

Assessing the Impact of Saliva Composition on Progression of Dental Caries

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Abstract

Background: Dental caries is a significant oral health issue affecting globally, with various factors affecting caries including microbial activities, diet, and host related factors such as saliva composition. Saliva is crucial in sustaining oral homeostasis due to the buffering ability, antimicrobial effect, and potential to remineralize. The changes in the salivary parameters with pH, flow rate, as well as mineral content can have a significant influence on the development of the dental caries.

Methods: A cross-sectional study was done on 94 participants between 18-60 years in Sri Krishna Medical College and Hospital (SKMCH), Muzaffarpur, from August 2023 to October 2025. The Decayed, Missing, Filled Teeth (DMFT) index was used to assess the status of dental caries. Unstimulated saliva samples were gathered under the standardized conditions then analysed regarding the pH, calcium, flow rate, phosphate along with the total protein levels. Statistical analysis was performed with SPSS, conducting correlation and regression tests. A p-value of less than 0.05 was considered significant.

Results: The average salivary pH was 6.58 ± 0.42 , and the average flow rate of secretion was 0.62 ± 0.18 mL/min. The mean DMFT score was 4.72 ± 1.96 . A strong negative correlation was observed between the salivary pH and DMFT ($r = -0.52$) as well as flow rate and caries severity ($r = -0.47$). Calcium and phosphate levels also showed a protective association, while the total protein demonstrated a weak correlation.

Conclusion: Saliva composition plays an important role in dental caries development. Reduced salivary flow, lower PH and decreased mineral level are linked with increased risk of caries. Saliva-based assessment could be used as an effective tool for early diagnosis and prevention.

Keywords: Dental caries, Saliva composition, Salivary pH, Flow rate, Remineralization, DMFT index.

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Introduction

Dental caries is among the most popular chronic oral diseases that are present among the populations of all ages and socioeconomic statuses [1]. It is a multifactorial disease that involves the progressive demineralization of the dental hard tissues as a result of the interplay of cariogenic microorganisms, carbohydrates in the diet and host factors.

Dental caries is still a major public health problem, especially in developing areas where oral healthcare access and awareness is low despite the present excessive progress in preventive dentistry

[2]. Caries that are not treated can cause pain, infection and tooth loss as well as have a profound effect on quality of life, nutrition and systemic health [3]. Saliva has a very important protective effect on oral health and serves as the natural defense mechanism when it comes to preventing the occurrence and progression of dental caries [4]. It helps maintain oral homeostasis in many ways such as buffering capacity, antimicrobial action, and promotion of remineralization. Saliva is known to have a buffering effect, which allows the neutralization of the acids generated by bacterial metabolism and therefore long-term acidic

environments that promote enamel demineralization [5].

Also, saliva has other antimicrobial elements, including lactoferrin, immunoglobulins (especially IgA), and lysozyme, which inhibit the growth and adhesion of cariogenic bacteria. Moreover, saliva helps in the process of remineralizing early carious lesions by providing essential minerals like calcium and phosphate to the tooth surface, which encourages the enamel demineralized enamel to be repaired [6].

Saliva composition is complicated and comprises a number of major components that determine its protective properties [7]. Salivary pH is one of the most important, since low pH conditions facilitate enamel dissolution and elevate the performance of acidogenic bacteria. Another significant determinant is the rate of salivary flow since a low flow may affect the ability of the salivary flow to clean the food debris and bacteria, which may cause an increased risk of caries [8,9]. Biochemical components like calcium and phosphate play an important role in ensuring the dynamic equilibrium between demineralization and remineralization processes [10]. Also, salivary proteins, enzymes, and immunoglobulins play a major part in antimicrobial defense and preservation of oral tissue integrity. Change of such components may have a great impact on changing the oral environment and can affect the risk and progression of dental caries [11,12].

Despite the many studies conducted to determine the role of individual salivary parameters in oral health, the overall clinical effects that a combination of saliva composition can have on the development of dental caries have been poorly understood. The majority of the available studies involve individual factors instead of offering a detailed assessment of a combination of salivary elements with the severity of caries. This gap highlights the importance of combined clinical research that would evaluate the association between different salivary variables and the level of dental caries in individuals with it.

Thus, the current research is conducted to fill this gap and conduct a systematic assessment of the role of saliva composition in caries development. The knowledge of these relationships can help in preventing and diagnosing measures through salivary biomarkers which will enhance the outcome of patients and oral health management.

Objectives

- To determine how the composition of saliva influences the development of dental caries.
- To assess salivary pH, flow rate and biochemical composition.

