



# Awareness of plaque-induced gingivitis during fixed orthodontic treatment due to oral hygiene practices among Malaysian university students

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## Abstract

**Background:** Fixed orthodontic treatment (FOT) is instrumental in addressing dental and skeletal discrepancies; however, it serves as a local predisposing factor for plaque-induced gingivitis. The placement of the fixed orthodontic appliance (FOA) components exacerbates plaque accumulation in the adjacent gingival sulcus, around bracket perimeters and beneath archwires. The mechanical hindrance posed by FOA complicates routine oral hygiene practices, thereby predisposing individuals to plaque-induced gingivitis. This study aimed to evaluate the awareness of periodontal health; as well as the knowledge and attitude of oral hygiene education (OHE) among Malaysian university students undergoing FOT.

**Methods:** The study also compared the routine oral hygiene practices and OHE knowledge across different durations of FOT and between dental and non-dental students with FOA. A questionnaire-based study was conducted among 394 Malaysian university students (mean age=23.12 years,  $\sigma=3.01$ ), all of whom had ceramic or metal brackets in either conventional or self-ligating systems. The average duration of orthodontic treatment was 16.61 months ( $\sigma=7.73$ ).

**Results:** The results indicated a moderate awareness of periodontal health (mean score: 1.33,  $\sigma=0.28$ ). Statistically significant differences were observed between the FOT duration and OHE knowledge and attitudes ( $P<0.001$ ); as well as between dental students with FOA and their adherence to routine oral hygiene practices ( $P<0.01$ ).

**Conclusion:** In conclusion, Malaysian university students undergoing FOT demonstrated moderate awareness of periodontal health and OHE knowledge. These findings emphasize the necessity of reinforcing oral hygiene education, particularly for non-dental students, to mitigate the oral health challenges associated with FOA.

**Keywords:** Orthodontics, Gingivitis, Dental health education

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## Introduction

Oral health is a fundamental determinant of overall health, well-being and quality of life. According to the World Health Organization (WHO), oral health is defined as “a state of being free from chronic mouth and facial pain, oral and throat cancer, oral infection, and sores, periodontal (gum) disease, tooth decay, tooth loss, and other diseases and disorders that limit an individual’s capacity in biting, chewing, smiling, speaking, and psychosocial well-being.”<sup>1</sup>

Oral diseases are the most common non-communicable diseases (NCDs), affecting individuals throughout their lifetime and potentially resulting in pain, discomfort, disfigurement, and even mortality. Common oral diseases include dental caries (tooth decay), periodontal (gum) diseases, oral cancers, oral manifestations of HIV, orodental trauma, cleft lip and palate, and noma. Most of these diseases and conditions are either largely preventable or can be treated in their early stages.<sup>2</sup> Despite their prevalence,



most oral diseases are largely preventable or treatable in their early stages through appropriate interventions.

Poor oral hygiene is a significant contributing factor to oral disease progression. Several evidence-based strategies can be adopted to maintain good oral hygiene, including brushing twice daily, flossing, minimizing snacking, changing toothbrush periodically, abstaining from smoking, and attending routine dental check-ups.<sup>3</sup> Given the impact of oral health on overall well-being, increased awareness and education on effective oral hygiene practices are essential for reducing the global burden of oral diseases.

Gingivitis is a localized inflammatory condition primarily induced by dental biofilm accumulation. It is characterized by gingival redness and edema without periodontal attachment loss.<sup>4</sup> As gingivitis is commonly painless and rarely leads to spontaneous bleeding, affected individuals may remain unaware of the condition due to its subtle clinical manifestations.<sup>4</sup>

Among various forms of gingival disease, plaque-induced gingivitis is the most prevalent. It differs from periodontitis by the containment of the inflammatory lesion within the gingiva, thereby preventing progressive attachment loss.<sup>5</sup> In plaque-induced gingivitis, inflammation remains confined to gingival tissues without extension and affects other tooth-supporting structures. The persistence of this inflammation is correlated with the presence of microbial dental plaque, which perpetuates the disease if not properly managed. However, research has demonstrated that plaque-induced gingivitis is reversible following the removal of causative microbial biofilm.<sup>6</sup>

