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Awareness and Perception of Salivary Diagnostics of Dental Students and Faculty: A Pilot Study

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ABSTRACT

Background: The purpose was to determine the perception of the use of salivary diagnostics amongst dental students and faculty and assess if this perception changed after personally experiencing salivary diagnostic testing.

Materials and Methods: Participants completed a pretest survey on salivary diagnostic testing perception. Participants supplied a saliva sample and samples were analyzed for detection of pathogens associated with periodontal disease. Test results were distributed to respective participants with a standardized verbal explanation. Participants completed a posttest survey. A paired sample t-test was conducted to compare the differences in perception between pre- and post-survey results.

Results: A total of 50 participants completed the study; among the participants, 92% were dental students and 8% were dental faculty. The distribution of familiarity with the concept of salivary diagnostics indicated that most participants were unfamiliar with it. Perception towards salivary diagnostics increased after first-hand experience with salivary diagnostic testing. The overall satisfaction on the experience of salivary diagnostics was positive. Furthermore, linear regression analysis showed that age had a significant negative effect on overall satisfaction, $p = 0.008$

Conclusions: The overall satisfaction on the experience of salivary diagnostics as a screening tool in dentistry was positive. Furthermore, dental students and faculty's perceptions of salivary diagnostics changed after first-hand experience with salivary diagnostic testing.

Practical Implications: Exposure to personal experiences with salivary diagnostics significantly improved the perception on salivary diagnostics, indicating the need for increased curricular emphasis on this topic at dental schools.

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Salivary diagnostics; dental students and faculty; dental school; perception


Introduction


Saliva plays a significant role in the health of the oral environment. Its unique composition of water, proteins, biomarkers, and characteristic ions allows saliva to be utilized in diagnostic tests.^{1–3} During the 1900s, several studies for oral and systemic treatment research were performed utilizing saliva testing. It has been nearly 200 years since the first saliva test, and only in recent decades has there been substantial development in the field of salivary analytics. It has been observed that one of the biggest challenges of the 21st century is using the seminal achievement of sequencing the human genome in conjunction with salivary diagnostic testing to prevent diseases.^{4,5}

In addition to being used as a screening and research tool, saliva testing has been used effectively in the diagnosis, prevention, and treatment of periodontal disease.⁶ It has been suggested that evaluation of key enzymes, inflammatory biomarkers, and specific bacteria can be linked to phases of periodontal disease and help in determining prognosis of disease.^{6,7} Additionally, some of the bacteria linked to

periodontitis are implicated and connected with elevated risk of systemic conditions such as diabetes, cardiovascular, oncology, endocrinology, and psychiatric diseases.⁸

For these reasons, salivary diagnostics has the potential to provide clinicians with an etiology for periodontal and systemic disease. In a clinical setting, the primary methods used to evaluate signs of periodontal disease typically include clinical symptoms, clinical findings, and radiographic observations. In the transition toward a preventive dentistry model, saliva testing could be an asset in not simply treating but also preventing periodontal diseases. Traditionally, clinicians often emphasize effective oral hygiene to prevent dental disease. Unfortunately, nonspecific oral hygiene alone may be inadequate to cope with the high levels of the pathogenic bacteria associated with periodontitis. Salivary diagnostics can alert clinicians and patients to the presence of these key pathogens, especially in those who show no obvious signs of periodontal disease. This would allow clinicians to implement preventative treatment better tailored to the patient's needs.

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As such, salivary diagnostic testings are becoming more common as providers move toward personalized preventive dentistry. Yet, there is little information regarding the general perception and awareness of salivary diagnostic testing. The purpose of this study was to assess the perception toward salivary diagnostic testing that can identify five key pathogens associated with periodontal disease, amongst dental clinicians and dental students within an academic institution. Specifically, we tested whether there is a change in perception once dental and dental hygiene students and faculty personally experience salivary testing. It was hypothesized that there would be no difference in perception amongst participants after experiencing the salivary diagnostic process.

