


BMJ Open Evaluation of frequency of consumption of cariogenic snacks by freshmen versus the senior dental students in Tehran and the related factors: a cross-sectional study

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To cite: Gholami M, Mohebbi SZ, Mafakheri M, *et al.* Evaluation of frequency of consumption of cariogenic snacks by freshmen versus the senior dental students in Tehran and the related factors: a cross-sectional study. *BMJ Open* 2024;**14**:e086041. doi:10.1136/bmjopen-2024-086041

► Prepublication history for this paper is available online. To view these files, please visit the journal online (<https://doi.org/10.1136/bmjopen-2024-086041>).

Received 06 March 2024
Accepted 27 August 2024



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ABSTRACT

Background Senior dental students are more aware of the harmful effects of cariogenic snacks and are expected to better watch their diet compared with freshmen dental students. This study aimed to compare the frequency of consumption of cariogenic snacks by senior and freshmen dental students of Tehran city and the related factors.

Methods This cross-sectional study evaluated the senior and freshmen dental students attending dental schools in Tehran in 2018, who were selected by census sampling. A cariogenic snack record form was used to collect information regarding the frequency of consumption of cariogenic snacks both prospectively (within the upcoming week) and retrospectively (previous 24 hours). We also collected information on the demographic characteristics of the participants. The plaque-producing and decay-producing potential of the diet (PAP) index was calculated for each dental student. Data were analysed by the backward regression model using SPSS.

Results A total of 294 dental students with a mean age of 22±2.85 years participated in this study. The mean PAP score was 76.48±49.91 for the freshmen and 89.87±49.41 for the senior dental students with a significant difference between them (p=0.023). Older dental students (p=0.008) and those not living with their parents (p=0.001) acquired a higher PAP score.

Conclusion The mean PAP score of freshmen and senior dental students in Tehran was slightly higher than the optimal level. So the instructional techniques of dental curricula are better to be revised to improve the performance of dental students to cut down the consumption of cariogenic snacks.

INTRODUCTION

Dental caries is the most common infectious disease in humans.¹ It is a dynamic process caused by the acids produced from the metabolism of carbohydrates and includes repeated cycles of demineralisation and remineralisation.² Repeated use of sugary substances minimises the chance of remineralisation and shifts the demineralisation/remineralisation equilibrium towards caries development.^{3–6} It

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ Both retrospective and prospective diet of students were evaluated in this study.
- ⇒ All dental schools in Tehran, which is the capital city and has students from different cities, studied.
- ⇒ Assessment of the plaque-producing and decay-producing potential of the diet index and its comparison between freshmen and senior dental students has been done for the first time in Iran.
- ⇒ This study was conducted on dental students of accredited dental schools in Tehran, so the results cannot be generalised to the entire country.

is particularly the case in the consumption of snacks. Intake of sugary snacks can prolong the pH drop in the oral cavity.⁷ Accordingly, sugar-rich diet plays an important role in the occurrence of dental caries, which is a common oral health problem at all ages. The triad of tooth decay includes the substrate (tooth tissue), cariogenic bacteria and sugar, which can progress to tooth decay over time. Hence, it is possible to control dental caries by limiting the consumption of foods containing sugar, along with other preventive methods such as proper oral hygiene and the use of fluoride.⁸

In addition to cariogenic foods, among a variety of foods that are consumed in the main meals, some are anticariogenic and exert a protective effect against dental caries. They can decrease or neutralise the effect of cariogenic foods. Evidence shows that intake of snacks containing sugar and rapidly digestible starch is associated with a higher risk of dental caries.^{9–12} Thus, cutting down the consumption of sugary snacks is important to decrease the demineralisation time and prevent dental caries.¹³ According to the WHO, individuals consuming free sugar for more than three times a day or

more than 10% total energy are at high risk of dental caries.¹⁴ Several studies have reported high sugar intake in different populations. For example, 30% of US adults were classified as high sugar consumers.¹⁵ The sugar consumption in India exceeds the average global annual per capita consumption. There are reports that sugar consumption has tripled in the last 50 years worldwide.¹⁶

