

Assessment of the knowledge, Attitude and Practice on the relationship between periodontal health and diabetes mellitus among Bangladeshi population: A Cross-sectional Study

Mustari Nailah Tabassum

mustarinaila19@gmail.com

North South University

Tarannum Mahmood

Chittagong Medical College

Sadia Sultana Imla

Chittagong Medical College

Bivasa Chakraborty

Chittagong Medical College

Tanvir Hossain

Institute of Research, Innovation, Incubation and Commercialization (IRIIC) United International University

Aishee Saha

Chittagong Medical College

Md. Majedur Rahman Maruf

Tangail Medical College

Arnob Biswas

Sher-E-Bangla Medical College

Mohammad Delwer Hossain Hawlader

North South University

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Abstract

Background

Diabetes mellitus and periodontal disease share a bidirectional relationship, yet oral-health concerns are often inadequately integrated into diabetes care. Evidence regarding patients' knowledge, attitudes, and practices (KAP) concerning this relationship remains limited in Bangladesh. This study assessed KAP related to periodontal health and diabetes mellitus among Bangladeshi adults living with diabetes.

Methods

A quantitative cross-sectional study was conducted between January and July 2026 among adults with diabetes recruited from Bangladesh's eight administrative divisions using convenience sampling. Data were collected through a pretested, bilingual semi-structured questionnaire administered face-to-face or electronically. The questionnaire assessed sociodemographic and clinical characteristics and included six knowledge, six attitude, and eleven practice items. Descriptive statistics, chi-square tests, independent-samples *t* tests, Pearson correlations, linear regression, and logistic regression were performed.

Results

Of 396 respondents, 331 with complete data were analyzed. Participants had a mean age of 52.99 ± 13.60 years. The mean knowledge score was 2.46 ± 1.88 of 6; 18.4% demonstrated good knowledge, whereas 71.6% had poor knowledge. In contrast, attitudes were comparatively favorable: the mean attitude score was 8.85 ± 2.52 , with 48.6% classified as positive and 17.2% as negative. Despite 97.3% reporting tooth cleaning, only 13.9% demonstrated good oral-health practices and 48.6% had poor practices. Awareness was highest for food impaction (68.6%) but lowest for tooth elongation (23.3%). Attitude and practice scores showed a moderate positive correlation ($r = 0.394, p < 0.001$), while knowledge was not significantly correlated with either domain. Knowledge varied significantly by geographic division, whereas practice scores were lower among older participants and those reporting poorer health. In adjusted analyses, Dhaka residence was associated with higher odds of good practice (adjusted odds ratio 4.67, 95% CI 1.02–21.41; $p = 0.047$).

Conclusions

Bangladeshi adults with diabetes showed a substantial knowledge–practice gap despite generally favorable attitudes toward oral health. Diabetes services should incorporate structured periodontal health education, preventive dental referrals, and practical oral hygiene counseling, particularly for older adults and populations with limited access to integrated care.

Introduction

Diabetes Mellitus (DM) is a group of metabolic diseases characterized by impaired utilization of glucose as an energy source and abnormal production of glucose due to abnormal gluconeogenesis and glycogenolysis, leading to hyperglycemia (1). There is a high prevalence of diabetes in Bangladesh, with the country being second on the list of the IDF South-East Asia region in prevalence of diabetes and diabetics aged 20–79 years (2). Poor glycaemic control can lead to complications involving many systems and cause morbidity and premature death (1). In addition to all these systemic complications, DM may cause oral complications, including periodontal disease, xerostomia, oral infection, and poor healing (3). More importantly, there is a lot of evidence suggesting a reciprocal relationship between periodontal disease and diabetes mellitus. Changes in glucose metabolism can increase susceptibility to periodontal disease, while periodontal disease has been shown to predispose patients to diabetes mellitus. This reciprocal relationship may be mediated, in part, by persistent inflammatory processes common to both conditions (4).

Periodontitis is a multifactorial, chronic inflammatory disease affecting the tissues that support the teeth. This condition is considered a major global public health problem. Periodontal tissue destruction results in clinical attachment loss, alveolar bone loss, periodontal pocketing, reduced oral function, and eventually tooth loss, which severely affects the quality of life. Severe periodontitis affects more than one billion people worldwide (5, 6). A review of the available evidence highlighted findings from an earlier meta-analysis of more than 3,500 adults with diabetes, in which periodontal disease was generally more severe among individuals with diabetes than among those without diabetes (7).

A systematic analysis encompassing 8,693 persons with diabetes identified large gaps in understanding of the diabetes–periodontal disease link, with fewer than half of participants aware of their elevated risk of periodontal disease (8). Another systematic review involving 27,894 persons with diabetes across 14 countries demonstrated inadequate oral health awareness, unsatisfactory oral health behaviors, and restricted dental attendance and referral, highlighting major gaps in diabetes-related oral healthcare (9). In a Cochrane review done in 2022 consisting of 30 studies on 2,443 participants, it has been demonstrated that periodontal therapies decrease HbA1c levels by 0.43% at 3–4 months, with moderate-certainty evidence supporting improved glycemic control among individuals with diabetes and periodontitis (10).

Despite the established bidirectional relationship between diabetes and periodontal disease, diabetes care often lacks sufficient integration of oral health. In Bangladesh, limited public awareness, policy gaps, and systemic barriers may hinder the prevention and management of both conditions (11). In addition, individuals with type 2 diabetes have an increased prevalence of periodontal disease, and poor glycemic control, poor diabetic self-management, and insufficient knowledge of oral health practices have been associated with poor periodontal disease outcomes (12). This lack of studies in the general population indicates a significant gap in understanding of how the public views the association between diabetes and periodontal health. As a result, this study aims to evaluate the existing knowledge,

attitudes, and practices (KAP) regarding periodontitis among patients with Type 2 diabetes in Bangladesh.

Methodology

A quantitative cross-sectional study was carried out to assess the knowledge, attitudes and practices (KAP) on the association between periodontal health and diabetes mellitus among adults with diabetes mellitus in Bangladesh. The study was carried out from January to July 2026, and participants were selected from different districts of the eight administrative divisions of Bangladesh. The study population included adults with diabetes mellitus from Bangladesh. The inclusion criteria were male and female adults aged ≥ 18 years with a diagnosis of diabetes mellitus. Individuals with severe cognitive or communication limitations that prevented them from providing reliable responses were excluded. The study protocol also excluded participants who were on psychiatric treatment or medication. Eligible participants were selected through non-probability convenience sampling techniques from the eight administrative divisions of Bangladesh. In the present study, data from 396 participants were taken but due to incomplete information 331 data were included in the final analysis with all information.

