ORIGINAL ARTICLE
DOI: 10.5152/EssentDent.2026.25034

The Role of Sociodemographic Characteristics, Body Mass Index, and Cariogenic Nutrition in Dental Health: A Cross-Sectional Study

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Cite this article as: Aktuğ-Karademir S, Karaaslan E. The role of sociodemographic characteristics, body mass index, and cariogenic nutrition in dental health: a cross-sectional study. *Essent Dent.* 2026, 5, 0034, doi:10.5152/EssentDent.2026.25034.

Abstract

Background: Dental health problems commonly observed in society are usually caused by the combination of multifactorial risks. This study aims to evaluate the association between sociodemographic characteristics, body mass index (BMI), cariogenic nutrition, and dental health in individuals aged 18-65 years using the DMFT (Decayed, Missing, and Filled Teeth) index.

Methods: This cross-sectional study included 362 volunteers aged 18-65 who presented to the Department of Restorative Dentistry at the Faculty of Dentistry, Ordu University between July and December 2023. Data on sociodemographic information, oral hygiene practices, individual habits (smoking, alcohol use), BMI, frequency of cariogenic nutrition, daily water consumption, and DMFT scores were collected using a survey administered by an expert researcher. The DMFT assessment was conducted using visual examination and radiographic analysis. Data were analyzed using SPSS software (version 22.0) ($\alpha = 0.05$).

Results: The effects of age, education level, frequency of dental visits, and BMI on the DMFT score were statistically significant ($P < .05$). Cariogenic diet was positively associated with tooth loss ($P = .009$), while water consumption was negatively associated ($P = .035$). Increased BMI was positively associated with missing teeth ($P < .001$) and DMFT score ($P = .015$), while it was negatively associated with decayed teeth ($P = .001$). The missing teeth, filled teeth, and DMFT scores were significantly lower in underweight individuals compared to other groups ($P < .05$).

Conclusion: Individuals' dental health status is significantly influenced by BMI and the frequency of cariogenic nutrition. Additionally, sociodemographic characteristics, oral care practices, and daily water intake play a significant role in shaping the outcomes.

Keywords: Body mass index, cariogenic diet, oral health, oral hygiene

What is already known on this topic?

- *The literature on the relationship between body mass index (BMI), cariogenic diet, and oral health has primarily focused on children and adolescents. Studies in adults are limited, and the findings have been highly variable.*
- *A major challenge in understanding this association lies in the standardized measurement of potential confounding variables, such as diet and education, as well as effect modifiers like age, oral hygiene habits, and fluoride exposure.*

What this study adds on this topic?

- *This study revealed that individuals' dental health status was significantly influenced by BMI and the frequency of cariogenic diets. Additionally, sociodemographic characteristics, oral care practices, and daily water intake played a crucial role in shaping the results.*
- *In this cross-sectional study, contrary to previous literature that often links obesity to increased dental caries, higher caries scores were observed in underweight individuals. Additionally, the association between obesity and increased Decayed, Missing, and Filled Teeth scores was primarily driven by greater tooth loss.*

INTRODUCTION

Overweight and obesity, major public health issues in modern society, are defined by a high ratio of body fat to lean body mass. The rising prevalence of sedentary lifestyles, reduced physical activity, and dietary changes are key contributors to their development.[1] Body mass index (BMI), the most used method for diagnosing obesity, is calculated by dividing body weight (kg) by the square of height (m^2). According to the World Health Organization (WHO), individuals with a BMI below 18.5 are classified as underweight, those with a BMI between 18.5 and 24.9 as normal weight, those with a BMI between 25 and 29.9 as overweight, and those with a BMI of 30 or higher as obese.[2]

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Received: April 4, 2025
Revision Requested: May 2, 2025
Last Revision Received: June 23, 2025
Accepted: October 13, 2025
Publication Date: February 25, 2026

Diet plays a major role in the increasing prevalence of obesity due to the increased consumption of foods rich in carbohydrates and fat. Eating habits, particularly those related to sucrose intake, along with sociodemographic aspects such as low socioeconomic conditions, have a well-known causal relationship with obesity and dental caries.[3] Obesity and oral diseases share common risk factors, including high sugar consumption, dental biofilm accumulation, socioeconomic factors, and both genetic and behavioral predispositions.[4] Research has shown a positive correlation between the intake of cariogenic foods rich in fermentable carbohydrates and an increased incidence of dental caries.[5,6] Furthermore, both the frequency and quantity of consumption of these cariogenic foods play a crucial role in the development of dental caries.[6]

