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Investigation of Nutrition Behaviour, Oral Health and Presence of Salivary *Porphyromonas Gingivalis* and *Bifidobacterium* Species of School Children in Istanbul

İstanbul'da Okul Çağindaki Çocukların Beslenme Davranışı, Ağız Sağlığı ile Tükürükte *Porphyromonas gingivalis* ve *Bifidobacterium* Türleri Varlığının Araştırılması

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ABSTRACT

Objective: One of the most important environmental factors affecting oral-dental health is nutrition. This study aimed to investigate the relation of Body Mass Index (BMI) and dietary habits to the oral-dental health of children, and the presence of *Porphyromonas gingivalis* and *Bifidobacterium* species in saliva.

Methods: One-hundred-thirty children between the ages of 9-14 were included in the study. Decayed, Missing, and Filled Teeth/Surfaces (DMFT, DMFS) of permanent, and decayed and filled teeth/surfaces (dft, dfs) of primary teeth were recorded, and plaque (PI) and gingival (GI) indexes were also assessed. Anthropometric measurements and food records were taken, and saliva samples were analyzed microbiologically.

Results: A negative correlation between BMI and dft, dfs scores, and a positive correlation between BMI and oral-dental health parameters was found (p<0.05). A positive correlation was also found between the visiting frequency of children to dentists and GI. Mutual interactions between PI and GI, DMFT and DMFS, a strong interaction between dft and dfs indexes was observed. Saliva *Bifidobacterium* sp. was significantly related to dft, dfs indexes. BMI, Bifidobacterium sp., DMFT, DMFS scores increased with age. None of the children had *P.gingivalis* in saliva, while 3.1% had *Bifidobacterium* sp.. A positive correlation occurred with bread consumption, whereas a negative correlation occurred in grain consumption with a comparison of the DMFS index (p<0.05). Sugar intake was positively correlated; total dietary fiber intake was negatively correlated with PI (p<0.05).

Conclusion: Besides age-related results, oral-dental health parameters were also affected by daily dietary intake and nutritional habits of school children.

Keywords: Nutrition, Dental health, *Porphyromonas gingivalis, Bifidobacterium*

ÖZ

Amaç: Ağız ve diş sağlığını etkileyen en önemli faktörlerden bir tanesi beslenmedir. Bu çalışmada çocuklarda vücüt kitle endeksi ve beslenme davranışının ağız-diş sağlığı ile tükürütkte *Porphyromonas gingivalis* ve *Bifidobacterium* varlığı üzerine etkilerini araştırma amaçlanmıştır

Yöntem: Çalışma 9-14 yaş arası 130 çocuk ile yapılmıştır. Kalıcı dişlerde çürük, kayıp ve dolgulu diş/yüzey (DMFT, DMFS) parametreleri, geçici dişlerde çürük ve dolgulu diş/yüzey (dft, dfs) parametreleri kaydedilmiştir. Ayrıca plak endeksi (PI) ve gingival endeks (GI) ölçülmüştür. Antropoetik ölçümler ve gıda tüketimi kaydedilmiş ve mikrobiyolojik analiz için tükürük örnekleri alınmıştır.

Bulgular: BMI, dft ve dfs parametreleri arasında negatif bir korelasyon tespit edilmiştir. Ağız-diş sağlığı parametreleri arasında pozitif korelasyon vardır (p<0.05). Aynı zamanda diş hekimmini ziyaret sıklığı ile GI arasında pozitif korelasyon bulunmuştur. PI, GI, DMFT ve arasında karşılıklı etkileşim varken, dft ve dfs endeksleri arasında güçlü bir etkileşim görülmüştür. *Bifidobacterium sp*. sonuçları anlamlı şekilde dft ve dfs ile bağlıntılıdır. BMI, *Bifidobacterium sp*., DMFT ve DMFS endeksleri yaş ile artmıştır. *Porphyromonas gingivalis* ise tükrük örneklerinde tespit edilmemiştir. *Bifidobacterium sp.* %3.1 oranında tespit edilmiştir. DMFS endeksi ekmek tüketimi ile pozitif, tahıl tükeimi ile arasında anlamlı negatif korelasyon görülmüştür (p<0.05). PI endeksi şeker tüketimi ile pozitif, lif tüketimi ile negatif korele olduğu tespit edilmiştir (p<0.05).

