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DMFT Index in Adolescents of Rafsanjan: Assessing the Role of Oral Health Behaviors, Demographic Characteristics, and Family and Individual Outcomes

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Abstract

Background: Oral health indices reflect untreated dental caries, which can adversely affect the physical and psychological well-being of individuals and their families.

Objectives: This study examined oral health-related quality of life (OHRQoL), oral health behaviors (OHBs), family and individual impacts, and the DMFT index, as well as the associations among them.

Methods: This descriptive cross-sectional study was conducted among 300 adolescents aged 11 - 14 years in Rafsanjan, Iran. Data were collected using validated Persian versions of the Child Perceptions Questionnaire (CPQ11 - 14), the Family Impact Scale (FIS), and an oral health behavior (OHB) checklist. The DMFT index was assessed clinically by trained dentists according to WHO criteria. Associations were examined using correlation analyses and multiple linear regression models.

Results: The mean scores for CPQ, FIS, OHB, and DMFT were 14.05, 3.64, 16.56, and 2.12, respectively. DMFT was significantly correlated with FIS (r = 0.159; 95% CI, 0.05 - 0.26; P = 0.006) and functional limitations (r = 0.163; 95% CI, 0.06 - 0.27; P = 0.005), whereas OHB was negatively correlated with oral symptoms (r = -0.132; 95% CI, -0.23 to -0.02; P = 0.022). FIS was significantly associated with all OHRQoL dimensions. Higher DMFT scores were observed among adolescents whose fathers were employed in government positions (beta = 1.21; 95% CI, 0.18 - 2.24) and those aged ≥ 13 years (beta = 0.66; 95% CI, 0.15 - 1.17). Lower DMFT scores were associated with higher fluoride concentration (beta = -1.37; 95% CI, -1.90 to -0.84), paternal university education (beta = -1.33; 95% CI, -2.48 to -0.18), and four-member households (beta = -1.45; 95% CI, -2.55 to -0.35).

Conclusions: Adolescent DMFT is influenced by household size, paternal occupation, and water fluoride concentration. Integrated public health measures, including optimal fluoride exposure and targeted education, are recommended.

Keywords: DMFT Index, Oral Health-related Quality Of Life, Family Impact Scale, Oral Health Behaviours

1. Background

The current state of oral health is alarming, underscoring the urgent need for action in this area. Recent data indicate that dental caries and related oral conditions rank among the most prevalent noncommunicable chronic diseases worldwide, imposing a substantial burden on public health, economic systems, and overall quality of life. According to the latest estimates, oral diseases affect more than 3.5 billion people globally, with approximately 2 billion individuals experiencing untreated permanent caries.

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Additionally, 514 million cases involve primary-tooth caries in children aged 0 - 14 years (1).

Evidence indicates that these conditions not only lead to clinical consequences, such as pain, infection, tooth loss, and impaired chewing, but also result in substantial psychosocial impacts on children, adolescents, and their families, including reduced self-esteem, diminished academic performance, and limited social interactions. Furthermore, the financial burden of oral diseases is considerable. Estimates show that direct costs alone, excluding indirect costs such as reduced productivity and reduced quality of life, exceed $380 billion annually.

Adolescence is a critical period for the development and consolidation of oral hygiene habits due to hormonal, behavioral, and social changes. During this stage, reduced parental supervision, increased consumption of sugary foods and beverages, and declining adherence to preventive behaviors such as regular tooth brushing are key contributors to the heightened risk of dental caries. At age 12 years, the average DMFT index ranges between 0.3 and 0.5. International evidence indicates a high prevalence of dental problems and caries among adolescents aged 11 - 14 years, particularly in developing countries (2-5). A national systematic review and meta-analysis in Iranian adolescents reported a caries prevalence of 72.8% and an overall mean DMFT of 2.33 (5). These figures appear to be associated with factors such as socioeconomic status, parental education, household size, high carbohydrate intake, and tooth-brushing frequency (4, 5).

Addressing oral health challenges requires a comprehensive understanding of overall oral health status and its associated factors, particularly in high-risk age groups such as adolescents. A holistic approach may involve examining the DMFT index alongside oral health behaviors (OHBs), oral health-related quality of life (OHQoL), and the family impact of oral health (FIS). Despite extensive evidence on the burden of oral diseases in adolescents, many low- and middle-income countries still lack up-to-date and detailed data on the interrelationships among OHBs, OHQoL, FIS, and DMFT. Most studies have focused on only one or two of these dimensions (6, 7).

Existing evidence suggests that dental caries and similar conditions negatively affect OHQoL, while family-related factors, such as parental education, family structure, and social support, play a crucial role in shaping oral health behaviors and related clinical outcomes (2, 6-8). Instruments such as the Child Perceptions Questionnaire and the Family Impact Scale have been widely used in international studies to assess these dimensions, and their validity and reliability have been confirmed across various cultures and languages (8). Despite the high prevalence of dental caries among Iranian adolescents, existing studies have predominantly focused on either clinical indices or behavioral factors in isolation. Evidence integrating oral health behaviors, oral health-related quality of life, family impacts, and clinical indicators such as DMFT within a single analytical framework remains limited. In particular, the role of family-related outcomes in shaping adolescents' oral health status has been insufficiently explored in the Iranian sociocultural context. This study addresses this gap by simultaneously examining individual, familial, and environmental determinants of DMFT among adolescents in Rafsanjan.