The relationship between periodontics and orthodontics has been extensively investigated, with growing evidence indicating that malocclusion negatively impacts gingival health. One of the primary objectives of orthodontic treatment is to improve oral health and prolong dental longevity. By correcting dental irregularities, orthodontic intervention contributes to better oral hygiene and minimizes or eliminates occlusal trauma.<sup>7</sup> Consequently, orthodontic treatment has been suggested to enhance periodontal status, as straighter teeth are easier to clean and optimal occlusion supports a healthier periodontium. Plaque accumulation surrounding brackets and archwires further complicates oral hygiene maintenance, making effective orthodontic care more challenging.<sup>8</sup> The interaction between orthodontics and periodontal health is often described as symbiotic; however, it also presents risks akin to a double-edged sword. Fixed orthodontic appliances (FOA) exacerbate plaque accumulation around the gingival sulcus, bracket perimeters, and beneath archwires.<sup>9</sup> Furthermore, the barriers imposed by orthodontic appliances hinder efficient plaque removal, leading to an increased risk of plaque-induced gingivitis.<sup>10,11,12</sup> Thus, while orthodontic treatment offers significant benefits in enhancing dental alignment

and function, it also necessitates rigorous oral hygiene practices to mitigate periodontal complications.

## Methods

A structured questionnaire was developed using a validated reference from a previous study, with prior permission obtained from the original author. The questionnaire was distributed to Malaysian university students, ensuring that the purpose of the survey was clearly communicated. Informed consent was obtained from participants before the study. The sample size was determined to be 394 and was calculated using the Stimulator app, based on the number of patients visiting the clinic within a specific timeframe. A total of 394 Malaysian university students participated in this questionnaire-based study, representing both public and private higher education institutions. Specifically, students from 19 public universities and 31 private universities across Malaysia were included, ensuring a diverse and representative sample.

The inclusion criteria were as follows: local or foreign students currently studying in Malaysian universities; students wearing FOA with either ceramic or metal, in conventional or self-ligating systems, while the participants were excluded if they wore invisible or lingual braces, or removable orthodontic appliances.

A structured questionnaire was designed based on a previously conducted study by Alhaja et al<sup>13</sup>, ensuring methodological consistency and relevance to the study objectives. Prior permission was obtained from the original authors to reference and adapt the questionnaire for this research. The questionnaire was then distributed to Malaysian university students to assess awareness of periodontal health, along with knowledge and attitude toward oral hygiene education. The questionnaire comprised four sections: Part 1: Personal information and dental history. Part 2: Awareness of periodontal health. Part 3: Routine oral hygiene practices. Part 4: Knowledge and attitude on OHE.

The data were analyzed using IBM SPSS Statistics 26 software. This statistical tool facilitated comprehensive data processing, ensuring accurate evaluation of the responses. Descriptive and inferential statistics were used to identify trends, relationships, and significant findings. The study sample consisted of students aged between 17 to 27 years with a mean age of  $23.12 \pm 3.01$ . Moreover, 183 (43.4%) of the students were male, while 211 (53.6%) were female students. Also, 353 (89.6%) were Malaysian students, while 41 (10.4%) foreign students participated in the study. A total of 301 (76.4%) subjects wore conventional metal FOA, while 93 (23.6%) subjects wore ceramic bracketed FOA (Table 1).

The study samples were also categorized into dentistry and other non-dentistry courses based on the course of the study. Of the 394 subjects, 134 (34%) were dental

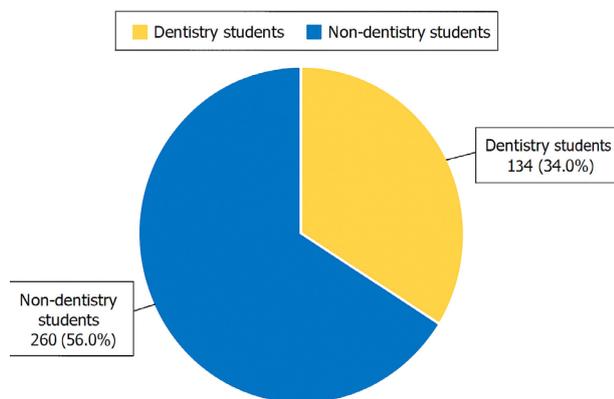
**Table 1.** The Descriptive and inferential statistics of the study sample to identify trends, relationships, and significant findings (Gender, Nationality and Types of fixed orthodontic appliance, FOA)

n = 394	Gender		Nationality		Type of FOA	
	Male n (%)	Female n (%)	Malaysian n (%)	Foreigner n (%)	Conventional n (%)	Ceramic n (%)
n (%)	183 (43.4)	211 (53.6)	353 (89.6%)	41 (10.4%)	301 (76.4%)	93 (23.6%)
Mean ± S.D.	1.54 ± 0.50		1.10 ± 0.30		1.36 ± 0.69	

S.D.: Standard deviation

**Table 2.** Study sample

Course of study n = 394	Dentistry n (%)	Non-dentistry n (%)
n (%)	134 (34%)	260 (66%)
Mean ± S.D.	1.66 ± 0.47	



**Figure 1.** Study sample

students, while 260 (66%) subjects were not dentistry students (Table 2 and Figure 1).