Data collection instruments:

Data were collected using a semi-structured questionnaire and administered through face-to-face interviews. The questionnaire was prepared in English and translated into Bengali. The questionnaire was available in written and Google Form versions to suit the respondent's preference. The questionnaire was pretested with a sample of the target population and modified for clarity and cultural appropriateness prior to data collection. The questionnaire was used to assess sociodemographic characteristics and KAP on the association between periodontal health and diabetes mellitus. These included age, sex, duration of diabetes, self-reported health status, number of remaining teeth, and other relevant characteristics. The KAP component was designed to measure knowledge, attitudes, and practices concerning periodontal disease, oral hygiene, dental care, and the relationship between periodontal health and diabetes mellitus.

Study Variables:

The questionnaire obtained information in four domains. The socio-demographic and clinical characteristics were age, sex, self-reported health status in the last 30 days, number of remaining natural teeth and time since diagnosis of diabetes. The knowledge domain (six items, K1–K6) assessed participants' knowledge of signs of periodontal disease including bone loss associated with gum disease, gingival redness, tooth mobility, food impaction, and tooth elongation. The responses were divided into three categories: more than 80% good, more than 60% moderate, and less than 60% poor knowledge. The attitude domain (six items, A1–A6) explored participants' opinions on routine dental check-ups, the importance of dental visits in diabetes management, worries about oral complications,

the necessity for enhanced oral hygiene alertness in diabetes, and the perceived preventative value of oral hygiene; each item's score was added to create an attitude score, which was then divided into three categories: ≥ 10 positive, 7–9 neutral, and ≤ 6 negative attitude level. The practice domain (11 items, P1–P11) assessed self-reported oral hygiene practices including toothbrushing frequency, toothbrush replacement interval, use of interdental aids, tongue cleaning, mouth rinsing, mouthwash use, frequency of preventive dental visits and frequency of blood glucose monitoring. These were combined to create a practice score, which was then divided into three categories: ≤ 14 (poor), 15–19 (moderate), and ≥ 20 (good practice).

Data management and statistical analysis:

The data analysis was conducted using Stata statistical software. Continuous variables were presented as mean and standard deviation, while categorical variables were shown as frequency and percentage. To assess the associations between sex and categorical levels of knowledge, attitude, and practice, the Pearson chi-square test was used. Independent-samples t-tests were used to compare the mean knowledge scores of male and female participants. Additionally, linear regression analysis was employed to explore the relationships between knowledge, attitude, practice scores, and selected explanatory variables. Reference categories were utilized for categorical predictors. Pairwise Pearson correlation coefficients were calculated to examine relationships among age, knowledge, attitude, and practice scores. Multiple logistic regression models were used to identify factors independently associated with good and poor knowledge, good and poor practice, and positive and negative attitudes. The explanatory variables included age category, sex, division, duration of diabetes, health status, and the number of remaining teeth. Results were presented as odds ratios (ORs) along with 95% confidence intervals (CIs). Statistical significance was determined at $p < 0.05$.

Results

Based on a total of 331 participants who were included in this study, participants' ages ranged from 18 to 98 years and the average was 52.99 ± 13.60 years. The mean period of diabetes was 2.13 ± 1.28 years (range: 1–7 years). The health-status score averaged 2.47 ± 1.00 and the remaining-teeth score 3.61 ± 0.84 . (Table 1)

Table 1
Distribution of study participants according to sex and selected clinical characteristics.

Variable	Frequency, N (%)	Mean $\pm$ SD	Range
Male	229(62.2%)	-	-
Female	102(30.8%)	-	-
Age (years)	331(100%)	52.99 $\pm$ 13.60	18–98
Diabetes duration (years)		2.13 $\pm$ 1.28	1–7
Health-status score		2.47 $\pm$ 1.00	1–5
Remaining-teeth score		3.61 $\pm$ 0.84	0–4

The mean knowledge score was 2.46 ± 1.88 out of a maximum of 6 points; thus, the mean knowledge percentage was $40.99 \pm 31.36\%$. Figure 1 shows the range of the knowledge scores observed was 0–6. Among the given binary indicators, 18.4% of the participants were considered to have good knowledge while 71.6% were considered to have poor knowledge. The average attitude score was 8.85 ± 2.52 and ranged from 0–12. The binary indicators showed that 48.6% of participants had a positive attitude and 17.2% had a negative attitude. The actual range was 2–27 and the mean practice score was 14.41 ± 4.84 . The mean practice percentage was $53.35 \pm 17.92\%$ (range: 7.41–100%). Of the indicators of good practice provided, 13.9% of participants demonstrated good practice, while 48.6% demonstrated poor practice. (Table 2)

Table 2
Distribution of study participants according to knowledge, attitude, and practice outcomes.

KAP outcome	Mean $\pm$ SD	Observed range	Category indicators	Frequency (n)	Percentage (%)
Knowledge score	2.46 $\pm$ 1.88	0–6	Good	61	18.4
			Poor	237	71.6
Attitude score	8.85 $\pm$ 2.52	0–12	Positive	161	48.6
			Negative	57	17.2
Practice score	14.41 $\pm$ 4.84	2–27	Good	46	13.9
			Poor	161	48.6

There was no statistically significant difference between male participant and female participant in terms of knowledge level ($\chi^2 = 0.12$, $p = 0.941$). Again, the mean knowledge score did not differ significantly between male and female participants (2.467 vs 2.441; $p = 0.907$).

In linear regression using Barishal as the reference division, knowledge scores were significantly higher in Dhaka ($\beta = 1.297$, 95% CI: 0.599–1.995, $p < 0.001$), Mymensingh ($\beta = 3.492$, 95% CI: 2.754–4.230, $p < 0.001$), Rajshahi ($\beta = 0.749$, 95% CI: 0.007–1.491, $p = 0.048$), and Rangpur ($\beta = 1.217$, 95% CI: 0.414–2.020, $p = 0.003$). The association for Chattogram was not statistically significant at 5% level ($\beta = 0.546$, $p = 0.097$) and Khulna and Sylhet also had no statistically significant difference.

For the provided linear regression model, there was no significant association between age category and knowledge score (F-test $p = 0.116$). (Table 3)

The logistic regression models revealed that only health status was significantly associated with both good and poor knowledge. The odds ratio for good knowledge was 0.558 (95% CI: 0.393–0.793, $p = 0.001$), whereas the odds ratio for poor knowledge was 1.477 (95% CI: 1.110–1.965, $p = 0.007$). (Table 3)

Table 3
Linear regression of knowledge score by division (reference division: Barishal).

