42. Correlation of Salivary pH and Plaque Index on the Occurrence of Permanent First Molar Dental Caries in Adolescents Aged 17–20 Years

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Submission date: 29-Aug-2024 02:48PM (UTC+0700)
Submission ID: 2440344222
File name: Arikel_MJMHS.pdf (255.22K)
Word count: 4472
Character count: 23247

ORIGINAL ARTICLE

Correlation of Salivary pH and Plaque Index on the Occurrence of Permanent First Molar Dental Caries in Adolescents Aged 17–20 Years

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ABSTRACT

Introduction: Dental caries is an infectious disease that causes damage to the tooth structure and has an increasing prevalence in developing countries. Dental caries often occur first in the first permanent molars because they are the first permanent teeth to erupt into the oral cavity. Salivary pH and plaque index can affect the development of dental caries. The purpose of this study was to determine the correlation between salivary pH and plaque index on the occurrence of caries in permanent first molars in adolescents aged 17–20 years. **Materials and methods:** This study is a cross-sectional study. The population in this study is adolescents aged 17–20 years, totaling 78 people, consisting of 16 men and 62 women. The sampling technique in this study used *a non-probability purposive sampling* technique. **Results:** A total of 40 people (51.28%) had caries in their permanent first molars, and 38 people (48.72%) did not have caries in their permanent first molars. While the results of the salivary pH examination found that only one person (1.28%) had a low salivary pH (pH 5.0–5.7), eight people (10.25%) had moderate salivary pH (pH 6.0–6.6), and 69 people (88.46%) had a high salivary pH (pH 6.8–7.8). The Spearman test was utilized to analyze the correlation of the results of this study. The relationship between salivary pH and the occurrence of caries in permanent first molars teeth was not significant ($p<0.05$) but the correlation value of plaque index to permanent first molars caries was significant ($p>0.05$). **Conclusion:** The dental plaque index significantly correlates with permanent first molar caries in adolescents aged 17–20 years. However, the incidence of caries does not have a significant relationship with the pH value of saliva in the oral cavity.

Keywords: Adolescent, Dental caries, Incidence, Prevalence, Saliva

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INTRODUCTION

Indonesian people have an average value of cavities and DMF-T values of 1.6 and 4.6; these values were obtained based on the Indonesia Basic Health Research (Riskesdas) in 2018 (1). Dental caries is an infectious disease in the oral cavity that causes damage to the tooth structure and has an increasing prevalence rate in developing countries from year to year. Dental caries often occurs first in permanent first molars because they are the first permanent teeth to erupt into the oral cavity. Dental conditions like this have a negative impact, not only on the health of the teeth and body in general but will also affect a quality of life (2).

Late adolescence (17-20 years) is a transition period from childhood to adulthood and will experience various physiological, social, and emotional changes. At this time, providing knowledge that has an impact on changing attitudes and behavior can be received positively before entering adulthood. This will cause a change in behavior from bad to good in maintaining oral health (3,4).

The etiology of caries is multifactorial and occurs due to the interaction between microbes, substrates, and host factors, including the anatomy of the tooth surface, which supports the occurrence of cariogenic microbial development. The proliferation and colonization of these microbes will form plaques associated with an increase in acid-producing and acid-resistant bacteria that cause a shift in the microbial balance of the biofilm. This condition can cause the fermentation of carbohydrates to form acids in the oral cavity, which results in a low pH. This will eventually damage the tooth structure through the demineralization process (5-10).

Plaque and bacteria will start working 20 minutes after eating (9). Dental plaque is a habitat where microbial metabolism occurs, affecting carious lesions' development (11). Research that has been conducted

shows that an increase in plaque index from acidogenic bacteria such as *Streptococcus mutans* can cause an increase in caries status. This can occur due to the formation of organic acids from bacterial fermentation in the biofilm, which causes the pH value in the oral cavity to drop to a value below the critical pH of 5.5 and 6.0 for enamel and dentin (12-14). Under conditions of phosphoric acid and hydroxyl below saturation levels, this condition allows the demineralization process of the tooth structure, which allows hydroxyapatite crystals to dissolve and form cavitation (8,12,13).

In the oral cavity, there are also basic genetic mechanisms that modulate the factors that cause caries, such as the presence of saliva that can affect bacterial adhesion or acid buffer capacity. Saliva is a physiological fluid with various functions and high diagnostic potential, so it can be used to monitor the condition of the oral cavity and bacterial adhesion or acid buffer capacity (8). Saliva is a physiological fluid with various functions and high diagnostic potential, so it can be used to monitor the condition of the oral cavity and determine the progressivity of caries. Salivary pH can be used to predict the risk of dental caries, where low pH in the oral cavity will show a very strong correlation with the occurrence of dental caries (6,7,14,15). The relationship between salivary characteristics, which include salivary pH, and plaque biofilms will play a role in the overall management of dental caries (16). Several studies still contradict the relationship between pH and caries. Therefore, it is important to know the correlation between salivary pH and plaque index and the occurrence of caries in teeth.

MATERIALS AND METHODS

This study is a clinical observational study (cross-sectional). The population in this study was adolescents aged 17–20 years, for a total of 78 people, consisting of 16 men and 62 women. Sampling techniques in this study used non-probability purposive sampling techniques. This research has obtained ethical clearance and received ethical approval from the Research Ethics Committee, Faculty of Medicine, Maranatha Christian University, No. 143/KEP/XI/2022.