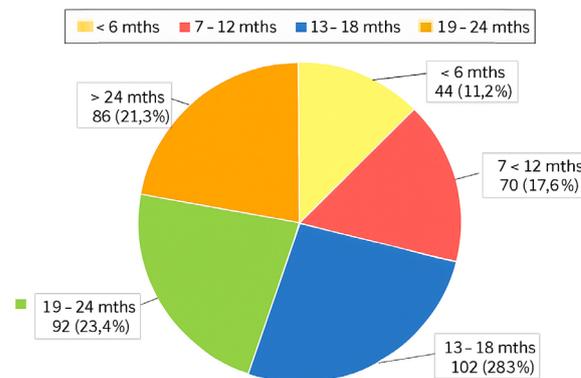
The students were categorized into five groups based on the duration of their fixed orthodontic appliance wear of the study samples with a mean duration of treatment of 16.61 ± 7.74 months. Most students (102 samples, 25.9%) underwent FOT between 13 months to 18 months (Table 3, Figure 2).

A standard statistical software package, IBM SPSS Statistics 26, was utilized to interpret the collected data. The results were analyzed using the one-way ANOVA test, where a statistical value of  $P < 0.001$  indicated the presence of a significant mean difference. Additionally, an independent  $t$ -test was conducted, with a statistical value of  $P < 0.01$  demonstrating a significant relationship between the analyzed groups.

**Results**

**Awareness of Periodontal Health**

Section 2 of the questionnaire assessed the subjects' awareness of periodontal health based on the presence of these eight given clinical parameters of periodontal health. Of the 394 subjects with FOA, 308 subjects (78.2%) reported the presence of dental plaque accumulating around the orthodontic components, 238 subjects (60.4%)



**Figure 2.** Pie chart illustrates the study sample based on the duration of the fixed orthodontic treatment

with gingival bleeding, 188 subjects (47.7%) with gingival recession, and 181 subjects (45.9%) with enlarged and inflamed gingiva. Additionally, 28.2% of the subjects reported calculus around the bracket and gingival sulcus, 26.4% reported halitosis, 13.2% reported a burning sensation in the gingiva, and 31.7% reported tooth mobility (Supplementary file, Table S1). An overall mean score of 1.33 ± 0.28 exhibited a moderate awareness of periodontal health among Malaysian university students with FOA (Figure 3).

**Routine oral Hygiene Practices**

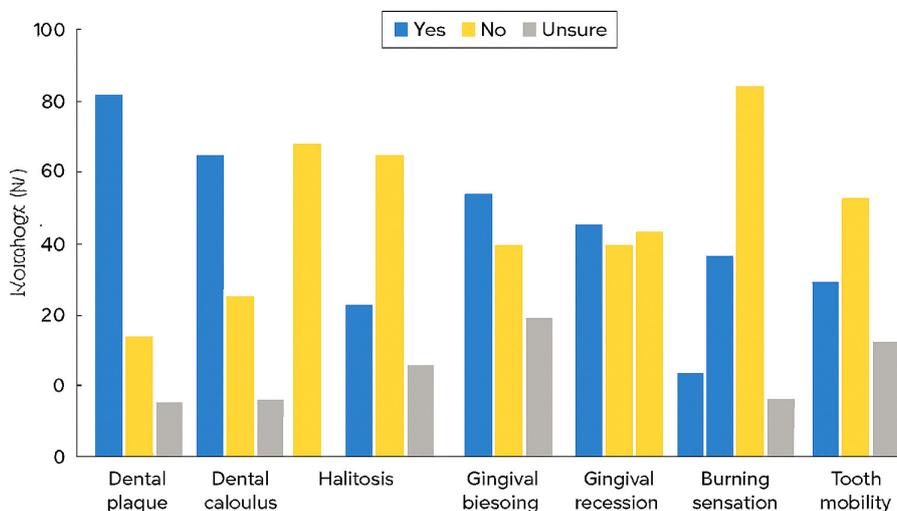
Section 3 of the questionnaire collected information on the subjects' routine oral hygiene practices. The oral hygiene practices were generally good, with 88.1% reporting that they brush their teeth at least twice a day and 58.6% spending between three to five minutes on brushing. Moreover, 78.9% of the subjects used ordinary toothbrushes and 54.6% brushed with the Charter's brushing technique. However, there was a display of lack in utilizing mechanical and chemical oral hygiene aids, with only 35.3% using mechanical accessory hygiene aids, such as interdental brush and floss; and only 17.8% of the subjects used mouthwash as the chemical accessory hygiene aid (Table 4).