1.1. Statement of the Problem

Despite the high prevalence of dental caries among Iranian adolescents, the existing body of evidence remains fragmented. Most previous studies conducted in Iran have focused primarily on either clinical indices such as DMFT or behavioral and quality-of-life measures separately, without integrating these dimensions into a comprehensive analytical framework. Furthermore, limited research has simultaneously examined oral health behaviors (OHBs), oral health-related quality of life (OHRQoL), family impact (FIS), and environmental determinants, such as fluoride concentration in drinking water. This lack of multidimensional assessment limits a deeper understanding of how individual, familial, behavioral, and environmental factors interact to influence adolescents' oral health status. Therefore, an integrated approach is needed to evaluate these interrelated components concurrently and to provide evidence-based guidance for targeted public health interventions in the Iranian sociocultural context.

2. Objectives

This study aimed to measure and analyze the associations among OHBs, OHQoL, FIS, and DMFT in adolescents aged 11 - 14 years in Rafsanjan and to evaluate demographic factors as potential predictors of these indices.

3. Methods

3.1. Study Design

This study was part of a broader thesis project and used a descriptive cross-sectional design to examine oral health behaviors, oral health-related quality of life

(OHQoL), family impacts, and predictors of dental caries among adolescents aged 10 - 14 years in Rafsanjan. Data were collected in 2024. The study was approved by the Ethics Committee of Shahid Sadoughi University of Medical Sciences, Yazd, Iran (IR.SSU.SPH.REC.1402.199; link: https://ethics.research.ac.ir/form/bguqy6safavxajsl.pdf).

3.2. Participants and Sampling

A multistage cluster random sampling method was used. Of 8 active comprehensive health service centers in Rafsanjan, 4 centers were randomly selected. From each selected center, 75 adolescents aged 10 - 14 years were randomly selected using lists extracted from the Iranian Integrated Health System, yielding a total sample of 300 participants.

Inclusion criteria were Iranian nationality, age 11 - 14 years, parental consent, and adolescent assent. Exclusion criteria were unwillingness to participate, absence on the day of the clinical examination, incomplete questionnaires, or withdrawal at any stage of the study.

The sample size was calculated using the formula for estimating a population mean:

$$n = \frac{S^2 Z^2}{d^2}$$

Based on Jabarifar et al. (2010) (9), the Persian CPQ11 - 14 validation study in adolescents aged 11 - 14 years reported a standard deviation (S = 16.6). For this study, we used S = 16.6, a 95% confidence level ($Z^2 = 3.84$), and a margin of error (d = 2.0). The calculation yielded n = 265; allowing for a 10% nonresponse rate, the final sample size was set at 300 adolescents. With prior coordination, participants were invited to the selected health centers, where they underwent a clinical examination by a dentist and completed the study questionnaires. Ethical approvals, coordination with health centers, parents, and participating adolescents, and data collection were completed between 28 January 2024 and 14 July 2024.

3.3. Data Collection Instruments and Procedures

Four validated instruments were used for data collection and were combined into a single questionnaire along with demographic items. All questionnaires used in this study were standardized, previously validated Persian versions. The CPQ11 - 14 showed high internal consistency (Cronbach alpha = 0.92), the FIS demonstrated acceptable reliability (Cronbach alpha = 0.83), and the OHB questionnaire showed satisfactory validity and reliability in Iranian adolescent populations.

The Persian version of the Child Perceptions Questionnaire (CPQ11 - 14) was previously validated in Iran by Jabarifar et al. (2010) (9) among adolescents aged 11 - 14 years and demonstrated strong psychometric properties, including high internal consistency (Cronbach alpha = 0.92) and confirmed construct validity.

The Persian validation of the Family Impact Scale (FIS), conducted by Jabarifar et al., confirmed acceptable reliability (Cronbach alpha = 0.83) and construct validity in Iranian populations (8, 9).

Initial data on adolescents aged 11 - 14 years were extracted from health center records. Coordination was conducted with each adolescent and their parents. Each participant received a copy of the questionnaire, and all items were explained individually, from the first to the last question. The questionnaire consisted of four sections.

3.3.1. Demographic Information

Based on prior studies and potential influencing factors, this section included age, gender, body mass index, parental occupation, and other relevant variables. In addition, fluoride concentration in drinking water (ppm) was included because of its potential impact. Multiple linear regression analysis was used because DMFT was treated as a continuous outcome variable, and the objective was to estimate adjusted associations with demographic, socioeconomic, behavioral, and environmental predictors. Variables with $P < 0.20$ in univariate analyses were entered into the multivariable model. Key potential confounders, including age, household size, parental education, economic status, and fluoride exposure, were controlled for in the adjusted analyses.

The fluoride concentration assessment scale was based on measured drinking water fluoride values in different areas of Rafsanjan city (0.32, 0.33, and 0.35 ppm). These values were obtained through laboratory analysis conducted under the supervision of the Health Deputy at the Imam Ali Comprehensive Health Service Center and were used for group comparisons.

