

Evaluation of Healthy Nutrition Index-2015, Dental Health and Oral Flora Relationship in School-Age Children

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Received: 17.05.2021

Accepted: 09.08.2021

ABSTRACT

Objective: The aim of the study is to evaluate the role of diet quality and oral flora on the dental health in the childhood period.

Methods: A cross-sectional study was carried out with the participation of 98 children aged 9-14 and their parents who applied to the Pedodontics Clinic Dental Faculty of Marmara University. The decayed, missing, filled tooth and surfaces and DMFT, DMFS indexes were determined through visual dental examination. Anthropometric measurements and saliva samples, as well as 24 h food consumption records, were taken from each child. Saliva samples were analysed microbiologically. To evaluate dietary quality from intakes Healthy Eating Index-2015 (HEI-2015) scores were calculated.

Results: The mean age of children was 10.8±1.5 and study sample comprised 44.9% males and 55.1% females. 75% of the children had normal height and 58.2% of them had normal BMI according to World Health Organisation (WHO) references. The mean number of decayed tooth and surface was 3.07±2.35; 4.34±3.78 respectively and the mean number of DMFT and DMFS indexes were 5.88±2.31; 8.05±4.58 respectively. The mean number of decayed, missing, filled teeth and DMFT, DMFS scores were found to be higher in children with poor diets (according to HEI-2015) but the difference was not statistically significant ($p>0.05$). The presence of lactobacilli in saliva samples of 5.5% of the children was observed and children have lactobacilli in their saliva samples had more decayed teeth ($p<0.05$).

Conclusion: The study findings illustrate the relationship between decay development and lactobacilli. Further studies with high sample sizes are needed to examine the diet quality and oral health.

Keywords: Healthy eating index, Dental caries, Diet quality, Childhood, Oral flora.

1. INTRODUCTION

In parallel with the definition of the general health status of the World Health Organization (WHO), it is emphasized that oral and dental health is the starting and basic point of body health (1). Despite improvements in oral disease prevention and treatment over the past decade incidence of dental caries, the most common oral disease, remains high in pediatric age. A systematic review conducted in 2015 reveals that 2.4 billion people are affected by caries in permanent teeth, while 621 million children are affected by caries in deciduous teeth, demonstrating the 10th most prevalent condition worldwide (2). Childhood dental caries have unfavorable effects on the life quality of children due to disturbance, pain, altered sleeping habits, poor nutrition, and even a decrease in school attendance and performance (3, 4).

Oral health and nutrition are interdependent and have multi-directional relationship (5). Depend on previous research

evidence, diet is still an important factor associated with dental caries and considered to be a main cause of dental erosion (6, 7). A good quality diet, which is one of the most important factors contributing to the health and quality of life of children and adolescents, is the only and valid way to prevent dental caries (6) with proper oral hygiene practices (5).

Until today various tools have been developed to assess diet quality. The Healthy Eating Index-2015 (HEI-2015), the most current version, is a dietary assessment tool prepared for this purpose and designed to measure specifically the degree to which a set of foods aligns with the Dietary Guidelines for Americans (8). In HEI-2015 diet quality is evaluated from two perspectives: the first part is adequacy (dietary components to increase) and the second part is moderation (dietary components to decrease) (9). Analyses demonstrated that HEI-2015 is a valid and reliable source in other aspects also

can be used to evaluate the diet quality of children older than two years as in different populations (8, 10). Thirteen components of the HEI-2015 show consistency with Dietary Guidelines for Americans, recommendations of World Health Organisation as well as dietary guidelines of Turkey (8, 11, 12).

The role of the host microbiota in the health of the individual has been an ongoing and distinct concept for many years (13). The oral cavity is densely colonized with bacteria, diet-like environmental changes may alter the composition of the oral microbiome, and as a result of dysbiosis the risk for oral diseases especially dental caries can increase (14). *Streptococcus mutans* and *Lactobacillus* species, which produce acid from bacteria that colonize the oral cavity, are associated with dental caries and cause various oral health problems (15).

The present study aims to evaluate the relationship of dietary intake, as measured by healthy eating index 2015, and oral health indicators in school-age children and the presence of lactobacilli in the oral flora.