Sonuç: Yaşa bağlı sonuçların yanında, ağız-diş sağlığı parametrelerinin okul çağındaki çocukların günlük diyet içeriğinden ve beslenme alışkanlıklarından da etkilendiği görülmüştür.

Anahtar Kelimeler: Beslenme, Diş sağlığı, *Porphyromonas gingivalis, Bifidobacterium*

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1. INTRODUCTION

Nutrition is an essential and integral part of the growth, development, and health of children. Unhealthy eating habits negatively affect oral health and increase the risk of the development of obesity. Hence, the quantity and frequency of carbohydrate consumption was linked to tooth decay and periodontal problems in children, as well as being associated with obesity (Li et al., 2015). In the presence of cariogenic bacteria, carbohydrates such as candies and sweets, sugar-sweetened beverages, chips, bread, rice, and pasta can lead to acid production. Besides the dietary sources of these cariogenic carbohydrates, there are several foods in literature, which are not associated with caries, such as fiber-rich foods, whole grains, and milk. Therefore, nutrition plays an essential role in the prevention of dental and oral health problems, because nutrition habits can change the oral microbiota (Moynihan, 2005).

Although *Bifidobacterium* species are gram (+) bacteria with well-known probiotic features, commensal strains of bifidobacterium in the oral cavity are thought to be caries promoters with their acid resistance properties (Valdez et al., 2016). *Porphyromonas gingivalis* (*P. gingivalis*) is a gram (-) bacterial pathogen, which has the potential to settle in the oral flora and increase the risk of periodontal disease in children (Hayashi et al., 2012). The presence of *Bifidobacterium* sp. and *P. gingivalis* in the oral cavity vary in healthy children depending on various factors, such as age, caries, and nutrition habits. In vitro experiments suggested that *Bifidobacterium* sp. contributes to the inhibition of *P. gingivalis* growth in subgingival biofilm (Jasberg et al., 2016). Nevertheless, the in vivo prevalence of these bacteria vary across studies and the relationship under in vivo conditions is lacking in the literature.

The period from childhood to adolescence is a critical stage of life, where children acquire important behaviours about their general and oral health. Habits like unhealthy diet, poor oral hygiene care that appear in childhood tend to move into adulthood (Markovic et al., 2015). The association between BMI and oral health status had been examined in various studies that cover periodontal health, missing teeth, and dental caries. Furthermore, there is still a lack of study examining the relationship between children's dental health, obesity, and food consumption habits combined with consideration of the oral microorganism. Thus, this study aimed to investigate the possible relationships between nutritional habits, BMI, oral health, presence of *P. gingivalis,* and *Bifidobacterium* sp. in the saliva of children.

2. METHODS

2.1. Sampling and Study Design

In this cross-sectional study, 130 healthy children between the ages of 9-14 (59 girls and 71 boys), who came to Marmara University Faculty of Dentistry Department of Pedodontics between February and June 2019, were included. Written approval to perform the study was obtained from Marmara University Clinical Studies Ethics Committee (2018/190). Power calculation for sampling showed the acceptable margin of error is 7%, and at least 130 people are planned to take part in the study at a 90% confidence level. Written informed consent was obtained from the parents of all patients.

A questionnaire for oral hygiene care and nutritional habits of the participants was given and 24-h food recalls were filled by the dietitian via face-to-face interviews. Furthermore, unstimulated saliva samples were collected in sterile polypropylene tubes between 8.00-10.00 am for the microbiological analyses. Tubes were transferred to the laboratory within 2 h and were analyzed immediately.