3.3.2. Oral Health-Related Quality of Life

OHQoL was assessed using the Persian version of the Child Perceptions Questionnaire (CPQ11 - 14), which comprises 37 items across 4 domains: oral symptoms, 6 items; functional limitations, 9 items; emotional well-

being, 9 items; and social well-being, 13 items. Items were rated on a 5-point Likert scale (0 = never to 4 = every day/almost every day). Domain scores were calculated as the mean item score (0 - 4) multiplied by the number of items, yielding a total OHQoL score of 0 - 148, with higher scores indicating greater limitations and poorer quality of life. The instrument demonstrated strong validity and reliability (Cronbach alpha = 0.92) (8).

3.3.3. Family Impact Scale

The FIS was used to assess the impact of the child's oral health on family quality of life. The scale includes 14 items across 4 domains: family activities, parental emotions, family relationships, and financial impact. Items are rated on a 4-point Likert scale (0 = never, 1 = sometimes, 2 = often, 3 = always), yielding a total score range of 0 - 42. Higher scores indicate a greater negative impact. FIS items have been validated as part of the Persian version of the ECOHIS, showing acceptable reliability (Cronbach alpha = 0.83) and validity (8, 9). The mean of all item scores was calculated as a composite indicator of psychosocial and economic burden.

3.3.4. Oral Health Behaviors

OHBs were assessed using a 12-item questionnaire covering personal oral care practices, including brushing frequency, flossing, dental visits, sugar intake, mouthwash use, and attention to symptoms. Each item was scored on a 3-point Likert scale: 0 = No, 1 = Sometimes, and 2 = Yes. The raw mean score ranged from 0 to 2, and the total score ranged from 0 to 24. Higher scores indicated better adherence to oral health behaviors. The validated Persian version of this WHO questionnaire has demonstrated acceptable reliability and validity in Iranian populations (10). OHB scores were treated as independent variables in the statistical analyses.

3.3.5. DMFT Index

Oral health status was assessed using the DMFT index by three trained dentists, following WHO guidelines (World Health Organization, 2013). Examinations were conducted in selected schools with prior coordination. Dentists completed an 8-hour training workshop supervised by an oral health specialist from Kerman University of Medical Sciences, covering DMFT theory, clinical practice, and data recording. Interrater reliability was assessed using Cohen kappa, yielding a value of 0.87, indicating high agreement. Examiners rotated across centers under mutual supervision to ensure consistency. Each participant's permanent teeth were examined, and the three DMFT components were recorded: decayed, defined as teeth with active caries, visible cavities, enamel softening, or discoloration with structural loss; missing, defined as teeth extracted due to caries, excluding orthodontic or traumatic causes and confirmed by participant/parent report and clinical validation; and filled, defined as teeth restored due to caries with no signs of active decay. All data were documented on WHO standard forms, including participant ID, date, examiner name, location, and DMFT components.

3.4. Ethical Considerations

Participants were adolescents aged 11 - 14 years residing in areas served by the selected health centers. Inclusion criteria were Iranian nationality, parental and adolescent consent, and the ability to complete the questionnaire. Exclusion criteria included noncooperation, absence on the examination day, or withdrawal. Parents/legal guardians were informed by phone, and written consent was obtained before participation.

3.5. Data Analysis

The distribution of quantitative variables (DMFT, CPQ11 - 14, FIS, and OHB scores) was assessed using the Kolmogorov-Smirnov test and skewness/kurtosis indices. Parametric tests (*t*-test and ANOVA) were used for normally distributed data; otherwise, nonparametric equivalents (Mann-Whitney and Kruskal-Wallis tests) were applied. Dependent variables included DMFT, FIS, OHB, and OHQoL domains; independent variables included demographic and socioeconomic factors. Bivariate relationships were examined using Spearman rank correlation. No causal modeling was conducted. To identify DMFT predictors, multiple linear regression was performed, including demographic, socioeconomic, behavioral, and fluoride-level variables. Variables with $P < 0.20$ in univariate analysis were entered into the multivariate model using backward elimination. Model assumptions, including normality of residuals, linearity, homoscedasticity, and absence of multicollinearity, were verified. A significance level of $P < 0.05$ was applied throughout.

To control for potential confounding factors, a structured modeling strategy was used. First, univariate linear regression analyses were conducted to identify candidate variables associated with DMFT at a significance level of $P < 0.20$. Subsequently, these

variables were entered into a multivariable linear regression model to estimate adjusted associations.

Key demographic and socioeconomic factors, including age, household size, parental education, economic status, BMI, and fluoride exposure, were treated as potential confounders and retained in the model during adjustment procedures.

Backward elimination was used to remove nonsignificant variables while preserving model stability. Multicollinearity was assessed using variance inflation factors (VIF < 2.0) and tolerance statistics (> 0.5). Model diagnostics confirmed normality of residuals, linearity, and homoscedasticity, ensuring the robustness of the adjusted estimates.