Research on the association between nutrition and dental health in adults remains limited.[7-9]Epidemiological studies often utilize the decayed, missing, and filled teeth (DMFT) index, a widely used tool in dental caries epidemiology that effectively assesses an individual's overall oral health status.[9] When calculating the DMFT index, different criteria are used based on age. For individuals under 30, only teeth missing due to decay are considered, whereas for those over 30, teeth missing due to both decay and other reasons are included. The index evaluates all permanent teeth but excludes those with abutments, crowns, implants, or fissure sealants.[10]

Previous studies examining the effects of obesity on the oral environment have reported a link between obesity and chronic periodontitis in adults, as well as various periodontal diseases in children. This association is attributed to elevated cytokine levels in the gingival crevicular fluid. Additionally, studies have reported that cytokines involved in central nervous system function in the presence of obesity can affect the activity of the hypothalamo-pituitary-adrenal axis, leading to reduced salivary gland secretions. [11] This decrease in saliva diminishes its beneficial effects, such as its washing and buffering properties on dental hard tissues, which may, in turn, contribute to the development of dental caries and caries-free lesions in the oral cavity.[3,12] However, the results of studies on the relationship between BMI and dental caries are conflicting. While some studies have found no association,[13,14] others have reported an inverse relationship.[8,15] A major challenge in understanding this association lies in the standardized measurement of potential confounding variables, such as diet and income, as well as effect modifiers like age, oral hygiene habits, and fluoride exposure.[16]This situation underscores the need for studies that explore the relationship between BMI, cariogenic nutrition, and dental health as interconnected, multifactorial factors.

In this context, the aim of this study is to examine the relationship between BMI, cariogenic nutrition, and dental health in the adult population aged 18-65, considering sociodemographic characteristics, oral care, and smoking, alcohol habits, and daily water consumption data.

MATERIALS AND METHODS

Study Design and Setting

This cross-sectional study was conducted at the Department of Restorative Dentistry, Faculty of Dentistry, Ordu University between July and December 2023. Ethical approval was obtained from the Ordu University Clinical Research Ethics Committee (Approval no.: 269; Date: November 25, 2022), and the study adhered to the principles of the Declaration of Helsinki.

Participants

In this study, a stratified random sampling method was used to select participants. A total of 518 volunteers aged 18-65 years were initially evaluated. After excluding 148 participants due to systemic diseases, medication use, or pregnancy, and 18 participants undergoing orthodontic treatment, 362 individuals were included in the final analysis. All participants provided written informed consent prior to data collection.

Sample Size Calculation

The minimum sample size was calculated using one-way ANOVA with a power of 0.90 ($\beta = 0.10$), an effect size of 0.25, and $\alpha = .05$ for 11 categorical variables using G Power 3.1.9.7 software, and 341 participants were found to be sufficient.[17]

Data Collection and Variables

Data were collected through a structured, face-to-face survey conducted by a trained expert researcher. The survey included questions on sociodemographic characteristics (age, gender, and education level), oral health behaviors (tooth brushing frequency, use of fluoride toothpaste, and frequency of dental visits), and individual habits such as smoking and alcohol use. The age range of the participants was examined in 3 categories: 18-34, 35-49, and 50-65 years, based on a previous study.[18]

The frequency of cariogenic nutrition was determined by adapting the National Health and Nutrition Examination Survey Food Frequency Questionnaire to sugary foods and beverages frequently consumed in Türkiye. Consumption frequencies of cariogenic foods were categorized as 1-2 times per day (5 points), 4-5 times per week (4 points), 3 times per week (3 points), 1-2 times per week (2 points), 1-2 times per month (1 point), and never consumed (0 points) based on a previous study.[19] Participants were asked to mark their monthly nutrition, considering the last year. The cariogenic nutrition score of each participant was calculated by scoring the consumption frequency score as ×1 for cariogenic foods and ×2 for cariogenic beverages. Participants' scores, reflecting the frequency of consumption of cariogenic foods and beverages, ranged from 15 to 109. As only 1 participant scored 109, the next highest score of 96 was used as the upper limit for standardizing the grading. Scores were categorized in 20-point intervals: Grade 1 indicated low cariogenic nutrition (15-35), Grade 2 indicated moderate cariogenic

nutrition (36-55), Grade 3 indicated high cariogenic nutrition (56-75), and Grade 4 indicated very high cariogenic nutrition (76-96). The participant with a score of 109 was also included in Grade 4.