2.METHODS

A cross-sectional study was carried out with the participation of children between the ages of 9-14 who applied to Pediatric Dentistry Department of Marmara University Faculty of Dentistry, Turkey. Exclusion criteria were; the children who had any mental or physical conditions, chronic diseases, and those who were taking any antibiotics 2 weeks before the examination. The families of the children were informed about the content and duration of the study in written and verbal by the researcher. A voluntary consent form was signed by the families who accepted to participate in the study. The approval of the research was obtained from Marmara University Faculty of Dentistry Clinical Research Ethics Committee. (The date, 20.12.2016; the number, 2016-66). The questionnaire created to be used in the study consists of two parts: demographic and general information about parents and children, and information on oral and dental health. In addition, food consumption records were taken with the 24-hour recall method to determine the nutritional status of the children. The answers given to the questionnaire and the 24-h recalls were recorded in line with the answers given by the children and their families.

2.1.Sample size estimation

The sample of the study was chosen by random sampling method, and the sample size was aimed to include 88 children with a minimum of 5% sampling error, 0,5 confidence interval, 95% confidence level, and 10% margin of error. The study was finished with the participation of 44 boys and 54 girls, a total of 98 children. Saliva samples were taken from 91 children due to reasons such as not being able to provide enough saliva or/and not want to give saliva.

2.2.Dental examination

Oral and dental examinations of the children were performed by a qualified dentist using a sterile dental mirror at the clinic. Decayed, missing, and filled teeth in permanent teeth were processed into pre-prepared forms according to WHO criteria (16). Soft tissue evaluation and dental anomalies were recorded. The total number of decayed, missing, and filled teeth (Decayed, Missing, And Filled Teeth: DMFT) and tooth surfaces (Decayed, Missing, And Filled Surfaces: DMFS) were calculated, and the mean number of DMFT or DMFS were calculated. The level of caries experience in permanent dentition was determined by the WHO severity criteria for the age groups of children (12 years), levels of DMFT; low < 2.6, moderate 2.7–4.4, high 4.5–6.5, very high >6.5 (17).

2.3.Anthropometric measurements

Anthropometric measurements of the participants were taken by a nutrition and dietetics specialist. The height measurements of the participants were taken with a portable height meter with the feet side by side and the head in the Frankfurt plane and body weights were taken by removing the thick clothes and shoes with a portable body scale. BMI of the children were evaluated according to age and gender by using WHO Anthro Plus Program according to the WHO 2007 reference for ages 5-19 (18).

2.4.Evaluation of food consumption

In order to identify the nutritional status of children, 24-hour food records were taken based on the child's family and child's responses. And evaluated by using the Healthy Eating Index 2015. HEI-2015 consist of thirteen components, while increasing levels of intake receive increasingly higher scores for components adequacy (Total Fruits, Whole Fruits, Total Vegetables, Greens and Beans, vegetables or beans and peas, Whole Grains, Dairy, Total Protein Foods, Seafood and Plant Proteins, Fatty Acids), increasing levels of intake receive decreasingly lower scores for components moderation (Refined Grains, Sodium, Added Sugars, Saturated Fats) (8). The scores of the 13 components were summed up to obtain the final score of the HEI-2015 for each child, which ranged from 0 to 100. For final scores; HEI-2015 <50 "poor diet", 50 <HEI-2015 <80 "diet needs improvement", HEI-2015 >80 signify "good diet" (19).

2.5.Collection of saliva samples and microbiological analysis

Unstimulated mixed saliva was collected from participants in the study two hours after breakfast. The children were asked to spit on the saliva accumulated in the mouth into a wide-mouthed sterile disposable box. Each of the samples was recorded with the same number as the questionnaire and delivered to the laboratory as soon as possible and taken for microbiological analysis.

For the lactobacilli analysis from saliva, the study of Ravindran et al. was followed (20). Loopful saliva was taken and streaked

on a plate with Rogosa SL agar. Samples were incubated at 37°C for 48 hours under an anaerobic environment. After the incubation period, transparent white colonies growing in petri dishes were obtained as suspicious *Lactobacillus* spp. And gram stained. A pure single colony was obtained by passaging the suspected samples and gram (+) lactobacilli identified after the biochemical testing with a negative oxidase reaction to Catalase/Oxy Test (Liofilchem).

2.6. Statistical Analysis

Data were transferred to the electronic environment, tabulated, and analyzed using the Statistical Package for Social Sciences (SPSS) version 22.0 (SPSS Inc., Chicago, IL, USA). In independent groups, the difference and significance between averages were examined according to whether they met the parametric conditions. Since the difference between the means in two independent groups did not conform to the normal distribution, the Mann-Whitney U test was used to analyze the data, while the Kruskal-Wallis test was used for more than two independent groups. The difference between groups in categorical variables was controlled by the chi-square test. Pearson's correlation test was used to examine the correlations between variables. Significance was assessed at 0.05 levels.