Division	Odds Ratio (β)	Standard Error (SE)	95% CI	p-value
Chattogram	0.546	0.328	-0.100 to 1.192	0.097
Dhaka	1.297	0.355	0.599 to 1.995	< 0.001
Khulna	0.467	0.750	-1.010 to 1.943	0.534
Mymensingh	3.492	0.375	2.754 to 4.230	< 0.001
Rajshahi	0.749	0.377	0.007 to 1.491	0.048
Rangpur	1.217	0.408	0.414 to 2.020	0.003
Sylhet	-0.325	0.362	-1.036 to 0.386	0.369

Table 4 demonstrates the difference between the practice score for divisions was significant (F-test $p < 0.001$). Using Barishal as the reference category, participants from Chattogram had significantly lower practice scores ($\beta = -2.400$, 95% CI: -4.294 to -0.506, $p = 0.013$), whereas the association for Dhaka was borderline ($\beta = 1.987$, 95% CI: -0.061 to 4.034, $p = 0.057$). No statistically significant difference was found for Khulna, Mymensingh, Rajshahi, Rangpur and Sylhet.

Table 4
Linear regression of practice score by division (reference division: Barishal).

Division	Odds Ratio (β)	Standard Error (SE)	95% CI	p-value
Chattogram	-2.400	0.963	-4.294 to -0.506	0.013
Dhaka	1.987	1.041	-0.061 to 4.034	0.057
Khulna	0.300	2.200	-4.028 to 4.628	0.892
Mymensingh	-1.725	1.100	-3.889 to 0.439	0.118
Rajshahi	1.767	1.106	-0.409 to 3.943	0.111
Rangpur	0.707	1.197	-1.647 to 3.062	0.555
Sylhet	-1.650	1.060	-3.736 to 0.436	0.121

Model statistics: Mean dependent variable = 14.405; SD = 4.837; $R^2 = 0.132$; N = 331; F-test = 7.029; $p < 0.001$.

The overall practice score was significantly related to age (F-test $p = 0.006$). Compared with participants aged 18–28 years, practice scores were significantly lower among those aged 59–68 years ($\beta = -2.914$, 95% CI: -5.556 to -0.273, $p = 0.031$) and 69–78 years ($\beta = -4.493$, 95% CI: -7.540 to -1.447, $p = 0.004$). Association for the 79–88 year age group was borderline ($p = 0.094$), while the other age groups were not statistically significant ($\beta = -0.529$ to 6.696). (Table 5)

Table 5
Linear regression of practice score by age group (reference: 18–28 years).

Age-group (years)	Odds Ratio (β)	Standard Error (SE)	95% CI	p-value
29–38	-0.115	1.484	-3.033 to 2.804	0.938
39–48	-1.169	1.344	-3.813 to 1.475	0.385
49–58	-1.808	1.315	-4.396 to 0.780	0.170
59–68	-2.914	1.343	-5.556 to -0.273	0.031
69–78	-4.493	1.549	-7.540 to -1.447	0.004
79–88	-3.083	1.836	-6.696 to 0.529	0.094
89–98	-3.000	2.999	-8.899 to 2.899	0.318

Model statistics: Mean dependent variable = 14.405; SD = 4.837; $R^2 = 0.060$; N = 331; F-test = 2.926; $p = 0.006$.

In Table 6, self-rated health status was related to the practice score (F-test, $p < 0.001$). Compared with participants reporting poor health, practice scores were significantly higher among those reporting fair

health ($\beta = 2.344$, 95% CI: 0.868–3.819, $p = 0.002$), good health ($\beta = 3.017$, 95% CI: 1.572–4.463, $p < 0.001$), very good health ($\beta = 4.319$, 95% CI: 2.164–6.474, $p < 0.001$), and excellent health ($\beta = 5.665$, 95% CI: 2.858–8.473, $p < 0.001$).

Table 6
Linear regression of practice score by self-reported health status (reference: Poor).

Health status	Odds Ratio (β)	Standard Error (SE)	95% CI	p-value
Fair	2.344	0.750	0.868 to 3.819	0.002
Good	3.017	0.735	1.572 to 4.463	< 0.001
Very good	4.319	1.095	2.164 to 6.474	< 0.001
Excellent	5.665	1.427	2.858 to 8.473	< 0.001

Model statistics: Mean dependent variable = 14.405; SD = 4.837; $R^2 = 0.081$; N = 331; F-test = 7.193; $p < 0.001$.

The overall practice score was also highly significant for the remaining natural teeth (F-test, $p < 0.001$). The scores of the practice group were significantly lower than those of participants who were unsure or refused to report the number of remaining teeth ($\beta = -8.250$, $p = 0.004$; $\beta = -7.778$, $p < 0.001$; $\beta = -4.208$, $p = 0.018$, respectively). There was no statistically significant difference between the association for participants with 21–25 or 26–30 natural teeth remaining. (Table 7)

Table 7
Linear regression of practice score by number of remaining natural teeth (reference: Not sure/refused).

Remaining natural teeth	Odds Ratio (β)	Standard Error (SE)	95% CI	p-value
None	-8.250	2.840	-13.838 to -2.662	0.004
Less than 10	-7.778	1.971	-11.655 to -3.900	< 0.001
10–20	-4.208	1.771	-7.693 to -0.724	0.018
More than 20	-2.567	1.666	-5.844 to 0.710	0.124

Model statistics: Mean dependent variable = 14.405; SD = 4.837; $R^2 = 0.092$; N = 331; F-test = 8.222; $p < 0.001$.

There was a weak positive correlation between age and knowledge score ($r = 0.168$, $p = 0.002$) and a weak negative correlation between age and practice score ($r = -0.219$, $p < 0.001$) in the pairwise correlation analysis. A correlation between age and attitude score was not statistically significant ($r = -0.105$, $p = 0.056$). (Table 8)

There was no significant correlation between knowledge score and attitude score ($r = 0.017$, $p = 0.758$) or practice score ($r = -0.011$, $p = 0.835$). Attitude score, on the other hand, has a moderate positive correlation with practice score ($r = 0.394$, $p < 0.001$). (Table 8)

Table 8
Pairwise correlations among age and KAP scores.