Daily water intake was recorded to assess hydration status. Water consumption was examined in 2 categories as under 2 L and over 2 L, with the ideal water consumption being accepted as 2L. Anthropometric measurements, including height and weight, were used to calculate BMI, which was classified according to WHO criteria as underweight (<18.5), normal weight (18.5-24.9), overweight (25.0-29.9), or obese (≥30).[2]

Dental Examination and Outcome Measurement

Dental health status was assessed using the DMFT index evaluated by visual examination and panoramic radiography by an expert researcher. To assess intra-rater reliability, DMFT scores were reassessed by the same researcher at a different time. Discrepancies were resolved by consensus with a second examiner.

Statistical Analysis

The data obtained were statistically analyzed using SPSS software (version 22.0; IBM Corp., Armonk, NY, USA). The conformity of the data to normal distribution was determined using the Kolmogorov–Smirnov test in groups of 50 people and higher, and the Shapiro–Wilk test in groups of 50 people and lower. The homogeneity of the variances was evaluated using the Levene test. The data belonging to the participants were not found to be normally distributed and the variances were not homogeneous ($P < .05$). The kappa test was used to assess the reliability of 2 different DMFT score evaluations by the expert researcher. The Kruskal–Wallis test was used to determine differences between groups for parameters with 3 or more subgroups, while the Mann–Whitney *U*-test was applied for parameters with 2 subgroups. Post-hoc Tamhane's T2 test was used in pairwise comparisons of the groups. Multiple regression analysis was used to determine the effects of each examined parameter on decayed teeth (DT), missing teeth (MT), filled teeth (FT), and DMFT, and Spearman correlation test was used to determine the relationships between the examined parameters. The findings were evaluated at a significant level of 95%.

RESULTS

Dental health findings related to the sociodemographic characteristics of the participants are shown in Table 1. In the current study consisting of 362 participants, the mean age was 29.61 ± 12.26, 158 of the participants were female and 204 were male. The expert researcher's evaluations of participants' DMFT scores at 2 different time points showed a high level of agreement, with a kappa value of 0.962 ($P < .001$). When age-related dental health findings were examined, MT (0.92 ± 1.89) and DMFT (8.90 ± 4.70) scores were significantly lower in the 18-34 age group compared to other age groups ($P < .001$). There was no significant difference in the DT, MT, and DMFT scores between females and males ($P > .05$). However, the FT score was significantly lower in males (3.62 ± 2.96) compared to females (4.66 ± 3.70) ($P = .017$). Missing teeth, FT, and DMFT scores were significantly lower among individuals with a university education or higher compared to those with only high school or primary school education ($P < .05$). However, the difference in DT scores between the groups was not statistically significant ($P > .05$).

Dental health findings based on participants' oral care and individual (smoking-alcohol) habits are presented in Table 2. There was a significant difference between groups regarding brushing frequency only for MT ($P = .004$). Individuals who brushed their teeth twice daily had significantly lower MT scores (1.69 ± 3.01) compared to those with irregular brushing habits (3.70 ± 5.17). Decayed teeth and MT scores were significantly lower, while FT scores were higher, among individuals who used fluoride toothpaste compared to non-users ($P < .05$). Considering the frequency of dental visits, DT and DMFT were significantly higher in irregular dental visits

Table 1. Dental Health Findings Related to Sociodemographic Characteristics of Participants