2.2. Anthropometric Measurements

Body weight measurements of the children were performed by a specialist dietitian with a portable scale (Tartı-ADE-M320600-01) and recorded in kg. Children's heights were measured with a portable stadiometer and recorded in cm. Body Mass Index (BMI) was calculated by dividing the body weight by the square of the height (kg/m^2) for all children. The reference values specified for age and gender developed by the World Health Organization (WHO) were taken as a basis for the evaluation of BMIs and the WHO AnthroPlus program was used.

2.3. Evaluation of Oral and Dental Health

Oral and dental examinations of the children were performed by a specialist dentist at Marmara University Faculty of Dentistry, Department of Pedodontics. Oral and dental health status (Decayed, Missing, and Filled Teeth – Surface (dft/DMFT-dfs/DMFS) was evaluated. Periodontal health status was determined using the plaque index (PI) and gingival index (GI). For PI, after the teeth were dried, the amount of methacryloyloxydecyl dihydrogen phosphate (MDP) on the surface of the teeth was evaluated on the 4 sides of all teeth – the mesiobuccal, mid buccal, distobuccal, and midlingual/palatinal sides. For GI, gingival papillary and gingival edges were evaluated, and then the periodontal probe was kept parallel to the long axis of the tooth and entered into the pocket. In the case of haemorrhaging in the pocket after probing, a total of 4 points, including mesiobuccal, distobuccal, midbuccal, midlingual/palatinal were scored between 0-3, and the inflammation status in the gum was evaluated (Löe, 1967).

2.4. Evaluation of Food Consumption Status

24-hour food recalls of all children were taken and energy and nutrient intakes were calculated via the nutrition information program BeBiS 7.0. Microsoft Excel was used to calculate the percentages of meeting daily requirements according to Turkey Dietary Guidelines (TÜBER) (Ministry of Health, 2019).

2.5. Microbiological Analyses

Microbiological analyses from saliva samples were based on the detection of *P. gingivalis* and *Bifidobacterium* sp. by conventional cultural plating techniques. Suspected colonies were identified and proved with biochemical testing using API 20A (bioMérieux).

For the analysis of *P. gingivalis*, 1 ml of saliva sample was pre-enriched in a 9 ml Brain Heart Infusion (BHI) broth consisting of 1 µg/ml iron and 5 µg/ml menadione and incubated at 37˚C for 48 h anaerobically. Then enriched samples were streaked on Brucella Blood Agar (sigma), containing hemin, Vitamin K_1 with 5% sheep blood and incubated at 37˚C for 48 h, anaerobically. Suspected colonies (brownish-black coloured) were gram-stained, and gram (-) rod-shaped bacteria were inspected. Antimicrobial reactions of suspected colonies were observed with the disc diffusion method on blood agar (*P. gingivalis* is expected to be susceptible to vancomycin, but resistant to both kanamycin and colicin) and then were taken to biochemical identification with API 20A (Biomerieux).

For the analysis of *Bifidobacterium* spp. a 10 µl loopful saliva was streaked onto the selective BD Bifidobacterium agar (Modified) and incubated at 37˚C for 48 h anaerobically. Creamy white colonies were evaluated as suspect and they were gram stained. Gram (+) irregular V or Y-shaped (bifid) bacterial colonies were taken to biochemical identification with API 20A (Biomerieux).

2.6. Statistical Analysis

Power calculation for sampling was done with Microsoft Excel (version 2013). Data were analyzed by the SPSS 11.5 statistical software (SPSS Inc., Chicago, IL, USA). Chi-square tests with cross-tabulation were used to compare the frequencies of parameters. The data means of age, BMI, education status, and dental indexes between BMI categories were compared by one-way analysis of variance (ANOVA). Differences among data means were compared using the Tukey post hoc test at a $p<0.05$ level of significance. Spearman's correlation coefficient was used to determine the correlations (two-tailed) between demographic characteristics, dietary habits and dental indexes. Associations between BMI, tooth brushing, snack consumption, sugar-sweetened drink consumption and dental indexes were tested using multiple linear regression analysis.

