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ORIGINAL RESEARCH

EXPLORING THE KNOWLEDGE AND ATTITUDES OF DENTAL STUDENTS AND PROFESSIONALS TOWARDS SALIVA AS A DIAGNOSTIC TOOL – A QUESTIONNAIRE STUDY.

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ABSTRACT

Aim: To assess the knowledge and attitudes of Dental Students and Professionals towards Saliva as a Diagnostic Tool – A questionnaire study.

Background: Early disease detection is essential for preventing complications that could adversely affect a patient's quality of life. Over the years, molecular diagnostics have used biofluids like blood, cerebrospinal fluid and urine to detect the biomarkers for disease diagnosis. Saliva provides many advantages like non-invasive and easy collection, untrained medical staff, multiple sample collection, minimal cross contamination, commercially available screening assays etc.

Settings and Design: A cross-sectional questionnaire study was conducted among dental students and professionals.

Materials And Methods: 21 multiple choice questionnaire was prepared and circulated among peers for validation. An online survey was created using google forms and distributed among dental students and professionals. Data was tabulated in Excel spreadsheets. Imported to SPSS software version 2.0 and statistical analysis were performed. Frequency, percentage, chi square test and Karl Pearson's correlation coefficient was performed.

Conclusion: While many people are aware of saliva-based diagnostics, their views on how effective, accurate, and reliable they are vary widely.

Keywords: Saliva, diagnosis, Dental students, Dental Professionals.

INTRODUCTION

Early disease detection is essential for preventing complications that could adversely affect a patient's quality of life.¹ For ex, oral cancer is the sixth most common cancer worldwide, with approximately 90% of cases diagnosed as oral squamous cell carcinoma.² Likewise, type 2 diabetes affects about 7% of the adult population and can often be managed through diet and lifestyle changes if diagnosed early. Additionally, despite regular screenings and check-ups, many diseases remain undetected until they reach an advanced stage, at which point severe

symptoms may emerge.² To address these challenges, researchers are exploring biomarkers.³ A biomarker is defined as “an objectively measured and evaluated as an indicator of normal biological processes, pathogenic processes, or pharmacologic responses to a therapeutic intervention.”⁴ These biomarkers encompass genetic materials (such as DNA and RNA) and protein molecules that indicate an individual's current physiological state, aiding scientists in gaining a deeper understanding of the underlying causes of diseases. Over the years, molecular diagnostics have used biofluids like blood, cerebrospinal fluid and urine

to detect the biomarkers for disease diagnosis. However, several challenges persist, including the lack of definitive biomarkers for specific diseases, the absence of affordable and minimally invasive sample collection methods, and the scarcity of accurate, portable detection systems. Fortunately, many of these limitations can be addressed through the analysis of saliva.¹ Saliva provides many advantages like non-invasive and easy collection, untrained medical staff, multiple sample collection, minimal cross-contamination, commercially available screening assays etc. But the current knowledge about the use of saliva as a diagnostic tool appears to be limited to researchers. Working closely with saliva, dentists especially can identify early indicators of gum disease, tooth decay, and oral cancer; track patient responses to treatment; assess the influence of lifestyle factors on oral health; and customize treatment regimens to meet the needs of each patient. Hence the current study aims to explore the knowledge and attitudes of dental students and professionals towards use of saliva as a diagnostic tool.

MATERIALS AND METHODS

After obtaining the institutional ethical clearance, the questionnaire, comprised of 21 meticulously validated inquiries categorized into sections including demographic details, knowledge and attitude regarding saliva, and aspects related to the use of saliva as a diagnostic tool, was administered via Google Forms through WhatsApp links to both undergraduate, postgraduate dental students, as well as dental professionals. A total of 157 respondents actively participated in the study, which commenced on 2nd December 2024 and concluded on 31 December 2024. The survey was developed based on a literature review, along with drafting and validating the questionnaire and conducting pilot

testing for clarity. Participants were duly briefed on questionnaire completion protocols, and consent was obtained before their involvement, ensuring adherence to ethical standards. Stringent measures were enforced to safeguard the confidentiality of participants' demographic information. Frequency distributions and percentages were meticulously scrutinized to discern patterns and trends within the dataset, facilitating a nuanced understanding of participants' perspectives, knowledge, and attitude domains. The collected data underwent statistical analysis by using different methods such as frequency percentage, mean standard deviation (SD), chi-square analysis, and correlation between knowledge and attitude scores by Karl Pearson's correlation coefficient.