Parameters		n (%)	DT	MT	FT	DMFT
Age (years)	18-34	254 (70.2)	4.01 ± 3.34[a]	0.92 ± 1.89[a]	3.96 ± 3.42[a]	8.90 ± 4.79[a]
	35-49	73 (20.2)	3.83 ± 2.72[a]	3.61 ± 2.86[b]	4.80 ± 3.54[a]	12.26 ± 4.59[b]
	50-65	35 (9.6)	3.14 ± 2.00[a]	6.57 ± 5.46[c]	4.68 ± 3.17[a]	14.40 ± 5.51[b]
*P**			.613	**<.001**	.066	**<.001**
Gender	Male	158 (43.6)	4.37 ± 3.58	1.89 ± 3.55	3.62 ± 2.96	9.89 ± 5.18
	Female	204 (56.4)	3.51 ± 2.66	2.10 ± 2.92	4.66 ± 3.70	10.28 ± 5.19
*P***			.061	.161	**.017**	.561
Education	Primary	51 (14.1)	4.21 ± 2.36[a]	5.86 ± 4.83[a]	3.82 ± 3.07[a]	13.90 ± 5.53[a]
	High	116 (32.0)	4.37 ± 2.96[a]	2.01 ± 3.01[b]	3.62 ± 3.34[a]	10.00 ± 4.97[a]
	University[+]	195 (53.9)	3.52 ± 3.35[a]	1.01 ± 1.70[c]	4.65 ± 3.53[b]	9.18 ± 4.78[b]
*P**			.05	**<.001**	**.018**	**<.001**

DT, decay teeth; DMFT, total DT, MT, FT; FT, filling teeth; MT, missing teeth. + indicates university-level education and above (including master's and doctoral degrees). Bold values indicate statistically significant differences ($p < 0.05$).
*Kruskal–Wallis test.
**Mann–Whitney *U*-test, statistically significant $P < .05$.

Table 2. Dental Health Findings Related to Oral Care and Individual Habits

Parameters		n (%)	DT	MT	FT	DMFT
Brushing frequency (Day)	Irregular	41 (11.3)	4.60 ± 3.33[a]	3.70 ± 5.17[a]	3.31 ± 2.96[a]	11.63 ± 5.60[a]
	Once	100 (27.6)	3.98 ± 3.06[a]	2.03 ± 2.29[ab]	4.32 ± 3.48[a]	10.33 ± 4.92[a]
	Twice	221 (61)	3.71 ± 3.11[a]	1.69 ± 3.01[b]	4.32 ± 3.47[a]	9.73 ± 5.19[a]
*P**			.190	**.004**	.221	.106
Fluoride Toothpaste	No	184 (50.8)	4.39 ± 3.12	2.39 ± 3.53	3.62 ± 3.02	10.41 ± 5.22
	Yes	178 (49.2)	3.37 ± 3.04	1.62 ± 2.79	4.80 ± 3.73	9.80 ± 5.15
*P***			**<.001**	**.006**	**.004**	.329
Dental visits (Year)	Irregular	271 (74.9)	4.26 ± 3.24[a]	2.23 ± 3.51[a]	4.09 ± 3.36[a]	10.58 ± 5.20[a]
	Once	54 (14.9)	2.90 ± 2.26[b]	1.59 ± 2.03[a]	4.77 ± 3.85[a]	9.27 ± 4.39[ab]
	Twice	37 (10.2)	2.62 ± 2.70[b]	1.05 ± 1.85[a]	4.21 ± 3.36[a]	7.89 ± 4.82[b]
*P**			**<.001**	.128	.581	**.003**
Smoking	No	285 (78.7)	3.78 ± 3.13	1.91 ± 2.98	4.23 ± 3.37	9.94 ± 5.20
	Yes	77 (21.3)	4.27 ± 3.10	2.37 ± 3.94	4.10 ± 3.67	10.75 ± 5.10
*P***			.141	.435	.579	.152
Alcohol	No	328 (90.6)	3.88 ± 3.12	2.04 ± 3.28	4.24 ± 3.43	10.16 ± 5.27
	Yes	34 (9.4)	4.00 ± 3.18	1.73 ± 2.51	3.88 ± 3.53	9.61 ± 4.27
*P***			.860	.859	.462	.755

DT, decay teeth; DMFT, total DT, MT, FT; FT, filling teeth; MT, missing teeth. Different superscript lowercase letters (a, b) indicate statistically significant differences between groups ($p < 0.05$).
*Kruskal–Wallis test.
**Mann–Whitney *U*-test, statistically significant $P < .05$.

compared to twice-yearly dental visits ($P < .05$). No significant differences were found in the DT, MT, FT, and DMFT scores based on smoking and alcohol use ($P > .05$).

