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The Effects of Saliva Characteristics and Oral Hygiene Habits on Dental Health: Evaluation with DMFT Index

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Abstract

Background: The World Health Organization (WHO) has identified oral health as an important public health priority. Dental caries is a common health problem worldwide, and the DMFT (Decayed, Missing, Filled Teeth) index is an effective measurement tool for evaluating this issue. This study examines the relationship between oral hygiene habits, saliva characteristics, and the DMFT index among first-year students at Burdur Mehmet Akif Ersoy University Faculty of Dentistry.

Methods: 56 dentistry students were included in the study. Clinical examinations determined the DMFT values of the participants. Saliva samples were collected using the stimulated saliva method, and pH, buffering capacity, and flow rate were measured. In addition, a questionnaire was administered to question the students' oral hygiene habits and nutritional behaviors. The data were analyzed with SPSS software, and $P < .05$ was considered significant.

Results: Women's mean DMFT value was lower than men's; however, no significant difference was observed ($P > .05$). Men's salivary flow rate was significantly higher ($P < .05$). An essential and negative correlation was found between DMFT and salivary pH value ($P < .05$). A negative correlation was observed between tooth brushing frequency and DMFT. However, this relationship was not significant ($P > .05$).

Conclusion: Regular tooth brushing, dental flossing, and adequate hydration are essential for oral health. Properties of saliva, such as pH and buffering capacity, are effective in preventing dental caries, and the DMFT index is a vital tool for evaluating these relationships. The study emphasizes the effects of oral hygiene habits and biological factors on oral health.

Keywords: Buffering capacity, DMFT, oral hygiene habits, salivary flow rate, salivary pH

What is already known on this topic?

- *The DMFT index recommended by the World Health Organization (WHO) is widely used in caries assessment. It is considered essential for determining caries prevalence and developing preventive strategies in public health research.*
- *Salivary pH and buffering capacity are determinants of caries development: In individuals with low pH and insufficient buffering capacity, the risk of caries increases significantly.*
- *Salivary flow rate plays a critical role in oral and dental health. The incidence of caries is significantly higher in individuals with low daily saliva production.*

What this study adds on this topic?

- *The study showed that men's salivary flow rate was significantly higher than women's, and it was suggested that this may be due to physiological or hormonal differences.*
- *It was observed that DMFT values were lower in individuals who started brushing their teeth early, revealing the importance of acquiring oral care habits at an early age.*
- *Bad breath (halitosis) is associated with high DMFT values, suggesting that bad breath may be a potential early caries indicator.*

INTRODUCTION

Oral health plays a crucial role in people's daily lives, prompting World Health Organization (WHO) to designate it as one of the world's foremost public health priorities.[1] Tooth decay is one of the critical diseases of the oral cavity that is frequently encountered and frequently the subject of epidemiological studies.[2]

Tooth decay is a public health problem in almost every country. Tooth decay and the resulting premature tooth loss affect the individual's general health and oral and dental

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health and cause large expenditures in the country's economy.[3] Dental caries have a multifactorial etiology, shaped by factors such as overall health, diet, plaque buildup, saliva production, the diversity and quantity of microorganisms, host susceptibility, oral hygiene routines, fluoride application, and social and behavioral influences. Despite the complexity of these interactions, which makes evaluating the relationship between oral hygiene practices and caries challenging, maintaining effective plaque control is fundamental for preventing dental caries.[4] Because dental caries are common, potentially preventable, and treatable, risk assessment is essential for dentists.

Oral and dental health research worldwide is mainly conducted under the guidance of the WHO and using its recommended methods. The primary purpose of these studies is to ensure that countries' targets and strategies for improving their oral and dental health align with their realities, and to provide the necessary information to decision-makers and practitioners by collecting it correctly.[5] One of the most widely used indexes in collecting this data is the DMFT. World Health Organization recommends this index for measuring and comparing dental caries in the population, and it has been used for 75 years. The DMFT index is defined as D: decay, M: missing, F: filled, T: teeth in permanent teeth. The DMFT index varies between 0-28 and 0-32 depending on whether the third molar teeth are included in the index.[6,7]

In addition to its many known functions, saliva is a diagnostic fluid that allows the diagnosis of various diseases (like blood and urine).[8,9] Therefore, changes in saliva content indirectly affect the formation of tooth decay, positively or negatively.

