

# Assessment of Periodontal Health Status and Oral Hygiene Practice Among Students of College of Health and Medical Technologies in Mosul City

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## ABSTRACT

**Background and Objective:** Periodontal disease is a major oral health concern caused primarily by dental plaque accumulation. Although dental technologists are not direct clinical care providers, their oral health knowledge may influence professional practice and patient awareness. This study aimed to assess periodontal health status, oral hygiene practices, and awareness among Prosthetic Dental Techniques students at Al-Noor University College, Mosul, Iraq.

**Materials and Methods:** A cross-sectional study was conducted on 120 students equally distributed across four academic stages. Data collection included a validated questionnaire assessing oral hygiene practices and periodontal awareness, in addition to clinical examination of Ramfjord teeth using William's periodontal probe. Clinical parameters included plaque index (PI), gingival index (GI), sulcus depth, and bleeding on probing (BOP). Statistical analysis was performed using non-parametric tests.

**Results:** Female students demonstrated significantly higher oral hygiene practice scores ( $6.60 \pm 2.10$ ) and awareness scores ( $8.07 \pm 1.91$ ) compared with males ( $5.38 \pm 1.88$  and  $6.79 \pm 2.28$ , respectively;  $p = 0.002$ ). Awareness scores increased significantly with academic progression ( $p < 0.001$ ). PI, GI, Sulcus Depth, and BOP also showed significant differences across academic stages ( $p < 0.05$ ). The dental curriculum (86.2%) was the primary reported source of oral health information.

**Conclusions:** Academic advancement was associated with improved periodontal awareness and clinical periodontal status among dental technology students. These findings highlight the importance of integrating periodontal education and preventive oral health practices into dental technology curricula.

**Keywords:** Periodontal disease, oral hygiene practice, awareness score, plaque index, gingival index, sulcus depth, bleeding on probing

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## INTRODUCTION

Oral health is an essential component of overall health and well-being. The oral cavity is a known reservoir of microbial infection, and many oral diseases can be prevented through proper oral hygiene. Dental cavities and periodontal diseases are largely caused by poor oral hygiene habits.<sup>1</sup>

Periodontal disease (PD) is one of the most common and serious dental conditions worldwide.<sup>2</sup> Gingivitis and periodontitis are the most common periodontal diseases, and they represent leading causes of tooth loss in adults. These degenerative conditions affect populations worldwide, regardless of geography or socioeconomic status.<sup>3</sup> Dental biofilm, particularly composed of gram-negative anaerobic bacteria, is central to the pathogenesis of PDs. These chronic inflammatory conditions result in irreversible destruction of the supporting structures of the teeth. The accumulation and persistence of dental plaque—if not properly removed—are primary contributors to the onset and progression of PDs.<sup>4</sup>

Clinically, dental plaque appears as a tenacious, yellow-grayish biofilm adhering to intraoral hard surfaces, including teeth and prostheses.<sup>5</sup> It is classified as a microbial biofilm—a complex community of microorganisms embedded in a self-produced matrix attached to surfaces. Because of this biofilm structure, dental plaque is resistant to removal and can become increasingly pathogenic over time.<sup>6</sup>

Periodontal diseases are characterized as a dysbiotic host–microbial interaction. The transition from periodontal health to disease results from an imbalance between microbial virulence and host defense. Factors such as increased plaque load, compromised immunity, or enhanced bacterial pathogenicity may disrupt this balance. Additionally, the clinical manifestations of PD are influenced by local and systemic factors, as well as individual behavior and lifestyle.<sup>7</sup>

Despite the recognized importance of prevention, oral healthcare often receives minimal attention in developing regions, where public dental services are limited and typically provide emergency care only.<sup>2</sup> Globally, it is estimated that approximately 10–15% of adults exhibit the most severe PD category. While many developed countries have seen significant improvements in oral health, periodontal conditions remain highly prevalent and even worsening in low-resource settings, as noted in WHO oral health surveillance reports.<sup>8</sup>