RESULTS

Demographic Profile of Participants:

- **Age Group:** The majority (90.45%) of participants were between 18-35 years old, with smaller percentages in the 36-50 (4.46%) and >50 (5.10%) age groups.
- **Gender:** More females (71.34%) participated in the study than males (28.66%).
- **Educational Qualification:** Most participants were undergraduates (86.62%) followed by postgraduates (5.10%), faculty members (7.01%), and practitioners (1.27%).

Awareness and Perception of Saliva-Based Diagnostics: (Table 1)

Table 1. Demographic profile of participants

Profile of participants	No of participants	% of participants
Age groups		
18-35yrs	142	90.45
36-50yrs	7	4.46
>50yrs	8	5.10
Gender		
Male	45	28.66
Female	112	71.34
Educational Qualification		
Undergraduates (including interns)	136	86.62
Postgraduates	8	5.10
Faculty members	11	7.01
Practitioner	2	1.27
Total	157	100.00

- **Awareness of Saliva as a Diagnostic Tool:** A high percentage (93.63%) of participants were aware that saliva can be used as a diagnostic tool.
- **Source of Information:** The primary source of information was healthcare professionals (44.59%), followed by scientific journals/articles (22.29%). Other sources included social media (19.75%) and others (11.46%).
- **Invasiveness:** 96 participants (61.15%), were aware that saliva-based tests are non-invasive. While a small percentage (8.92%) did not feel so and around 47 participants (29.94%), were unsure about the invasiveness of saliva-based tests.
- **Effectiveness and Accuracy:** Participants had mixed views on the effectiveness of saliva compared to traditional methods, with 34.39% finding it more effective and 38.85% being unsure. Similarly, the study showed divided views on whether saliva-based diagnostics are as accurate as blood tests (40.13% yes, 41.40% unsure).
- **Speed and Cost:** Participants were somewhat divided on the speed of providing results of saliva-based tests compared to blood tests (41.40% gave 'yes' as an answer, while, 50.32% were unsure). Most (70.06% yes) believed saliva-based diagnostics could help reduce the cost of medical testing.
- **Biomarkers detection:** The majority of the participants (57.32%) believed in the potential of saliva-based tests for early diagnosis, while a significant portion (38.22%) remained uncertain. A smaller percentage (4.46%) said that saliva-based tests are effective in this regard.
- **Uses of saliva in various diseases:** More than 50% of the respondents were aware that saliva could be used in various diseases like oral cancer, periodontal disease, viral infection, etc.
- **Replacement to tissue and serum:** The opinions were fairly divided, with a significant portion (45.22%) unsure about the effectiveness of saliva in the detection of OPMD's. Meanwhile, 42.04% believe in its potential as a replacement, while a smaller group (12.74%) do not think saliva can be used for this purpose.
- **Advantages of using saliva as a diagnostic tool:** Majority (64.9%) said that it is noninvasive, 55.4% felt it is cost effective and 40% believed that is easily accessible. (**Figure 1**)