Saliva serves multiple vital functions, including lubricating oral tissues, protecting soft tissues from abrasion during chewing, aiding in carbohydrate digestion, exhibiting antibacterial properties against harmful microorganisms, cleansing the oral cavity by removing food particles and residues, and maintaining a balanced environment rich in calcium, phosphate, and acid-buffering agents.[10] Therefore, in this study, saliva was collected from the participants, and the characteristics of the participants' saliva were chemically investigated and correlated with the DMFT index.

The main hypothesis of this study is that saliva properties (pH, buffering capacity, and flow rate) and oral hygiene habits of individuals have a decisive effect on the DMFT index. In particular, higher salivary pH and buffering capacity are predicted to be associated with lower DMFT values. In addition, it is assumed that tooth brushing and flossing frequency will reduce caries formation. In line with this hypothesis, the study seeks answers to the following fundamental research questions: How are salivary pH and buffering capacity related to the DMFT index? Do individuals' tooth brushing frequency and dental flossing significantly affect the DMFT index? Is there a statistically significant difference between gender, salivary flow rate, and DMFT index?

This study aims to determine the tooth brushing habits, oral and dental health status, and nutritional characteristics of first-year Burdur Mehmet Akif Ersoy University Faculty of Dentistry students and evaluate the relationship between DMFT values and saliva characteristics.

MATERIAL AND METHODS

Decayed, Missing, Filled Teeth Index Determination

The study included first-year Burdur Mehmet Akif Ersoy University Faculty of Dentistry students. Before starting the study, the students were informed about it, and their consent was obtained.

A single dentist determined each student's DMFT index through clinical examinations, and the third teeth were included in the study. The evaluation of DMFT indexes in the clinical examination was conducted and recorded under a light source with the help of a dental mirror and a probe. Appropriate inclusion criteria were established to prevent the DMFT index from producing misleading results. These criteria assessed whether the participants had systemic diseases, regular medication use, or an orthodontic treatment history. Lesions that did not show cavitation were not included in the study. The DMFT index was calculated by summing the numbers of decayed (D), filled (M), and missing (F) permanent teeth diagnosed by clinical examination.[11,12]

Stimulated Saliva Collection and Chemical Analysis

Participants were advised to avoid eating or drinking for at least 1 hour before sample collection, chew a piece of sugar-free gum until it softened, and then swallow the saliva produced during this period. After the gum softened, the saliva formed by chewing using both sides of the jaw for 5 minutes was collected in sterile containers. The mouths of the containers were opened and closed only during spitting to prevent contamination. The saliva collected was measured without loss of time with a precision scale (Radwag, Radom, Poland). The saliva flow rate was calculated as mL/min. Saliva volume was measured with a pipette. Then, pH measurements from chemical parameters were made using a pH meter. For buffering capacity, 1 mL of the collected saliva was taken and transferred to glass tubes, and buffering capacity was checked using the Ericsson method. According to this method, the stimulated saliva collected was taken into a glass tube without waiting, 1 mL was withdrawn, and 3 mL of 0.005 n HCl (Sigma-Aldrich, Darmstadt, Germany) was added. The container was slightly vibrated to remove carbon dioxide. The samples were kept for 10-20 minutes. At the end of the period, the pH was measured. The measurement was made using a pH meter (Hanna, Woonsocket, RI).[13]

Survey Study

The survey form, created after a literature review on the subject,[14,15] was used in the study. Experts reviewed the questions and their clarity to assess the survey's content validity

(2 restorative dentistry specialists, 2 periodontology specialists, and 1 biochemistry specialist), and the questions were revised according to their suggestions. The survey study, consisting of 7 questions, evaluates the sociodemographic characteristics of the participants, their use of tooth brushing and oral care tools, nutrition, and dry mouth. The survey questions were applied face-to-face to the first-year students of Burdur Mehmet Akif Ersoy University, Faculty of Dentistry.