Plaque index (PI), gingival index (GI), sulcus (or probing pocket) depth, and bleeding on probing (BOP) are widely recognized as non-invasive, reproducible, and essential clinical measures for detecting early signs of periodontal disease and monitoring its progression or response to treatment.<sup>9</sup> These indices allow clinicians to assess the presence of dental plaque, the degree of gingival inflammation, the depth of the gingival sulcus (which reflects tissue destruction), and the tendency of the gums to bleed upon gentle probing—each providing valuable information about periodontal health or disease status.<sup>10</sup> PI and GI are particularly effective for identifying gingivitis and early inflammatory changes, while increased sulcus depth and BOP are more closely associated with periodontitis and ongoing tissue breakdown.<sup>11</sup> Bleeding on probing, in particular, is a sensitive indicator of current inflammation, though its absence is a stronger predictor of health than its presence is of disease.<sup>12</sup> These indices are also useful for evaluating the effectiveness of periodontal therapies, as significant reductions in PI, GI, sulcus depth, and BOP typically indicate successful treatment outcomes. While some subjectivity exists in visual indices, their combined use with probing measurements and bleeding assessments forms the current standard of care for periodontal diagnosis and monitoring.<sup>9</sup>

Currently, there is a lack of epidemiological data on the periodontal health of dental technology students in Mosul, Iraq. Dental technologists are members of the dental team who specialize in making dentures, crowns, bridges, and other dental appliances. Although they are not directly involved in patient care, their work plays an important role in restoring oral function and aesthetics. Understanding their level of awareness about periodontal health is important because it can influence how they design appliances and how they support oral health goals through their work. Thus, this study was conducted among students of Al-Noor University College of Health and Medical Technology in Mosul, to assess their periodontal health status, oral hygiene practices, and level of awareness, and to compare outcomes across academic stages and genders.

This study hypothesized that there would be no significant differences in periodontal health status, oral hygiene practices, or awareness among students across different academic stages or between genders. It utilized William's periodontal probe, a

first-generation manual probe designed in 1936, to measure pocket depth in Ramfjord teeth, which are commonly used for periodontal assessments.<sup>13</sup>

## METHODS

The study was conducted at the College of Health and Medical Technologies in Mosul City at Al Noor University, which includes four academic stages (first through fourth year). The target population included all undergraduate students enrolled in the Prosthetic Dental Techniques Department during the academic year 2024–2025.

Out of 165 eligible students, 120 were selected using convenience sampling, a widely accepted non-probability method for recruiting participants in cross-sectional studies when the population is readily accessible.<sup>14</sup>

### Study Population

- The study population consisted of students enrolled at College of Health and Medical Technologies in Mosul city in the Prosthetic Dental Techniques Department. Both male and female students, from all four academic years, were included.
- Inclusion criteria: Students aged 17-25 years, were willing to participate in the study and provided informed consent.
- Exclusion criteria:
  - Students with systemic conditions (e.g., diabetes, cardiovascular diseases) that could influence periodontal health.
  - Students undergoing orthodontic treatment or recent periodontal therapy.
  - Students with less than 20 teeth.<sup>15</sup>

### Data Collection Tools and Procedure:

#### A. Questionnaire on awareness and oral hygiene practices

A structured self-administered questionnaire was developed, combining items adapted from validated instruments used in previous studies and newly created questions tailored to the study context.

#### The questionnaire comprised three sections:

1. Oral hygiene practices – e.g., brushing frequency, toothbrush type, interdental cleaning aids, dental visits, smoking, and sources of information.
2. Awareness and Knowledge – covering basic concepts of periodontal disease, risk factors, signs, prevention, and management.
3. Case-based Knowledge Application – testing practical understanding of periodontal health

through situational questions. Responses were scored to create oral hygiene practice score and awareness score for each participant (higher scores indicate better awareness).

#### B. Clinical Periodontal Examination

- Clinical index:
  - The Ramfjord Teeth method was employed for clinical periodontal examination. This index assesses the periodontal condition using six specific teeth: #16, #21, #24, #36, #41, and #44. These teeth are considered representative of the entire mouth for periodontal assessments.<sup>16</sup>
- Clinical Parameters:
  - Plaque index (PI): was assessed using the Silness and Loe plaque index, evaluating the presence of visible plaque on selected teeth.<sup>17</sup>
  - Gingival index (GI): was based on the Loe and Silness gingival index, assessing inflammation on selected teeth.<sup>18</sup>
  - Sulcus depth: was measured in millimeters from the gingival margin to the base of the pocket using William's periodontal probe.<sup>19</sup>
  - Bleeding on probing (BOP): was recorded as present or absent within 15 seconds after gentle probing on the selected sites.<sup>20</sup>
- Procedure:
  - Measurements were taken on the Ramfjord teeth (instead of a full-mouth examination), focusing on four key sites per tooth. The use of Ramfjord teeth significantly reduces examination time while still providing reliable indicators of periodontal health.<sup>21</sup>
  - The clinical periodontal examination was conducted using William's periodontal probe, and results were recorded on a standardized periodontal charting sheet.