**Knowledge and Attitude Toward OHE**

The first three questions in Section 4 of the questionnaire evaluated the knowledge and attitudes toward OHE. The statistics showed 161 subjects (28.75%) answering that wearing FOA was the initiative factor for gingivitis,

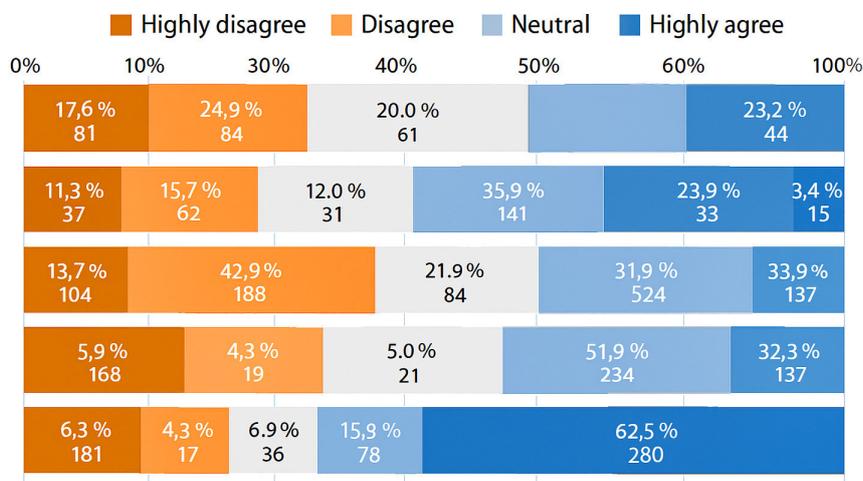
**Table 3.** Grouping and study sample based on the duration of fixed orthodontic treatment

Duration of FOT (months) n=394	Group 1 Less than 6 months	Group 2 7 - 12 months	Group 3 13 – 18 months	Group 4 19 – 24 months	Group 5 More than 24 months
n (%)	44 (11.2%)	70 (17.8%)	102 (25.9%)	92 (23.4%)	86 (21.8%)
Mean ± S.D.	16.61 ± 7.74				



Section 2. Answer "Yes" "No" or "Unsure" pertaining to the noticeable changes in your oral structures during the past 5 months while wearing fixed orthodontic appliances (FDA).

**Figure 3.** Awareness of periodontal health among Malaysian university students with fixed orthodontic appliance



Section 4. Please rate from the scale of 1 (highly disagree) to 5 (highly agree).

**Figure 4.** Knowledge and attitudes toward OHE among Malaysian university students with fixed orthodontic appliance

and 234 subjects (59.4%) identified FOA as the cause of increased bleeding frequency. Only 214 (55.6%) subjects answered correctly, by disagreeing that FOA causes increased frequency of oral halitosis (Supplementary file, Table S1). These findings indicate that Malaysian university students with FOA had low knowledge of OHE.

The final three questions in Section 4 assess the orthodontic subjects' attitudes toward OHE. Moreover, 331 subjects (83.3%) agreed that oral hygiene practice was

difficult while wearing FOA, and 44% of the respondents admitted that they had either omitted or shortened steps in their oral hygiene routines. This difference in attitude contradicted the heavy 85% agreeing that oral hygiene care was more prominent during FOT (Figure 4).