The cariogenicity of foods varies depending on the presence of sugar molecules inside or outside of the cellular structure of the food substance. Internal sugars as in fruits, vegetables and foods rich in starch have low cariogenicity. External sugars that are present in dairy products are relatively non-cariogenic (unless in certain circumstances such as the long presence of milk in the oral cavity and in contact with the teeth in baby feeding at night). Non-dairy external sugars as in pastries, fruit juices and honey have maximum cariogenicity¹⁷ and are known as free sugars.¹⁸

The presence and adhesion of food particles in the oral cavity are also important in caries development. For instance, some starch-containing foods such as potato chips can adhere to the tooth structure. In such cases, the salivary amylase converts the starch to disaccharides, which are used in the composition of dental plaque and lead to acid production. Also, foods with a slow rate of dissolution such as caramel and candies have high cariogenicity due to their long-term presence in the oral cavity.¹⁷

Following the consumption of sugar, the acid produced by the metabolism of carbohydrates decreases the baseline pH of the oral cavity. Enamel demineralisation starts when the pH drops below 5.5. Depending on the duration of the presence of foods in the oral cavity, the duration of pH drop may vary. This time is the longest after the consumption of slow-dissolving foods followed by solid and sticky foods and finally liquid foods. This time is an averagely 60 min for the slow-dissolving foods, 45 min for solid foods and 30 min for liquid foods. Therefore, we can record intake of cariogenic snacks based on the PAP index (The plaque-producing and decay-producing potential of the diet), which can indirectly indicate the duration of oral pH drop.¹⁷ However, most of the studies that have been conducted in the field of consumption of sweet snacks have examined the number of consumption regardless of the type of sweet substance.¹⁸

Since carbohydrates are an integral part of the nutritional regimen of most people and are needed to provide daily energy requirements, their elimination from the diet is not feasible and is also incorrect. Thus, in order to maintain oral health, decreasing the frequency of intake of cariogenic substances or their intake along with the main meal and not as a snack can be a good strategy to prevent dental caries. It should be noted that cutting down the consumption of sugary foods is not only important for oral health promotion but is also fundamental for public health and prevention of common diseases such as diabetes mellitus, cardiovascular diseases and obesity.¹⁷

Prevention of dental caries is the first step in oral health promotion, which requires oral hygiene maintenance and a healthy diet.¹⁹ This is particularly important for dental students since they have a fundamental role in providing dental services and information to patients and can serve as a role model with regard to oral health for the community. Based on this, the question was raised whether senior dental students who have received more professional training have a better performance on how to consume cariogenic foods compared with freshmen students. Since the consumption of cariogenic snacks in the form of the duration of pH drop and tooth demineralisation had not been evaluated among dental students in Iran, the present study was conducted with the aim of assessing and comparing the performance of freshmen and senior dental students in Tehran with regard to the frequency of consumption of cariogenic snacks, and the influential factors in this regard to find out whether educational interventions are required in this respect.

METHODS

Study design and sample

This descriptive, cross-sectional study was conducted on freshmen and senior dental students attending dental schools of Tehran including the Schools of Dentistry of Tehran University of Medical Sciences (TUMS), Shahid Beheshti University of Medical Sciences (SBMU), Shahed University of Medical Sciences (SUMS) and Islamic Azad University (IAU). Sampling was a census, and the data were collected from December 2017 to March 2019 in all four dental schools in Tehran. Dental students who signed informed consent forms participated in this study. Dental students who were on a specific diet (for weight loss or weight gain) were excluded. A sample size of 294 was estimated using a sample size calculation for estimating the mean of a quantitative trait in the population considering $\alpha=0.05$, $\beta=0.2$ and $R^2=0.05$ and using the results of Kunitomo's study in 2016²⁰ to calculate the SD of the mean.

Data collection

All freshmen and senior dental students of the aforementioned dental schools who expressed their informed consent after receiving information about the purpose and process of the study were included in the study. After necessary coordination, a cariogenic snack record form was administered by one of the researchers (MM) among the students and they were requested to write down the cariogenic snacks that they would use in the upcoming week as well as the snacks they consumed in the past 24 hours. 'Snack' was defined as any food or drink consumed at least 20 min before or after a main meal. The forms were anonymous and were filled out by the students themselves in about 15–20 min. Approximately after 7 days, the forms were collected. In case some students were not reached at the appointed time, repeated visits were made to the schools. Based on the information recorded in the forms, the researcher (MM) calculated

the PAP index for each dental student as a dependent variable.¹⁷ Demographic information of students such as their university name, academic level (freshman/senior), sex, age, grade point average (GPA), level of education of father and mother, place of residence (dormitory, living alone, with parents or with friends), self-reported family's financial status (very good, good, moderate, poor, very poor)²¹ and financial support by the family (inadequate, good, very good) was also recorded.