3. RESULTS

A total of 130 children between the ages of 9-14 (11.22±1.64) participated in this study. The general characteristics of children and oral health parameters concerning BMIs were summarized in Table 1. No significant difference was found between the mean ages of the BMI groups. In terms of gender difference, the highest overweight/obesity rate was appeared in boys (66.7%; $p<0.05$).

Oral health indexes showed no statistically significant difference between BMI groups. *P. gingivalis* was not found in any of the saliva samples, whereas *Bifidobacterium* sp. was found in 3.1% (n=4) of the samples. According to the difference in gender, *Bifidobacterium* sp. was more common in boys (n=3) than girls (n=1; not shown in table).

The correlation of the parameters was given in Table 2. Accordingly, BMI, presence of *Bifidobacterium* sp., DMFT, and DMFS scores in permanent teeth increased with age ($p<0.01$, r=0.296 and 0.257, respectively). However, there is a negative correlation between age, BMI and dft, dfs scores ($p<0.01$, r=0.536 and 0.530, respectively), as well as between toothbrushing frequency and PI, GI, DMFT, and DMFS scores ($p<0.01$, r=0.290, 0.451, 0.291, and 0.265, respectively). The dental visiting frequency of children was positively correlated with GI ($p<0.05$, r=0.210). Snack consumption does not have any correlation with the parameters, except the BMI ($p<0.05$, r=0.188). Sugar-sweetened drink consumption has a negative correlation with DMFT index ($p<0.05$, r=0.206). The presence of *Bifidobacterium* sp. in saliva was related to dft, dfs indexes in deciduous teeth ($p<0.001$, r=0.311 and 0.234). PI and GI were positively correlated with oral-dental health parameters (DMFT, DMFS), and vice versa ($p<0.05$, r=0.190, 0.305, 0.329, and 0.361, respectively).

Table 3 includes the regression analysis of the indicator parameters of dental health. There was only a significant relationship between GI and tooth brushing frequency ($p<0.01$). There was a mutual interaction between PI and GI ($p<0.01$), as well as between DMFT and DMFS and a strong interaction between dft and dfs parameters ($p<0.05$).

24-hour food recalls of children were categorized into food groups, and their correlation with the oral-dental health parameters was presented in Table 4. A positive correlation occurred in bread consumption, whereas a negative correlation was found in grain consumption when compared to DMFS index of children ($p<0.05$, r=0.179). A positive correlation was found between sugar intake and PI of children ($p<0.01$, r=0.262). Consumption of fats and oils was positively correlated with dft and dfs scores of children ($p<0.01$, r=0.234 and 0.234).

Energy and nutrient intakes from the food recall of children were calculated and correlated with the oral-dental health parameters as presented in Table 5. A negative correlation was found between children's n-3 fatty acids intake and the frequency of decay in deciduous teeth ($p<0.001$, r=0.308). A positive correlation was observed between children's daily n-6 fatty acid intake and dft index ($p<0.05$, r=0.176). A negative correlation occurred between the total dietary fiber intake of children and PI scores ($p<0.05$, r=0.191). A positive correlation was observed between children's sugar alcohols ($p<0.01$, r=0.273), glucose ($p<0.05$, r=0.217), starch intake ($p<0.001$, r=0.302), and a negative correlation was found between children's galactose intake ($p<0.001$, r=0.308) and the number of decayed deciduous teeth. A negative correlation was found between daily maltose intake and the dft index ($p<0.05$, r=0.203).