**Duration of Fixed Orthodontic Treatment**

The objective is to examine the correlation between two independent variables—routine oral hygiene practices

and knowledge and attitude towards oral health education (OHE)—and the duration of FOT as the dependent variable. The subjects were classified into five categories based on the duration of fixed orthodontic treatment. The results were generated using the one-way ANOVA test. There was no significant difference between the mean duration of FOT and routine oral hygiene practice ( $P > 0.001$ ) (Table 4); however, there was a significant difference between the mean duration of FOT and knowledge and attitudes toward OHE ( $P < 0.001$ ) (Table 5).

#### Dentistry Students Compared to non-dentistry Students

Based on the course of the study, the subjects were categorized into 134 (34%) dental students and 260 (66%) non-dental students. Similarly, this section evaluates the association between the two independent variables—routine oral hygiene practices and knowledge and attitude toward OHE— and the two groups of students. The results were analyzed using independent-t test. There was a significant relationship between dental students with FOA and those who exhibited good oral hygiene practices ( $P < 0.01$ ) (Table 5). There was no significant relationship between dental students with FOA and the knowledge and attitudes on OHE possessed ( $P = 0.73$ ) (Table 5).

#### Discussion

The study revealed a moderate level of periodontal awareness among Malaysian university students undergoing fixed orthodontic treatment (FOT). Significant findings were observed regarding dental plaque accumulation, gingival bleeding, gingival recession, and

enlargement. Despite the importance of oral hygiene education (OHE) during FOT, knowledge levels remained relatively low. Only 28.75% of the students reported that wearing fixed orthodontic appliances (FOA) could lead to gingivitis, and 35.8% reported an increase in gingival bleeding frequency. Regarding oral hygiene practices, most students demonstrated good habits, with 88.7% brushing at least twice daily. Additionally, 58.6% reported brushing for an adequate duration of 3 to 5 minutes. However, many participants did not use mechanical and chemical oral hygiene aids effectively, indicating a need for improved hygiene interventions during FOT.

The attitude toward OHE also appeared insufficient, with 34.3% of students admitting to shortening or skipping certain oral hygiene practices. This was in contrast to the 83.85% who recognized the significance of maintaining good oral hygiene during orthodontic treatment. Furthermore, the oral hygiene behaviors observed in this study aligned with findings reported by Baheti et al<sup>14</sup> reinforcing the consistency of these trends across different study populations. These findings emphasize the need for targeted educational initiatives to improve oral hygiene awareness, knowledge, and adherence to effective hygiene practices among orthodontic patients. Strengthening these aspects could play a vital role in reducing the adverse effects of orthodontic appliances on periodontal health.

The study demonstrated that students who underwent a longer duration of FOT exhibited better knowledge and attitude toward OHE, consistent with findings reported by Alhajja et al.<sup>13</sup> This suggests that prolonged exposure to orthodontic care may contribute to greater awareness and adherence to oral hygiene recommendations.

**Table 4.** Routine oral hygiene practices among Malaysian university students with fixed orthodontic appliance.

Questions		Sample (n), (%)	Mean $\pm$ S.D.	Overall mean $\pm$ S.D.
Frequency of brushing daily	Once	34 (8.6%)	1.95 $\pm$ 0.34	1.53 $\pm$ 0.40
	2 - 3 daily	347 (88.1%)		
	>3 daily	13 (3.3%)		
Time spent on brushing (min)	Less than 3	129 (32.7%)	1.76 $\pm$ 0.60	
	Between 3 – 5	231 (58.6%)		
	More than 5	34 (8.6%)		
Type of toothbrush	Ordinary	311 (78.9%)	1.24 $\pm$ 0.50	
	Orthodontic	70 (17.8%)		
	Electric	13 (3.3%)		
Brushing method	Fone's	98 (25.0%)	2.30 $\pm$ 0.84	
	Modified Bass'	80 (20.4%)		
	Charter's	214 (54.6%)		
Number of oral hygiene aids used	None	83 (21.1%)	1.21 $\pm$ 0.85	
	1 accessory only	172 (43.7%)		
	At least 2 accessories	113 (28.7%)		
	>2 accessories	26 (6.6%)		
Frequency of using oral hygiene aids	Not applicable	83 (21.1%)	1.47 $\pm$ 1.03	
	Rarely	118 (29.9%)		
	Occasionally	117 (29.7%)		
	Daily	76 (19.3%)		
Frequency of using mouthwash daily	None	153 (38.8%)	0.81 $\pm$ 0.76	
	Once	171 (43.4%)		
	At least twice	63 (16.0%)		
	More than twice	7 (1.8%)		

**Table 5.** The correlation between two independent variables—routine oral hygiene practices and knowledge and attitude towards oral health education (OHE)—and the duration of fixed orthodontic appliance (FOT) as the dependent variable practices.