Ethics Considerations

The research had the approval of the Burdur Mehmet Akif Ersoy University Ethics Committee (Approval no: GO 2022/818, Date: July 6, 2022), which complies with the Helsinki Declaration.

Statistical Analysis

The results from the study were coded and statistically analyzed using the Statistical Package for Social Sciences version 20.0 software (IBM Corp.; Armonk, NY, USA). Descriptive statistics were obtained, and means, standard deviation, frequency distribution, and Pearson's product–moment correlation coefficient were calculated. The chi-square test was used for statistical analysis. A *P*-value of <.05 was considered statistically significant.

RESULTS

A total of 56 people participated in the study; 33 students were female, and 23 were male. The mean age of the students was 19.68 ± 1.13. The prevalence of decayed teeth, missing teeth, filled teeth, and DMFT index in female and male students are shown in Table 1. The number of decayed (D) teeth in females (1.24 ± 2.09) was found to be lower than in males (1.74 ± 1.98), but no significant difference was observed (*P* = .82). The DMFT index of females (3.30 ± 2.54) was similarly found to be lower than that of males (4.43 ± 3.56), but no significant difference was observed (*P* = .349).

The relationship between the survey questions directed to the students and the D and T index values is shown in Table 2. In terms of the frequency of toothbrushing, the highest D (1.65 ± 0.492) and T (4.19 ± 0.54) index averages were found in those who brushed their teeth once a day (2.12 ± 2.1). It was observed that as the frequency of toothbrushing increased, the D and T values decreased. However, no statistically significant differences were observed among the groups that brushed their teeth 1, 2, 3, or more times per day in terms of the D (*P* = .185) and T (*P* = .372) indexes. The D value was determined as 1.07 ± 0.508 in smokers and 1.57 ± 0.32 in non-smokers; however, no significant difference was found between the 2 (*P* = .436). When the T value was examined, the T value of smokers was 4.57 ± 0.95, and the T value of non-smokers was 3.50 ± 0.43. However, no significant difference was found between the 2 (*P* = .427).

When the D and T indexes were examined in terms of the time they started brushing their teeth, the D value (1.64 ± 0.73) (*P* = .668) and the T value (4.21 ± 0.57) (*P* = .604) were found to be higher in those who started brushing after the age of 12. However, no significant difference was found when they began brushing their teeth.

When a comparison was made between students who used dental floss and those who did not, the D (1.46 ± 0.28) (*P* = .77) and T (3.84 ± 0.441) (*P* = .883) values were found to be higher in those who did not use dental floss. However, no significant difference was observed between those who used dental floss and those who did not.

It was observed that students with bad breath had higher D and T index values D: (1.71 ± 0.63), (*P* = .212); T: (4.10 ± 0.46), (*P* = .473); however, no significant differences were observed between individuals with and without bad breath. While the D value was 1.03 ± 0.3 in those who drank 8-10 glasses of water daily, the T value was 3.20 ± 0.47. The D and T values were lower in those who drank 8-10 glasses of water

Table 1. Distribution of DMFT Index by Gender

Gender (N)	D (Mean ± SD) (Min-Max)	M (Mean ± SD) (Min-Max)	F (Mean ± SD) (Min-Max)	Total (Mean ± SD) (Min-Max)
Women (33)	1.24 ± 2.09 (0-7)	0.06 ± 0.24 (0-1)	2.00 ± 2.08 (0-6)	3.30 ± 2.54
Men (23)	1.74 ± 1.98 (0-6)	0.04 ± 0.209 (0-1)	2.65 ± 3.26 (0-13)	4.43 ± 3.56
P	.82	.635	.762	.349