Table 1. *Descriptive of demographic data, nutrition behavior, and oral health status divided according to the BMI of children (n=130).*

Parameters	Total (n=130) (%)	BMI			p-value
		Underweight (n=7)	Normal weight (n=84)	Overweight / Obese (n=39)	
Age (year)	11.22±1.64	11±1.73	11.05±1.63	11.61±1.59	0.523
Gender					
Female	59 (45.4)	4 (57.1)	42 (50)	13 (33.3)	**0.042**
Male	71 (54.6)	3 (42.9)	42 (50)	26 (66.7)	
BMI (kg/m^2)	19.03±3.98	13.55±1.36	17.32±1.81	23.66±3.52	**<0.01**
Education (year)					
Mother	9.69±2.27	10.85±3.02	9.28±1.97	10.4±2.54	0.065
Father	11.05±2.90	12.57±3.59	10.8±2.70	11.4±3.11	0.205
Tooth brushing (per day)					
≥2	26 (20)	2 (28.6)	18 (21.5)	6 (15.4)	0.664
≤1	88 (67.7)	3 (42.8)	56 (66.7)	29 (74.4)	
None	16 (12.3)	2 (28.6)	10 (11.8)	4 (10.3)	
Visits to Dentist (in a year)					
≥1	44 (33.9)	3 (42.9)	31 (36.9)	10 (25.7)	0.479
When needed	85 (65.3)	4 (57.1)	53 (63.1)	28 (71.8)	
None	1 (0.8)	0	0	1 (2.6)	
Main Meal (per day)					
3 times	112 (86.2)	6 (85.7)	74 (88.1)	32 (82.1)	0.665
2 times	18 (13.8)	1 (14.3)	10 (11.9)	7 (17.9)	
Snack Consumption (Yes)	128 (98.5)	7 (100)	84 (100)	37 (98.5)	0.094
Candy, Chocolate	122 (93.8)	7 (100)	79 (94)	36 (92.3)	0.732
Cake, Cookie	120 (92.3)	7 (100)	80 (95.2)	33 (84.6)	0.89
Chips	59 (45.4)	5 (71.4)	36 (42.8)	18 (46.2)	0.664
Nuts	33 (25.4)	0	26 (31)	7 (18)	0.276
Fresh fruits	69 (46.1)	2 (28.6)	45 (53.6)	22 (56.4)	0.282
Sugar-Sweetened Drink Consumption (Yes)	120 (92.3)	7 (100)	76 (90.5)	37 (98.5)	0.511
Carbonated beverages	58 (44.6)	5 (71.4)	35 (41.6)	18 (46.2)	0.890
Concentrated fruit juices	94 (72.3)	6 (85.7)	60 (71.4)	28 (71.8)	
Sugared tea	33 (25.3)	2 (28.6)	23 (27.4)	8 (20.5)	
Sugared milk	31 (23.8)	1 (14.3)	20 (23.8)	10 (25.7)	
None	10 (7.7)	0	8 (9.5)	2 (1.5)	
Probiotic Intake (Yes)	8 (6.2)	1 (14.3)	2 (2.4)	5 (12.8)	0.053
Dairy Product Consumption					
Daily	59 (45.4)	3 (42.9)	35 (41.7)	21 (53.8)	0.690
1-3 times in a week	54 (41.5)	3 (42.9)	36 (42.9)	15 (38.5)	
Once in a month or none	17 (13.1)	1 (14.3)	13 (15.5)	3 (7.7)	
Oral Health Indexes					
PI	1.26±0.52	1.57±0.53	1.25±0.49	1.23±0.58	0.146
GI	0.76±0.58	1±0.57	0.76±0.59	0.71±0.55	0.346
DMFT	3.86±2.54	4.00±2.78	3.90±2.64	3.74±2.34	0.955
DMFS	7.98±8.15	5.57±3.55	7.98±8.35	8.41±8.34	0.578
dft	1.25±2.24	2.14±3.07	1.41±2.42	0.74±1.49	0.17
dfs	3.70±7.45	5±9.29	3.97±7.74	2.87±6.51	0.691
P. gingivalis **(n)**	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	-
Bifidobacterium **sp. (n)**	4 (3.1)	0	3	1	0.85

Table 2. *Correlation coefficients between demographic data, nutrition behavior, and the oral health status of all children*

