-free children (10). Unfortunately, according to 2014 health survey conducted in Turkey the prevalence of dental caries is reported as 69.8% and dmft is found as 3.7±3.9 in Turkey (11).

Dental caries have a close relation with nutritional habits (12). Proper and balanced nutrition is important for preventing caries and developing immunity against infections (13,14). Risk of caries is related to how and when foods are taken and the frequency of adding sugar is shown to increase the risk of caries (15). Sugar taken with daily food, fruit juice and starchy food are accepted to have high cariogenic potential (16,17). Consumption of these foods is causing the accumulation of pathogenic number of bacteria on teeth leading to development and worsening of dental caries (13). Besides food known to have cariogenic effects, foods such as milk, cheese, meat, whole grain bakery and unprocessed herbal food are evaluated for their anti-cariogenic effects (16, 18-20).

The aim of this study is to evaluate the relation between childhood caries and consumption of cariogenic and non-cariogenic foods among children 30-78 months old.

Materials and methods

The study is a cross-sectional survey and was carried out between January 2019 and December 2019, Ankara. Approval of the Ethics Committee was received from the Health Sciences University, Ministry of Health Ankara City Hospital (protocol number: 2019-005), and the Helsinki Declaration principles were followed in the research.

Subject selection

A total of 200 patients aged 30-78 months old who applied to pediatric dental health clinic of the hospital, which is tertiary research, and education hospital were included in the study. Children aged between 30 and 78 months who had physical and/or mental disorders affecting oral health and had a previous history of antibiotic treatment in the past 2 weeks, and those whose family or caregiver not agreed to participate in

the study were excluded. A pilot study was first conducted including twenty 30-78 months children and their parents to test the questionnaire. The volunteers in the pilot study did not participate in the main study.

Data collecting

The data is gathered via a standard questionnaire including information about demographic data (age of child and parents, family structure, educational status of parents, monthly income of the family) and nutritional habits. Household income was analysed as a numerical value based on the Turkish monthly minimum wage, which was 2500 Turkish Liras (US\$450) at the time of data collection. According to the examination of the dentist, dmft index was calculated by dividing number of decayed + missed + filled teeth to total number of teeth the child had at the time of examination. Children were divided to two groups as "caries-free" and "with caries" (dmft<4 for 3 years old, dmft<5 for 4 years old, dmft<6 for 5 years old and dmft<7 for 6 years old) (21).

The food frequency questionnaire (FFQ), which consisted forty-five items semi-quantitative, was used to assess cariogenic and anti-cariogenic foods consumption in the last one month. The questionnaire is an adapted version of the FFQ developed by Willett et al. (2015) (22), and it has already been used and validated in the general population in Turkey (23). The frequency and amounts of food intake were evaluated per day. The "A Photographic Atlas of Food Portions Sizes" developed for Turkey was used in order to correctly assess the amounts of the food consumed (24). The amounts that children consume the cariogenic (crackers, bread, cereal, potato, chips, pastry-cookies, cake, French fries, banana, dried fruit, instant juice, carbonated drinks, confectionery bon sugar, tea sugar, jelly foods, caramel foods, honey-jam), and anti-cariogenic foods (milk, yogurt, cheese, red meat, chicken, eggs, fish, other seafood, peanuts, carrots, apples, raw vegetables, cucumber, tomato, pepper, etc.) at once were learned by asking the parents.

Statistical analysis

All statistical analyses were conducted using the Statistical Package for Social Science (SPSS version 21

for Windows, Chicago, IL). The normality of continuous variables was tested using the Kolmogorov-Smirnov test. A Fisher exact test was used to compare general characteristics and nutrition habits of the participants with or without dental caries. An Independent t-test was used to compare the age, cariogenic and anti-cariogenic foods of the study participants within dental caries groups. The results were assessed based on 95% confidence interval and $p < 0.05$ significance levels.

Results

During the study period, 200 children (84 girls and 116 boys) were evaluated. Subjects ages ranged between 30–78 months and mean age was 61.4 ± 11.9 months. Education level of both mother and father are related to presence of caries in the study group

($p < 0.005$). Mean monthly income was US\$676; US\$754 in caries-free group and US\$656 in the group with caries ($p = 0.172$). Presence of caries was more frequent (41.9%) among children with a monthly income under US\$450. Socio-demographic characteristics of patients are listed in Table 1.

79.5% of the included to the study had caries. Of the patients, 17.0% was 30–47 months old, 19.0% was 48–59 months old and 64.0% was 60–78 months old. Mean number of teeth with caries (dt), missing teeth (mt), filled teeth (ft) and dmft was 2.4 ± 3.0 , 0.0 ± 0.0 , 0.1 ± 0.2 and 2.5 ± 3.0 in 30–47 months group; 4.6 ± 5.1 , 0.5 ± 2.6 , 0.2 ± 1.2 and 5.3 ± 5.4 in 48–59 months group; 3.9 ± 3.4 , 0.0 ± 0.2 , 0.2 ± 0.8 and 4.1 ± 3.5 in 60–78 months group. There was a significant difference between age groups for both dt and dmft ($p < 0.05$) (Figure 1).