Table 2. The Effects of Oral Hygiene Habits on the DMFT Index

Toothbrushing Frequency	D	*P*	T	*P*
1	1.65 ± 0.492		4.19 ± 0.54	
2	1.44 ± 0.355	.185	3.35 ± 0.60	.372
3 or more times	0.33 ± 0.33		1 ± 1	
Smoking status				
Yes	1.07 ± 0.508	.436	4.57 ± 0.95	.427
No	1.57 ± 0.32		3.50 ± 0.43	
Brushing initiation age				
Before age 6	1.28 ± 0.354		3.13 ± 0.68	
Between ages 6 and12	1.63 ± 0.531	.668	3.55 ± 0.99	.604
After age 12	1.64 ± 0.73		4.21 ± 0.57	
Dental floss usage				
Yes	1.33 ± 0.98	.770	3.17 ± 0.91	.883
No	1.46 ± 0.28		3.84 ± 0.41	
Halitosis status				
Yes	1.71 ± 0.63	.212	4.10 ± 0.46	.473
No	1.36 ± 0.30		2.79 ± 0.80	
Daily water consumption (8-10 glasses)				
Yes	1.03 ± 0.3	.615	3.20 ± 0.47	.304
No	2.14 ± 0.5		4.71 ± 0.69	

Table 3. Comparison of Salivary Parameters by Gender

	Female (Mean ± SD) (Min-Max)	Male (Mean ± SD) (Min-Max)	*P*
Salivary flow rate (mL/min)	1.16 ± 0.58 (0.14-2.26)	1.61 ± 0.46 (0.76-2.56)	.003
Salivary pH	7.29 ± 0.17 (7.01-7.63)	7.25 ± 0.25 (6.51-7.56)	.519
Buffering capacity	6.43 ± 0.28 (6.05-6.95)	6.35 ± 0.28 (5.60-6.95)	.266

daily compared to those who did not; however, no significant difference was observed ($P > .05$).

The values of female and male students in terms of saliva flow rate, volume, pH, and buffering capacity are given in Table 3. When female and male students were compared in terms of saliva flow rate, the saliva flow rate of female students was found to be 1.16 ± 0.58; the saliva flow rate of male students was found to be 1.61 ± 0.46, and a significant difference was found between female and male students in terms of saliva flow rate ($P = .003$). Saliva pH was 7.29 ± 0.17 in female students and 7.25 ± 0.25 in male students. There was no significant difference between female and male students regarding saliva pH ($P = .519$). Saliva buffering capacity was 6.43 ± 0.28 in female students and 6.35 ± 0.28 in male students. There wasn't a significant difference between female and male students in terms of saliva buffering capacity ($P = .266$).

The *r* and *P* values of the correlations are given in Table 4. A positive correlation was found between salivary flow rate-pH and DMFT-salivary flow rate, and a negative correlation between DMFT-pH, DMFT-buffering capacity, and DMFT-brushing frequency. The negative correlation between DMFT-pH values was significant ($P = .005$).

Table 4. Correlation Values Between DMFT and Salivary Characteristics

	r	*P*
Salivary flow rate—pH	0.198	.271
DMFT—pH	−0.183	.005
DMFT—buffering capacity	−0.115	.96
DMFT—salivary flow rate	0.034	1
DMFT—brushing frequency	−0.014	.372

DISCUSSION

This study hypothesized that saliva properties (pH, buffering capacity, and flow rate) and oral hygiene habits significantly affect the DMFT index. The findings revealed a significant negative correlation between saliva pH and the DMFT index. In addition, it was observed that DMFT values tended to decrease with increasing toothbrushing frequency; however, this relationship was not found to be statistically significant. One of the basic assumptions of the study, the protective effect of saliva buffering capacity on caries formation, was partially supported by our findings. These findings emphasize the effects of oral hygiene habits and biological factors on dental health.