Participants' BMI, cariogenic diet, and dental health findings related to daily water consumption are listed in Table 3, and the distribution of BMI and cariogenic diet by gender and age is listed in Table 4. In the current study, all the underweight individuals were between the ages of 18–34. The differences in all dental health parameters (DT, MT, FT, and DMFT) among groups based on BMI were statistically significant ($P < .05$). When examining the cariogenic diet frequencies of participants, there were no statistically significant differences in dental health findings among the groups ($P > .05$).

Regarding water consumption, the MT score was significantly higher in individuals who consumed less than 2 L (2.27 ± 3.26) of water compared to those who consumed more than 2L (1.52 ± 3.06) ($P = .03$).

The results of multiple regression analysis regarding the effects of the examined parameters on dental health are presented in Table 5. The scores related to the participants' education, brushing frequency, dentist visits, and BMI were negatively associated with DT scores (Adjusted $R^2 = .096$, $P < .001$). For MT, the effects of participants' age, BMI, and cariogenic diet were positive, while the effects of education, fluoride toothpaste, and water consumption were negative (Adjusted $R^2 = .371$, $P < .001$). Age, gender, and education

Table 3. Dental Health Findings Related to Body Mass Index, Cariogenic Diet, Daily Water Intake

Parameters		n (%)	DT	MT	FT	DMFT
Body mass index	Underweight	23 (6.4)	4.43 ± 3.51[a]	0.17 ± 0.38[a]	1.91 ± 2.29[a]	6.52 ± 3.36[a]
	Normal	207 (57.2)	4.21 ± 3.33[a]	1.57 ± 2.53[b]	4.33 ± 3.50[b]	10.12 ± 5.06[b]
	Overweight	102 (28.2)	3.50 ± 2.65[ab]	2.98 ± 3.95[b]	4.32 ± 3.15[b]	10.80 ± 5.36[b]
	Obese	30 (8.3)	2.56 ± 2.35[b]	3.23 ± 4.39[b]	4.66 ± 4.10[b]	10.46 ± 5.63[b]
*P**			**.019**	**<.001**	**.004**	**.002**
Cariogenic diet	Low	30 (8.3)	4.16 ± 4.01	1.40 ± 2.68	3.13 ± 2.48	8.70 ± 5.16
	Medium	162 (44.8)	3.62 ± 2.85	1.87 ± 2.76	4.56 ± 3.49	10.07 ± 5.36
	High	69 (19.1)	4.23 ± 3.29	1.55 ± 2.74	4.27 ± 3.76	10.05 ± 4.49
	Very High	101 (27.9)	4.00 ± 3.15	2.74 ± 4.11	3.90 ± 3.29	10.64 ± 5.33
*P**			.564	.133	.170	.455
Water intake	Less 2 L	239 (66)	4.02 ± 3.03	2.27 ± 3.26	4.08 ± 3.34	10.38 ± 5.10
	More 2 L	123 (34)	3.62 ± 3.29	1.52 ± 3.06	4.43 ± 3.60	9.58 ± 5.33
*P***			.094	**.003**	.450	.155

DT, decay teeth; DMFT, total DT, MT, FT; FT, filling teeth; MT, missing teeth.
*Kruskal–Wallis test.
**Mann–Whitney *U*-test, statistically significant $P < .05$.

Table 4. Distributions of Body Mass Index and Cariogenic Nutrition by Gender and Age

		Male, n (%)			Female, n (%)		
Groups		**18-34**	**34-49**	**50-65**	**18-34**	**34-49**	**50-65**
Body mass index	Underweight	9 (7.8)	–	–	14 (10.1)	–	–
	Normal	73 (63.5)	7 (28)	5 (27.8)	96 (69.1)	20 (41.7)	6 (35.3)
	Overweight	27 (23.5)	12 (48)	11 (61.1)	23 (16.5)	20 (41.7)	9 (52.9)
	Obese	6 (5.2)	6 (24)	2 (11.1)	6 (4.3)	8 (16.7)	2 (11.8)
Cariogenic diet	Low	16 (13.9)	1 (4.0)	1 (5.6)	11 (7.9)	–	1 (5.9)
	Medium	45 (39.1)	16 (64.0)	3 (16.7)	64 (46.0)	26 (54.2)	8 (47.1)
	High	34 (29.6)	2 (8.0)	4 (22.2)	27 (19.4)	2 (4.2)	–
	Very high	20 (17.4)	6 (24.0)	10 (55.6)	37 (26.6)	20 (41.7)	8 (47.1)

level were positively associated with FT scores, whereas the use of fluoride toothpaste showed a negative association (Adjusted R^2 = .059, P < .001). Age and BMI had a positive effect on the DMFT score, while education level and dental visit frequency had a negative effect (Adjusted R^2 = .154, P < .001).