Nutrition habits of children are showed in Table 2. Frequency of caries was more frequent among children who had regular breakfast and lunch than children

Table 1. Socio-demographic characteristics of children with and without caries

Variables	Caries-free (n=41)		Caries present (n=159)		P value
Age [†]	58.2 (14.8)		62.3 (11.0)		0.199
Gender[‡]					
Female	16	19.0	68	81.0	0.401
Male	25	21.6	91	78.4	
Mother's education levels					
Primary school	14	34.1	71	44.7	0.019*
Secondary school	7	17.1	32	20.1	
High school	8	19.5	41	25.8	
College	12	29.3	15	9.4	
Father's education levels					
Primary School	9	21.9	48	30.3	0.040*
Secondary School	8	19.6	38	23.9	
High school	11	26.8	54	33.9	
College	13	31.7	19	11.9	
Income (n=195)					
<\$450	15	37.5	65	41.9	0.172
\$450-\$1600	20	50.0	83	53.6	
>\$1600	5	12.5	7	4.5	

[†] Numeric variables are presented as mean±standard deviation. t test is used for p value.

[‡] Nominal variables are shown as percentage (frequency). Fisher's Exact test was used for p value.

*p value<0.05

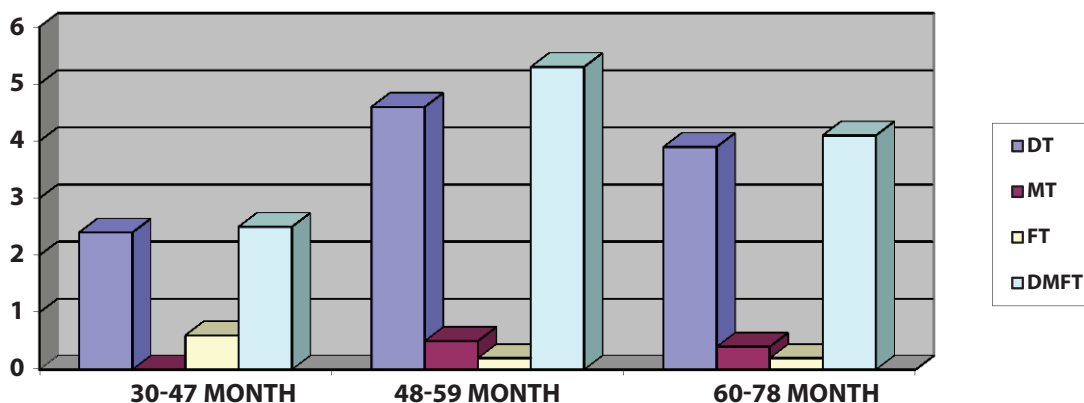


Figure 1. Relation between age groups and number of decayed teeth (dt), missed teeth (mt), filled teeth (ft) and dmft.

Table 2. Nutrition habits of children with and without caries

Nutrition habits	Caries-free (n=41)		Caries present (n=159)		P value
Breakfast					
Yes	40	97.6	139	87.4	0.043
No	1	2.4	20	12.6	
Lunch					
Yes	39	95.1	123	77.4	0.005
No	2	4.9	36	22.6	
Dinner					
Yes	39	95.1	146	91.8	0.341
No	2	4.9	13	8.2	
Snack meals					
Yes	40	97.6	157	98.7	0.499
No	1	2.4	2	1.3	

Nominal variables are shown as percentage (frequency).

Fisher's Exact test was used for p value.

*p value<0.05

who did not have ($p<0.05$); presence of caries was not different between groups who had and did not have regular dinner ($p>0.05$). Of the children, 98.5% were having snacks between meals; 79.7% of children with caries and 20.3% of caries-free children had at least one snack between meals ($p<0.05$). Foods most frequently consumed during snacks were fresh fruits, chocolate, biscuits-cakes and milk and milk products. Most frequently consumed food during snacks were

chocolate (48.1%), biscuit-cake (44%) among children with caries whereas they were milk (84.6%) and fresh fruits (58.5%) among caries-free children. Biscuit-cake consumption during snacks was more frequent among children with caries ($p=0.025$).

Children with caries are consumed more French fries, fizzy drinks and sweets than their caries-free peers ($p<0.05$) (Table 3). Consumption of cariogenic foods such as bananas, dried fruit and cracker was not different between children with and without caries ($p>0.05$).