#### Data Management

The independent variables in this study were gender and academic stage, while the dependent variables included plaque index (PI), gingival index (GI), sulcus depth, bleeding on probing (BOP%), oral hygiene practice score, and awareness score. All collected questionnaires and clinical examination forms were reviewed for completeness before data entry. No missing data were identified in the final dataset; therefore, all 120 participants were included in the statistical analysis. In cases of in-

complete responses or missing clinical measurements, participants would have been excluded from the affected analysis to maintain data accuracy and consistency.

The study followed these steps:

- Ethical approval was obtained from the Scientific Research Ethical Committee of Hawler Medical University. Reference Number: HMUD,2425047 Date of Approval: 22/12/2024.

Official permission was granted by the College of Health and Medical Technologies administration.

- Students were given a brief introduction about the study, and informed consent was signed by each individual.
- The questionnaires were distributed and collected in classroom settings.
- Clinical examinations were performed in a designated, well-lit room using proper infection control procedures.
- Participants' identities and responses were kept confidential and anonymized in the dataset.

The data collection process spanned January to April 2025.

**Data Analysis**

Microsoft Excel was used to enter the data, and IBM SPSS was used for analysis. Descriptive statistics were calculated (means, standard deviations, frequencies, percentages) for all demographic variables, awareness scores, and clinical indices. One-way ANOVA was used to compare mean scores of plaque index, gingival index, sulcus depth, BOP percentage, and awareness score across academic stages.

Normality of continuous variables was assessed using the Shapiro–Wilk test. As most variables demonstrated non-normal distribution, non-parametric statistical methods were applied. Com-

parisons among academic stages were performed using the Kruskal–Wallis test, followed by pairwise Mann–Whitney U tests for post hoc comparisons where appropriate. Effect sizes were calculated using epsilon squared ( $\epsilon^2$ ). Ninety-five percent confidence intervals (95% CI) were calculated for descriptive statistics. Statistical significance was set at  $p < 0.05$ .

**RESULTS**

A total of 120 students from the College of Health and Medical Technologies in Mosul/Iraq were included in this study, equally distributed across four academic stages (30 students each). Clinical parameters assessed included plaque index (PI), gingival index (GI), sulcus depth, and bleeding on probing (BOP). In addition, a questionnaire was used to assess students' awareness and oral hygiene practices. The questionnaire used in this study was developed based on a review of existing literature assessing oral health knowledge, attitudes, and practices (Table 2). In particular, question formats and thematic domains were inspired by the work of Selvaraj,<sup>22</sup> who conducted a similar assessment among the South Indian population.

The age range of participants was 17 to 25 years, with a mean age of  $21 \pm 3$  years. Females made up 35% of the sample, while males constituted 65%.

Table 1 revealed that oral hygiene practices among female students had a significantly higher mean score ( $6.60 \pm 2.10$ ) than males ( $5.38 \pm 1.88$ ), indicating better overall health behavior among females ( $p = 0.002$ ).

Male students had a mean awareness score of  $6.79 \pm 2.28$ , while female students had a score of  $8.07 \pm 1.91$ . There was statistically significant difference in awareness scores as well between male and female students ( $p = 0.002$ ).

**Table 1.** Difference in Oral Hygiene Practices and Awareness Score Between Male and Female Students

Variables	Male Students	Female Students	Sig.
Oral hygiene practice (Mean $\pm$ Std.)	5.38 $\pm$ 1.88	6.60 $\pm$ 2.10	0.002
Awareness score (Mean $\pm$ Std.)	6.79 $\pm$ 2.28	8.07 $\pm$ 1.91	0.002

**Table 2.** Results of the Questionnaire

Variables	Category	Number	Percentage
<b>Part I. Oral Hygiene Practice Questions</b>			
Brushing frequency (per day)	Once	54	45%
	Twice	43	36%
	More than twice	11	9%
	Occasionally	12	10%
Toothbrush Type	Manual	115	96%
	Electrical	5	4%
Brushing technique	Horizontal	24	20%
	Vertical	37	31%
	Circular	44	37%
	Bass	15	13%
Brushing Duration	Less than 2 minutes	48	40%
	2 min	57	48%
	More than 2 min	15	13%
Use of Dental Floss	Yes	53	44%
	No	67	56%
Use of Mouthwash	Yes	49	41%
	No	71	59%
Do you regularly go for professional cleaning/scaling?	Yes, every 6 months	30	25%
	Yes, once a year	34	28%
	No, I only go when I have a dental issue	56	47%
When was your last dental visit?	Less than 6 months ago	70	58%
	Between 6 months and 1 year ago	12	10%
	More than 1 year ago	70	58%
Smoking habit:	Yes	39	33%
	No	69	58%
	Former	12	10%