Variable pair	Coef. (r)	p-value	Interpretation
Age vs knowledge score	0.168	0.002	Weak positive
Age vs attitude score	-0.105	0.056	Not statistically significant
Age vs practice score	-0.219	< 0.001	Weak negative
Knowledge vs attitude	0.017	0.758	Not statistically significant
Knowledge vs practice	-0.011	0.835	Not statistically significant
Attitude vs practice	0.394	< 0.001	Moderate positive

Table 9 shows that the knowledge levels of everyday warning signs were the highest for food impaction (K5, 68.58%), but recognition of more clinically meaningful indicators of periodontal disease self-perceived gum disease (K1, 42.30%), a prior dentist diagnosis of periodontal disease with bone loss (K2, 38.37%), gum redness (K3, 36.86%), and tooth mobility (K4, 36.56%) went below half. Awareness of tooth elongation, a subtler sign of gingival recession, was lowest of all (K6, 23.26%).

Table 9
Distribution of knowledge questions of the participants about bidirectional relationship between oral health and diabetes mellitus:

Knowledge	Correctness Frequency (Percentage)
K1. In your opinion, do you have periodontal disease or gum disease?	140 (42.30%)
K2. Have you ever been told by a dentist that you have periodontal / gum disease with loss of bone mass?	127 (38.37%)
K3. Do you find any area of your gums redder than normal?	122 (36.86%)
K4. Do any of your teeth feel loose?	121 (36.56%)
K5. Does food get caught in your teeth?	227 (68.58%)
K6. Do you notice that your teeth are getting longer?	77 (23.26%)

Attitudes were considerably more favorable than knowledge, indicating a gap between what participants believed and what they actually understood. A large majority agreed that oral hygiene prevents gum problems (A6, 94.56%) and that diabetics should be more cautious about oral health (A4, 71.60%), and similarly high proportions saw oral complications of diabetes as a genuine concern warranting dental review (A3, 71.30%) and believed hygiene practices such as brushing and flossing could help diabetes

management (A5, 64.65%). Support for routine dental check-ups was also strong (A1, 61.33%), but only 18.13% correctly identified dental visits as part of diabetes management (A2), suggesting that positive attitudes toward oral hygiene are not yet grounded in an understanding of their specific role in diabetes control. (Table 10)

Table 10
Distributions of Attitude questions of participants about bidirectional relationship between oral health and diabetes mellitus

Attitude	Preferred Answer	Frequency (N)	Percentage (%)
A1. Do you think that one should go for a regular dental check-up?	Yes	203	61.33
A2. According to you, what should be the reason for a diabetic to visit a dentist?	As a part of the management of diabetes	60	18.13
A3. Do you think the oral complications of diabetes are a cause of concern and one should get it checked by a dentist?	Yes	236	71.30
A4. Do you think that people with diabetes should be more cautious about their oral health and maintain better oral hygiene than a person without diabetes?	Yes	237	71.60
A5. Do you brushing twice a day flossing regularly, maintaining proper hygiene can help diabetes?	Yes	214	64.65
A6. Do you agree that oral hygiene can prevent gum problems?	Yes	313	94.56

Practices showed the widest gap between intention and consistent execution. Basic hygiene behaviors were nearly universal almost all participants reported cleaning their teeth (P1, 97.28%) and most rinsed after eating (P6, 81.87%) or controlled blood glucose regularly (P10, 76.74%) but frequency and thoroughness dropped sharply: only 3.32% brushed more than twice daily (P2), just 12.99% changed their toothbrush at the recommended interval (P3), and interdental aids (P4, 18.13%) and mouthwash (P7, 19.64%) were rarely used. Preventive dental visits every three months or more were especially uncommon (P9, 4.53%), and fewer than half had ever noticed oral odor in themselves or family members (P8, 47.73% reporting "no"), suggesting unaddressed hygiene issues went undetected. (Table 11)

Table 11

Respondents' practices concerning bidirectional relationship between oral health and diabetes mellitus:

Practice	Preferred Answer	Frequency (N)	Percentage (%)
P1. Do you clean your teeth?	Yes	322	97.28
P2. How often do you clean your teeth?	More than twice daily	11	3.32
P3. How often do you change your toothbrush?	Once in 3 months or more frequently	43	12.99
P4. Do you use any of these interdental aids?	Floss	60	18.13
P5. Do you clean your tongue?	Yes	226	68.28
P6. Do you rinse your mouth after eating?	Yes	271	81.87
P7. Do you use a mouthwash?	Yes	65	19.64
P8. Have you or your family members ever noticed a smell from your mouth?	No	158	47.73
P9. How often do you make preventive visits to the dentist?	Once in 3 months or more frequently	15	4.53
P10. Do you control your blood glucose level regularly?	Yes	254	76.74
P11. If yes, how often?	One or more times per day	51	15.41

In Table 12, divisional residence and duration of diabetes were the only consistent independent predictors. Mymensingh division showed the strongest association, and adjustment strengthened it (UOR = 27.00, $p < 0.001$ → AOR = 72.86, $p < 0.001$). Barishal was protective in univariate analysis (UOR = 0.11, $p < 0.001$) but became the reference category in the adjusted model, so no AOR is available for direct comparison. Long DM duration (26–30 years) showed the same reinforcing pattern (UOR = 6.82, $p = 0.011$ → AOR = 18.26, $p = 0.021$), while the 11–15-year band lost significance after adjustment (UOR = 2.82, $p = 0.016$ → AOR = 1.89, $p = 0.372$), indicating its unadjusted effect was confounded. Due to very few respondents in Khulna division and the DM durations of 21–25 years and 31–35 years were shown as 1 in the analysis.

Table 12
Univariate and Multivariate Analysis of Good Knowledge with Significant Socio-demographic Factors

Variable	Univariate		Multivariate	
	OR (95% CI)	P-value	OR (95% CI)	P-value
Division				
Chattogram	1.025 (.259–4.066)	0.972	1.002 (.17–5.912)	0.998
Dhaka	2.093 (.528–8.295)	0.293	4.961 (.842–29.223)	0.077
Khulna	NE	-	NE	-
Mymensingh	27 (6.718–108.512)	< 0.001	72.856 (11.642–455.94)	< 0.001
Rajshahi	1.029 (.212–4.988)	0.972	1.147 (.159–8.254)	0.891
Rangpur	1.5 (.304–7.391)	0.618	1.112 (.135–9.155)	0.921
Sylhet	0.191 (.019–1.933)	0.161	0.045 (.002–1.004)	0.05
Barishal	0.111 (.034 – .366)	< 0.001	Ref.	
Duration of Diabetes Mellitus				
0–5 years	0.147 (.088 – .244)	< 0.001	Ref.	
6–10 years	1.891 (.951 – 3.76)	0.069	1.814 (.589–5.588)	0.310
11–15 years	2.824 (1.215–6.564)	0.016	1.888 (.468–7.621)	0.372
16–20 years	1.264 (.428–3.727)	0.672	2.86 (.517–15.826)	0.229

Variable	Univariate	Multivariate		
	OR (95% CI)	P-value	OR (95% CI)	P-value
21–25 years	NE	-	NE	-
26–30 years	6.824 (1.559–29.868)	0.011	18.261 (1.559–213.961)	0.021
31–35 years	NE	-	NE	-

Barishal division and diabetes duration of 0–5 years were the reference categories in both univariate and multivariate logistic-regression analyses. NE indicates that an odds ratio could not be estimated reliably because of sparse data or inadequate outcome variation within the category. AOR: adjusted odds ratio; CI: confidence interval; Ref.: reference category.