Nowadays, the relationship between saliva's protective effects on dental health and clinical assessment tools such as the DMFT (decayed, missing, filled teeth) index is a growing research topic and attracts significant clinical interest. Saliva parameters such as pH, buffering capacity, and flow rate have been designed as diagnostic tools in comprehensive caries risk assessment models.[16,17] Therefore, in this study, the buffering capacity, flow rate, pH of saliva, personal habits, and other biological factors on the formation of teeth are examined and the potential reflections of these effects on the DMFT index in clinical applications are evaluated.

Among the students participating in the study, the number of "D" teeth and the DMFT index were lower in women than in men; however, the difference was not statistically significant. In the study conducted by Chapain et al,[18] unlike this study, the D and DMFT values were significantly higher in women than in men. In the survey conducted by Behram et al,[19] the DMFT index was also higher in women. In the study conducted by Koçak,[2] similar to this research, the DMFT values of men were found to be higher than in women. The DMFT values according to gender vary according to the oral hygiene habits of the study groups.

The most commonly used method for mechanical plaque removal today is tooth brushing. This study observed that D and T values decreased as toothbrush use increased, but no significant difference was found. According to the study conducted by Karaoğlanoğlu et al,[20] the DMFT value was found to be the highest in those who did not brush at all, while the DMFT rate of those who brushed 3 times a day was higher than those who brushed once or twice a day. They explained this situation as individuals being aware of their teeth problems and giving oral care more importance. In a study conducted by Casanova-Rosado et al[21] on 6-7-year-old children, the DMFT index values of those who brushed their teeth at least once a day were lower than those who brushed less than once a day. Güngör et al[22] stated that the need for dental treatment decreased as the frequency of toothbrushing increased. Again, in the study conducted by Casanova Rosado et al[21], the DMFT value of those who started brushing their teeth before the age of 2 was found to be lower, and the DMFT value of those who began brushing their teeth after the age of 2 was found to be lower. In this study, D and DMFT values were lower in those who started brushing their teeth before age 6. In conclusion, the findings obtained in this research and the studies support that brushing teeth early and regular oral care are essential in preventing tooth decay and maintaining a healthy tooth structure.

Various studies have been conducted on smoking and its effects on oral and dental health. In the Karaoğlanoğlu

et al[20] survey, a statistically significant relationship was found between smoking habits and DMFT ratio. According to a study conducted by Hanci et al,[23] DMFT values of smokers were found to be higher than those of non-smokers. In this research, the DMFT values of smokers were higher than those of non-smokers, similar to those of these studies. Smoking is a serious risk factor for tooth loss. Reducing this risk can be possible by changing individual habits and quitting tobacco use. Raising awareness about the effects of smoking on oral and dental health is of critical importance for improving public health.

It is recommended that daily tooth brushing be done together with dental flossing to prevent caries and periodontal diseases.[24] In this study, students who use dental floss had lower D and DMFT values; however, no significant difference was found. In the survey conducted by Sönmez et al[25] on nursing students, it was observed that students who use dental floss had lower D and DMFT values than those who did not, similar to our study; however, the difference was not statistically significant. In the survey conducted by Moradi et al,[26] similar to this study, those who used dental floss had lower D and DMFT values, and a significant difference was observed. Dental flossing is an indispensable habit for maintaining oral health; it prevents plaque formation, supports gum health, and reduces caries risk.

Bad breath is a common problem, characterized by an unpleasant and foul odor coming from the mouth.[27] Bad breath originating from oral causes is associated with poor oral hygiene, dental plaque, tooth decay, gingivitis, stomatitis, periodontitis, rusty tongue, and oral carcinoma.[28] This study examined the relationship between DMFT values and bad breath. Accordingly, while those experiencing bad breath had higher D and DMFT values, it was observed that those who drank 8-10 glasses of water every day had lower D and DMFT values. It was concluded that bad breath is associated with high DMFT values and that regular water consumption can protect oral health and reduce both bad breath and caries rates.