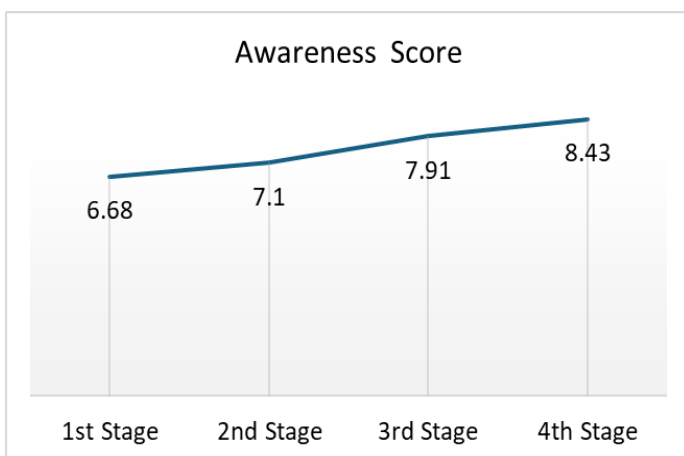
Part II. Awareness Questions			
Do you think gum health is important for overall health?	Yes	120	100%
	No	0	0%
Do you believe gum disease can affect systemic health (e.g., heart disease, diabetes)?	Yes	41	34%
	NO	79	66%
Which of the following are signs of gum disease?	Bleeding gums	41	34%
	Bad breath	49	41%
	Loose teeth	18	15%
	No symptoms	12	10%
What do you think is the main cause of gum disease?	Bacteria in dental plaque	80	67%
	Poor diet	10	8%
	Genetic factors	11	9%
	Smoking	19	16%
How can gum disease be prevented?	Brushing twice daily	21	18%
	Using interdental brushes/floss	33	28%
	Regular dental check-ups	62	52%
	Avoiding sugary foods	4	3%
A patient complains of bleeding gums during brushing. What is your advice?	Brush less frequently to avoid irritation	10	8%
	Use mouthwash only, no brushing	14	12%
	Brush properly, focusing on gum margins, and visit a dentist	72	60%
	Ignore, as it will resolve on its own	24	20%
Sources of Information	Dental curriculum	103	86%
	Social media	59	49%
	Dental visits	49	41%
	Family and friends	47	39%
	Online articles	31	26%
Totally		120	100%

The awareness score was calculated based on a 12-point scale from questionnaire responses. There was a significant increase in awareness score with

academic progression ( $p=0.000$ ), suggesting improved knowledge over the years (Figure 1 and Table 3).

**Table 3.** Mann-Whitney U Test of Awareness Score Among the Four Stages

	Awareness Score	Z Value	P Value
First	6.683 ± 1.51	-1.370-	0.171
Second	7.10 ± 1.45		
First	6.683 ± 1.51	-3.329-	0.001
Third	7.92 ± 2.26		
First	6.683 ± 1.51	-3.938-	0.000
fourth	8.43 ± 1.72		
Second	7.10 ± 1.45	-2.708-	0.007
Third	7.92 ± 2.26		
Second	7.10 ± 1.45	-2.628-	0.009
fourth	8.43 ± 1.72		
Third	7.92 ± 2.26	-.530-	0.596
fourth	8.43 ± 1.72		



**Figure 1.** Awareness score across the academic stages

The mean plaque index was highest among first-stage students (mean ± SD = 1.59 ± 0.47) and lowest among fourth-stage students (1.21 ± 0.30). Similar trends were observed in Sulcus depth (Table 4).

Shapiro–Wilk normality testing demonstrated that most continuous variables were not normally distributed ( $p < 0.05$ ), except for oral hygiene practice

score. Therefore, non-parametric statistical analyses were primarily applied.