Correlations between the examined parameters, except dental health findings, are presented in Table 6.

DISCUSSION

Dental caries is the most prevalent disease globally and has long been considered one of the most significant oral health burdens worldwide.[20] The literature on the association between obesity and oral health has focused primarily on children and adolescents.[12,14,15] While normal-weight children tend to experience fewer caries in their primary teeth compared to permanent teeth, obese children are reported to be more likely to experience tooth loss.[12,21,22] However, these findings are not consistent in adults,[19] and studies that include adult populations are limited.[7-9,22-24] In this cross-sectional study, the aim was to assess the association between BMI and oral health in adults, considering the impact of confounding factors such as sociodemographic characteristics, nutritional status, adequate water consumption, and oral hygiene habits.

Table 5. Multiple Regression Analysis Results for the Examined Parameters

Parameters	DT	MT	FT	DMFT
Age (years)	β=-.110 *P*=.072	β=.434 ***P* < .001****	β=.171 ***P* = .006***	β=.315 ***P* < .001****
Gender	β=-.076 *P*=.148	β=.023 *P*=.663	β=.177 ***P*=.001***	β=.036 *P*=.477
Education	β=-.179 ***P*=.003***	β=-.241 ***P* < .001****	β=.220 ***P* < .001****	β=-.276 ***P* < .001****
Brushing frequency	β=-.059 *P*=.493	β=-.097 *P*=.065	β=.115 *P*=.191	β=.130 *P*=.119
Fluoride toothpaste	β=-.123 ***P*=.019***	β=-.265 ***P* < .001****	β =- .148 ***P*=.028***	β=-.099 *P*=.221
Dental visits	β=-.189 ***P* < .001****	β=-.071 *P*=.096	β=.021 *P*=.690	β=-.149 ***P*=.003***
Smoking	β=.076 *P*=.281	β=.037 *P*=.427	β=-.028 *P*=.621	β=.070 *P*=.302
Alcohol	β=.050 *P*=.475	β=-.006 *P*=.898	β=.042 *P*=.466	β=.034 *P*=.615
Body mass index	β=-.176 ***P*=.001***	β=.253 ***P* < .001****	β=.104 *P*=.063	β=.127 ***P*=.015***
Cariogenic diet	β=.045 *P*=.502	β=.137 ***P*=.009***	β=.039 *P*=.471	β=-.059 *P*=.364
Water intake (daily)	β=-.050 *P*=.333	β=-.111 ***P*=.035***	β=.046 *P*=.381	β=-.023 *P*=.648
Adjusted R^2 *P*	.096 <.001	.371 <.001	.059 <.001	.154 <.001

DT, decay teeth; DMFT, total DT, MT, FT; FT, filling teeth; MT, missing teeth; *P*, statistical significance value, β, standardized coefficient. **P* < .05, ***P* < .001 .
**P* < .05.
***P* < .001.

The present study revealed a positive association between age and MT, FT, and DMFT scores (Table 5). These results are consistent with those reported by Hilgert et al[24] and Prpić et al.[25] Missing teeth and DMFT scores were significantly higher in individuals aged 18-34 years compared to those aged 35-49 and 50-65 years. One reason individuals tend to have higher DMFT scores with increasing age may be that the DMFT score is a cumulative index.[22]Moreover, being over

Table 6. Correlations of Variables Other Than Dental Health Findings

Parameters	*r*	*P*
Age-BMI	.394**	<.001
Age-Cariogenic diet	.261**	<.001
Education-Brushing	.180**	.001
Education-Fluoride toothpaste	.227**	<.001
Education-Dental visits	.108*	.040
Education-Water intake	.156**	.003
Education-Age	-.425**	<.001
Education-Alcohol use	-.104*	.048
Education-Cariogenic diet	-.115*	.028
Education-BMI	-.147**	.005
Brushing-BMI	-.105*	.047
Smoking-Fluoride toothpaste	.511**	<.001
Alcohol-Fluoride toothpaste	.317**	<.001
Cariogenic diet-BMI	.210**	<.001

BMI, body mass index; *P*, statistical significance value; *r*, Spearman's correlation coefficient.
**P* < .05.
***P* < .001.