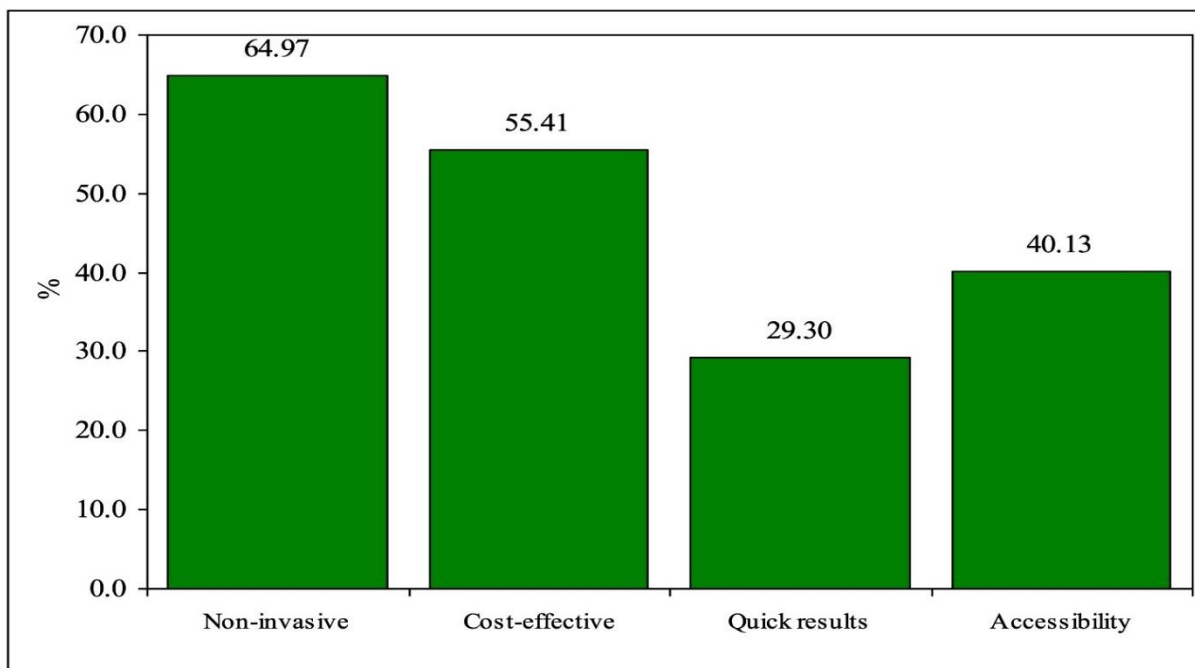


Figure 1 Depicting the responses for the question related to knowledge regarding applications of saliva as a diagnostic tool

Preferences and Usage

- **Alternative to blood test for diagnosis of Oral diseases:** Majority of participants (71.34%) do not find saliva-based diagnostics to be as reliable as blood tests for the diagnosis of oral diseases, while a smaller portion (28.66%) believe they are a reliable alternative.
- **Preference for Saliva Tests:** Despite acknowledging the benefits, a majority (72.61%) still prefer blood tests over saliva tests if both offered similar accuracy.
- **Willingness to Use Saliva Tests:** A significant portion of participants (89.81%) would not consider using saliva-based tests in the future.

- **Past Usage:** Most participants (69.43%) had not used saliva-based tests, though a considerable number (30.57%) mentioned that they have used saliva-based tests.
- **Recommendations:** A high percentage (89.17%) would not recommend saliva-based diagnostics to friends or family.

Training and Education

- **Training Received:** A significant number of participants (68.79%) had received training related to the use of saliva in diagnostics.
- **Inclusion in Education:** A majority (47.77% agree, 36.94% strongly agree) believe saliva diagnostics should be included in healthcare professional education.

On comparison of the responses with the qualifications, there was similarity among the groups except for the source of information and inclusion of saliva diagnostics in healthcare profession education. Undergraduate students, the majority heard regarding saliva from healthcare professionals (47.79%) and social media (22.79%). While postgraduate students (87.50%), faculty (72.73%) and professionals (50.00%). read from scientific journals/articles. The chi-square value of 43.667 with a p-value of (0.0001*) indicates a statistically significant difference in the sources of information across these groups. The faculty and practitioners were more perceptive to undergo salivary diagnostic training as compared to undergraduates (p<0.05).

Comparison of Knowledge and attitude Scores by Demographic Profile (Table 2)

Table 2. Question wise responses of participants

Questions	No of participants	% of participants
Are you aware of whether saliva can be used as a diagnostic tool?		
No	10	6.37
Yes	147	93.63
Are saliva-based tests non-invasive?		
Other	18	11.46
Social Media	31	19.75
Television/Radio	3	1.91
Healthcare Professional	70	44.59
Scientific Journals/Articles	35	22.29
Where did you first hear about saliva-based diagnostics?		
Not sure	47	29.94
No	14	8.92
Yes	96	61.15
How effective is saliva compared to traditional methods (e.g., blood tests, invasive biopsy) in diagnosing oral diseases?		
Not sure	61	38.85
Less effective	42	26.75
More effective	54	34.39
Are saliva-based diagnostics, as accurate as blood tests for some conditions?		
Not sure	65	41.40
No	29	18.47
Yes	63	40.13
Are Saliva-based tests, faster in providing results compared to blood tests?		
Not sure	79	50.32
No	13	8.28
Yes	65	41.40