3. RESULTS

The age of the children in the study ranged from 9 to 14 years with a mean of 10.8±1.5. The study sample comprised 44.9% males and 55.1% females. Mean weight, height and body mass index of children are 38.3±10.9, 141.9±11.44 and 18.6±3.08 respectively. When the BMI and height measurements of the children were classified according to gender and WHO references, it was seen that 75% of the children had normal height and 58.2% of them had normal BMI ($p>0.05$) (Table 1).

Table 1. Distribution of children's height and BMI measurements by WHO growth references

	Boys (n:44)		Girls (n:54)		Total (n:98)		
	n	%	n	%	n	%	
Height for age	Short	6	13.6	7	12.9	13	13.3
	Normal	32	72.8	42	77.8	74	75.5
	Tall	6	13.6	5	9.3	11	11.2
BMI for age	Underweight	4	9.1	3	5.6	7	7.1
	Healthy weight	28	63.6	29	53.7	57	58.2
	Overweight	9	20.5	16	29.6	25	25.5
	Obese	3	6.8	6	11.1	9	9.2

BMI: Body Mass Index

The number of decayed, missing, filled teeth and tooth surfaces and the mean, minimum and maximum values of DMFT and DMFS indexes of the children were given in Table 2. The mean of decayed, missing, and filled teeth number was 3.07±2.35; 0.10±0.48; 2.75±2.17, respectively. The

mean number of DMFT and DMFS indexes were 5.88±2.31; 8.05±4.58, respectively (Table 2).

Table 2. The values of decayed, missing, filled teeth and tooth surface and DMFT, DMFS indexes

	Mean (SD)	Min	Max
Decayed teeth	3.07±2.35	0	10
Decayed tooth surface	4.34±3.78	0	17
Missing teeth	0.10±0.48	0	4
Missing tooth surface	0.51±2.43	0	20
Filled teeth	2.75±2.17	0	12
Filled tooth surface	3.11±2.38	0	12
DMFT	5.88±2.31	1	12
DMFS	8.05±4.58	1	29

DMFT: decayed, missing and filled teeth; DMFS: decayed, missing and filled tooth surfaces

While 63.2% of the children brush their teeth regularly, 24.5% did not brush their teeth regularly. 60.7% of those who brush their teeth brush once a day, 39.3% of them brush twice a day. There was no significant difference between the presence and number of decayed, missing, filled teeth and tooth brushing presence or brushing frequency ($p>0.05$) (Table 3).

Table 3. Comparison of the oral health indicators and HEI-2015 group

	HEI-2015 Group		P value
	Poor diet	Diet needs improvement	
Decayed teeth	3.10±2.40	2.87±2.09	0.83
Missing teeth	0.12±0.53	0.00±0.00	0.26
Filling teeth	2.89±2.28	2.50±1.54	0.86
DMFT	6.02±2.26	5.18±2.53	0.21
DMFS	8.32±4.64	6.62±4.12	0.07

DMFT: decayed, missing and filled teeth; DMFS: decayed, missing and filled surfaces, HEI-2015: Healthy Eating Index 2015 (Mann Whitney U test)

The mean HEI-2015 score of the group was 40.39±9.66 and, it was observed that 83.7% had a "poor diet" and the diet of 16.3% was "needs improvement". When the oral health indicators are evaluated according to HEI-2015 the mean number of decayed, missing, filled teeth and DMFT, DMFS scores were found to be higher in children with poor diets but the difference was not statistically significant ($p>0.05$) (Table 4).

In Table 5, the relationship between the mean score of thirteen HEI components and DMFT index groups was evaluated, and no significant difference was observed between the groups (Table 5).

The presence of lactobacilli in saliva samples of 5.5% of the children was observed (Not shown in Table). The relationship between the presence of lactobacilli in saliva samples and oral health indicators given in Table 6. It was observed that children have lactobacilli in their saliva samples had more decayed teeth ($p<0.05$).