Three divisions retained significance after adjustment, all with attenuated but stable odds: Chattogram (UOR = 4.59, $p = 0.003$ → AOR = 4.00, $p = 0.018$), Dhaka (UOR = 5.22, $p = 0.002$ → AOR = 3.88, $p = 0.023$), and Rajshahi, by far the strongest predictor in the model (UOR = 35.00, $p < 0.001$ → AOR = 24.51, $p < 0.001$). Sylhet moved from non-significant to significant after adjustment (UOR = 2.86, $p = 0.053$ → AOR = 3.39, $p = 0.047$), suggesting a suppressed effect unmasked by adjustment. Conversely, the 26–30-year duration band lost significance after adjustment (UOR = 6.82, $p = 0.011$ → AOR = 3.14, $p = 0.257$), while the 16–20-year duration gained it (UOR = 1.26, $p = 0.672$ → AOR = 3.01, $p = 0.046$). Age (69–78 years) reached significance only after adjustment and only marginally (AOR = 0.17, $p = 0.049$). (Shown in Table 13)

Table 13
Univariate and Multivariate Analysis of Positive Attitudes with Significant Socio-demographic Factors

Variable	Univariate		Multivariate	
	OR (95% CI)	P-value	OR (95% CI)	P-value
Age-group				
18–28 years old	1.143 (.414–3.152)	0.796	Ref.	
29–38 years old	1.279 (.372 – 4.4)	0.696	0.98 (.238–4.045)	0.978
39–48 years old	0.95 (.312–2.893)	0.928	0.559 (.141–2.214)	0.408
49–58 years old	0.893 (.3–2.656)	0.839	0.529 (.138–2.031)	0.354
59–68 years old	0.785 (.258–2.388)	0.67	0.468 (.112–1.948)	0.296
69–78 years old	0.34 (.089–1.297)	0.114	0.172 (.03 – .995)	0.049
79–88 years old	0.292 (.056–1.525)	0.144	0.171 (.02–1.445)	0.105
89–98 years old	1.75 (.129–23.703)	0.674	3.763 (.123–115.402)	0.448
Division				
Chattogram	4.585 (1.708–12.313)	0.003	3.995 (1.266–12.606)	0.018
Dhaka	5.217 (1.832–14.859)	0.002	3.875 (1.209–12.422)	0.023
Khulna	1 (.094–10.664)	1	0.32 (.019–5.377)	0.429
Mymensingh	2.154 (.713–6.507)	0.174	2.17 (.635–7.423)	0.217

Variable	Univariate		Multivariate	
	OR (95% CI)	P-value	OR (95% CI)	P-value
Rajshahi	35 (8.915–137.412)	< 0.001	24.507 (5.338–112.515)	< 0.001
Rangpur	1.6 (.475–5.384)	0.448	0.868 (.211–3.573)	0.844
Sylhet	2.857 (.987 – 8.27)	0.053	3.392 (1.018–11.298)	0.047
Barishal	0.25 (.102 – .612)	0.002	Ref.	
Duration of Diabetes Mellitus				
0–5 years	0.147 (.088 – .244)	< 0.001	Ref.	
6–10 years	1.891 (.951 – 3.76)	0.069	1.363 (.722–2.571)	0.339
11–15 years	2.824 (1.215–6.564)	0.016	1.337 (.54–3.314)	0.53
16–20 years	1.264 (.428–3.727)	0.672	3.01 (1.02–8.883)	0.046
21–25 years	NE	-	2.018 (.366–11.137)	0.421
26–30 years	6.824 (1.559–29.868)	0.011	3.14 (.435–22.666)	0.257
31–35 years	NE	-	NE	-

Barishal division and diabetes duration of 0–5 years were the reference categories in both univariate and multivariate logistic-regression analyses. NE indicates that an odds ratio could not be estimated reliably because of sparse data or inadequate outcome variation within the category. AOR: adjusted odds ratio; CI: confidence interval; Ref.: reference category.

Dhaka division was the only division to remain significant in both models, with a consistent effect size (UOR = 3.89, $p = 0.045 \rightarrow$ AOR = 4.67, $p = 0.047$) mentioned in Table 14. Barishal was protective only

before adjustment (UOR = 0.11, $p < 0.001$). The 26–30-year duration band showed the clearest reinforcing pattern in the entire analysis, more than doubling in strength after adjustment (UOR = 5.65, $p = 0.021 \rightarrow$ AOR = 14.38, $p = 0.014$).

Table 14
Univariate and Multivariate Analysis of Good Practices with Significant Socio-demographic Factors

Variable	Univariate		Multivariate	
	OR (95% CI)	P-value	OR (95% CI)	P-value
Division				
Chattogram	0.542 (.121 – 2.42)	0.422	0.496 (.09–2.745)	0.422
Dhaka	3.892 (1.03–14.703)	0.045	4.668 (1.018–21.409)	0.047
Khulna	2.25 (.186–27.272)	0.524	2.33 (.12–45.056)	0.576
Mymensingh	NE	-	NE	-
Rajshahi	2.323 (.559–9.644)	0.246	2.115 (.367–12.203)	0.402
Rangpur	3 (.691–13.019)	0.142	2.292 (.399–13.183)	0.353
Sylhet	1.286 (.296 – 5.58)	0.737	1.175 (.227–6.086)	0.847
Barishal	0.111 (.034 – .366)	< 0.001	Ref.	
Duration of Diabetes Mellitus				
0–5 years	0.177 (.11 – .285)	< 0.001	Ref.	
6–10 years	0.654 (.298–1.434)	0.289	0.672 (.269–1.676)	0.394
11–15 years	0.611 (.196–1.902)	0.395	0.759 (.198 – 2.91)	0.688
16–20 years	1.304 (.476–3.569)	0.606	3.085 (.803–11.852)	0.101

Variable	Univariate		Multivariate	
	OR (95% CI)	P-value	OR (95% CI)	P-value
21–25 years	0.628 (.075–5.23)	0.667	1.139 (.096–13.492)	0.918
26–30 years	5.65 (1.305–24.455)	0.021	14.381 (1.732–119.434)	0.014
31–35 years	NE	-	NE	-

Barishal division and diabetes duration of 0–5 years were the reference categories in both univariate and multivariate logistic-regression analyses. NE indicates that an odds ratio could not be estimated reliably because of sparse data or inadequate outcome variation within the category. AOR: adjusted odds ratio; CI: confidence interval; Ref.: reference category.