35 years of age is considered a risk factor for tooth loss due to periodontal disease.[26] In this study, one of the reasons for increased tooth loss after the age of 35 may be losses due to periodontal disease. Changes in diet and the loss of essential nutrients with age may contribute to the development of oral diseases, potentially leading to tooth loss. Conversely, the decrease in the number of teeth (< 20) due to tooth loss can affect chewing efficiency and dietary habits, which may, in turn, impact BMI.[22,27] This may explain the positive significant correlations observed in the present study between age-BMI and age-cariogenic diet. Additionally, 148 participants with systemic diseases were excluded from the study to minimize the impact of general health on oral health, as systemic diseases are a common risk factor with advancing age.

In the present study, FT scores were significantly higher in women than in men, and there was a significant positive association. The DMFT scores were also higher in women than in men, although not significantly. Similarly, Eslamipour et al[28] reported that the prevalence of DT did not vary significantly between genders, but the prevalence of FT was significantly higher in women. This has often been attributed to hormonal changes in women, which can affect the quantity and quality of saliva, increasing the likelihood of a higher DMFT score.[22,29] Higher FT scores are ultimately associated with greater prior caries experience. Additionally, a higher FT score in women compared to men also indicates a higher likelihood of utilizing dental health services.

Education level is a commonly used socioeconomic indicator in determining social health inequalities and has been reported to be relatively more stable than other determinants.[30] Therefore, education level was used as a socioeconomic determinant in the study. The findings of the study showed that MT and DMFT scores were significantly lower in individuals with university and higher education levels compared to primary school and high school education levels, while FT scores were significantly higher in individuals with university and above education levels. In addition, the effect of education level was statistically significantly negative for DT, MT, and DMFT, and positive for FT. These findings were consistent with the results of previous studies that reported that the level of treated dental caries increased as education level increased, and the FT score increased as the DT score decreased.[6,31] This relationship can be explained by the fact that education level can affect a person's interaction with oral health services and the way they use information.[32]

Positive significant correlations were observed between education level and tooth brushing frequency, use of fluoride toothpaste, dental visits, and water consumption, whereas negative significant correlations were found with age, alcohol use, cariogenic diet, and BMI (Table 6). The findings of the present study supported that individuals with higher education levels and higher socioeconomic status, which can be considered a partial reflection of this, are more likely to visit the dentist frequently and regularly. The findings of the study conducted by Koletsi-Kounari et al[8] in Greek adults were like the findings of the present study. Again, the positive correlation between level of education and brushing and fluoride paste was associated with increased awareness and greater interaction with oral health services in individuals with higher levels of education.[32] Dietary habits associated with obesity, low education levels, and low income may lead to more frequent and higher intakes of sucrose, which are prominent factors in the etiology of caries. Higher sucrose intake and reduced fiber may be associated with a higher prevalence of poor oral health and overweight/obesity in individuals with lower education levels and socioeconomic circumstances.[16] Based on these findings, it can be said that level of education is a common risk factor for general health and oral health, with a significant impact on health-related lifestyle behaviors (healthy diet, alcohol and tobacco use, physical activity, and obesity, etc.).

In this study, there was a negative significant correlation between tooth brushing and BMI (Table 6). A recent study in Japan with 4537 participants reported that low frequency of tooth brushing (once a day) was associated with the development of obesity.[33] Another study conducted by Chang et al[34] found that people who brushed their teeth twice a day had lower BMI. These results were consistent with the findings of this study. These results suggest that leptin-related pathways that regulate appetite balance are likely responsible for the link between tooth brushing and obesity. Another reason may be that poor oral hygiene triggers an inflammatory response in the oral cavity, leading to an increase in C-reactive protein levels, which are associated with obesity. As a result, it is possible to say that regular tooth brushing may help reduce appetite and reduce the risk of obesity.[3,35]

In the present study, no significant relationship between smoking and alcohol use and dental health findings could be found. Interestingly, there was a positive significant correlation between smoking and alcohol use and fluoride toothpaste use of the participants in the study (Table 6). This situation may have prevented the negative potential of smoking and alcohol use on oral and dental health. The results may vary in studies including different populations.