Caries-free children are found to consume more animal originated anti-cariogenic foods such as milk, yogurt and chicken than their peers with caries ($p<0.05$) (Table 4). Consumption of plant originated anti-cariogenic foods was not significant difference between children with and without caries ($p>0.05$) (Table 4).

When patients were evaluated for dental hygiene they have reported that 27.0% brushed their teeth once, 28.5% brushed twice a day. Of the children, 27.0% brushed their teeth irregularly, whereas 38.0% never brushed. Twenty-three percent of children without caries and 76.9% of children who had dental caries reported that they have never brushed their teeth ($p>0.05$). Of the parents, only 15.5% reported that they were acknowledged about fluorination of teeth but there was not a significant difference for the frequency between parents of children with and without dental caries (data not shown).

Table 3. Cariogenic food consumption of children with and without caries

Cariogenic foods	Caries-free		Caries present		p value
	X	SD	X	SD	
Cracker (g)	4.5	5.2	6.0	6.7	0.208
Bread (g)	83.1	53.4	80.6	47.9	0.837
Cereals (g)	1.4	5.0	2.6	7.5	0.382
Potato crisps (g)	8.8	12.7	7.9	10.9	0.825
Bakery-cookies-cake (g)	7.6	8.4	11.6	13.7	0.168
French fries (g)	16.0	22.7	21.8	20.5	0.011*
Banana (g)	62.1	66.2	72.4	72.3	0.382
Dried fruit (g)	4.4	10.5	4.9	9.9	0.571
Fruit juice (mL)	70.7	87.4	84.9	92.4	0.462
Fizzy drinks (mL)	21.3	52.9	27.0	49.1	0.020*
Sweets (g)	4.3	4.6	6.4	10.5	0.022*

X: Mean, SD: Standard deviation

Numeric variables are presented as mean±standard deviation. t test was used for p value.

*p value<0.05

Table 4. Anti-cariogenic food consumption of children with and without caries

Anti-cariogenic foods	Caries-free		Caries present		p value
	X	SD	X	SD	
Milk (mL)	277.7	151.5	211.5	147.3	0.010*
Yogurt (g)	143.4	82.2	115.0	92.1	0.033*
Cheese (g)	20.1	14.5	17.6	16.9	0.227
Meat (g)	17.3	19.1	11.7	16.5	0.127
Chicken (g)	34.5	39.3	23.2	26.7	0.049*
Egg (g)	38.6	20.3	34.3	22.3	0.134
Fish (g)	20.3	21.3	14.5	19.2	0.176
Peanut (g)	4.0	7.8	5.9	14.3	0.245
Carrots (g)	29.2	32.6	36.2	52.9	0.700
Apple (g)	137.4	81.3	144.5	100.5	0.868
Raw vegetables (g)	31.8	25.9	30.0	25.3	0.663

X: Mean, SD: Standard deviation

Numeric variables are presented as mean±standard deviation. t test was used for p value.

*p value<0.05

Discussion

Caries, which is one of the most important problems of dental health, can develop due to individual and environmental factors. Dental caries is one of the problems that must be solved for the preservation of public health. The present study was carried out to

investigate the impact of cariogenic and anti-cariogenic foods affecting dental caries in 30-78 months old children. The main nutritional risk factors for ECC are feeding practices of the children such as prolonged breast feeding, bottle-feeding with sugar containing liquids, breast-feeding on demand, falling asleep with sugar containing liquids etc. Although the data on the

impact of cariogenic and anti-cariogenic food on the development of dental caries is very limited for pre-school children.

This study found that 79.5% of 30-78 months old children had dental caries that is a very high prevalence and must be alarming for Turkish parents and health officers. Actually, this high frequency is in accordance with studies from other countries. A recent survey in US children reported a prevalence of 80.0% among 3-year-old children (25). Another study by Phipps et al. (26) stated a prevalence of 61.0% for children 3 years old. In this study the wider age group compared to other studies may result in different results.

In our study dmft index was found as 4.1 ± 4.0 , number of caries as 3.8 ± 3.8 , number of filling as 0.2 ± 0.8 and number of decayed teeth as 0.1 ± 1.2 . Similarly, Morikava et al. (2018) (27) found the rate of dental caries higher in children under the age of eight compared to children over the age of eight.

Changing of nutritional habits may explain the increase in the prevalence of dental caries by age. Consumption of cariogenic food may increase by age contributing to development of dental caries. Children develop independent eating behaviour with increasing age and during playtime, they are affected by their peers.

Gender is another factor that has an impact on dental caries. In a study by Kurian et al. (28), girls were reported to have dental caries more often than boys. This relation was not shown in our study. The reason for the more frequent caries among girls may be the earlier dental formation and longer exposition of teeth to cariogenic food.

