

Dental caries prevalence among elementary school students and its relationship with body mass index and oral hygiene in Ardabil in 2019

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ABSTRACT

Background and Aim: Tooth decay as a significant but preventable public health priority continues to be a common disease in developing countries, including Iran, which is particularly prevalent among children. The present study aims to determine dental caries prevalence among elementary school students and its relationship with body mass index and oral hygiene in Ardabil, Iran in 2019. **Materials and Methods:** This cross-sectional study was conducted on 581 elementary school students selected through cluster random sampling method in Ardabil city in 2019. Demographic data was collected using questionnaire and anthropometric indices (height, weight) were measured using the weighing scale and stadiometer, and dental caries was evaluated using the decayed, missing, or filled teeth index (dmft for primary teeth and DMFT for permanent). **Results:** The mean age of students was 9.61 ± 1.76 years, and 50.8% of them were female. 20.7% ($n = 120$) were obese, and 19.1% ($n = 111$) were overweight. The overall prevalence of caries was 74.9% ($n = 435$) in primary teeth, 72.8% ($n = 423$) in permanent teeth, and 96.6% ($n = 561$) in all teeth. The average dmft and DMFT scores were 4.16 ± 3.72 and 1.96 ± 1.76 , respectively. There was a significant inverse relationship between body mass index and dmft ($r = -0.146, P < 0.0001$) and DMFT ($r = -0.111, P = 0.004$). **Conclusion:** The findings showed that prevalence of dental caries in elementary school children in Ardabil city is higher than global standards, obese and over-weight children experience fewer caries compared to normal-weight children, and there is a significant relation between not brushing the teeth and dental caries.

KEYWORDS: Body mass index, children, dental caries

Introduction

Oro-dental diseases, including dental caries, are one of the major prevalent problems in children.^[1] Dental

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caries is considered as the main reason for orofacial pain and tooth loss, influencing different aspects of life quality.^[2] It can limit the children's activities at home or school, leading to the loss of millions of educational hours worldwide.^[3] According to the US statistical information in 2015, almost 23% of children aging 2–5 years developed tooth decay in their deciduous teeth, while the rate of caries was equal to 27% for children of 6–11 years old and 44% for the adolescents of 12–19 years old.^[4] In Iran, few studies have investigated dental caries prevalence in young children, the results of which indicate a high

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prevalence of this problem among children under 12 years.^[5-8]

Dental caries is a multifactorial problem affected by a collection of factors such as orodental hygiene, salivary characteristics, socioeconomic status, low awareness among parents, ethnicity, age, dental anatomy and arrangement, limited access to dental health-care services, and hereditary factors.^[9] In addition to the above factors, the relationship between tooth decay and obesity has also been investigated.^[10,11] Dental caries usually results from frequent consumption of fermentable sugars (glucose, fructose, sucrose, maltose, and maltotriose), that can also contribute to obesity. Hence, the hypothesis of the correlation between dental caries and obesity have long been proposed.^[12] However, the available evidence regarding the association between tooth decay and the deviation from the normal body mass index (BMI) is ambiguous and contradicting. For instance, in a systematic study, Hooley *et al.* (2012) indicated that a major disagreement still exists about the relationship between dental caries and BMI in children and adolescents. Nearly half of their reviewed studies (47%) reported no relationship, 35% reported a positive relationship, and 18% reported an inverse association between children and adolescents' BMI and dental caries.^[10] Another systematic review in 2015 demonstrated that there are inconsistent findings regarding the correlation between anthropometric measurements and tooth decay in children, and it is impossible to comment decisively on this association.^[11]

Due to the high rates of health risks and comorbidities coupled with dental caries and obesity in children^[13-15] and a lack of local knowledge in this area in our country and regarding the inconsistent findings in the literature about relationship between obesity and dental caries in children,^[11] this study is to investigate the prevalence of dental caries and its relationship with BMI and orodental hygiene in elementary students of Ardabil city, Iran, in 2019.