Can saliva-based tests help detect biomarkers for early diagnosis of oral precancer/cancer?		
Not sure	60	38.22
No	7	4.46
Yes	90	57.32
Can saliva be used as a replacement to tissue and serum for detection of oral potentially malignant disorders (OPMD's)?		
Not sure	71	45.22
No	20	12.74
Yes	66	42.04
Do you think saliva-based diagnostics could help reduce the cost of medical testing?		
Not sure	39	24.84
No	8	5.10
Yes	110	70.06
Do you consider saliva-based diagnostics to be a reliable alternative to blood tests for diagnosis of oral diseases?		
No	112	71.34
Yes	45	28.66
Would you prefer a saliva test over a blood test if both offered similar accuracy?		
No	114	72.61
Yes	43	27.39
If you are advised a medical test in the future, would you consider using a saliva-based test?		
No	141	89.81
Yes	16	10.19
Have you ever used a saliva-based test (e.g., genetic testing, COVID-19 test)?		
No	109	69.43
Yes	48	30.57
Would you recommend saliva-based diagnostics to friends or family?		
No	140	89.17
Yes	17	10.83
Have you received any training related to the use of saliva in diagnostics?		
No	49	31.21
Yes	108	68.79
Do you think saliva diagnostics should be included in healthcare professional education?		
Disagree	1	0.64
Neutral	23	14.65
Agree	75	47.77
Strongly Agree	58	36.94
Total	157	100.0

Levels of Knowledge and Attitude among the Participants

When the level of knowledge and attitude was assessed almost half of participants (47.13%) showed a proper understanding of the subjects, indicating a strong understanding of the relevant concepts. However, there was still no sufficient knowledge about the full knowledge. 22.93% have inadequate knowledge, and 29.94% are classified into medium knowledge categories, providing a place for improvement in the training or training field. When studying relational levels, the results were more conclusive. The majority of participants, 41.40%, showed a bad relationship, and 56.69% only showed average attitudes towards this subject. Only 1.91% of active people showed positive or good attitudes. This indicates that while many participants can have a reasonable level of knowledge, this does not necessarily translate into a proper positive attitude. These results illustrate the need for targeted interventions that not only improve knowledge but also positively contribute to more favourable opinions among participants. This suggests a considerable portion of participants had a reasonable but not comprehensive understanding. When this was associated with demographic profile, it was found that majority of the participants with inadequate knowledge were in the age group of 18-35years and belonged to the undergraduate category (**Table 1**).

The level of attitude was poor in 65(41.4%), average (56.7%) and good in only 3(1.9%). When this was associated with the demographic profile, it was seen that majority with poor attitude belonged to the age group of 18-35 years and were in the undergraduate category. Most of the faculty had average levels of attitude followed by the postgraduates. Undergraduates (including interns) had a mean attitude score of 8.35, with a statistically significant difference (p-value = 0.0120), indicating their attitudes differed reliably. The postgraduates had a mean attitude score of 9.88, reflecting positive attitudes slightly lower than faculty members who had a highest mean attitude score of 10.36, indicating the most positive attitudes among all groups. While the practitioners had a mean attitude score of 10.00, demonstrating favorable attitudes but with greater variability (standard deviation of 4.24). It appears that faculty members have the most positive attitudes, followed by practitioners and postgraduates. Undergraduates have lower attitude scores but show statistically significant differences (**Table 3**).

Table 3. Comparison of demographic profile with mean knowledge and attitude scores

Demographic profile	Knowledge Score Mean ±SD	p-value	Attitude score Mean ±SD	p-value
Age groups				
18-35yrs	9.32± 3.33	0.0148*	8.47±2.41	0.1762
36-50yrs	11.86±3.08		9.71±1.25	
>50yrs	12.00±2.27		9.63±1.69	
Gender				
Male	9.51±3.38	0.8952	8.98±2.05	0.1885
Female	9.59±3.35		8.43±2.47	
Educational Qualification				
Undergraduates (including interns)	9.16±3.31	0.0007*	8.35±2.38	0.0120*
Postgraduates	12.63±2.13		9.88±1.73	
Faculty members	12.36±2.20		10.36±0.81	
Practitioner	9.50±2.12		10.00±4.24	
Total	9.57±3.35		8.59±2.36	

*p<0.05

Correlation between Knowledge and Attitude of the Participants

There was a significant positive correlation between knowledge and attitude (r=0.4866, p<0.001) This means that enhancing the knowledge can have a significant impact on the attitude towards saliva as a diagnostic tool.(**Table 4**)