Parameters	BMI	*Bifidobacterium* sp.	PI	GI	DMFT	DMFS	dft	dfs
Age	**0.427****	**0.224***	-0.009	0.028	**0.296****	**0.257****	**-0.536****	**-0.530****
Gender	-0.040	0.073	-0.380	0.041	0.056	-0.082	0.016	0.033
BMI	-	-0.019	-0.096	-0.026	0.062	0.013	**-0.323****	**-0.314****
Mother Education	0.081	0.052	-0.158	0.025	-0.005	-0.093	-0.088	-0.055
Father Education	0.054	0.079	0.001	0.032	0.013	-0.120	0.028	0.041
Tooth Brushing	0.046	-0.107	**-0.290****	**-0.451****	**-0.291****	**-0.265****	-0.104	-0.111
Visits to Dentist	-0.058	-0.038	-0.115	**0.210***	-0.082	0.046	-0.022	0.003
Meal (per day)	-0.088	-0.071	-0.062	-0.160	-0.112	-0.156	0.118	0.106
Snack Consumption	**-0.188***	0.022	-0.057	0.056	0.092	0.035	0.087	0.087
Sugar-Sweetened Drink Consumption	-0.017	0.051	0.142	0.129	**0.206***	0.163	-0.021	-0.042
Probiotic Intake	0.120	-0.046	-0.011	-0.011	0.091	0.084	-0.026	-0.039
Bifidobacterium sp.	-0.019	-	0.082	0.085	-0.003	-0.029	**0.311****	**0.234****
PI	-0.096	0.082	-	**0.501****	**0.190***	**0.305****	0.127	0.145
GI	-0.026	0.085	**0.501****	-	**0.329****	**0.361****	0.024	0.035

(*) Correlation is significant at the 0.05 level, and (**) is significant at the 0.01 level

Table 3. *Multiple regression analyses between oral health status and potential factors in relation to oral health*

Parameters	β Coefficients					
	PI	GI	DMFT	DMFS	dft	dfs
BMI	-0.084	0.029	0.079	-0.042	-0.084	0.003
Tooth Brushing	-0.056	**-0.295****	-0.091	-0.051	-0.077	0.029
Snack Consumption	-0.117	0.067	0.059	0.005	0.004	0.011
Sugar-Sweetened Drink Consumption	0.073	0.031	0.067	0.033	0.052	-0.052
PI	-	**0.387****	0.028	0.034	-0.028	0.103
GI	**0.436****	-	0.137	-0.007	-0.037	0.050
DMFT	0.036	0.158	-	**0.613****	0.027	-0.112
DMFS	0.041	-0.007	**0.566****	-	-0.125	0.125
dft	-0.058	-0.068	0.043	-0.216	-	**0.785****
dfs	0.213	0.092	-0.180	0.217	**0.791****	-

(*) Regression is significant at the 0.05 level, and (**) is significant at the 0.01 level.

Table 4. *Correlation of oral-dental health parameters according to the daily consumed food groups*

Food group	PI	GI	DMFT	DMFS	dft	dfs
Milk, dairy products	0.127	-0.015	0.012	-0.057	-0.102	-0.115
Meat, fish, poultry	-0.049	-0.104	0.071	-0.008	-0.079	-0.086
Breads	-0.066	-0.065	0.108	**0.224***	-0.152	-0.157
Grains	-0.088	0.086	-0.094	**-0.179***	0.065	0.086
Fruits	0.039	-0.009	0.107	0.088	-0.023	-0.018
Vegetables	0.025	-0.048	0.097	0.063	-0.066	-0.075
Sugars	**0.262****	-0.104	-0.115	-0.157	-0.062	-0.084
Oilseeds	-0.149	0.038	-0.094	-0.154	-0.107	-0.113
Fats, oils	0.127	-0.015	-0.115	-0.157	**0.234****	**0.234****

(*) Correlation is significant at the 0.05 level, and (**) is significant at the 0.01 level

Table 5. *Correlation of children's oral-dental health indicators and daily intake of some nutrients*