Calculation of PAP index

PAP index was calculated to find the mean rate of daily acid production (equal to mean minutes of daily pH drop) in the mouth following the use of cariogenic snacks.¹⁷ For each participant, a reduction in pH by 60 min was considered after each time of consuming a slow-dissolving sugary snack; this time was 45 min for the consumption of solid/sticky foods, and 30 min for the consumption of liquid foods. The sum of all times was calculated and divided by 7 to calculate the PAP index as the main outcome of the study. The optima PAP index is ≤ 60 min. This means that amounts above this limit can increase the likelihood of tooth decay over time.¹⁷

Patient and public involvement

The study's design did not involve patients. However, all participating dental students were informed of the research objectives and their informed consent was obtained. Their participation in the study was anonymous and voluntary. They were assured that the results of the study would not be published except for research purposes.

Statistical analysis

The data were analysed by SPSS V.25. The frequency (number and percentage) of each independent variable was calculated. The PAP score for the consumption of cariogenic snacks in the past 24 hours was calculated, and the PAP score for the upcoming week was also analysed. The correlation of PAP score with each independent variable was analysed using the Pearson's correlation test. Assuming a linear relationship between the response and predictors, and a normal distribution of the dependent variable, the backward linear regression model was used to determine the effect of independent variables on the PAP score. The level of significance was considered 0.1 for the linear regression and 0.05 for all other statistical analyses.

RESULTS

Demographic information

A total of 294 freshmen and senior dental students were assessed for eligibility. Of those, five individuals were excluded (one of whom did not meet the inclusion criteria and four refused to participate in the study). Finally, 289 students were included in the study and analysed (the response rate was 98%). The mean age of the participants

Table 1 Frequency distribution of the demographic variables of the participants (n=289)

Variable		Number	Percentage
University	Tehran	109	37.7
	Shahid Beheshti	65	22.5
	Islamic Azad	65	22.5
	Shahed	50	17.3
Academic level	Freshman	133	46
	Senior	156	54
Sex	Female	154	53.3
	Male	135	46.7
Place of residence	Dormitory	107	37
	Living alone	42	14.5
	Living with friends	7	2.4
	Living with parents	133	46
Financial status	Very good	25	8.7
	Good	136	47.1
	Moderate	124	42.9
	Poor	3	1
	Very poor	1	0.3
Financial support from the family	Very good	23	8
	Good	173	59.9
	Inadequate	93	32.2

was 22 ± 2.85 years (range 17–35 years). The mean GPA of students was 16.2 ± 1.23 (range 12.5–19.92). The mean years of education was 16 ± 2.59 years (range 10–25 years) for the fathers and 15 ± 2.73 years (range 4–23 years) for the mothers. Table 1 shows the frequency distribution of the demographic variables of the participants.

The majority of the participants were from TUMS (N=109, 37.7%) and the lowest number of participants were from SBMU (N=50, 17.3%). There were 133 (46%) freshmen and 156 (54%) senior dental students ($p > 0.05$). Of the participants, 154 (53.3%) were females. The majority of the participants were living with their parents (N=133, 46%). Also, the majority of them had good financial status (N=136, 47.1%) and had good financial support from their family (N=173, 59.9%).

Comparison of the PAP score between freshmen and senior dental students

Figure 1 compares the mean daily acid production due to the use of cariogenic snacks by the freshmen and senior dental students according to the PAP index.

Table 2 compares the results of the PAP score of freshmen and senior dental students. The mean PAP score was calculated to be 83.71 ± 50.00 for dental students in Tehran city. This rate was 76.48 ± 49.91 for the freshmen and 89.87 ± 49.41 for the senior dental students; this difference was statistically significant ($p = 0.023$).