Materials and Methods

In this cross-sectional study, the research sample was the elementary school children of Ardabil city, who met the inclusion criteria of age between 6 and 12 years old, attending a public elementary school of Ardabil in the educational year of 2018-2019, residency in Ardabil, and consent of parents for participation in the study. Parental dissent in any phase of the research, incomplete questionnaires, having systemic diseases such as diabetes, and dialysis, among others, led to exclusion from the study. The sample size was obtained according to the following formula, taking into account a previously reported caries prevalence of 85% among Iranian students aging 6-12 years old:^[5]

$$n = \frac{z^2 \times P(1 - P)}{d^2}$$

The sample size was obtained as 544 (error of 3% and confidence interval of 95%). However, a total of 600 subjects were recruited for this study considering a 10% probability of the sample drop. The multistage cluster sampling method was used. Ardabil was divided into four districts of North, South, East, and West, and the number of existing schools in each district was specified. Then, one female and one male school were selected per district using simple random sampling method. Then, 75 students of grade 1-6 were chosen from each elementary school through proportional stratified random sampling method. Ethical approval for this study was obtained from the Ethics Committee of Ardabil University of Medical Sciences prior to the study and written informed consent was obtained from all students' parents prior to the data collection. A questionnaire in two sections was applied as the information collecting tool and the students and their parents were asked to answer the questions. The first section collected the demographic variables, including Student's age, gender, and educational grade, while the second section recorded the anthropometric indexes (height and weight) and dental caries. Students' anthropometric parameters were measured by a trained nurse using a scale and stadiometer (both manufactured by Seca, Germany) and BMI was calculated by the Student's weight in kg divided by the square of his height in meter. According to the CDC charts for children, each subject's weight fell into one of the following categories: BMI for age and gender below the 5th percentile as underweight; between 5th and 85th percentile as normal; above 85th and below 95th as overweight; and above 95th as obese.^[16,17] Dental caries diagnosis was performed by one trained senior dentistry student with reference to the World Health Organization (WHO) criteria.^[18] Caries was classified as present when a lesion in pit or fissure, or on a smooth tooth surface, has a detectably softened floor, undermined enamel, softened wall, or presence of restoration materials. The caries index was measured as the number of decayed (d), missed (m) and filled (f) teeth (t), the mean decayed, missing, or filled teeth (dmft) and DMFT indexes for deciduous and permanent dentition, respectively.^[19] Dental caries detection and anthropometric measurements were performed in one classroom of each school. The students' orodental hygiene was asked with a yes-no question about their daily dental brushing and flossing status. The data analysis was performed using SPSS.

Results

Out of 600 students participating in the study, 19 were excluded due to the incomplete questionnaire, and eventually, data of 581 subjects were analyzed. The average age of students was 9.61 ± 1.76 years old, and 295 (50.8%) subjects were female.

Average students' BMI was 19.01 ± 3.92 kg/m². BMI of male students was higher than females, but the

1 difference was not statistically significant (19.14 ± 3.84
 2 for boys versus 18.89 ± 4.0 for girls; $P = 0.450$). Of
 3 all students, 111 (19.1%) were overweight, and
 4 120 (20.17%) were obese. When splitting by gender,
 5 54 (18.3%) female and 57 (19.9%) male students were
 6 overweight and 52 (17.16%) female and 68 (23.8%)
 7 male students were obese; however, their differences
 8 were not statistically significant ($P = 0.229$) [Table 2].

9 One hundred and twenty (42.3%) male and
 10 94 (31.9%) female students had never brushed their
 11 teeth ($P = 0.01$). Two hundred and forty-nine (87.7%)
 12 male and 262 (88.8%) female students had never
 13 flossed their teeth ($P = 0.671$).

14 The total caries prevalence in deciduous and permanent
 15 dentitions were 74.9% ($n = 435$) and 72.8% ($n = 423$),
 16 respectively. Furthermore, the average caries score
 17 was 4.16 ± 3.72 in deciduous (dmft), and 1.96 ± 1.76 in
 18 permanent (DMFT) [Table 3].

19 There was no meaningful difference between female
 20 and male students concerning the caries index of
 21 deciduous teeth. However, the average caries index of
 22 permanent teeth was meaningfully higher in female
 23 students than males ($P = 0.044$) [Table 4].

24 There existed a significant inverse correlation between
 25 students' age and caries index of deciduous ($r = -0.712$,
 26 $P < 0.001$) teeth. Conversely, students' age showed a
 27 significant direct correlation with caries index of
 28 permanent teeth ($r = 0.475$, $P < 0.0001$) [Table 5].