Nutrients			Permanent Teeth		Deciduous Teeth	
	PI	GI	Number of Decays	DMFT	Number of Decays	dft
n-3 fatty acids	0.040	0.063	-0.009	-0.008	**-0.308****	-0.053
n-6 fatty acids	0.037	0.017	-0.053	-0.091	-0.029	**0.176***
Saturated fatty acids	-0.122	-0.042	0.058	0.007	0.048	0.038
Mono unsaturated fatty acids	-0.080	-0.007	0.043	0.024	0.080	0.109
Poly unsaturated fatty acids	0.060	0.004	-0.073	-0.092	-0.043	0.143
Cholesterol	0.038	-0.100	0.117	0.057	0.035	0.080
Dietary fiber	**-0.191***	-0.083	-0.068	-0.025	0.022	-0.016
Sugar alcohols	-0.006	0.084	0.088	0.080	**0.273****	-0.060
Glucose	0.063	0.128	0.090	0.113	**0.217***	-0.056
Fructose	0.035	0.068	0.081	0.101	0.168	-0.062
Galactose	-0.128	-0.110	0.009	-0.008	**-0.308****	-0.053
Maltose	0.156	0.023	0.049	0.077	0.134	**-0.203***
Lactose	-0.213	-0.110	-0.019	-0.038	-0.143	-0.079
Sucrose	-0.118	0.037	-0.137	-0.130	-0.079	-0.040
Starch	-0.122	-0.085	-0.030	0.013	**0.302****	0.119

(*) Correlation is significant at the 0.05 level, and (**) is significant at the 0.01 level

4. DISCUSSION

In our study, the relationship between BMI, nutritional habits, oral health, and the presence of *P. gingivalis* and *Bifidobacterium* sp. in the saliva of children and adolescents between 9-14 years of age was investigated and relations between BMIs; dft, and dfs scores and between oral-dental health parameters (PI, GI, and DMFT, DMFS) were found. While none of the children had *P. gingivalis* in their saliva, 3.1% had *Bifidobacterium* sp.. Moreover, sugar intake was positively correlated; total dietary fiber intake was negatively correlated with PI.

Most of the studies found that BMI increases with age and the health of permanent teeth, decreases (Köksal et al., 2011; Bimstein et al., 2004; Marro et al., 2020), whereas the health of deciduous teeth increases (Köksal et al., 2011). Similar to our findings, some studies reported that socioeconomic factors and the education levels of the parents affected neither obesity nor the dental health of children (Polat et al., 2012; Peng et al. 2014). Cinar and Murtomaa (2011) suggested that as socioeconomic levels increased, obesity, gingival bleeding, and filled teeth numbers increased (Cinar et al., 2011). However, tooth brushing frequency effects were observed as higher in obese children and enhanced oral-dental health (especially against PI and GI) (Cinar et al., 2011; Markovic et al., 2015; Marro et al., 2020). In this study, it was observed that tooth brushing has an effect on oral health (especially on GI) independently of BMI status. Some researchers reported that sugary drinks do not have any effect, whereas snack consumption harms BMI and oral-dental health (Markovic et al., 2015; Marro et al., 2020), while other researchers reported that sugary drinks increased obesity risk and dental problems (Hooley et al., 2012; Kesim et al., 2016). In our study, poor eating habits were high in underweight children, but not significant.