Table 4. Comparison of the HEI-2015 components among the DMFT group

HEI-2015 components	DMFT group Mean (SD)				P value
	Low	Moderate	High	Very high	
Total Fruits	2.68±2.49	2.30±2.05	1.81±2.13	1.82±2.12	0.69
Whole Fruits	3.00±2.73	1.80±2.40	1.79±2.53	1.84±2.31	0.76
Total Vegetables	1.64±2.1	1.49±1.57	1.30±1.66	0.99±1.06	0.77
Greens and Beans	1.34±1.53	1.80±2.10	1.55±2.13	1.71±2.04	0.92
Whole Grains	2.00±4.47	2.08±4.14	2.36±4.01	2.04±3.82	0.88
Dairy	6.36±3.61	5.58±3.56	5.49±3.92	6.00±3.57	0.94
Total Protein Foods	4.10±0.84	3.18±1.83	3.09±1.90	3.06±1.87	0.74
Seafood and Plant Proteins	4.06±0.59	2.92±1.37	3.64±1.40	3.14±2.02	0.09
Fatty Acids	1.54±2.37	1.63±2.51	1.51±2.58	1.66±2.90	0.98
Refined Grains	0.24±0.53	0.42±1.46	0.83±2.23	0.67±1.75	0.77
Sodium	4.00±3.82	2.50±3.31	3.70±3.44	4.18±3.51	0.21
Added Sugars	10.00±0.00	9.72±0.93	9.82±0.58	9.68±1.27	0.65
Saturated Fats	4.76±2.24	2.88±2.60	3.87±3.72	3.76±3.46	0.59
Total score	45.72±10.03	38.37±9.42	40.81±9.63	40.61±9.86	0.51

DMFT: decayed, missing and filled teeth, HEI-2015: Healthy Eating Index 2015 (Kruskal Wallis test)

Table 5. The relationship between the presence of lactobacilli in saliva samples and oral health indicators

	Yes (n:5)	No (n:86)	P value
Decayed teeth	5,8±3.34	2.81±2.17	0,042
Missing teeth	0.00±0.00	0.11±0.51	0,544
Filling teeth	1.60±1.51	2.81±2.24	0,204
DMFT	7.40±2.60	5.70±2.32	0,146
DMFS	11.80±10.05	7.56±3.88	0,415

DMFT: decayed, missing and filled teeth; DMFS: decayed, missing and filled surfaces (Mann Whitney U test)

4. DISCUSSION

Good and favorable oral health is precisely important in childhood and oral health diseases such as dental caries have a considerable impact on self-esteem, school performance, eating ability, and a child's quality of life from early childhood to later period (5, 21, 22). According to WHO it's important to reduce the prevalence of caries, which is known to be an infectious and transmissible multifactorial disease accepted to be "triggered" by improper dietary habits (23). Among the many etiological factors, diet has been determined as a specific type of risk factor that draws attention to the development of caries in children (24). This study examined the relationship between diet quality according to Healthy Eating Index 2015 and oral health and oral flora in school-age children.

Within the scope of the research children between the ages of 9-14, which is the age group of the children during their primary education, were included. Anthropometric measurements used in the evaluation of growth and development in children and interpretation of height for age and BMI values for age are important in terms of disease risk assessment. In the TBSA 2010 study, when the height for age status of the children between the ages of 9-14 was examined, it was seen that 57.5%-61.1% had normal height, while this rate was found to be 75% in our study (25). When the BMI for age (for the 9-14 age group) is examined in the TBSA data for normal weight, it is seen that the range of 55.1%-56.8% is similar to our study (58.2%). The present study population showed similar anthropometric measurements compared with the population of Turkey for the same age groups.

Dental caries, which is still a crucial health problem in developed countries, affects 60-90% of school-age children (26). While it is less common in African countries around the world, it is more common in Asian and Latin American countries (1). According to the research profile of oral and dental health of 12 and 15 years age of children in Turkey, caries prevalence was respectively 61.1% and 61.2%; the prevalence of filling was 6.5% and 12.4%, respectively (27). In previous studies conducted with similar age groups, the prevalence of caries was found between 71.2% and 82.6%, parallel to the prevalence in our study (85.6%) (28, 29). While the mean DMFT index of 5.88 ± 2.31 in this study was similar to the averages obtained from various studies (27,30-32), it was observed that it was higher than the averages obtained from other studies (28, 29, 33, 34).