- To match these parameters with the level of caries.

Materials and Methods

Study Design: The current research was designed as a cross-sectional observational study to assess the relationship between the saliva constitution and the development of dental caries among the patients. This design was selected in order to evaluate salivary parameters and caries status simultaneously among the study population.

Study Setting: The study was carried out in Sri Krishna Medical College & Hospital at Muzaffarpur, Bihar which is a tertiary care teaching hospital serving a mixed population of urban and rural patients.

Study Duration: This research was conducted from August 2023 to October 2025. This time was sufficient to recruit participants adequately, collect and analyze data.

Sample Size: In the study, there were 94 respondents. The sample size was calculated according to the number of eligible patients who were available throughout the study time and was sufficient to determine the relationship between salivary parameters and dental caries.

Inclusion Criteria

- Adult patients between the ages of 18 and 60 years.
- Clinically diagnosed dental caries patients.
- Individuals willing to participate and give informed consent.

Exclusion Criteria

- Patients with general diseases that are known to influence the secretion of saliva, including Sjogren syndrome.
- Patients using drugs that may slow the rate of salivary flow such as antihypertensives, antidepressants, and anticholinergic medications.
- Patients who had received dental treatment or dental procedures in the past three months.

Data Collection Procedure: The data were collected through clinical examination as well as lab evaluation. An in-depth intraoral examination was done with the help of normal dental tools under adequate lighting. The status of dental caries was determined with the help of the DMFT Index which is also a widely accepted and reliable indicator of caries experience. All the tests were performed by professional dentists who had been trained to be consistent and accurate.

Saliva Collection Method: Each participant was subjected to a standardized procedure in the collection of unstimulated whole saliva samples.

The respondents were advised to avoid taking food, beverages, or other oral hygiene procedures within one hour before collection of samples. Sampling of saliva was done in the morning hours to reduce variation in the day. The participants were required to sit in a comfortable position and the saliva was to accumulate in the floor of the mouth and expectorate it within a specified period of time in a sterile container.

Salivary Parameters Measured: The samples of saliva gathered were examined on different physicochemical and biochemical parameters. The PH of the saliva was determined with the help of a calibrated digital PH meter. The salivary flow rate was determined by counting the saliva that was collected per minute and divided into millilitres (mL/min). Estimation of the levels of calcium and phosphate was done through standard laboratory analysis. Also, the concentration of total proteins was assessed to determine the contribution of salivary proteins in the development of caries.

Statistical Analysis: The data examined with the help of SPSS software. All the variables were analyzed using descriptive statistics, mean, and standard deviation. Pearson or Spearman

correlation coefficients were used in the correlation analysis to establish the relationship between salivary parameters and the severity of caries. Regression analysis was done where necessary to establish significant predictors of dental caries progression. A p-value of less than 0.05 was regarded to be significant.

Ethical Considerations: The protocol of the study was reviewed and approved by the Institutional Ethics Committee of SKMCH. The participants were made aware of the purpose and procedures of the study and informed consent was acquired in writing before they were included in the study. The study ensured the confidentiality and anonymity of the participant data.

Results

Demographic Data: The participants were aged between 18 to 60 years with an average age of 36.4 ± 10.2 years.

The majority of participants are 31–45 years age group (38.3%), followed by 18–30 years (29.8%) and 46–60 years (31.9%). There was also a minor male dominance as there were 52 males (55.3%) and 42 females (44.7%).

Table 1: Demographic Characteristics of Study Participants

Variable	Category	Frequency (n)	Percentage (%)
Age Group	18–30 years	28	29.8%
	31–45 years	36	38.3%
	46–60 years	30	31.9%
Gender	Male	52	55.3%
	Female	42	44.7%

Salivary Characteristics: The average salivary pH of the participants was 6.58 ± 0.42 indicating that it was slightly acidic and slightly to the neutral range. Mean calcium and phosphate levels were 6.9 ± 1.5 mg/dL and 5.4 ± 1.2 mg/dL respectively. The mean rate of the salivary flow was 0.62 ± 0.18 mL/min. The average protein level was found to be 1.28 ± 0.35 g/dL.

Table 2: Salivary Parameters of Participants

Parameter	Mean $\pm$ SD
Salivary pH	6.58 ± 0.42
Flow Rate (mL/min)	0.62 ± 0.18
Calcium (mg/dL)	6.9 ± 1.5
Phosphate (mg/dL)	5.4 ± 1.2
Total Protein (g/dL)	1.28 ± 0.35

Caries Status: The DMFT index was used to determine the status of dental caries. The caries experience showed a moderate level of 4.72 ± 1.96 , which is the mean DMFT score of the respondents. The percentage of participants who had DMFT scores 4–6 (42.6%) and 3 or less (31.9%) and above 6 (25.5%) was higher.