In this study, the BMI had a positive effect on MT and DMFT, but a negative effect on DT. Interestingly, DT scores were significantly higher in underweight individuals than in obese individuals. Song et al[9] and Ahmadi-Motamayel et al[16] reported more dental caries in underweight individuals, like the results of this study. It is important to consider the age range and the fact that the results are two-sided when interpreting the results. All underweight individuals in this study were between the ages of 18-35. Considering that age after 35 is a risk factor for increased tooth loss,[26] the lower MT and therefore DMFT scores in underweight individuals may be associated with all of them being at the young age range.

Since FT score is also a factor related to access to health care, it is difficult to fully explain the causal relationship. Americano et al[36] reported that underweight or malnutrition may lead to poor development or hypomineralization of tooth enamel, a known risk factor for caries formation. In addition, it has been reported that severe dental caries can negatively affect food intake by making it difficult to chew or bite food effectively and can lead to low BMI.[15,37] These may explain the finding of more dental caries in underweight individuals in this study. However, early and immature caries have no effect on food intake.[37] The fact that DMFT was examined with panoramic radiography in the current study is a limitation that prevents the severity of caries from being interpreted.

In individuals with higher BMI, low-density general inflammation-related cytokines have been reported to regulate central nervous system activity and reduce salivary flow. This may be a contributing factor to periodontitis in obesity and may lead to increased tooth loss.[38] Similarly, in this study, it was found that BMI was positively associated with tooth loss. Furthermore, this relationship is bidirectional. Increased tooth loss may lead individuals to switch from fibrous and dry foods to a softer diet, which is higher in fat and carbohydrates but lacking in essential vitamins and minerals. This change in diet may increase an individual's risk of obesity or higher BMI.[3,22,27] This may explain the positive correlation between cariogenic diet and BMI in the present study.

When the distribution of cariogenic diet was examined according to age and gender, 55.6% of male individuals categorized as having a very high cariogenic diet were between the ages of 50-65, while 47.1% of female individuals were between the ages of 55-65. A significant association was observed between a higher cariogenic diet and increased MT scores, with this relationship being more pronounced among individuals who brushed their teeth irregularly. This situation may be related to a bidirectional causality such as the fact that increasing tooth loss due to age significantly affects the person's eating habits and shifts to a soft diet with high carbohydrate content, or that the increased cariogenic diet increases tooth loss associated with severe caries.[22,27] In this study, the amount of saliva and daily water consumption—which may significantly affect its washing efficiency—were also evaluated.[11] More than half of the participants (66%) reported that they consumed less than 2 L of water. Missing teeth scores were significantly higher in individuals who consumed less than 2 L of water compared to those who consumed more than 2 L of water. Based on these findings, it can be said that adequate water consumption is an important factor that reduces tooth loss.

The main limitations of this study include a smaller total sample size, the inclusion of only the Turkish population, the evaluation of dental health findings solely with the DMFT index (excluding periodontal indices), only using panoramic radiography and the lack of consideration for cariostatic nutrients in the assessment of nutritional status. Nutritional habits, differences in genetic predisposition to caries and obesity, and lifestyle specific to each society and demographics may cause differences and contradictions in the results between studies. Due to the limited sample size of the study, correlations were weak and moderate. Larger studies with different sample sizes that will increase the power of the results are needed.

CONCLUSION

The dental health status of individuals is significantly affected by BMI and the frequency of cariogenic nutrition. In addition, sociodemographic characteristics, oral care practices, and daily water intake play an important role in shaping the results.

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

Ethics Committee Approval: Ethical committee approval was received from the Ordu University Clinical Research Ethics Committee (Approval No.: 269, Date: November 25, 2022).

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

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – S.AK., E.K.; Design – S.AK., E.K.; Supervision – S.AK., E.K.; Funding – S.AK., E.K.; Materials – E.K.; Data Collection and/or Processing – S.AK., E.K.; Analysis and/or Interpretation – S.AK.; Literature Search – S.AK., E.K.; Writing Manuscript – S.AK.; Critical Review – S.AK., E.K.

Declaration of Interests: The authors have no conflicts of interest to declare.

Funding: The authors declared that this study has received no financial support.

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