29 The caries prevalence in deciduous and permanent
 30 teeth of children who had never brushed their teeth
 31 were significantly higher than that of students who
 32 brushed their teeth at least once a day (79.9% versus
 33 71.5%; $P = 0.021$ for deciduous teeth; and 77.4% versus
 34 69.7%; $P = 0.043$ for permanent teeth). However, no
 35 meaningful relationship was found between dental
 36 floss usage and dental caries.

37 The linear regression analysis by controlling for
 38 students' age and gender showed that there was a
 39 meaningful inverse correlation between children's
 40 BMI and caries index of deciduous ($r = -0.146$ and
 41 $P < 0.0001$), and permanent ($r = -0.111$ and $P = 0.004$)
 42 teeth [Table 6], implying that with an increase children's
 43 BMI, the level of their dental caries decreased.

44 Discussion

45 The findings of the current study suggest that dental
 46 caries was a highly prevalent finding in our studied
 47 population. The caries prevalence in these children was
 48 far distant from the established goals of the World Dental
 49 Federation (FDI) and WHO, which stated that 50% of
 50 first-graders should be caries-free and average DMFT at
 51 children aged 12 years old would not exceed 3.^[20] While
 52 in our study, dental caries prevalence and average caries
 53 index in dentition were above 90% and more than 6,
 54 respectively, indicating a two-fold higher prevalence than
 the expected figure. Dental caries of children in advanced
 countries has remained constant at relatively low levels
 since the early 21st century. For instance, a Spanish
 epidemiologic study revealed a caries prevalence of 32%
 in deciduous teeth of 6-year-old children and 42.5% in
 permanent teeth of 12-year-old children in 2004 that
 these caries rates remained constant almost in this range
 until 2017.^[21] The total caries prevalence of 6–11-year-old
 children in the US during 2015-2016 was reportedly
 equal to 50.5%, which is about half of our findings and

Table 1: Frequency distribution of students by educational grade, gender, and parents' education level

Variable	Frequency (%)
Educational grade	
First	95 (16.4)
Second	96 (16.5)
Third	100 (17.2)
Fourth	97 (16.7)
Fifth	95 (16.4)
Sixth	98 (16.9)
Gender	
Male	286 (49.2)
Female	295 (50.8)

Table 2: Frequency distribution of students based on weight categories

Weight category	Frequency (%)		Total (%)
	Male	Female	
Underweight	9 (2.8)	9 (3.1)	17 (2.9)
Normal	153 (53.5)	180 (180)	333 (57.3)
Overweight	57 (19.9)	54 (54)	111 (19.1)
Obese	68 (23.8)	52 (52)	120 (20.7)
Total	286 (100)	295 (100)	581 (100)

Table 3: Frequency distribution of caries and average decayed, missing, or filled teeth/Decayed, Missing, or Filled Teeth scores in students' deciduous, and permanent dentition

	Yes (%)	No (%)	Mean±SD
Deciduous teeth			
d	401 (69)	180 (31)	4.16±3.72
m	206 (35.5)	375 (64.5)	
f	48 (8.3)	533 (91.7)	
dmft	435 (74.9)	146 (25.1)	
Permanent teeth			
D	403 (69.4)	178 (30.6)	1.96±1.76
M	36 (6.2)	545 (93.8)	
F	45 (7.7)	536 (92.3)	
DMFT	423 (72.8)	158 (27.2)	

D/d=A decayed or a filled tooth with caries beneath or around it; M/
 m=A missing tooth due to decay; F/f=A filled tooth without any caries;
 Lowercase letter=Deciduous tooth; Uppercase letter=Permanent tooth;
 dmft=decayed, missing, or filled teeth; DMFT=Decayed, Missing, or Filled
 Teeth; SD: Standard deviation

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 until 2017.^[21] The total caries prevalence of 6–11-year-old
 children in the US during 2015-2016 was reportedly
 equal to 50.5%, which is about half of our findings and

falls into the range of established WHO/FDI goals. In the case of underdeveloped countries, the prevalence of dental caries was reported 90% in 8–12-year-old children in Pakistan,^[22] 78.9% in 6–11-year-old children in India^[23] and 80 and 70% for deciduous and permanent teeth, respectively, in Saudi Arabia.^[24] It can be seen that the caries rate in these regions, similar to our study, is higher than that of the advanced countries and established goals. The high prevalence of dental caries in the current study agrees well with other studies in Iran. For example, the total caries prevalence among 6–11-year-old children was reportedly 86.8% in a study by Shahraki *et al.* in Zahedan,^[6] and 94.9% in a study by Mojarrad *et al.* in Hamedan.^[7] Bayat-Movahhed *et al.* obtained an average prevalence of 88.6% for dental caries in 6–12 years old children, which is in line with our study.^[8]