In Fig. 2, the distribution of standardized KAP scores among 331 participants. The median score was highest for attitude (75.0%; IQR: 58.3–91.7%), followed by practice (55.6%; IQR: 40.7–66.7%) and knowledge (33.3%; IQR: 16.7–66.7%). Knowledge scores showed the most variation while attitude scores were mostly clustered toward the top of the scale.

Discussion

The knowledge, attitudes, and practices of Bangladeshi adults regarding the associations between diabetes mellitus and periodontal health were assessed in this study. The findings provide important information about the current state of knowledge and health-related behaviors among adults with diabetes. The findings of this study indicate that, although participants showed comparatively better attitudes, important gaps remained in knowledge and practice related to periodontal health. This observed pattern suggests that a positive perception alone may not always result in appropriate health-related practices.

The knowledge assessment showed that participants had a low level of knowledge regarding the relationship between periodontal health and diabetes mellitus. The mean knowledge score was 2.46 ± 1.88 out of 6, and only 18.4% of participants were classified as having good knowledge, whereas 71.6% were classified as having poor knowledge. This indicates inadequate understanding of the association between diabetes and periodontal health among a large proportion of participants. Similar knowledge gaps have been reported among diabetic populations. Fatema et al. reported that among Bangladeshi participants with type 2 diabetes, only 15% demonstrated good diabetes-related knowledge, while most participants had average knowledge levels (13). Although the proportion of good knowledge in the current study was slightly higher, direct comparison should be interpreted cautiously because Fatema et al. assessed general diabetes knowledge, whereas the present study focused specifically on the relationship between periodontal health and diabetes mellitus.

The limited periodontal health-related knowledge observed in this study is consistent with previous international findings. Allen et al. reported that only 33% of diabetic patients were aware of their increased risk of periodontal disease despite higher awareness regarding other diabetes complications (14). This indicates that periodontal health may receive less attention compared with other diabetes-related complications. The importance of improving awareness is supported by evidence describing diabetes and periodontal disease as a bidirectional relationship, where diabetes increases susceptibility to periodontal disease and periodontal inflammation may influence diabetes outcomes (15).

The analysis of factors associated with knowledge showed that geographical division was significantly related to knowledge score. Compared with Barishal, participants from Dhaka, Mymensingh, Rajshahi, and Rangpur had significantly higher knowledge scores, with the strongest association observed among participants from Mymensingh. In comparison, sex and age category were not significantly associated with knowledge level. Similar regional variation has been reported in Bangladesh, where Fatema et al. found that residence and socioeconomic characteristics were associated with diabetes-related knowledge and practice outcomes (13). However, the current analysis did not evaluate education or socioeconomic status; therefore, the reasons behind these geographical differences cannot be confirmed.

In terms of practice, the findings showed that appropriate oral health practices were less common compared with positive attitudes. The mean practice score was 14.41 ± 4.84 , with only 13.9% of participants categorized as having good practice and 48.6% categorized as having poor practice. This difference between attitude and practice suggests that positive attitudes may not automatically lead to the adoption of recommended oral health behaviors. Poudel et al. similarly reported that people living with diabetes in South Asia had some awareness regarding oral health but continued to demonstrate gaps in oral health practices (16).

The regression analysis identified several factors associated with practice scores. Practice scores differed significantly across divisions, with participants from Chattogram showing significantly lower practice scores compared with Barishal. Age was also significantly associated with practice, where participants aged 59–68 years and 69–78 years had lower practice scores compared with participants aged 18–28 years. These findings suggest that geographical and age-related factors may influence oral health practices within the study population. Similar variations in health-related practices according to residence and age have been reported in previous studies. Fatema et al. found that residence was significantly associated with diabetes-related knowledge, attitude, and practice among Bangladeshi participants, with urban residents demonstrating better KAP scores compared with other groups (13). Similarly, Islam et al. reported that age and sociodemographic factors were significantly associated with diabetes-related KAP in rural Bangladesh, where older participants showed poorer knowledge and attitudes toward diabetes management compared with younger groups (17).

Self-reported health status showed a significant positive association with practice scores. Participants reporting fair, good, very good, or excellent health status had higher practice scores compared with

those reporting poor health status. Remaining natural teeth were also significantly associated with practice scores, indicating a relationship between oral health condition and reported practices. Although previous studies have not directly assessed self-reported health status as a predictor of periodontal health practice scores, evidence suggests an association between overall health conditions and oral health-related outcomes. Allen et al. reported a significant association between metabolic control and dentate status among diabetic patients, highlighting the relationship between diabetes-related health conditions and oral health status (14). Furthermore, Hasan et al. demonstrated that oral hygiene practices were associated with periodontal disease outcomes among Bangladeshi patients with type 2 diabetes, where adherence to appropriate oral hygiene practices reduced the likelihood of periodontal disease (12). These findings support the importance of maintaining appropriate oral health behaviors among individuals with diabetes, although further studies are needed to clarify the relationship between perceived health status, remaining teeth, and oral health practices.

Therefore, the findings of the study highlight that knowledge, attitude, and practice are not always progressing together. Attitudes appeared to be relatively favorable, but limitations in knowledge and practice remained evident. The significant associations identified with geographical division, age, health status, and remaining natural teeth provided important areas for further investigation.

In the adjusted logistic-regression analysis, division of residence and duration of diabetes mellitus were associated with good practices. Barishal division and diabetes duration of 0–5 years were used as the reference categories in both univariate and multivariate analyses. Compared with respondents from Barishal, those residing in Dhaka had significantly higher odds of reporting good practices after adjustment for potential confounders (AOR 4.67, 95% CI 1.02–21.41; $p = 0.047$). However, this finding should be interpreted cautiously because the confidence interval was wide and its lower limit was close to 1.00. In addition, no statistically significant adjusted associations were found for Chattogram, Khulna, Rajshahi, Rangpur, or Sylhet. Therefore, the findings do not demonstrate a uniform geographical gradient in good practices across Bangladesh; rather, they suggest a possible disparity between Dhaka and Barishal.