Regular tooth brushing habits and frequency of tooth brushing are known as two important factors in preventing caries formation. In this study, 24.5% of the children did not brush their teeth regularly and there was no significant difference between the number of decayed, missing, filled teeth and brushing frequency ($p>0.05$) similar to the findings in the previous study (24). The main reason for this situation may be the lack of information about the appropriate brushing method and/or the biased over reporting of the frequency of brushing by the parents (24).

Among different foods, dietary sugars, juices, and starchy foods have been suggested to have high cariogenic potential. Apart from those foods, there are foods such as milk, dairy products, and whole grain foods that show anticariogenic effects (35). Undoubtedly cariogenic and anticariogenic foods have an impact on dental caries, however the effect of nutritional status receives insufficient attention. Adoption of healthy eating habits may have positive effects on oral health. HEI-2015, used as one of the most up-to-date tools for dietary assessment comprises all of the major food groups found in MyPyramid.

The impact and quality of dietary intake on oral health status have been investigated infrequently. In this study, Healthy Eating Index-2015, a valid and reliable screening tool, was used to evaluate diet quality. To our knowledge, HEI-2015 utilization has not been reported to identify the relationship

between nutritional status and dental caries, DMFT index in older children. In our study, the mean number of decayed, missing, filled teeth and DMFT, DMFS scores were found to be higher in children with poor diets ($p>0.05$). Studies evaluating the relationship between Healthy Nutrition Index and childhood dental caries are limited in the literature; however, they have focused especially on early childhood caries in the younger age group (24, 35-37). Unlike our study, previous studies revealed that children with higher HEI scores were less likely to have risk of early childhood caries (25, 36, 37). A study which comprise National Health and Nutrition Examination Survey population over 20 years old evaluating the HEI-2015 and coronal caries found a relationship between HEI quintiles and DMFT index, although the relationship was not consistent among all racial or ethnic groups (38). Apart from the total diet, food items should also be taken into account for their potential based on different food components for the DMFT index. Similar to the study conducted by Zaki et al., most of the HEI components and between the DMFT index groups a significant relationship was not found in our study (35). These findings show that in the older childhood period no statistically significant difference related to dental caries or DMFT index and diet quality according to HEI-2015. One of the reasons for this condition might be related to the age group of the study population. There are individuals with mixed dentition in the age range examined in this study. The expressive power of DMFT in the mixed dentition is limited. Besides, 24 h recall method depended on the declaration and ability to remember all day consumption for parents and their children. The main reason for this situation might be shown as the children participating in the study could not meet the HEI-2015 "adequacy components" following the recommendations on an individual basis or they remained low in the "moderation components" such as added sugar.

There is a dynamic relationship between plaque formation and oral microflora called "The ecological plaque hypothesis". Dental plaque-induced oral diseases such as dental caries are not species specific but are caused by changes in the environment that lead to an ecological shift favouring the growth of dental caries (39). From this point of view lactic acid bacteria can produce acid and survive in an acidic environment, caries formation has been associated with high lactobacillus counts in the oral flora (40, 41). In present study, It was observed that children have lactobacilli in their saliva samples had more decayed teeth ($p<0,05$). This significant difference confirms that in addition to *S.mutans*, *Lactobacillus* bacteria also cause caries formation. In parallel with the study performed by Bhayat et al., The DMFT index of children with lactobacilli in saliva samples is higher, but the difference is not statistically significant (41). The presence of caries-causing bacteria depends on oral hygiene practice, snacking habit as well as saliva flow and high bacterial infection gives a sign of poorer oral hygiene status .

The 24-hour recall food intake data gathered from participants confined to only one day and 98 children who applied to Marmara University Faculty of Dentistry, Pedodontics Clinic

in a certain time interval were proven to be among the study's primary limitations.

5.CONCLUSION

Childhood is one of the most important periods of life for children who becoming individuals. A good quality diet and good oral health are important factors contributing to health and quality of life. Further studies are needed on eating indices, which provide an accurate and reliable measurement of the cariogenicity of the daily diet consumed by individuals. Additionally, oral health education should be integrated into the nutrition education included in the school education of children.

Acknowledgment: This study was supported by Marmara University Research Council (BAPKO, SAG-C-YLP-070.317.0090).

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How to cite this article: Kargin D, Omurtag Korkmaz BI, Mungan NC, Akyuz S. Evaluation of Healthy Nutrition Index-2015, Dental Health and Oral Flora Relationship in School-Age Children. *Clin Exp Health Sci* 2021; 11: 642-647. DOI: 10.33808/clinexphealthsci.938353