Materials and Methods

Institutional Review Board and Participant Recruitment

The study was approved by the Loma Linda University Institutional Review Board for a minimal risk clinical study that involved data collection by noninvasive means on December 20, 2023 (#5230539). Participants were recruited through posting flyers at dental student announcement boards. The following inclusion and exclusion criteria determined the eligibility of participants.

Inclusion Criteria

1. Subjects are 18 years or older;
2. Subjects who will comply with study protocol;
3. Subjects who can read and understand the consent form;
4. Subjects available during the study period;

5. Subjects are dental students, dental hygiene students, or dental faculty.

Exclusion Criteria

1. Subjects under the age of 18.
2. Subjects who have fever, chills, or tested positive for COVID-19.
3. Subjects are on antibiotic treatment.
4. Subjects had a saliva diagnostic taken in the past.

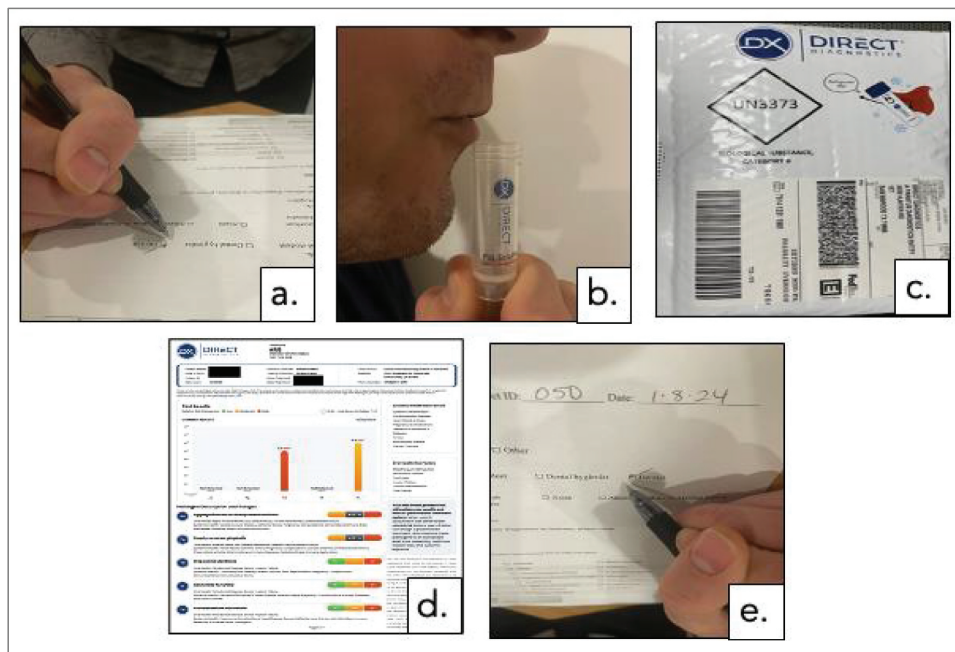
Consent and Pre-Survey

The step-by-step procedures of the study are illustrated in Figure 1. Once participants consented, they were asked to complete a pre-survey which included three sections (Figure 1a). A demographics section consisting of seven questions, a health history section addressing general health conditions, and the knowledge and perception section including three questions with responses on a 5-point Likert scale.

- (1) How familiar are you with the concept of salivary diagnostics?
- (2) How likely are you to consider implementing salivary diagnostics in your practice/patients' treatments? (Implementation).
- (3) Please indicate your level of agreement with the following statement: "I am concerned about the accuracy and reliability of salivary diagnostics." (Reliability).