4. Results

4.1. Demographic Characteristics and Dental Health Indices

In this study, 300 adolescents participated; 60.4% were boys and 39.6% were girls. More than half (58.7%) were aged 12 years or younger. Regarding Body Mass Index (BMI), 57.0% had normal weight, 20.0% were underweight, 15.3% were overweight, and 7.7% were obese. Most parents were aged 40 years or older. Fathers' education was mainly at the high school diploma level (46.3%) or middle school level (29.6%), whereas 15.7% had university education. Tobacco use was very low among mothers (1.0%) and was reported in 17.8% of fathers. Family economic status was mostly moderate (56.3%) or good (35.0%). The most common paternal occupation was self-employment (56.4%), whereas most mothers were housewives (73.7%). Although some differences were observed, including a slightly higher mean DMFT in girls than in boys (2.29 ± 2.63 vs. 2.00 ± 2.09), higher DMFT among underweight adolescents (2.57 ± 2.49) and lower DMFT among overweight adolescents (1.50 ± 2.03), and a higher mean DMFT in those aged ≥ 13 years than in those aged ≥ 12 years (2.42 ± 2.65 vs. 1.91 ± 2.04), none of the demographic or socioeconomic variables showed a statistically significant association with DMFT scores (P > 0.05). Children of fathers with university education had the lowest mean DMFT (1.33 ± 1.95). Family economic status, parental occupation, and parental tobacco use also showed no significant differences in DMFT, although minor variations in mean values were noted across groups (Table 1).

4.2. Oral Health Scores and Fluoride Levels

Based on the calculation methods described in the Methods section, the mean FIS and OHB scores were 3.64 ± 0.42 and 16.56 ± 2.28, respectively. The overall oral health score was 1.49 ± 0.98, with an overall impact of 2.87 ± 0.83, and the mean DMFT index was 2.12 ± 2.32. For the CPQ11 - 14 dimensions, the mean scores were 4.91 ± 3.83 for oral symptoms, 3.48 ± 4.94 for functional limitations, 3.02 ± 4.96 for emotional well-being, and 2.63 ± 5.19 for social well-being, with a total score of 14.05 ± 18.91. Caries (beta = 2.61; 95% CI, 2.39 - 2.83; P < 0.001), DMFT (beta = 3.20; 95% CI, 3.02 - 3.38; P = 0.002), and FIS (beta = 0.29; 95% CI, 0.25 - 0.33; P = 0.003) were significantly higher in the group with 0.32 ppm fluoride, whereas the overall oral health score was significantly lower (beta = 1.21; 95% CI, 0.96 - 1.46; P = 0.006), and the highest overall impact was also observed in this group (beta = 3.08; 95% CI, 2.73 - 3.43; P = 0.001). No significant differences were found across fluoride groups in OHQoL, OHB, or the numbers of missing and filled teeth (P > 0.05) (Table 2).

4.3. Correlations Among DMFT, FIS, OHB, and OHQoL Dimensions

A significant positive correlation was found between DMFT and FIS (r = 0.159; 95% CI, 0.05 - 0.26; P = 0.006), as well as between DMFT and functional limitations (r = 0.163; 95% CI, 0.06 - 0.27; P = 0.005). Other correlations with DMFT were not statistically significant (P > 0.05). In contrast, FIS was significantly associated with all OHQoL dimensions (P < 0.01). OHB showed a negative correlation with oral symptoms (r = -0.132; 95% CI, -0.24 to -0.02; P = 0.022) but no significant associations with other variables. All CPQ11 - 14 domains were positively interrelated at the 0.01 level (Table 3).

4.4. Regression Analysis

Before analysis, the assumptions of linear regression, including normality, linearity, homoscedasticity, and the absence of multicollinearity, were examined and confirmed. The normality of residuals was assessed using the Shapiro-Wilk test and Q-Q plots. Linearity was evaluated using scatterplots of standardized residuals against predicted values. Homoscedasticity was evaluated by inspecting residual plots, and multicollinearity was assessed using variance inflation factors (all values < 2.0) and tolerance statistics (> 0.5). To evaluate the impact of demographic, socioeconomic, and oral health behavior variables on DMFT, univariate linear regression analyses were first conducted. Variables with P values below 0.20 were then entered into a multivariate model, and nonsignificant predictors were gradually removed using backward elimination. In the univariate analysis, significant associations with DMFT were observed for paternal university education (beta = -1.33; 95% CI, -2.48 to -0.19; P

Table 1. Association of Demographic and Socioeconomic Factors with Dental Health Indices (Decayed, Missing, Filled, and DMFT Scores) [a]