Saliva ensures tooth enamel's physicochemical continuity by maintaining the balance between demineralization and remineralization.[9] Magnesium and phosphate levels decrease with increased salivary flow rate, while chloride, protein, sodium, and bicarbonate rates increase.[29] Studies investigating the relationship between salivary flow rate and caries lesion development reported that caries were the most common result of hyposalivation.[30] In the hyposalivation state, the amount of saliva is quantifiably reduced, and the stimulated salivary flow rate is ≤0.5 mL/min.[31] This study also examined the difference in stimulated salivary flow rate between girls and boys. Accordingly, the salivary flow rate was higher in boys; a significant difference was observed between girls and boys. However, hyposalivation cannot be mentioned since the salivary flow rate values of girls and boys were higher than ≤0.5 mL/min. In the study conducted by Kılınç et al,[32] contrary to this study, no significant difference was found between girls and boys regarding salivary flow rate. Galvão-Moreira et al[33] found that the salivary flow rate ratio was similar in women and men. The effect of gender on salivary flow rate may be due to anatomical and hormonal differences. However, individual differences and environmental factors should also be considered.

In this study, saliva pH values varying according to gender were measured; however, no significant difference was found between girls and boys. Similar to this study, no relationship was found between pH value and gender in the survey conducted by Kılınç et al.[32] According to a study by Galvão-Moreira et al[33] men's saliva pH is higher than women's, and a significant difference was found. Thanks to saliva's buffering capacity, organic acids formed in the mouth are neutralized and buffered to protect against dental caries. Caries activity can be determined according to the level of saliva buffering capacity. Individuals with high buffering capacity are resistant to caries formation. Conversely, individuals with low buffering capacity are at risk for dental caries.[34] In this study, the saliva's buffering capacity was also examined. Although there was no significant difference in buffering capacity between men and women, men had higher buffering capacity.

According to the study conducted by Shetty et al[35] it was determined that as the DMFT score increases, the salivary flow rate, pH value, and buffering capacity decrease. This study found a significant and negative correlation between the DMFT value and pH. As the DMFT value increases, the pH value decreases. In addition, a negative correlation was found between the frequency of brushings and the DMFT score. As the frequency of brushings increases, the DMFT values decrease. In the study conducted by Taşveren et al,[36] a negative correlation was found between the frequency of brushings and the DMFT value, similar to this research. In the study conducted by Kılınç et al,[32] a favorable correlation emerged between the salivary pH value and the flow rate in children of all age groups, similar to this study.

The findings have shown that while men have a higher salivary flow rate than women, there is no significant difference in saliva buffering capacity and pH value. It has been observed that frequent tooth brushing, early initiation of brushing, and the use of dental floss have positive effects on reducing the number of caries; however, these differences were not statistically significant. Additionally, the higher DMFT values in individuals with bad breath problems suggest that inadequate oral hygiene may increase caries risk, leading to bad breath. The study determined that as saliva pH decreases, DMFT values increase. It has highlighted the importance of adequate hydration, regular tooth brushing, and dental floss use in maintaining oral health. In this regard, it has been concluded that education programs and practices to improve oral hygiene across society should be developed.

This study has some limitations. The small sample size and its performance with only 1 university student further limit the generalization of these findings. Oral hygiene habits and nutritional behaviors are also subject to bias, as they are based on self-reporting. Even though the DMFT index is a standard caries assessment, it does not reflect their activity or severity. To better understand these relationships, longer-term studies involving more significant and diverse populations will be necessary.

Availability of Data and Materials: The data that support the findings of this study are available on request from the corresponding author.

Ethics Committee Approval: The research had the approval of the Burdur Mehmet Akif Ersoy University Ethics Committee (Approval no: GO 2022/818, Date: July 6, 2022), which complies with the Helsinki Declaration.

Informed Consent: Written informed consent was obtained from students who participated in this study.

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