The relationship between the duration of wear of FOA and routine oral hygiene practices				
Duration of FOT (months)	Mean score	S.D.	F-statistic (df)	P value
<6 months	1.46	0.37		
6 – 12 months	1.50	0.45		
12 – 18 months	1.51	0.41	1.23 (4)	0.298
18 – 24 months	1.61	0.40		
>24 months	1.54	0.37		
Duration of FOT (months)	Mean score	S.D.	F-statistic (df)	P value
<6 months	3.14	0.74		
6–12 months	3.56	0.65		0 – 6 months. vs. 12 – 18 months, $P=0.03$
12–18 months	3.58	0.59	8.25 (4)	<0.001
18–24 months	3.26	0.73		6 – 12 months. vs >24 months, $P=0.01$
>24 months	3.16	0.62		12 – 18 months. vs >24 months, $P<0.01$
The relationship between the duration of wear of FOA and routine oral hygiene practices				
Course of study	Mean score	S.D.	F-statistic (df)	P value
Dentistry	1.69	0.35		
Non-dentistry	1.50	0.45	4.16 (392)	<0.01
The relationship between the duration of wear of FOA and knowledge and attitude toward OHE				
Course of study	Mean score	S.D.	F-statistic (df)	P value
Dentistry	3.28	0.58		
Non-dentistry	3.40	0.73	10.35 (392)	0.73

Furthermore, the study compared dental and non-dental students undergoing FOT to assess their routine oral hygiene practices, knowledge, and attitudes toward OHE. The results indicated that dental students performed superior oral hygiene routines, likely due to their professional training and familiarity with oral health principles. However, despite their better hygiene practices, dental students did not show significantly improved knowledge or attitudes toward OHE compared to non-dental students. Notably, the majority of non-dental students undergoing FOT lacked awareness regarding dental plaque and gingivitis, as well as their implications. This finding is consistent with the study conducted by,<sup>15</sup> which reported that only 12.6% of participants identified dental plaque as soft debris on teeth. Such results highlight the need for targeted educational interventions to enhance periodontal awareness and oral hygiene knowledge among non-dental students, especially those undergoing orthodontic treatment.

Overall, Malaysian university students wearing FOA exhibited moderate awareness of plaque-induced gingivitis, along with moderate oral hygiene practices, knowledge, and attitude toward OHE. The study findings suggest that students who have worn FOA for a longer duration tend to have better knowledge and attitudes toward OHE, reinforcing the role of prolonged orthodontic exposure in shaping oral hygiene behaviors. Additionally, the comparative analysis between dental and non-dental

students revealed that dental students demonstrated superior routine oral hygiene practices. However, their knowledge and attitude toward OHE were not significantly different from those of their non-dental counterparts. This underscores the need for enhanced educational initiatives targeted at improving oral hygiene awareness, especially among non-dental students undergoing orthodontic treatment. These findings highlight the importance of structured oral hygiene education programs to mitigate the adverse effects of orthodontic appliances on periodontal health and promote optimal dental care among university students.

The findings suggest that students undergoing FOT may selectively exclude certain oral hygiene practices from their routine due to the perceived tediousness of maintaining optimal care. This highlights the critical need for enhanced oral health education targeted at orthodontic patients to ensure the proper maintenance of periodontal health. Clinicians, through their long-term engagement with orthodontic patients, hold the responsibility and opportunity to actively promote awareness of periodontal health. Their role extends beyond treatment to include educating patients on proper oral hygiene practices, fostering positive attitudes, and emphasizing preventive measures against periodontal disease. Strengthening these educational efforts can significantly improve the oral health outcomes of orthodontic patients, mitigating the risks associated with plaque accumulation and gingival

inflammation. Although orthodontic patients may possess basic oral hygiene knowledge, they must be continually encouraged to implement effective hygiene practices. Clinicians should emphasize the risks associated with poor periodontal health and demonstrate the correct use of interdental aids, ensuring that patients develop sustainable hygiene habits.

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#### Authors' Contribution

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#### Competing Interests

The authors declare no conflict of interest.

#### Ethical Approval

This study was approved by Research Management Centre, MAHSA University (RMC/EC13/2020).

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#### Supplementary File

Supplementary file contain Tables S1 and S2.

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