Variables	Value	Decayed	Missing	Filled	DMFT	P-Value [b]
Gender						
Female	119 (39.6)	1.69 ± 2.20	0.03 ± 0.22	0.56 ± 1.15	2.29 ± 2.63	0.691
Male	181 (60.4)	1.56 ± 1.77	0.07 ± 0.37	0.36 ± 0.93	2.00 ± 2.09	0.691
Education status						
Student	297 (99.0)	1.62 ± 1.96	0.06 ± 0.32	0.45 ± 1.04	2.13 ± 2.33	0.673
Nonstudent	3 (1.0)	1.33 ± 1.53	0.00 ± 0.00	0.00 ± 0.00	1.33 ± 1.53	0.673
BMI						
Underweight	60 (20.0)	1.93 ± 2.07	0.08 ± 0.42	0.55 ± 1.11	2.57 ± 2.49	0.096
Normal	171 (57.0)	1.69 ± 2.04	0.06 ± 0.33	0.40 ± 0.97	2.16 ± 2.38	0.096
Overweight	46 (15.3)	1.09 ± 1.55	0.02 ± 0.15	0.39 ± 1.16	1.50 ± 2.03	0.096
Obese	23 (7.7)	1.30 ± 1.49	0.04 ± 0.21	0.57 ± 1.04	1.91 ± 1.70	0.096
Age (y)						
≤ 12	176 (58.7)	1.45 ± 1.64	0.09 ± 0.40	0.37 ± 0.96	1.91 ± 2.04	0.180
≥ 13	124 (41.3)	1.85 ± 2.31	0.02 ± 0.15	0.55 ± 1.12	2.42 ± 2.65	0.180
Mother's age (y)						
≤ 39	128 (42.7)	1.49 ± 1.78	0.05 ± 0.32	0.40 ± 0.88	1.95 ± 2.07	0.484
≥ 40	172 (57.3)	1.71 ± 2.07	0.06 ± 0.33	0.48 ± 1.13	2.25 ± 2.49	0.484
Father's age (y)						
≤ 44	154 (53.7)	1.64 ± 1.83	0.06 ± 0.33	0.50 ± 1.08	2.20 ± 2.22	0.654
≥ 45	133 (46.3)	1.71 ± 2.13	0.07 ± 0.33	0.41 ± 1.03	2.45 ± 2.32	0.654
Father's education						
Primary	24 (8.4)	2.29 ± 2.60	0.00 ± 0.00	0.38 ± 1.01	2.67 ± 3.09	0.984
Middle school	85 (29.6)	1.72 ± 1.56	0.09 ± 0.48	0.41 ± 0.88	2.22 ± 2.00	0.984
High school diploma	133 (46.3)	1.78 ± 2.11	0.05 ± 0.22	0.53 ± 1.17	2.36 ± 2.43	0.984
University	45 (15.7)	0.93 ± 1.74	0.07 ± 0.33	0.33 ± 0.85	1.33 ± 1.95	0.984
Mother's smoking						
Yes	3 (1.0)	3.33 ± 1.15	0.00 ± 0.00	0.00 ± 0.00	3.33 ± 1.15	0.171
No	297 (99.0)	1.60 ± 1.95	0.06 ± 0.32	0.45 ± 1.04	2.11 ± 2.33	0.171
Father's smoking						
Yes	51 (17.8)	1.63 ± 1.67	0.10 ± 0.46	0.55 ± 1.12	2.27 ± 1.88	0.325
No	236 (82.2)	1.68 ± 2.03	0.06 ± 0.29	0.43 ± 1.01	2.17 ± 2.41	0.325
Family economic status						
Poor	26 (8.7)	1.31 ± 1.59	0.04 ± 0.20	0.50 ± 1.33	1.85 ± 2.49	0.562
Moderate	169 (56.3)	1.60 ± 1.95	0.05 ± 0.29	0.42 ± 0.95	2.07 ± 2.23	0.562
Good	105 (35.0)	1.72 ± 2.05	0.08 ± 0.38	0.47 ± 1.08	2.27 ± 2.42	0.562
Father's occupation						
Employee	50 (17.4)	2.14 ± 2.63	0.08 ± 0.34	0.68 ± 1.30	2.90 ± 3.17	0.105
Self-employed	162 (56.4)	1.68 ± 1.84	0.07 ± 0.38	0.43 ± 0.98	2.18 ± 2.12	0.105
Other	75 (26.1)	1.35 ± 1.70	0.03 ± 0.16	0.35 ± 0.91	1.72 ± 1.97	
Mother's occupation						
Housewife	221 (73.7)	1.57 ± 1.91	0.05 ± 0.27	0.43 ± 0.99	2.05 ± 2.23	0.579
Employed	79 (26.3)	1.75 ± 2.07	0.09 ± 0.43	0.49 ± 1.14	2.33 ± 2.55	0.579

[a] Values are expressed as No. (%) or mean ± SD.

[b] Mann-Whitney and Kruskal-Wallis tests.

= 0.023), paternal employment as a government employee (beta = 1.18; 95% CI, 0.35 - 2.01; P = 0.005), and higher fluoride concentrations in drinking water (0.33 and 0.35 ppm; beta = -1.38; 95% CI, -2.00 to -0.75; P < 0.001 and beta = -1.56; 95% CI, -2.28 to -0.83; P < 0.001). Marginal associations were observed for four-member households (beta = -0.87; 95% CI, -1.89 to 0.15; P = 0.094), maternal education at the middle school level (beta =

Table 2. Overall Means and Mean Differences of DMFT, FIS, OHB, and Dimensions of CPQ According to Drinking Water Fluoride Levels (Raw Means) [a]