The higher odds of good practices among participants from Dhaka may reflect greater access to diabetes education, specialized facilities, oral health services, health information, and other urban healthcare resources. Nevertheless, residential division should not be interpreted as a causal determinant of good practices because unmeasured contextual factors, including income, education, healthcare utilization, disease severity, and availability of dental services, may partly explain the observed association. A Bangladeshi multicenter study of 379 adults with type 2 diabetes similarly showed that diabetes self-care and oral-hygiene practices were important modifiable factors associated with periodontal health. In that study, adherence to recommended diet, physical activity, and oral-hygiene practices was associated with lower odds of periodontal disease (12). Thus, differences in the availability and uptake of self-care and oral-health information may contribute to geographical variation in good practices among people living with diabetes.

The Mymensingh category contained very few observations, resulting in an unstable or non-interpretable model estimate. Therefore, the value of 1.00 shown in the Stata output should not be interpreted as indicating that Mymensingh was a reference category or that its odds of good practices were equal to those of Barishal. Similarly, the 31–35-year diabetes-duration category had sparse data and should not be interpreted as a reference group. In the final table, these categories should preferably be labeled as “NE” or “not estimable due to sparse data,” rather than being reported as OR = 1.00. This clarification is important because Barishal and 0–5 years were the actual reference categories used in the regression models.

Previous evidence from Bangladesh suggests that longer duration of diabetes does not uniformly translate into better self-care. In a 2024 community-based study, people with diabetes for more than six years reported more frequent missed medication and substantially lower uptake of diabetic retinal examinations than those with a shorter duration of disease. Likewise, Hasan et al. found that a diabetes duration of at least five years was associated with greater severity of periodontal disease among Bangladeshi adults with type 2 diabetes, whereas good oral-hygiene behaviors were independently associated with lower odds of periodontal disease (18). These findings indicate that longer exposure to diabetes may increase cumulative complication risk even when individuals have had greater opportunities for health education. The apparently favorable association for the 26–30-year group in the present study may therefore represent accumulated experience among a small group of long-term survivors, selective retention in care, or residual confounding by age, education, income, disease severity, treatment modality, or frequency of healthcare contact.

The present findings are consistent with wider South Asian evidence showing important gaps in oral-health knowledge, attitudes, preventive behaviors, and dental-care utilization among people living with diabetes (16). In Bangladesh, diabetes-related knowledge and practice are also influenced by education, socioeconomic circumstances, age, and access to health services (17). A rural Bangladeshi population-based study found that more than half of participants with known diabetes had never checked their blood glucose level after diagnosis, highlighting substantial deficiencies in diabetes self-management (17). Therefore, interventions should integrate diabetes education with oral health promotion, including counseling on periodontal risks, twice-daily toothbrushing with fluoride toothpaste, interdental cleaning, tobacco cessation, glycemic control, and regular dental attendance. Such programs should be tailored to divisions and patient groups with potentially restricted access to diabetes and oral health services.

Future studies should further explore the reasons behind regional differences in knowledge and practice and examine additional factors that may influence oral health-related behaviors. Longitudinal studies may help determine whether improvements in knowledge and awareness result in improvements in practice over time. Further research may also evaluate interventions that can help translate positive attitudes into effective oral health behaviors among individuals with diabetes.

Conclusion

In this research, the knowledge gaps and practices concerning the association between periodontal health and diabetes mellitus in the Bangladeshi population were discovered despite the generally positive attitude toward the relation between oral health. Thus, it can be seen that even though people have positive perceptions, it does not always mean that they have enough knowledge regarding proper oral health behavior. It indicates the need for oral health education, greater knowledge of the associations between oral and systemic health, and more integrated management of periodontal disease. The collaborative efforts between the dental and medical healthcare professionals may aid in the comprehensive management of diabetes and periodontal disease. Ultimately, enhanced knowledge and positive attitudes can lead to effective practices that promote both oral and systemic health among the Bangladeshi population.

Declarations

Ethics approval and consent to participate

The study was approved by the Ethical Review Committee of North South University before initiation. The study objectives and procedures were explained to the eligible participants and informed consent was obtained before data collection. Participation was voluntary and participants were free to refuse to answer or to withdraw at any time. Data collection, management and analysis were undertaken in a manner that protected participant privacy and confidentiality. The ethical guidelines established in the 1964 Declaration of Helsinki and its subsequent amendments were followed.

Consent for publication

Informed written consents were taken.

Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

All authors meet the four ICMJE criteria for authorship: (1) substantial contributions to the conception or design of the work, or the acquisition, analysis, or interpretation of data; (2) drafting the work or revising

it critically for important intellectual content; (3) final approval of the version to be published; and (4) agreement to be accountable for all aspects of the work.

Mustari Nailah Tabassum: Conceptualization, methodology, and design of the cross-sectional KAP survey on periodontal health and diabetes; development and validation of the questionnaire; coordination of data collection; data cleaning, formal analysis, and interpretation of findings; writing – original draft of the manuscript; and final approval of the version to be published.

Tarannum Mahmood: Conceptualization, Participant recruitment, data entry and curation, interpretation of results related to knowledge, attitude, and practice domains, critical revision of the manuscript for important intellectual content, and final approval.

Sadia Sultana Imla: Participant recruitment, data curation, interpretation of KAP findings, critical revision of the manuscript, and final approval.

Bivasa Chakraborty: Participant recruitment, data curation, interpretation of results, critical revision of the manuscript, and final approval.

Tanvir Hossain: Participant recruitment and data collection, interpretation of associations between periodontal health and diabetes mellitus, critical revision of the manuscript, and final approval.

Aishee Saha: Participant recruitment and data collection, data curation, interpretation of findings, critical revision of the manuscript, and final approval.

Md. Majedur Rahman Maruf: Participant recruitment and data collection, data curation, interpretation of results, critical revision of the manuscript, and final approval.

Arnob Biswas: Participant recruitment and data collection, data curation, interpretation of findings, critical revision of the manuscript, and final approval.

Mohammad Delwer Hossain Hawlader: Overall supervision of the study; conceptualization and design of the KAP survey on periodontal health–diabetes relationship; oversight of methodology, ethical approval, and data collection; interpretation of key findings; critical revision of the manuscript for important intellectual content; and final approval of the version to be published.