Educational status of parents also affects dental caries. In this study both maternal and paternal educational status are found to be related to the frequency of dental caries. Earlier studies have shown that children of mothers with a lower educational status are more prone to dental caries (3,29-31). Higher education of families is supposed to bring awareness about general health issues and make parents pay more attention to dental health of their children. In addition to education, economic status of the family is known to effect dental health status. In our study, children of families with a higher income were shown to have less dental caries. Bonotto et al. (32) have also revealed a relation between

lower family income and dental caries. Other previous studies have also supported the effect of low income on dental caries (33-35). Living in lower economic conditions may have a negative impact on quality of life. Families with a lower income may skip regular dental controls and may take the child to a dentist only when there is a toothache. Furthermore, poor nutritional status may negatively affect dental health. Unfortunately, we have not questioned our patients for these features so we cannot give information on this subject.

It is important to have regular meals during pre-school period to help developing healthy nutritional habits and preventing dental caries. In our study, dental caries were found to be more frequent among children who do not have regular breakfast and/or regular lunch. Diocinova et al. (1) could not relate number of meals with dental caries but they have reported that increased daily sugar intake is related to proximal dental caries. Type of consumed food has an important impact on the development of caries. Exposition of teeth to cariogenic food causes an increase in the frequency of dental caries (12). Especially sugar consumption has a considerable effect (10,36). Punitha et al. (37) have reported that sweet and chocolate intake was related to dental caries. Carbohydrates accumulating on the surface of teeth cause a decrease in pH leading to dental caries (38). In our study, we have also found that dental caries are more frequent among children consuming sugary food and fizzy drinks. In accordance with our study, Australian children were shown to have more dental caries if they consumed fizzy drinks frequently (39). Nunn et al. (4) reported that sugar and fruit juice consumption is related to severe early childhood caries. In our study, although not significant, fruit juice consumption was more frequent among children with dental caries. Decreasing consumption of sugary food can help preventing dental caries and measures can be taken to force decreasing sugary food intake. Finkelstein et al. (40) and Andreyeva et al. (41), reported that increasing taxes put on sugar-added beverages may decrease their consumption and may help prevention of childhood dental caries. Increasing taxes for sugar-added beverages might be a step in the prevention of caries in our country.

Besides simple sugars, starch consumption, especially when processed, can have a negative impact

on dental caries (42). In our study, eating potato crisps was more amount among children with caries. Some former studies have also shown that processed starchy food taken for snacks, such as potato crisps, tortilla potato crisps and crackers are related to development of caries (43,44). Processed starchy food can be more dangerous when sugar is added. Milgrom et al. (45) reported that dental lesions and enamel cavitation's are more frequent among children who frequently have cake and pastry. Accordingly, in our study cake, pastry and cracker intake was more frequent among children with caries but the difference was not significant.

Protein rich foods are accepted as anti-cariogenic; because when they are digested, urea is released neutralizing acidic pH and suppressing demineralization (20). In this study, we have revealed that milk, yogurt and chicken consumption was significantly more amount among caries-free children. Furthermore, animal originated food as cheese, red meat, fish and egg consumption was more frequent among caries-free children but the difference was not significant. Milk and cheese are reported to decrease metabolic acid activity in the mouth causing a preventive effect against dental caries (19,46). Some studies have shown that casein, calcium and phosphate included in milk also has a preventive effect against dental caries (47,48). Moreover, consumption of protein rich food can help gaining a habit of regular meal consumption by decreasing consumption of snacks (20).

Unprocessed herbal foods are also accepted as anti-cariogenic (49). Vegetables contain polyphenols, phytates and phosphate can decrease acid production and prevent plaque formation. This helps the re-mineralization of dental mine. Fibre content of vegetables increases chewing and saliva formation thus augments the buffering effect of saliva (18). In our study, caries-free children consumed more carrots, apples, and uncooked vegetables.

Limitations

In terms of the limitations of this study, as it was a cross-sectional study, the results may not be generalizable for all children. This study was conducted with children applying to only one center, which

may constitute a potential bias in the results. Another limitation; parents may not know the food they eat at kindergarten because children attending daycare. Therefore, this information is limited to what parents know. Besides, many different foods and beverages are taken together and/or 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.

Conclusions

This study has proven that cariogenic food has an important role in the early formation of dental caries during childhood. Anti-cariogenic food such as milk, yogurt and chicken are shown to be effective for decreasing dental caries in early childhood. Preschool period is a vulnerable age group for nutrition and health. Adopting good nutritional habits in this age group may help to develop healthy eating behaviour in a teenager. Nutritional education must include information about the relation between eating habits and dental health. During education, attitudes and characterizations of families must be taken into account for better collaboration. Furthermore, additional cohort studies are needed to confirm this association and to investigate the underlying mechanism between cariogenic and anti-cariogenic foods and dental caries.

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