The frequency of consumption of cariogenic snacks was significantly higher among the senior dental students

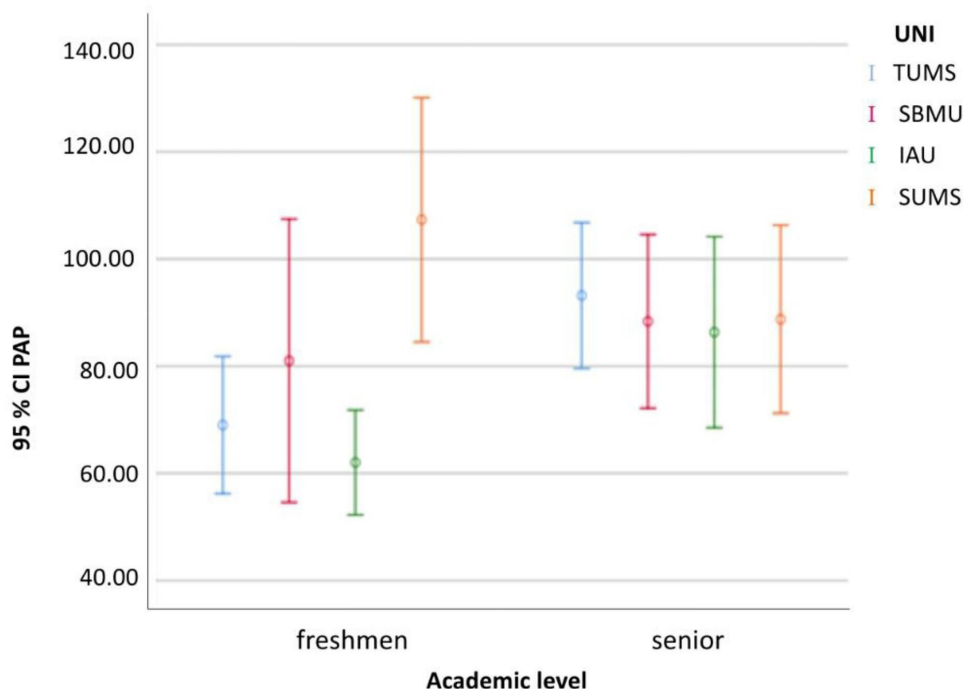


Figure 1 Comparison of the frequency of consumption of cariogenic snacks according to the PAP score. IAU, Islamic Azad University; PAP, plaque-producing and decay-producing potential of the diet; SBMU, Shahid Beheshti University of Medical Sciences; SUMS, Shahed University of Medical Sciences; TUMS, Tehran University of Medical Sciences.(UNI:University)

compared with freshmen in TUMS ($p=0.012$) and IAU ($p=0.015$). However, this difference was not significant in SBMU ($p>0.05$). The frequency of consumption of cariogenic snacks was lower among the senior dental students compared with freshmen in SUMS; however, due to the small sample size in this university, this difference did not reach statistical significance. These results, which indicated more consumption of cariogenic snacks in senior dental students compared with freshmen dental students, reject the hypothesis of the research. Comparison of the PAP score in dental schools revealed that the PAP score of freshmen dental students of SUMS was significantly

higher than that of TUMS ($p=0.009$) and IAU ($p=0.003$) but had no significant difference with the rate acquired by freshmen dental students of SBMU ($p>0.05$). The PAP score of freshmen dental students from other universities was not significantly different ($p>0.05$).

Frequency of consumption of cariogenic snacks based on sex

Table 3 presents the frequency of consumption of cariogenic snacks by freshmen and senior dental students in Tehran based on sex. Drinks were the most commonly consumed snack (57.1%) while slow-dissolving foods were the least commonly consumed snacks (0.3%).

Backward regression model

Table 4 shows the correlation of independent variables (including university, sex, age, mean GPA, level of education of father, level of education of mother, place of residence and socioeconomic status) with the PAP score according to the backward linear regression model. Of the independent variables, only the correlation of age ($p=0.008$) and place of residence ($p=0.001$) with PAP was statistically significant such that by an increase in age, the PAP score also increased. Regarding the place of residence, dental students not living with parents (those residing in dormitories, living alone or with friends) acquired a higher PAP score than those living with parents. In other words, the variables of students' age and place of residence (with or without family) could predict the consumption of cariogenic snacks by them. Other independent variables including university, GPA, sex, parents' education level and economic status did not have such a predictive feature in connection with the consumption of

Table 2 Comparison of the frequency of consumption of cariogenic snacks according to the PAP score

University	Academic level	PAP score	P value
Tehran (TUMS)	Freshmen	69	0.012*
	Senior	93.17	
Shahid Beheshti (SBMU)	Freshmen	83.01	0.611
	Senior	88.35	
Islamic Azad (IAU)	Freshmen	62.01	0.015*
	Senior	86.33	
Shahed (SUMS)	Freshmen	107.32	0.185
	Senior	88.76	

* $p<0.05$.