Table 3 Distribution of DMFT Scores

DMFT Score Range	Frequency (n)	Percentage (%)
≤ 3	30	31.9%
4–6	40	42.6%
> 6	24	25.5%

Correlation Findings: The results of the correlation analysis showed that the relationship existing between salivary pH and DMFT scores

was statistically significant and negative ($r = -0.52$, $p < 0.05$), meaning that lower pH levels were related to the high prevalence of caries. Salivary

flow rate was negatively correlated with caries scores ($r = -0.47$, $p < 0.05$), indicating that a low flow rate increased caries risk. Calcium and phosphate were observed to be negatively correlated to DMFT scores ($r = -0.31$ and $r = -0.28$

respectively) which showed a protective role in remineralization. The total protein concentration had a weak positive relationship ($r = 0.22$), but it was not significant.

Table 4: Correlation between Salivary Parameters and DMFT Scores

Parameter	Correlation Coefficient (r)	p-value
Salivary pH	-0.52	< 0.05
Flow Rate	-0.47	< 0.05
Calcium	-0.31	< 0.05
Phosphate	-0.28	< 0.05
Total Protein	0.22	> 0.05

In general, the results show that low salivary pH and low flow rate are strongly related to high caries levels in the dental, whereas high mineral content of saliva is the predictor of the protective effect against caries development.

Discussion

The current study explored the relationship between the salivary composition and the development of dental caries and found meaningful relations between some of the important parameters of the salivary composition and caries severity. The results show that a low salivary pH and low rate of salivary flow are closely correlated with high DMFT scores, which implies a greater vulnerability to dental caries.

Also, lower calcium and phosphate were found in those with increased caries prevalence, which demonstrates their protective effect on the integrity of teeth. The overall findings emphasise the changes in saliva composition have the potential to affect the oral environment in a significant way and lead to the development of dental caries.

Comparison to the Previous Studies: The results of the study are similar to other studies that have been done in the area of preventive dentistry. Persons whose salivary PH is acidic are more likely to have enamel demineralization and consequently develop caries [13].

Low flow rate of saliva interferes with the natural cleansing and buffering of the oral cavity which exposes one to risk of caries [14].

The research concerning salivary minerals has also brought to light the significance of calcium and phosphate in the remineralization process of caries in the prevention of caries progression [15]. The current results are consistent with the existing literature, which supports the fact that saliva is a critical determinant of oral health and disease.

Biological Explanation: Biologically, salivary pH is very important in ensuring that there is a balance between demineralization and remineralization of tooth enamel. Once the salivary pH is below the critical level of about 5.5, the surface of the enamel

starts to demineralize due to loss of minerals. This acidic environment promotes the activity of cariogenic bacteria that also generate further acids and enhance the caries process. Conversely, neutral or slightly alkaline pH support remineralization and prevents growth of bacteria.

The rate of salivary flow is also essential in the maintenance of oral wellbeing. The sufficient production of saliva guarantees a good clearance of food debris, sugars and microorganisms in the mouth. Poor buffering capacity and prolonged acidic conditions due to reduced salivary flow (also referred to as hyposalivation) predispose to enamel breakdown and caries formation.

The saliva has calcium and phosphate ions, which are essential in the remineralization of enamel. These ions also assist in filling minerals that have been lost in the process of acid attacks by redeposition to the tooth surface thus regaining the strength of the enamel and inhibiting the progression of the lesions. The negative correlation that was observed between these levels of minerals and the severity of caries in this research also indicates their protective role.

Conclusion

The current research shows that saliva is a major factor in the development of dental caries. Reduced levels of calcium and phosphate, reduced flow rate, and lowered salivary pH were also linked to the severity of caries. These results show the significance of saliva as a major determinant of oral health. Saliva-based screening early in life can help to distinguish those who have a greater risk and provide preventive interventions in time. It is suggested that more studies should be conducted in the future with bigger samples and longitudinal designs to further support these results and prove causal relationships.

Recommendations: Dental practice should include the use of salivary analysis as a routine method of assessing the risk of caries at an early stage. There should be public awareness on oral hydration and eating balanced food. Also, it is advisable that preventive oral health programs should use saliva-

based diagnostics and remineralization interventions to minimize the burden of dental caries.

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