Saliva Collection and Handling

Saliva collection and handling were performed according to the manufacturer's instructions. Participants were instructed to



- a. Consent and Pre-Survey
- b. Saliva Collection
- c. Overnight Shipping
- d. Test Results
- e. Post-Survey

Figure 1. Procedures of clinical trial.

refrain from consuming food, gum, water, or other beverages, as well as smoking, using tobacco, brushing, and in-office pre-rinse for 15 min before saliva collection. Participants were asked to salivate into a sterile, labeled test tube (HR5™ High Risk Pathogen Test, Direct Diagnostics, San Marcos, TX) for one minute to collect 1–2 mL of non-stimulated saliva for testing (Figure 1b). Collected samples were refrigerated, participants' information was entered into the Direct Diagnostics test ordering site, and the samples were sent the same day via overnight delivery (Figure 1c) to the laboratory for processing and identification of the five key pathogens: *Aggregatibacter actinomycetemcomitans* (Aa), *Porphyromonas gingivalis* (Pg), *Treponema denticola* (Td), *Tannerella forsythia* (Tf), and *Fusobacterium nucleatum* (Fn).

Test Results and Post-Survey

The test results were available to view the next day on the Direct Diagnostics ordering site and were printed as hard copies (Fid 1d). Results provided information on the bacterial load of the five key pathogens. It also contained description of the pathogens and their potential relationship to oral and systemic health. All participants were given their results with a standardized script explaining the results and its implications related to periodontal and systemic disease. Upon reviewing the test results, participants completed a 3-item post-survey (Figure 1e). Questions on implementation and reliability from the pre-survey were asked again to assess any changes in perception toward salivary diagnostics. A new question was added to the post-survey to assess overall satisfaction on the experience of salivary diagnostics as a screening tool in dentistry.

Statistical Analysis

The results from the surveys were entered into an Excel spreadsheet. The sample size of 50 participants was a convenience sample

determined by feasibility and funding availability. Demographics, responses and comparison of pre- and post-intervention Likert scale responses were summarized in a tabulated format. Non-parametric tests were applied, specifically the Wilcoxon Signed Rank Test, to compare the pre- and post-intervention responses given the small sample size and the ordinal nature of the data. The generalized linear model (GLM) used to analyze overall satisfaction (SATISFIED_POST) included four predictors: Age, Implementation_POST, Reliability_POST, and Ethnicity (Hispanic: 1; Non-Hispanic: 2). This model was designed to assess the impact of these key factors on overall satisfaction following the intervention. The Gaussian distribution (normal distribution of residuals) with an identity link function was employed, as the response variable (SATISFIED_POST) is continuous and approximately normally distributed, making this the appropriate distribution and link for the model. Statistical inferences were made based on a 5% significance level for all tests. Data were analyzed using Jamovi software 2.5.4.⁹

Results

A summary of the demographic descriptive analysis is provided in Table 1. A total of 50 participants completed the study, with a gender distribution of 54% male and 46% female. The participants' ages ranged from 20 to 44 years, with a mean age of 28.3 years (SD = 5.4). Among the participants, 92% were dental students, and 8% were dental faculty. The racial composition was 55.3% Caucasian, 42.6% Asian, and 2.1% African American. The distribution on the familiarity of the concept of salivary diagnostics is illustrated in Figure 2 as a pie-chart. Approximately, 60% were slightly to not at all familiar, 24% were moderately familiar while 18% were very to extremely familiar about the concept of salivary diagnostics.

Table 1. Demographic descriptive analysis of participants (N = 50).

Demographic	Details
Mean Age (SD) & Range	28.32 (5.43), 20–44 years
Gender	Male: 27 (54%), Female: 23 (46%), Other: 0
Role	Dental Student: 46 (92%); Faculty: 4 (8%)
Race	White: 26 (55.3%), African American: 1 (2.1%), Asian: 20 (42.6%), American Indian/Native Hawaiian: 0
Ethnicity	Hispanic: 10 (20%), Non-Hispanic: 39 (79.6%)