IAU, Islamic Azad University; PAP, plaque-producing and decay-producing potential of the diet; SBMU, Shahid Beheshti University of Medical Sciences; SUMS, Shahed University of Medical Sciences; TUMS, Tehran University of Medical Sciences.

Table 3 Frequency of consumption of cariogenic snacks by dental students in Tehran based on sex

	Types of cariogenic snacks						
	Drinks	Solid	Slow-dissolving	Drinks and solid	Drinks and slow-dissolving	Solid and slow-dissolving	Drinks, solid, and slow-dissolving
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Female	88 (57.1)	32 (20.8)	0 (0)	29 (18.9)	1 (0.6)	1 (0.6)	3 (2)
Male	77 (57)	32 (23.7)	1 (0.7)	20 (14.9)	0 (0)	1 (0.7)	4 (3)

cariogenic snacks by dental students. The R^2 of the model was 0.063.

According to the Pearson's test, the correlation between the PAP score for the upcoming week and the PAP score of the past 24 hours was significant ($p < 0.001$).

DISCUSSION

This study aimed to compare the frequency of consumption of cariogenic snacks by freshmen and senior dental students in Tehran and the related factors. The present results showed that the mean daily acid production due to the use of cariogenic snacks by freshmen and senior dental students in Tehran (83.71 ± 50.00) was slightly higher than the optimal level. This rate was 76.48 ± 49.91 for the freshmen and 87.89 ± 49.41 for the senior dental students, which were slightly higher than the optimal level for both groups.

According to the present results, the mean daily acid production by the senior dental students was higher than that by freshmen dental students. However, in a study by Khami *et al.*²² male students who had passed the oral health-related courses had a significantly lower frequency of intake of sugary snacks than other male students ($p < 0.001$) and paid more attention to preventive care. Although the frequency of consumption of sugary snacks is expected to be lower among senior dental students compared with freshmen students due to their enhanced knowledge in this respect, this was not the case in the present study. Although theoretical courses regarding nutrition and oral health have long been included in dental curricula, practical courses and workshops were recently added to dental curricula and may have some differences in terms of implementation in different dental schools; this may explain their inefficacy

and insignificant effect on the attitude and performance of dental students and highlight the need for their modification. Moreover, a higher frequency of consumption of sugary snacks by senior dental students may be related to the fact that sixth-year dental students are studying for the residency examination and may shift to sugary snacks due to the lack of time and their easier availability.

In the present study, sex had no significant correlation with the PAP score. Similarly, Akarslan *et al.*²³ evaluated the nutritional habits and oral health-related behaviours of a group of young adults presenting to a dental school and found no significant correlation between sex and the frequency of consumption of cariogenic snacks. However, Kang and Song²⁴ evaluated the correlation of consumption of snacks and oral hygiene behaviours of high school students. The frequency of consumption of snacks and drinks by males was significantly higher than that by females ($p < 0.001$). In addition, a study conducted among adult dental patients in Poland showed that men were more likely to consume products harmful to the teeth compared with women. This finding was in contrast with the present study.⁸ This difference could be due to the fact that in our study male and female students received the same education, but in the last two studies, the participants included lay people and probably men compared with women who had less time and attention to focus on getting healthy nutrition. Khami *et al.*²² evaluated the oral hygiene behaviour of Iranian dental students with respect to their sex, demographics, knowledge about preventive measures and attitude towards preventive dentistry. They found a significant correlation between sex and oral health-related behaviours ($p < 0.001$).

In the present study, the frequency of consumption of sugary snacks was not significantly correlated with the level of education of the parents or the financial status of the family. However, Khami *et al.*²² reported that having at least one dentist parent was significantly correlated with lower consumption of sugary snacks ($p = 0.047$). Also, those with a dentist parent practised oral hygiene measures significantly more than others ($p = 0.048$).