Variables	Min	Max	Mean ± SD	Percentage [b]	0.32 [c]	0.33 [c]	0.35 [c]	H [d]	P Value
Decay	0.00	9.00	1.62 ± 1.95	56.1	2.61 ± 2.39	1.32 ± 1.77	1.21 ± 1.43	20.49	< 0.001
Missing	0.00	3.00	0.06 ± 0.32	4.3	0.09 ± 0.50	0.04 ± 0.23	0.06 ± 0.25	1.30	0.521
Filling	0.00	5.00	0.44 ± 1.03	21.1	0.49 ± 1.20	0.46 ± 0.99	0.36 ± 0.92	1.39	0.499
DMFT	0.00	13.00	2.12 ± 2.32	62.41	3.20 ± 3.02	1.82 ± 2.03	1.64 ± 1.64	12.78	0.002
FIS	0.00	2.26	0.26 ± 0.42	-	0.29 ± 0.35	0.27 ± 0.47	0.23 ± 0.50	11.46	0.003
OHB	0.58	2.00	1.38 ± 0.28	-	1.35 ± 0.29	1.40 ± 0.26	1.42 ± 0.28	3.31	0.192
Overall OH	0.00	4.00	1.49 ± 0.98	-	1.21 ± 0.96	1.67 ± 1.03	1.40 ± 0.84	10.18	0.006
OH Impact	0.00	4.00	2.87 ± 0.83	-	3.08 ± 0.73	2.90 ± 0.84	2.60 ± 0.84	14.33	0.001
OS	0.00	16.02	4.91 ± 3.83	-	5.23 ± 4.07	5.05 ± 3.51	4.33 ± 3.44	2.19	0.334
FL	0.00	27.00	3.43 ± 4.94	-	4.96 ± 7.16	2.82 ± 5.08	3.32 ± 5.91	6.75	0.034
EW	0.00	27.00	3.02 ± 4.96	-	3.90 ± 7.27	2.18 ± 5.34	3.83 ± 7.50	6.18	0.045
SW	0.00	21.96	2.63 ± 5.19	-	3.47 ± 6.78	1.88 ± 4.82	3.31 ± 7.08	4.73	0.094
Total CPQ	0.00	91.98	14.05 ± 18.91	-	15.26 ± 18.73	13.80 ± 13.51	14.12 ± 17.83	2.23	0.327

[a] Values are expressed as mean ± SD unless otherwise indicated.

[b] Percentages indicate having ≥ 1 decayed tooth, ≥ 1 missing tooth, ≥ 1 filled tooth, and DMFT ≥ 1.

[c] Mean ± SD based on water fluoride (ppm).

[d] Kruskal-Wallis H.

Table 3. Correlations Between DMFT, FIS, OHB, and Dimensions of OHQoL

Variables	DMFT	FIS	OHB	EW	OS	FL
FIS	0.159 [a]					
OHB	0.017	0.076				
EW	0.104	0.538 [a]	0.013			
OS	0.063	0.268 [a]	-0.132 [b]	0.369 [a]		
FL	0.163 [a]	0.536 [a]	0.002	0.805 [a]	0.486 [a]	
SW	0.082	0.542 [a]	0.008	0.906 [a]	0.348 [a]	0.807 [a]

[a] Correlation is significant at the 0.01 level (2-tailed).

[b] Correlation is significant at the 0.05 level (2-tailed).

1.12; 95% CI, -0.17 to 2.40; P = 0.088), overweight BMI status (beta = -0.66; 95% CI, -1.41 to 0.10; P = 0.087), and age ≥ 13 years (beta = -0.51; 95% CI, -1.04 to 0.02; P = 0.061). No other variables showed significant associations (P > 0.05). In the final multivariate model, significant predictors of DMFT included four-member household size (beta = -1.45; 95% CI, -2.53 to -0.36; P = 0.010), age ≥ 13 years (beta = 0.66; 95% CI, 0.14 - 1.18; P = 0.010), paternal employment as a government employee (beta = 1.21; 95% CI, 0.42 - 2.00; P = 0.023), and fluoride levels of 0.33 and 0.35 ppm (beta = -1.37; 95% CI, -2.02 to -0.71; P < 0.001 and beta = -1.36; 95% CI, -2.12 to -0.61; P < 0.001) (Table 4). These findings suggest that household size and higher fluoride exposure were associated with lower DMFT scores, whereas older age and paternal employment in the government sector were associated with higher DMFT scores.

5. Discussion

This study employed validated instruments to assess multiple dimensions of oral health among adolescents aged 10 - 14 years. The mean FIS score was 3.64 (range, 0 - 42), indicating a mild impact of adolescents' oral health issues on family life. Similar findings have been reported in previous Iranian studies (11, 12), although both showed slightly greater impacts, possibly because of differences in age and DMFT levels. International studies have also supported the notion that oral health problems in children and adolescents generally exert mild to moderate effects on family quality of life (13-18).