All authors have read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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Figures

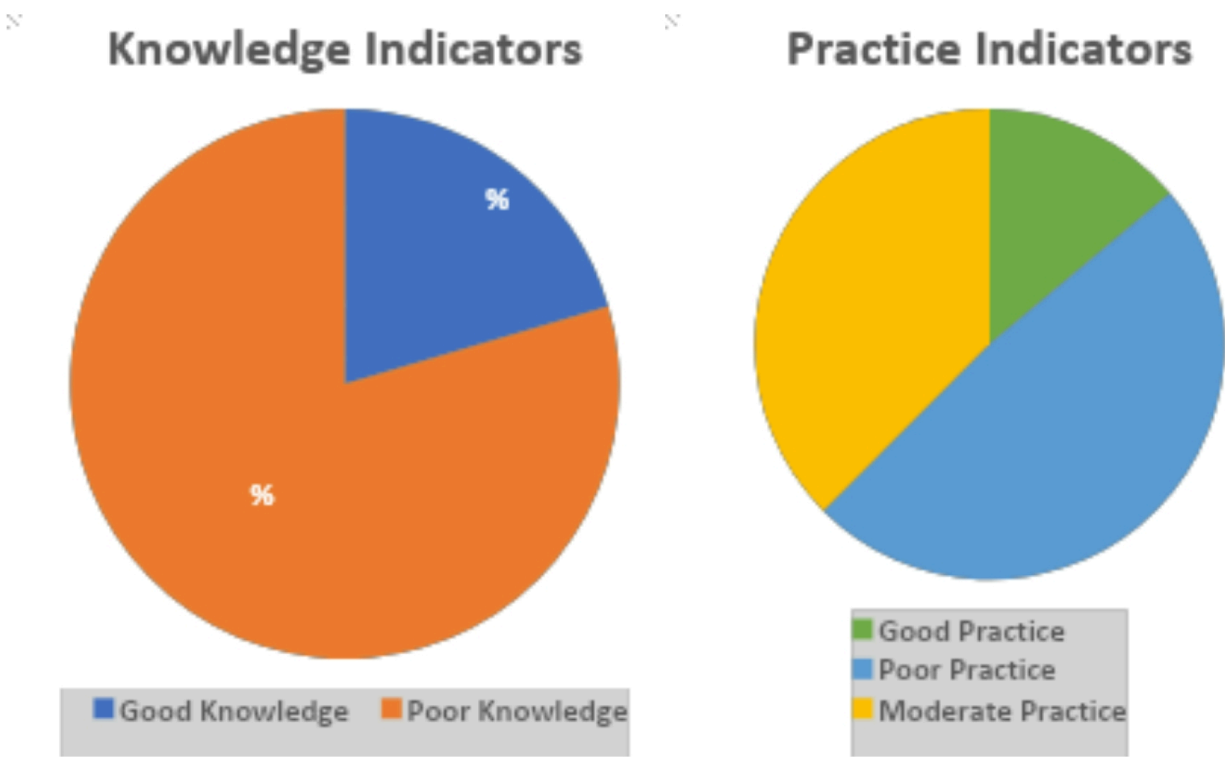


Figure 1

Selected knowledge and practice indicators.

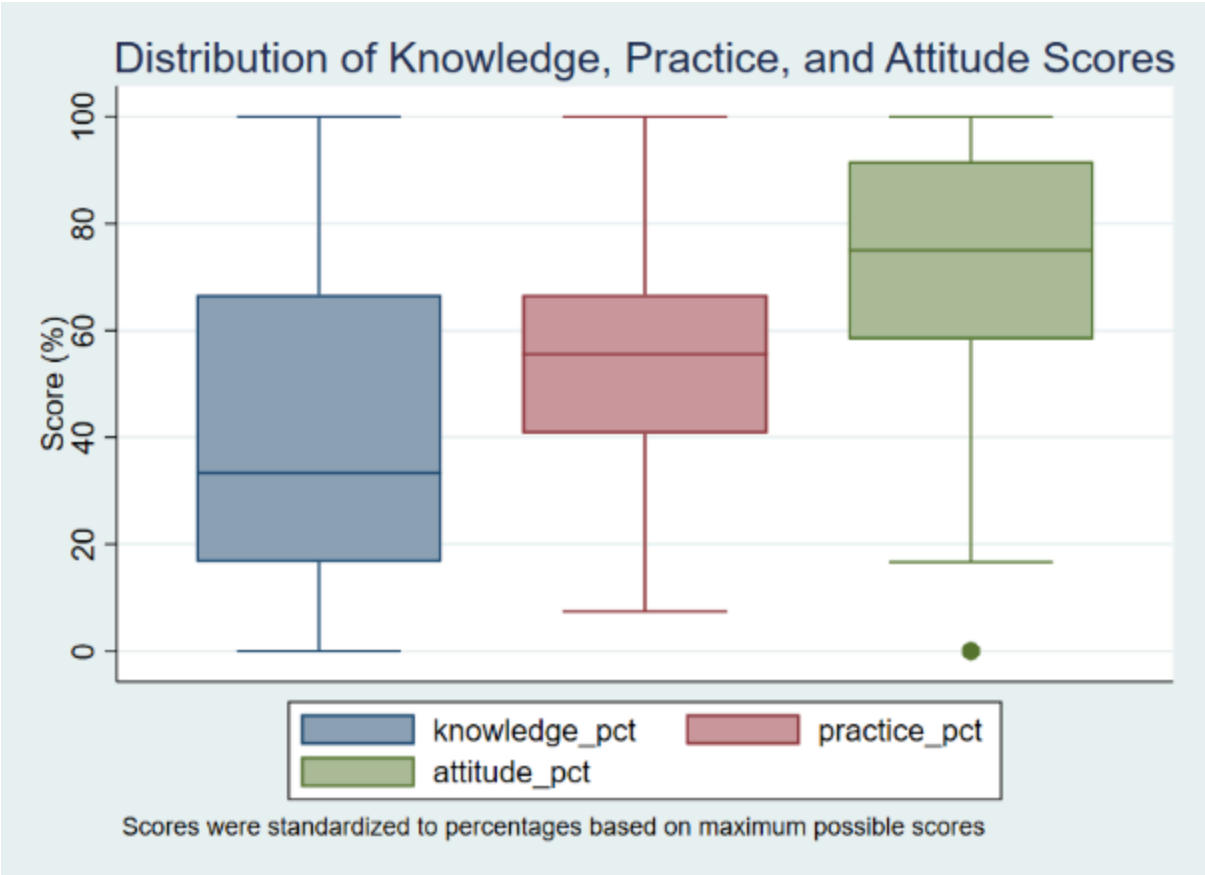


Figure 2

Distribution of standardized Knowledge, Practice, and Attitude (KAP) scores among participants (n = 331). [Boxes represent the interquartile range (IQR), horizontal lines within the boxes represent median values, whiskers indicate the range of non-outlying observations, and dots indicate outliers. Scores were standardized to a 0–100% scale, with higher percentages indicating higher Knowledge, Practice, and Attitude scores]