According to the present results, the PAP score increased with age that it was in line with the findings of a research among US adults that demonstrated high prevalence of added sugars consumption among 20–30 years than those aged ≥ 70 years.¹⁴ In addition, we found that the PAP score was higher in students living alone, in dormitory or with friends, compared with those living with parents. This

Table 4 Results of the regression test regarding the correlation of independent variables with the PAP score

Variable	Unstandardised Coefficients beta-value	Standardised Coefficients beta-value	t-value	P value
Age	2.661	0.152	2.653	0.008
Place of residence	-6.941	-0.192	-3.348	0.001

PAP, plaque-producing and decay-producing potential of the diet.



finding may be due to the fact that those living far from the family do not have the required place or time for the preparation of healthy snacks; also, they may even skip the main meals and replace them with cariogenic snacks.

In a systematic review, Sangsefidi and Salehi-Abargouei²⁵ reported that higher frequency of consumption of snacks especially dried fruits, pastries, sugar and salty snacks was associated with a higher incidence of dental caries ($p < 0.05$). They added that sweet drinks were the most commonly used cariogenic snacks. This result was in agreement with the present finding that drinks were the most commonly used snack by dental students.

Recall bias is a limitation of retrospective cross-sectional studies.²⁶ To overcome this bias, both retrospective and prospective diets of students were evaluated in this study. So we assessed the cariogenic snacks that they would use in the upcoming week as well as the snacks they consumed in the past 24 hours. For the first time, this study calculated the consumption of cariogenic snacks quantitatively and in the form of PAP index, which represents the minutes of daily drop in oral pH among dental students. The high response rate was another strength of this study. However, since this study was conducted on dental students of four accredited dental schools in Tehran, the results cannot be generalised to the entire country. In addition, the cross-sectional design of the study does not allow us to state a causal relationship between the variables, which can be investigated by designing future observational studies.

Since dental students have more knowledge about oral hygiene measures than the public, they are expected to be more successful in dental plaque control and caries prevention compared with the general population, and therefore, they may be able to control the adverse effects of slightly higher than normal consumption of sugary snacks. However, dental students should be taught that consuming too much sugary food over time can endanger their oral health and general health, so they should shift their eating habits toward healthy food groups, including fruits, vegetables, dairy products and proteins and limit the use of sugar and fat. Particularly limit the use of cariogenic drinks and snacks between main meals and replace them with healthy options. Therefore, future studies are required on indices such as DMFT and plaque index and habits such as drinking water after the consumption of sugary snacks, or combined use of cariogenic and anticariogenic foods in this population and compare the results with the PAP index.

Considering the present results regarding the higher PAP score of senior dental students compared with freshmen, and no correlation between GPA and PAP score, which is part of oral hygiene performance, educational interventions may be designed and implemented to correct the performance of dental students in this respect. Despite adding practical courses and workshops regarding nutrition and oral health to the curricula, the behaviour of senior students has not changed regarding reducing the consumption of cariogenic snacks. Therefore, we need to monitor the implementation of curricula

and, if necessary, revise them in order to improve the knowledge, attitude and behaviour of dental students in the field of consuming a healthy and low-cariogenic diet.

Conclusions

In general, the mean daily acid production due to the use of cariogenic snacks by freshmen and senior dental students in Tehran was slightly higher than the optimal level. Also, the mean rate of daily acid production by senior dental students was higher than that by freshmen students. Thus, educational interventions are required in this respect, and the educational curricula and instruction methods may be revised to enhance the knowledge and improve the performance of dental students with regard to cutting down the consumption of cariogenic snacks and replacing them with healthy choices.

Acknowledgements This study was derived from a thesis submitted for a DDS degree at TUMS in 2019.

Contributors MG, SZM and MM conducted the review of retrieved documents and designed the study. MM collected the data and performed the data analysis. MM and HS prepared the first draft of the manuscript. All authors (MG, MM, SZM and HS) performed the interpretation, contributed to drafting the manuscript, provided input into versions of the manuscript, read and approved the final manuscript. The guarantor of the study is MG. MG accepted full responsibility for the finished work, had access to the data and controlled the decision to publish.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient and public involvement Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

Patient consent for publication Consent obtained directly from patient(s).

Ethics approval This study involves human participants and the study protocol was approved by the Ethics Committee of TUMS (Tehran University of Medical Sciences) (ethical approval code: IR.TUMS.DENTISTRY.REC.1397.027). Patient consent for publication was obtained. Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request.

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