Table 4. Univariate and Multivariate Linear Regression Analysis of DMFT in Relation to Demographic, Socioeconomic, and OHB

Reference Variable	Comparison Category	Univariate Coefficient (95% CI)	*t*	P-Value	Multivariate Coefficient (95% CI)	*t*	P-Value
Sex (female)	Male	-0.29 (-0.83, 0.25)	-1.05	0.293	-	-	-
Educational status (student)	Nonstudent	-0.79 (-3.45, 1.86)	-0.59	0.556	-	-	-
Family size (≤ 3 members)	4 members	-0.87 (-1.89, 0.15)	-1.68	0.094	-1.45 (-2.53, -0.36)	-2.62	0.010
Family size (≤ 3 members)	≥ 5 members	-0.45 (-1.48, 0.57)	-0.87	0.386	-0.87 (-1.95, 0.21)	-1.59	0.110
Mother's education (primary school)	Middle school	1.12 (-0.17, 2.40)	1.71	0.088	1.02 (-0.34, 2.39)	1.48	0.140
Mother's education (primary school)	Diploma	0.05 (-1.14, 1.24)	0.08	0.937	0.22 (-1.08, 1.53)	0.34	0.740
Mother's education (primary school)	University	0.27 (-0.96, 1.50)	0.43	0.667	0.98 (-0.38, 2.34)	1.42	0.160
Father's education (primary school)	Middle school	-0.44 (-1.49, 0.61)	-0.83	0.406	0.16 (-0.94, 1.26)	0.29	0.770
Father's education (primary school)	Diploma	-0.31 (-1.31, 0.70)	-0.60	0.550	-0.02 (-1.08, 1.04)	-0.04	0.970
Father's education (primary school)	University	-1.33 (-2.48, -0.19)	-2.29	0.023	-1.10 (-2.32, 0.11)	-1.79	0.080
Mother's occupation (housewife)	Employed	0.28 (-0.31, 0.88)	0.93	0.352	-	-	-
Mother's smoking (Yes)	No	-1.23 (-3.88, 1.42)	-0.91	0.364	-	-	-
Father's smoking (yes)	No	-0.11 (-0.82, 0.60)	-0.30	0.762	-	-	-
Family economic status (poor)	Moderate	0.22 (-0.74, 1.19)	0.46	0.646	-	-	-
Family economic status (poor)	Good	0.42 (-0.58, 1.42)	0.83	0.410	-	-	-
BMI (normal)	Underweight	0.41 (-0.27, 1.09)	1.18	0.239	0.43 (-0.23, 1.10)	1.29	0.200
BMI (normal)	Overweight	-0.66 (-1.41, 0.10)	-1.72	0.087	-0.67 (-1.41, 0.06)	-1.81	0.070
BMI (normal)	Obese	-0.24 (-1.25, 0.76)	-0.48	0.633	-0.34 (-1.30, 0.61)	-0.71	0.480
Age (≤ 12 years)	≥ 13 years	0.51 (-0.02, 1.04)	1.88	0.061	0.66 (0.14, 1.18)	2.52	0.010
Mother's age	≥ 40 years	0.30 (-0.23, 0.84)	1.13	0.261	-	-	-
Father's age (≤ 39 years)	≥ 40 years	-0.01 (-0.75, 0.72)	-0.03	0.972	-	-	-
Father's occupation (other)	Employee	1.18 (0.35, 2.01)	2.81	0.005	1.21 (0.42, 2.00)	3.01	< 0.001
Father's occupation (other)	Self-employed	0.46 (-0.17, 1.09)	1.43	0.155	0.44 (-0.18, 1.05)	1.41	0.160
Water fluoride (0.32 ppm)	0.33 ppm	-1.38 (-2.00, -0.75)	-4.35	< 0.001	-1.37 (-2.02, -0.71)	-4.12	< 0.001
Water fluoride (0.32 ppm)	0.35 ppm	-1.56 (-2.28, -0.83)	-4.26	< 0.001	-1.36 (-2.12, -0.61)	-3.54	< 0.001
OHB	OHB score	-0.01 (-0.08, 0.06)	-0.27	0.787	-	-	-

The mean OHB score was 16.56 out of 24, suggesting relatively favorable oral hygiene practices in the study population. Previous research has shown better OHB in younger age groups (19), and findings from Shushtar adolescents aged 13 - 15 years were consistent with our results (20). A large-scale study involving more than 19,500 students across 26 countries also reported generally positive oral health behaviors (21). These trends may reflect increased health literacy, generational shifts, and a growing cultural emphasis on dental aesthetics.

The mean DMFT score was 2.12, with a substantial proportion attributable to untreated caries. Our results were comparable to some Iranian studies but inconsistent with others that reported higher or lower values (22). Although DMFT scores in Romania were slightly higher (23), rates in developed countries tend to be considerably lower (24). Overall, the DMFT level observed in Rafsanjan adolescents appears comparable to regional and global norms (25), although multiple contributing factors should be considered in efforts to improve it.

The mean CPQ11 - 14 score was 14.05, indicating a moderate impact of oral health on quality of life, particularly in the domains of oral symptoms and functional limitations. Similar patterns have been reported in studies by Jabarifar et al. (9) and Faghani et al. (27), although domain-specific scores varied. Our overall score aligns with Asian averages and exceeds those reported in European populations (28), suggesting that Iranian adolescents, similar to their Asian peers, experience a notable burden of oral health-related challenges. Variations across studies may reflect cultural, socioeconomic, and methodological differences.