Table 4. Levels of knowledge and attitude among the participants

Levels of knowledge	No of participants	% of participants
Inadequate (<=50%)	36	22.93
Moderate (51-75%)	47	29.94
Adequate (>=76%)	74	47.13
Levels of attitude	No of participants	% of participants
Poor (<=50%)	65	41.40
Average (51-75%)	89	56.69
Good (>=76%)	3	1.91

DISCUSSION

Saliva is considered a valuable diagnostic tool for several reasons:

- **Non-invasive Collection:** Unlike blood tests, saliva can be collected non-invasively, which reduces discomfort and the risk of infection.
- **Ease of Collection:** It can be collected by individuals with minimal training, making it accessible for large-scale screenings.
- **Cost-effective:** Saliva collection and analysis are generally more cost-effective compared to blood tests.¹
- **Reflects Systemic Health:** Saliva contains many of the same biomarkers found in blood, such as hormones, antibodies, and enzymes, making it a good indicator of systemic health.²
- **Use in Various Diagnoses:** It can be used to diagnose hereditary disorders, autoimmune diseases, infectious diseases, endocrine disorders, and even for monitoring therapeutic drug levels.²

Significant efforts have been devoted for development of non-invasive tools using saliva for diagnosis of oral potentially malignant lesions and identifying malignant transformation risk but no candidate marker has yet been approved for clinical use.^{3,4} Despite its immense potential as a non-invasive and cost-effective diagnostic tool, the utility of saliva in clinical diagnostics remains largely underappreciated and underutilized, with many healthcare professionals and the public still unaware of its ability to diagnose systemic health and disease.⁵ Its use is largely limited to researchers as the knowledge regarding its use is not available on social media platforms and the information is largely restricted to scientific journals and selected healthcare professionals. Hence the need to test the knowledge of undergraduate and post graduate students and faculty, regarding the utility of saliva as a diagnostic tool in the form of a questionnaire study. The study's demographic profile predominantly consists of younger adults, with 90.45% of participants aged between 18-35 years. This demographic is likely to be more open to new diagnostic methods and participating in medical studies (**Table 5**).

Table 5. Association between Levels of knowledge with demographic profile

Demographic profile	Levels of knowledge						Total	Chi-square	p-value
	Inadequate	%	Moderate	%	Adequate	%			
Age groups									
18-35yrs	35	24.65	44	30.99	63	44.37	142	5.3610	0.2520
36-50yrs	1	14.29	1	14.29	5	71.43	7		
>50yrs	0	0.00	2	25.00	6	75.00	8		
Gender									
Male	12	26.67	12	26.67	21	46.67	45	0.6120	0.7360
Female	24	21.43	35	31.25	53	47.32	112		
Qualification									
Undergraduates	35	25.74	43	31.62	58	42.65	136	10.4480	0.1070
Postgraduates	0	0.00	2	25.00	6	75.00	8		
Faculty members	1	9.09	1	9.09	9	81.82	11		
Practitioner	0	0.00	1	50.00	1	50.00	2		
Total	36	22.93	47	29.94	74	47.13	157		

Females made up 71.34% of the participants, which suggests a higher engagement or willingness among women to partake in health-related research. Educational qualifications show a significant number of undergraduates (86.62%), indicating that a large portion of the participants are still in the formative stages of their medical careers.

here is a high level of awareness about saliva as a diagnostic tool among participants (93.63%), with healthcare professionals being the primary source of information (44.59%). Significant differences in sources of information were observed based on educational qualifications, with undergraduates mostly learning from healthcare professionals and social media, while postgraduates, faculty, and professionals relied more on scientific journals.

Participants identified several conditions that could be diagnosed using saliva-based tests, including oral cancer (22.93%), periodontal (gum) disease (28.66%), dental caries (tooth decay) (31.85%), viral infections such as Herpes simplex virus (30.57%), systemic diseases like diabetes mellitus, cardiovascular disease, and gastric issues (21.02%), systemic cancers like pancreatic cancer and glioblastoma (9.55%), drug monitoring and abuse (14.65%), and a majority (55.41%) mentioned all of the above.

A majority of participants (61.15%) perceive saliva-based tests as non-invasive. However, opinions on the effectiveness and accuracy of saliva-based diagnostics⁶ are mixed. Only 34.39% found saliva more effective than traditional methods, and 38.85% were unsure. Similarly, the accuracy of saliva-based diagnostics compared to blood tests showed divided views, with 40.13% affirming their accuracy and 41.40% unsure. (Table 6)

Table 6. Association between Levels of attitude with demographic profile.