Kruskal–Wallis analysis revealed statistically significant differences among academic stages in awareness Score ( $H = 20.696$ ,  $p < 0.001$ ,  $\epsilon^2 = 0.152$ ), plaque Index (PI) ( $H = 13.260$ ,  $p = 0.004$ ,  $\epsilon^2 = 0.092$ ), gingival index (GI) ( $H = 27.044$ ,  $p < 0.001$ ,  $\epsilon^2 = 0.205$ ), sulcus depth ( $H = 46.840$ ,  $p < 0.001$ ,  $\epsilon^2 = 0.379$ ), and bleeding on probing (BOP) ( $H = 16.964$ ,  $p < 0.001$ ,  $\epsilon^2 = 0.126$ ). Oral hygiene practice score showed a small effect size and borderline statistical significance ( $H = 8.002$ ,  $p = 0.046$ ,  $\epsilon^2 = 0.043$ ).

Pairwise Mann–Whitney U tests demonstrated significant differences in awareness scores between first-stage students and both third-stage ( $p = 0.001$ ) and fourth-stage students ( $p < 0.001$ ), as well as between second-stage students and both third-stage ( $p = 0.007$ ) and fourth-stage students ( $p = 0.008$ ). No significant differences were observed between third- and fourth-stage students.

Similar trends were observed for periodontal parameters. First-stage students demonstrated significantly higher PI and GI scores compared with later academic stages. Sulcus Depth showed the largest

effect size, with significant differences observed between early and advanced academic stages, particularly between first- and fourth-stage students

( $p < 0.001$ ). BOP percentages were significantly lower among fourth-stage students compared with first- and second-stage students.

**Table 4.** The Mean of the Four Periodontal Parameters Across the Four Academic Stages

Academic Stage	PI (Mean ±Std.)	GI (Mean ±Std.)	Sulcus Depth (Mean ±Std.)	BOP% (Mean ±Std.)
1st Stage	1.5880 ±0.46933	1.6056 ±0.62894	2.5820 ±0.54113	44% ±29%
2nd Stage	1.2833 ±0.38965	1.3104 ±0.34140	3.1587 ±0.57655	37% ±31%
3rd Stage	1.2263 ±0.45650	1.2551 ±0.36034	3.4093 ±0.47791	35% ±32%
4th Stage	1.2110 ±0.30794	1.2488 ±0.23911	2.3193 ±0.45677	18% ±20%

**Table 5.** Kruskal–Wallis Test

Variable	H Statistic	P value	Effect Size ( $\epsilon^2$ )	Interpretation
Awareness Score	20.696	<0.001	0.152	Moderate
PI	13.260	0.004	0.092	Moderate
GI	27.044	<0.001	0.205	Moderate–Large
Sulcus Depth	46.840	<0.001	0.379	Large
BOP	16.964	<0.001	0.126	Moderate

**Table 6.** Summarizes the Sources of Oral Health Information Reported by Students

Source of Information	Percentage (%)
Dental curriculum	86.2%
Social media	49.1%
Dental visits	41.4%
Family and friends	38.8%
Online articles/websites	25.9%

## DISCUSSION

This cross-sectional study investigated periodontal health status, oral hygiene practices, and awareness among Prosthetic Dental Techniques students across four academic stages in Mosul city. Overall, our findings demonstrated a significant improvement in periodontal awareness and certain clinical parameters, notably plaque accumulation and sulcus depth, from the first to the fourth academic stages. Additionally, female students showed superior oral hygiene practices and higher periodontal awareness compared to males. A study of private university dental students found that oral health attitudes and behaviors improved sig-

nificantly as students progressed through their academic years, demonstrating a positive effect of clinical training and education.<sup>23</sup>

A systematic review noted that men consistently report poorer oral hygiene behaviors, including less frequent brushing and dental visits, compared to women.<sup>24</sup> Other studies reported that female students exhibited higher oral health literacy, more consistent self-care routines, and better clinical periodontal outcomes.<sup>25</sup>

The observed improvement in awareness and clinical periodontal parameters across academic stages aligns with international studies among dental students. For example, a comparative study between

Japanese and Greek dental students demonstrated that oral health attitudes and behaviors significantly improved as students progressed through their dental education. This aligns with the findings of the present study, which also observed a notable improvement in periodontal knowledge, attitudes, and behaviors among dental students with each advancing academic stage.<sup>23</sup>

The progressive improvement in awareness scores with advancing academic stages aligns with previous research showing that clinical education enhances periodontal health knowledge, for example, Naruishi found that Japanese dental students significantly increased their awareness of the clinical importance of periodontal treatment after clinical training.<sup>26</sup> Similarly, a 2025 systematic review reported higher oral health knowledge, attitudes, and behaviors among senior and clinically experienced dental students across multiple countries.<sup>27</sup>