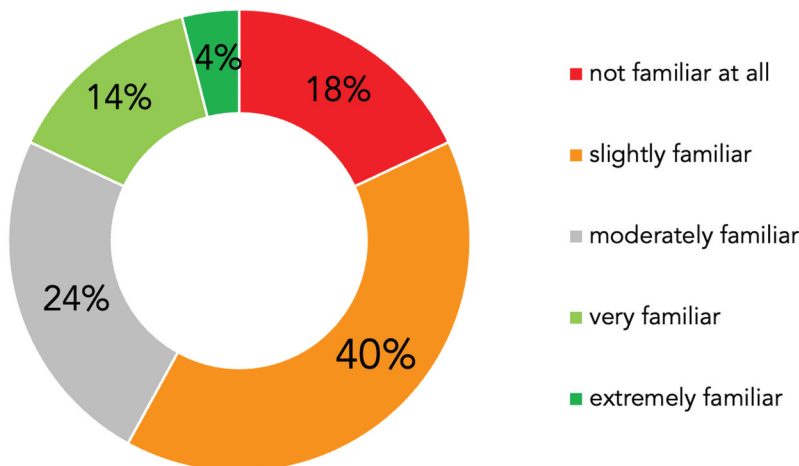


Figure 2. Pie-chart indicating participants' familiarity with salivary diagnostic testing.

Table 2. Descriptive statistics of key variables.

Variable	N	Median	IQR	Minimum	Maximum
SATISFIED_POST	50	4	0	2	5
Implementation_PRE	50	3	1	1	5
Implementation_POST	50	3	1	1	5
Reliability_PRE	50	3	0	1	5
Reliability_POST	50	3	1	1	5
TOTAL	50	5	4.5	1	12

Table 3. Frequency and percentage of likert responses pre- and post-intervention.

Variable	Likert Score	Pre (N = 50)	%	Post (N = 50)	%
Implementation	1	4	8%	1	2%
	2	10	20%	5	10%
	3	22	44%	24	48%
	4	10	20%	15	30%
	5	4	8%	5	10%
Reliability	1	5	10%	2	4%
	2	7	14%	7	14%
	3	20	40%	22	44%
	4	12	24%	12	24%
	5	6	12%	7	14%

Descriptive statistics of key variables are summarized in Table 2. The frequency and percentage of Likert responses pre- and post-intervention are summarized in Table 3. The Wilcoxon Signed Rank Test was conducted to evaluate the change in perceptions between pre- and post-intervention responses. The results indicated a significant improvement in perceptions of implementation from pre-intervention (Mdn = 3.00, IQR = 1.00) to post-intervention (Mdn = 3.00, IQR = 1.00), $z = -3.56$, $p < .001$. Additionally, perceptions of reliability improved, though this change was not statistically significant ($z = -1.96$, $p = .05$). These results suggest that while participants' perceptions of the implementation of salivary diagnostics significantly improved after firsthand experience, perceptions of reliability showed only a trend toward improvement. The overall satisfaction on the experience of salivary diagnostics as a screening tool in dentistry was positive with 84% being satisfied to strongly satisfied, while 14% were neutral and 2% were dissatisfied.

The model fit was assessed using several indices. The R^2 value of 0.322 indicated that the predictors explain 32.2% of the variance in overall satisfaction (SATISFIED_POST), suggesting that while the predictors have a substantial relationship with overall satisfaction, a significant portion remains unexplained. The log-likelihood was -40.28 , with an AIC of 92.559 and a BIC of 103.910, both were in acceptable ranges for model comparison and fit. The deviance (14.850) and chi-squared/DF ratio (0.338) indicated no major concerns regarding overdispersion or underdispersion in the model.

Coefficients and Predictors

The key predictors in the model demonstrated the following relationships with overall satisfaction:

- **Age:** The negative coefficient for age ($B = -0.041$, $SE = 0.016$, $p = .008$) indicated that as age increases, overall satisfaction tends to decrease slightly, suggesting a small but statistically significant inverse relationship between age and satisfaction.
- **Implementation_POST:** This predictor ($B = 0.309$, $SE = 0.094$, $p = .001$) had a positive and statistically significant relationship with overall satisfaction, indicating that participants' post-intervention perceptions of implementation positively influenced their overall satisfaction with the intervention.
- **Reliability_POST:** The negative coefficient ($B = -0.194$, $SE = 0.099$, $p = .050$) indicated a marginally significant inverse relationship between post-intervention perceptions of reliability and satisfaction. While the significance level is borderline, it suggested that perceptions of reliability may not have had as strong a positive influence on satisfaction as initially hypothesized.
- **Ethnicity (Hispanic: 1; Non-Hispanic: 2):** The ethnicity variable was not a significant predictor of satisfaction ($B = -0.310$, $SE = 0.211$, $p = .142$), suggesting that there were no substantial differences in satisfaction levels between Hispanic and Non-Hispanic participants.