Altogether, the higher incidence of dental caries in our studied population could be a reflection of issues, including low awareness of orodental health and economic status in our community. This indicates the necessity of increasing the knowledge of families about orodental hygiene and also developing and expanding insurance coverage for oral and dental diseases.

Based on the results of the current study, the prevalence of caries in deciduous teeth was higher than the permanent teeth which is consistent with a previous

Table 4: The relationship between gender and dental caries

Index	Gender	n	Mean±SD	P
dmft	Male	286	4.31±3.82	0.335
	Female	295	4.01±3.63	
DMFT	Male	286	1.81±1.68	0.044
	Female	295	2.11±1.82	

dmft=decayed, missing, or filled teeth; DMFT=Decayed, Missing, or Filled Teeth; SD: Standard deviation

Table 5: The relationship between age and dental caries

Index	n	Mean±SD	Pearson correlation	
			r	P
Age	564	9.61±1.76	-0.712	<0.001
dmft		4.16±3.72		
Age	564	9.61±1.76	+0.475	0.001
DMFT		1.96±1.76		

dmft=decayed, missing, or filled teeth; DMFT=Decayed, Missing, or Filled Teeth; SD: Standard deviation

Table 6: The relationship between students' body mass index and dental caries

Dentition	Predictor variable	R	Adjusted R ²	F	Significant (P)	Nonstandard coefficients		Standard B coefficients	t	P
						B	SE			
Deciduous	Constant	0.728	0.527	209.95	<0.001	20.43	0.714	-0.146	28.62	<0.001
	BMI					-0.137	0.028		-4.83	<0.001
Permanent	Constant	0.494	0.240	60.36	<0.001	-2.118	0.433	-0.111	-4.89	<0.001
	BMI					-0.05	0.017		-2.90	0.004

BMI=Body mass index; SE=Standard error

study.^[24] The reason for this can be lower enamel thickness and calcium content in deciduous dentition and its structural difference with permanent dentition. All these factors, together with additional ones such as the inability of young children to brush their teeth correctly, can increase the susceptibility of deciduous teeth to decay.^[25-27]

In this study, there was no meaningful difference in caries index of deciduous teeth (dmft) between male and female students. However, female students had a significantly higher caries index of permanent teeth (DMFT) than males. This finding contradicts the study by Nakhostin *et al.* in Kermanshah, Iran,^[28] but it is in line with other studies in Iran^[29-31] and those conducted in other countries including India, Brazil and China.^[32-34] The observed gender difference may result from earlier eruption and development of permanent dentition in girls,^[29] compared to boys, which leads to longer exposure of their teeth to the cariogenic factors.

The age of children in our study showed a significant inverse correlation with the caries index of deciduous teeth (dmft) and a significant direct correlation with caries index of permanent teeth (DMFT). This means that when the children's age increases, the caries level reduces in deciduous teeth, but increases in permanent teeth. Given the age range of studied children, this observation was expectable because the deciduous teeth begin to fall out, starting from 6 years of age and are gradually replaced with permanent teeth. As a result, with the advance of the age in children, the number of deciduous teeth and subsequently dmft decreases, while the number of permanent teeth and subsequently DMFT increases. The same trend has been seen in other studies.^[29,30]

Overall, dental caries is a multifactorial problem depending on lifestyle and individual's health habits and behaviors. The behavioral factors under the control of an individual contribute to the disease. One of the most significant of these factors is poor oral hygiene.^[35] In line with this, our findings demonstrate that, unfortunately, 37% of our studied children had never brushed their teeth. The same rate was reported as 22.7 in the study by Mohebbi *et al.*^[31] in Gonabad and 32.7% in the study by Tumarian *et al.* in Qom.^[36] We can observe that the rate of not brushing teeth was high in our studied children. Our results also showed a statistically meaningful relationship between not

brushing teeth and dental caries prevalence, so that 100% of students who had never brushed their teeth developed dental caries. This rate was significantly lower in students who had brushed their teeth not less than once a day. These findings indicate that dental brushing is associated with a lower level of caries, because even if a student had not developed the correct dental brushing technique, the act of tooth brushing may remove food particles and carbohydrates from the mouth and contribute to the reduction of caries.^[37]