Gender differences in oral hygiene practices and awareness were also evident in this study. Female students demonstrated significantly higher awareness scores and better oral hygiene behaviors compared to males. This finding is consistent with several recent studies. For instance, a 2023 study of Saudi adults found that women had significantly higher oral health knowledge scores and reported more frequent tooth brushing and dental visits compared to men.<sup>25</sup> Similarly, a 2021 review highlighted that women generally exhibit more positive attitudes toward dental care, greater oral health literacy, and better oral hygiene habits than men.<sup>28</sup> These differences are often attributed to behavioral and social factors—females tend to be more health-conscious and take greater responsibility for personal hygiene, which likely contributes to their higher awareness and better oral health outcomes.

Clinically, our findings revealed significant variations in plaque index, gingival index and sulcus depth across the four academic stages, with plaque accumulation highest in first-year students and lowest in fourth-year students, indicating improved plaque control with academic progression. These improvements align with studies among dental student cohorts—such as Karem,<sup>29</sup> who reported significant reductions in plaque and gingival scores from preclinical to clinical stages.

The observed changes may indicate a gradual increase in personal oral hygiene awareness and behavioral adaptation as students progress

through their academic education. The decrease in mean BOP percentage in the final year may reflect better plaque control and reduced gingival inflammation due to improved self-care behaviors reinforced by theoretical exposure to oral health principles.

The null hypothesis was rejected in all aspects of the study. Statistically significant differences were observed in plaque index, sulcus depth, gingival index, bleeding on probing, oral hygiene practice and awareness scores across academic stages, supporting the role of educational progression in improving periodontal health and awareness. The overall findings indicate that academic advancement positively influences both knowledge and clinical periodontal parameters.

This interpretation is supported by recent literature suggesting that non-clinical health education can still positively influence personal health behavior, particularly in dental-related fields (e.g., oral hygiene and diet awareness).<sup>30,25</sup> While prosthetic dental technology curricula do not typically involve clinical patient management, increased familiarity with dental terminology and exposure to dental health topics may contribute to improved self-care practices across academic progression.

The dental curriculum was cited as the main source of knowledge (86.2%) impacting students' oral hygiene behaviours, followed by social media and dental visits, according to our study. These results highlight the value of structured educational programs and the impact of modern communication channels on the development of oral health behaviour and knowledge.

Similar trends have been reported recently; a 2024 scoping review found that dental students frequently use social media platforms like YouTube, Instagram, and WhatsApp for oral health education and professional development.<sup>31</sup> Furthermore, a 2023 study reported that social media-based oral health interventions—such as short videos and infographics—led to significant improvements in users' knowledge and oral hygiene habits.<sup>32</sup> These findings support the notion that traditional curricula, when combined with digital outreach, can be highly effective in educating future dental professionals and strengthening oral health behaviors.

This study is not without limitations. The use of convenience sampling may limit the generalizability of the findings, as such samples are not ran-

domly selected and may not represent the broader population—only those readily available at the college during the study period. One limitation of this study is the use of convenience sampling, which may limit the generalizability of the findings beyond the studied cohort. Since participants were selected based on accessibility rather than random sampling, the study may be subject to selection bias, and the sample may not fully represent all dental technology students in Mosul or other populations. Consequently, the external validity of the findings should be interpreted with caution. Future studies employing randomized sampling techniques and larger multi-center populations are recommended to improve representativeness and generalizability.<sup>33</sup> Additionally, the clinical assessment was confined to Ramfjord teeth, a method that, while efficient and validated, provides only a partial-mouth evaluation. A research shows that using a limited set of index teeth can introduce bias in estimating prevalence and severity of periodontal disease, and may not accurately reflect full-mouth conditions.<sup>34</sup> Future studies should adopt randomized sampling methods and perform full-mouth periodontal assessments to enhance external validity and better capture the complete periodontal health status of the prosthetic dental technology students.

## CONCLUSION

This cross-sectional study demonstrated that periodontal awareness and clinical periodontal parameters improved with academic progression among prosthetic dental technology students. Significant gender differences in oral hygiene practices and awareness were also observed, highlighting the need for tailored educational approaches. These findings emphasize the importance of introducing periodontal education earlier in the curriculum and incorporating behavior-oriented interventions to further enhance oral health knowledge, practices, and outcomes in this population.

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## Conflict of Interest

The authors declare no conflicts of interest.

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