Discussion

The dental curriculum currently provides minimal education on salivary diagnostic testing for dental students.¹⁰ This is partly due to the lack of course material focused on genetic testing of DNA and RNA within the oral microbiome.¹⁰ Although there are numerous Continuing Education courses available for practicing dentists, it may be beneficial to begin educating dental students on the potential use of salivary diagnostic testing as a screening

and diagnostics tool during comprehensive and periodic oral examinations. The study assessed the perception on the use of salivary diagnostics amongst dental students and dental faculty using a HR5™ salivary test that quantifies key bacterial pathogens: Aa, Pg, Td, and Tf that lead to oral dysbiosis, altering the normal healthy flora into a pathogenic one, and causing diseases of the periodontium and may be linked to systemic diseases such as atherosclerotic cardiovascular disease, oral squamous cell carcinoma, obesity, and Type 2 diabetes.^{11–18}

Our study identified a critical gap in the dental curriculum regarding education on salivary diagnostics, as most participants demonstrated limited to moderate familiarity with this concept. While scientific perspectives and initiatives from the National Institute of Dental and Craniofacial Research are increasingly recognizing saliva as a valuable diagnostic resource alongside blood and urine,^{19–22} comprehensive integration of salivary diagnostics into the educational framework is lacking.

Our results indicated that personal experience with salivary testing positively influenced participants' perceptions. Consequently, we rejected our hypothesis, as participants' views shifted, becoming more favorable toward the potential implementation of salivary diagnostics in their own practice. Additionally, perceptions of reliability improved, though this change was not statistically significant. The results of our linear model indicated an interesting relationship between age and satisfaction. Overall satisfaction tended to decrease slightly, suggesting a small but significant inverse relationship between age and satisfaction. This may suggest that younger generations are more receptive to new and innovative tools in the practice of future dentistry. However, it is important to note that while the linear model explained 32.2% of the variance in satisfaction, it left 67.8% unexplained. This suggested that additional factors not included in the model likely contribute to overall satisfaction. Potential factors include other psychosocial variables, such as participant engagement, previous experience with salivary diagnostics, or faculty support during the intervention. These factors may significantly shape participants' perceptions and satisfaction levels but were not measured in the current study. There is limited research on these relationships and further research is required to fully understand these factors that influence acceptability and perception of salivary diagnostics in dental students and faculty.

Advancements in science and technology has enabled a shift toward a more personalized preventative care model. Salivary diagnostic testing holds immense potential for analyzing indicators of diseases and conditions affecting both the oral cavity and the entire body. However, if dental providers and students are unaware of its benefits and hold negative perceptions, these diagnostic tools may be significantly underutilized. The major strength of the study was the assessment of the perception of dental students and faculty on salivary diagnostics. There is scarce information on this topic, and this research showed that dental students and faculty were initially hesitant to implement salivary diagnostics in their practice. However,

exposure to personal experiences with salivary diagnostics significantly improved their perception, indicating the need for increased curricular emphasis on this topic. The study's limitations include the small sample size of dental students and faculty evaluated. Additionally, inclusion of private practitioners could have enhanced the comprehensiveness of the findings.

Conclusion

Within the limitations of the study, it was concluded that the overall satisfaction on the experience of salivary diagnostics as a screening tool in dentistry was positive. Furthermore, dental students' and faculty's perceptions of salivary diagnostics changed after first-hand experience with salivary diagnostic testing.

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Disclosure Statement

No potential conflict of interest was reported by the author(s).

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