Higher fluoride concentrations were associated with lower DMFT scores, better overall oral health, and lower FIS scores. However, no significant associations were found between fluoride levels and OHQoL, OHB, or the number of missing and filled teeth. National data from Lithuania support the protective role of fluoride against caries (29), and post-1975 evidence suggests a modest but meaningful reduction in DMFT and caries prevalence with fluoridated water. Nonetheless, recent

studies report diminished effects, and concerns about fluorosis and aesthetics underscore the need for balanced public health policies (30).

Our findings revealed significant positive correlations between DMFT and both FIS and the functional limitations domain of OHQoL. This suggests that greater experience of caries, tooth loss, or restorations is associated with increased family burden and functional impairment. This is consistent with some previous studies (12, 15) but inconsistent with others that reported no association (11). Research from India showing elevated FIS among parents of children with malocclusion also supports our findings (15). No significant correlations were observed between DMFT and other OHQoL domains, consistent with Kamyabi et al.'s conclusion that DMFT may not fully capture the subjective impact of oral health on quality of life (26).

Regression analysis identified four-member households and higher fluoride levels as predictors of lower DMFT, whereas older age and paternal employment in government sectors were associated with higher DMFT. Although previous studies (4) have reported higher mean dental caries among children with low parental education and unemployed parents, our results were inconsistent, as parental education and occupation did not show any significant effect on DMFT. Medium-sized families may offer better financial and supervisory support for preventive care. As age increases, teeth are exposed longer to decay risk, explaining the rise in DMFT, a trend supported by other studies (4, 12).

The significant positive correlations between FIS and all OHQoL domains suggest that adolescents' oral health issues across symptomatic, functional, emotional, and psychosocial dimensions negatively affect family life. A study from Sari found that FIS was more strongly associated with OHQoL than with the child's own perception, reinforcing our findings (12). These results imply that adolescent dental problems impose psychological, financial, and time burdens on families, often requiring parental absence from work or additional expenses for dental care.

OHB was negatively correlated with oral symptoms, indicating that better hygiene practices may reduce symptom burden. However, no significant associations were found between OHB and other variables. A study involving more than 8,500 patients showed that good or moderate OHB was linked to higher OHQoL compared with poor OHB (31). The lack of significant associations in our study may reflect the younger age range (11 - 14 years), in which the consequences of poor hygiene may not yet be fully manifested.

Although these findings provide valuable insights into adolescent oral health in Rafsanjan, caution is warranted when generalizing the results to other regions of Iran because of potential differences in socioeconomic conditions, fluoride exposure, and access to dental care (32).

5.1. Generalizability of the Findings

The findings of this study should be interpreted in light of their generalizability. Although the study was conducted in Rafsanjan using a random cluster sampling approach, variations in socioeconomic conditions, access to dental care services, cultural practices, dietary patterns, and fluoride concentration in drinking water across different regions of Iran may limit the direct applicability of the results (33). In particular, rural areas, underserved provinces, and regions with substantially different water fluoridation levels may exhibit distinct oral health profiles. Nevertheless, the observed associations between DMFT and key determinants, such as age, household size, paternal occupation, and fluoride exposure, are consistent with evidence from other Iranian and international studies, suggesting that the underlying mechanisms may be transferable to similar middle-income settings. Therefore, while the prevalence estimates should not be generalized nationally, the identified relationships may inform oral health promotion strategies for adolescents in comparable sociocultural and environmental contexts.

5.2. Limitations and Recommendations

This study has several limitations. Its cross-sectional design precludes causal inference. Behavioral data were self-reported and may be subject to recall or social desirability bias. Although multiple confounders were adjusted for, residual confounding due to unmeasured factors, such as dietary habits and frequency of dental visits, cannot be excluded. These limitations should be considered when interpreting the findings.

5.3. Conclusions

Findings from this study indicate that although the mean DMFT score among participating adolescents was relatively low, it was influenced by factors such as household size, paternal occupation, and fluoride concentration in drinking water. Adolescents from four-member households and those consuming water with higher fluoride levels had lower DMFT scores, whereas those aged 13 years and older and those with fathers employed in government sectors exhibited higher

scores. Lower fluoride concentrations were associated with increased caries, higher DMFT, lower overall oral health scores, and greater overall impact, highlighting the protective role of optimal fluoride levels.

Footnotes

AI Use Disclosure: The authors declare that no generative AI tools were used in the creation of this article.

Authors' Contribution: Study concept and design: N. M., M. N., and A. A. D. T. Acquisition of data: N. M., M. N., T. S., and H. A. Analysis and interpretation of data: M. N., H. A., and A. A. D. T. Drafting of the manuscript: N. M. and M. N. Critical revision of the manuscript for important intellectual content: A. A. D. T., T. S., and H. A. Statistical analysis: H. A. and M. N. Administrative, technical, and material support: T. S. and H. A. Study supervision: A. A. D. T.

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Informed Consent: We invite your child to participate in a study on oral health among adolescents aged 11 - 14 years in Rafsanjan. Participation involves answering a questionnaire and a non-invasive dental examination by trained dentists. There are no expected risks. All information will remain confidential and anonymous. Participation is voluntary, and you may withdraw your child at any time without penalty. By signing below, you confirm that you have read and understood this information and consent to your child's participation.

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