Demographic profile	Levels of attitude						Total	Chi-square	p-value
	Poor	%	Average	%	Good	%			
Age groups									
18-35yrs	62	43.66	78	54.93	2	1.41	142	8.1200	0.0870
36-50yrs	1	14.29	6	85.71	0	0.00	7		
>50yrs	2	25.00	5	62.50	1	12.50	8		
Gender	0.00		0.00		0.00		157		
Male	17	37.78	27	60.00	1	2.22	45	0.3540	0.8380
Female	48	42.86	62	55.36	2	1.79	112		
Qualification	0.00		0.00		0.00		157		
Undergraduates	61	44.85	73	53.68	2	1.47	136	34.7560	0.0001*
Postgraduates	3	37.50	5	62.50	0	0.00	8		
Faculty members	0	0.00	11	100.0	0	0.00	11		
Practitioner	1	50.00	0	0.00	1	50.00	2		
Total	65	41.40	89	56.69	3	1.91	157		

*p<0.05

The perception of saliva-based diagnostics being faster than traditional methods remains uncertain, with 50.32% of participants unsure about the speed advantage. Nevertheless, a majority (70.06%) believe that saliva-based diagnostics could help reduce the cost of medical testing, highlighting a potential economic benefit.

Participants have considerable confidence in the potential of saliva-based diagnostics for early diagnosis of oral precancer and cancer^{7,8} (57.32%). However, there is significant uncertainty about using saliva as a replacement for tissue and serum in detecting oral potentially malignant disorders (45.22% unsure).

Majority of the participants are aware that using saliva as a diagnostic tool presents several significant advantages: it is non-invasive, making it convenient and comfortable for patients (64.97%); it is cost-effective, providing a less expensive option compared to other tests (55.41%); it offers quick results, enabling swift diagnosis and timely decision-making (29.30%); and it is highly accessible, suitable for large-scale screening and easily administered (40.13%).

Despite acknowledging the benefits, a majority of participants (71.34%) do not find saliva-based diagnostics as reliable

as blood tests for diagnosing oral diseases. Additionally, 72.61% prefer blood tests over saliva tests if both offer similar accuracy. A significant portion (89.81%) would not consider using saliva-based tests in the future, and 89.17% would not recommend them to others, indicating substantial barriers to acceptance.

The importance of training is highlighted, with 68.79% of participants having received training related to saliva diagnostics. A majority also believe that saliva diagnostics should be included in healthcare professional education, reflecting the recognition of their value and potential.

The knowledge and attitude scores vary significantly across different demographic profiles. Faculty members and postgraduates exhibit higher mean knowledge and attitude scores, indicating a more positive outlook towards saliva-based diagnostics. Undergraduates, despite having lower scores, show statistically significant differences, (Table 7) suggesting the potential for improvement through targeted educational interventions.

Table 7. Correlation between knowledge and attitude scores by Karl Pearson’s correlation coefficient

Variables	Correlation between knowledge scores with		
	r-value	t-value	p-value
Attitude scores	0.4866	6.9344	0.0001*

*p<0.05

It was seen that though the participants were aware regarding the tremendous utility of saliva as a diagnostic tool and the numerous advantages for its widespread use, the attitude of the participants was not in sync with majority believing that it can’t be alternative to serum and questioned its accuracy. This attitude, especially prevalent in the undergraduates highlights the need for educational interventions by including salivary diagnostics as a part of undergraduate curriculum.

CONCLUSION

In conclusion, there was high awareness of saliva-based diagnostics, attitudes regarding their effectiveness, accuracy, and reliability are mixed. Addressing these concerns through comprehensive training and inclusion in healthcare education could enhance acceptance and utilization of saliva-based diagnostics. Further research to validate their efficacy and a cost-benefit analysis could help promote their adoption in clinical practice.

DECLARATION

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Conflicts of Interest

The authors declare that there are no known competing financial interests.

Ethical Approval

This article does not contain any studies involving human participants or animals performed by any of the authors. The study has been approved by the Institutional Ethical Committee, KLE VK Institute of Dental Sciences, Belagavi with Number EC/NEW/INST/2021/2435.

Informed Consent

Informed consent was obtained from all participants included in the study.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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