About BMI and periodontal health status, some studies found positive correlations between gingivitis, periodontal diseases, and overweight or obese children (Polat et al., 2012; Modeer et al., 2011). It is generally reported that gingivitis, gingival bleeding, GI, and PI were higher in overweight and obese children than in normal and underweight children (Cinar et al., 2011; Markovic et al., 2015; Kesim et al., 2016; Marro et al., 2020). The means of GI and PI scores of overweight and obese children in our study (0.76, 1.26; respectively) were higher, but, no significant difference and no correlations were found between their BMI values and periodontal indexes. Many studies found a negative correlation or no relationship between BMI status of the children and tooth decays (Jamelli et al., 2010; Cinar et al., 2011). Some studies reported that the number of decayed, missing, and filled teeth, DMFT, DMFS, dft, and dfs indexes were lower in overweight and obese children regardless of gender, but significantly higher in underweight children (Beinghton et al., 1996; Kimura et al., 2002; Peker and Bermek, 2008; Cinar et al., 2011; Markovic et al., 2015; Kesim et al., 2016). In this study, no difference in dental health indexes between BMI status was observed. Additionally, a weak negative correlation was found between BMI values and tdft and dfs scores of children's deciduous teeth.

Some studies showed the effects of unhealthy dietary patterns on both periodontal health and tooth decay (Köksal et al., 2014; Markovic et al., 2015). Increased dietary fiber intake promotes the increase of saliva flow rate, which

positively affects oral and dental health. Saliva flow rate is related to the buffering capacity of saliva and when the buffering capacity increases, it has a protective effect against tooth decay (Laine et al., 2014). In our study, a weak negative correlation was found between the total dietary fiber intake and PI scores of the children (p<0.05). In a study, GI score and mean frequency of sugar consumption were significantly associated variables (p<0.001) (Beighton et al., 1996). In our study, a positive correlation was found between sugar consumption of children and PI scores (p<0.01).

The consumption of high-starchy and low-sugary foods have less decay potential when compared to the consumption of low-starchy and high-sugary foods (Peker and Bermek, 2008). In a study, negative correlations between DMFT index and fruit consumption, as well as between the frequency of tooth decay and dairy consumption were found (Köksal et al., 2014). In another study, significant positive associations were found between DMFT, DMFS, and sugary food consumption, but no significant associations were found with starchy food consumption (Beighton et al., 1996). In our study, there was a positive correlation between children's bread consumption and DMFS index, whereas there was a negative correlation with the consumption of grains (p<0.05). In a cross-sectional study, children with dental problems were more likely to consume a high-fat diet than children without any dental problems. It is concluded that both a high-fat diet and high consumption of sweetened drinks contributed to the development of dental caries in children (Hooley et al., 2012). Following these findings, a positive correlation was found in our study between dft and dfs indexes of the children and the consumption of fats and oils. This result indicates an association between nutrition habits and the dental health status of children.

The prevalence of *P. gingivalis* in children varies from 4.8% to 79% depending on population characteristics and periodontal health. In the study conducted by Bimstein et al. (2004), the incidence of *P. gingivalis* was 47% in children, whereas in the study of Okada et al. (2000) it was 4.8%. In our study, similar to the study of Kimura et al. (2002), *P. gingivalis* was not detected in any saliva samples of children. The presence of *Bifidobacterium* increases the frequency of caries due to its acid-producing and resistance properties (Valdez et al., 2016). In our study, *Bifidobacterium* was detected only 3.1% of the saliva samples, and children with *Bifidobacterium* present in saliva had significantly higher dft and dfs indexes than those without salivary *Bifidobacterium* sp.. Thus, *Bifidobacterium* sp. was more common in those children with deciduous tooth defects (Table 2; p<0.001). This result supports caries promoting activity of this bacterium, however, due to the small number of samples with *Bifidobacterium*, there are limitations in the interpretation of this correlation. The limitations of this study are that food consumption records were taken from children for 24 hours. Another limitation is on the microbiological analyses, which could enhance the positive results if concomitant molecular biological quantification would be applied.

5. CONCLUSION

There is evidence that the formation of dental caries is multifactorial, and in this manner, nutrition and oral hygiene habits act together. Unhealthy eating habits, high calorie and sugary food consumption in children is important factor not only for obesity and metabolic diseases but also for oral and dental diseases. Lifestyle habits such as healthy nutrition, regular and sufficient tooth brushing, and visiting the dentist regularly which can be gained during childhood, will greatly contribute to the protection of oral and dental health and general health for adulthood.

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