Furthermore, over 88% of investigated children in this research had unfortunately, never flossed their teeth. Other studies conducted in Iran also indicates the low rate of dental floss usage. As an example, the rate of not flossing among students was reported as 91.7% in Gonabad and 89% in Qom, which are in agreement with our findings.^[31,36] These observations suggest that the culture of dental floss usage has not yet been fostered among Iranian families, and this requires training, promoting its benefits, and also improving its cost-effectiveness and accessibility.^[31]

In this study, a meaningful inverse correlation was found between BMI and dental caries in students. Since teeth decays and overweight/obesity share similar predisposing risk factors,^[10] their relationship has long been suspected and investigated by numerous studies. However, the obtained results were contradictory and indecisive. In their study, Kopucka-Kedzierawski *et al.*^[38] stated that overweight might associate with lower rates of dental caries in children. Likewise, a large study of 1951 Filipino children showed a meaningful inverse correlation between caries and children's BMI.^[39] A cross-sectional study in Saudi Arabia found an inverse linear relationship between dental caries and anthropometric indexes among school going children. A Chinese study has suggested that higher BMI in children is correlated with lower dental caries.^[19] However, in their study performed on 1290 children of 6–11 years old age, Willerhausen *et al.* showed a meaningful positive relationship between weight and dental caries. Similarly, Marshall *et al.*^[40] showed that dental caries was seen more in obese children. One study in Sweden also suggested that dental caries in children is positively correlated with obesity.^[41] The finding of a study performed by Shahraki *et al.*, in Zahedan, Iran, also contradicted ours; In their study, caries level in overweight children was notably higher than normal-weight children. There are several other studies that found no relationship between BMI and dental caries in children.^[7,21,42,43] The studies suggesting the positive relationship of obesity with dental caries proposed the intake of high carbohydrate foods as a reason for developing obesity and also dental caries.^[44] Other researchers postulated that low-weight children might have some degree of malnutrition, which can lead to developmental defects and consequently, higher dental caries in teeth.^[45] For example, A recent study by Madhusudhan and Khargekar showed that malnutrition (low BMI for age) is a risk factor for teeth

decays among 3–6 years old Children.^[46] Moreover, a study by Adeniyi *et al.* revealed that malnutrition (low weight for age) was a risk factor for developing teeth decays among school-aged children.^[47] Our findings seem to support the latter hypothesis. On the other hand, one should keep in mind that a mutual relationship is considered here, implying that the existence of dental caries in children during their growing years may be a factor for malnutrition and lead to bodyweight loss and BMI reduction.

Heterogeneity of the results regarding the relationship between teeth decays and BMI across various studies can result from numerous factors some of which include: different sample sizes, employing diverse criteria for BMI definition and stratification, applying different definitions and indexes of dental caries, and controlling/not controlling for confounding factors such as age, gender, race, ethnicity, nutritional, and socioeconomic status.

One of the limitations of the current research is that a portion of data was collected through self-reporting items in the questionnaire, which may lead to bias information due to either under-reporting of unhealthy behaviors or over-reporting of healthy behaviors. Further limitations of the study include the lack of investigation of other contributing factors to dental caries such as salivary characteristics, socioeconomic status, the parents' awareness, anatomy and arrangement of the dentition, and access level to orodental health-care services.

Conclusion

The results of this study showed that dental caries prevalence among elementary students of Ardabil city is higher than global standards. The overweight and obese students experience less caries than students with normal weight, and there exists a meaningful relationship between lack of tooth brushing and the development of dental caries.

Due to high prevalence of dental caries in our examined students, planning preventive measures and therapeutic interventions seems essential in this population. Pediatric dentists can include BMI estimation in the standard dental examination as a screen marker for timely detection and treatment of the children at risk of malnutrition and dental caries.

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Conflicts of interest

There are no conflicts of interest.

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