Salivary pH Test

The salivary pH test using GC Saliva-Check Buffer kit (GC Corporation, Tokyo, Japan). Previously, the interviewees were instructed not to eat or drink for 90 minutes before saliva was collected 9-10 AM in the morning. The interviewee was asked to collect saliva resting in a sitting position and instructed to remove saliva into the cup provided. Next, insert the tip of the pH test strip into the saliva collected in the cup for 10 seconds. Match the colors that are visible/occurring on the pH test strip that is still wet with the table below. The pH value is matched against the available control chart and evaluated. A value 5.0–5.8 indicates low pH, 6.0–6.6 indicates a moderate pH, and 6.8–7.8 indicates a high pH (Fig. 1).

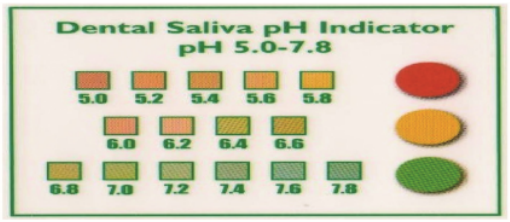

Fig. 1: pH test strip color result table (GC Corporation, Tokyo, Japan)

Plaque Index Score Interpretation

Plaque index examination is carried out by the O'Leary method. Drop GC Tri Plaque ID gel (GC Corporation, Tokyo, Japan) under the tongue and try to spread it on the surface of the teeth. Examine the entire surface tooth, divided into four parts, buccal, lingual, mesial, and distal. Pink to red indicates a new plaque is forming, and blue to purple indicates the plaque is ripe. Staining on the tooth's surface is rated as positive (+).

The plaque index can be calculated by summing the entire value (+) of the stained tooth surface, divided by the sum of all teeth examined, multiplied by four, and multiplied by 100%. The plaque score is good when the score is 10% or less. The classification of index plaque scores, according to O'Leary (17), is as follows (Table I).

Table I: O'Leary classification of index plaque scores

Percentage	Classification
0-20%	Good
21-40%	Medium
41-60%	Poor
>60%	Very bad

Permanent First Molar Tooth Examination

Caries examination is carried out on permanent first molars following WHO standards, using a dentist mirror and explorer on a dental unit with good lighting. The entire surface of the first molars is permanently examined, either on the smooth surface or the occlusal surface. If it looks brown or changes in color to black, there is a cavity, or it has been restored, it is considered that this tooth has caries.

Statistical Analysis

Data was entered in the Excel spreadsheet and descriptive statistics such as mean and standard deviation were calculated. Statistical data analysis using Minitab software version 20 (Minitab, LLC, 2002) The normality test of all research data using the Ryan-Joiner test obtained a p-value of 0.05, so the data is not normally distributed; then, the correlation test uses the Spearman test.

RESULTS

Examinations were conducted on 78 research subjects,

consisting of 16 men (20.51%) and 62 women (79.49%). Salivary pH, plaque index, and caries checks on permanent first molars were performed on all subjects. A total of 40 people (51.28%) had caries in their permanent first molars, and 38 people (48.72%) did not have caries in their permanent first molars. While the results of the salivary pH examination found that only one person (1.28%) had a low salivary pH (pH 5.0–5.7), eight people (10.25%) had a moderate salivary pH (pH 6.0–6.6), and 69 people (88.46%) had a high salivary pH (pH 6.8–7.8).

The mean and standard deviation of plaque score, pH, and caries in permanent first molars teeth can be seen in Table II.

Based on the normality test on salivary pH data, plaque score, and dental caries for permanent first molars, it was obtained p value <0.01, which shows that the data in this study were abnormally distributed. The correlation test used in analyzing the results of this study was the Spearman test. The results of the Spearman test correlation between salivary pH and plaque index on the occurrence of permanent first molars dental caries can be seen in Table II.

Table II: Comparison of mean plaque index, salivary pH, and Permanent First Molars Caries

Parameter	N	Mean	Std. Deviation	Correlation	p-value
Plaque Index	78	25.360	23.38	0.245	0.031*
Salivary pH	78	2.872	0.37	0.144	0.208
Permanent First Molars Caries	78	0.936	1.15		

*Independent Samples t-test, (p<0.05 – Statistically Significant)

The correlation value of salivary pH to permanent first molars caries was 0.144 with a p-value of 0.208; this value was higher than 0.05, so it can be concluded that the relationship between salivary pH and the occurrence of caries in permanent first molars teeth was not significant. The correlation value of plaque index to permanent first molars caries was 0.245 with a p-value of 0.031, less than 0.05, so it can be concluded that there was a significant relationship between plaque index and the occurrence of caries in permanent first molars.

DISCUSSION

Dental caries can occur due to a complex interaction of several factors, including acid-producing anchovies and carbohydrates that can be fermented, causing demineralization (18). In addition, oral health conditions, nutritional status, saliva, and oral flora play an essential role in the occurrence of dental caries. The disease also affects 60–90% of children and adults worldwide (19). The permanent first molars are the first permanent teeth to erupt into the oral cavity. However, due to their morphology and function in mastication, these permanent first molars are susceptible to caries immediately after the eruption (2,20). It is also consistent with this study that as many as 51.28% of people examined had caries in the first permanent molar.

Saliva is essential in maintaining oral health and tooth integrity, as it contributes to defense mechanisms through its buffering action, lubrication, and capabilities as an antimicrobial (14,21). In the literature, it was found that pH indicates a high prevalence of caries (14). This did not happen in this study; in this study, it was found that salivary pH affects the occurrence of caries in the first permanent molar teeth. However, it is not statistically significant. In this study, 88.46% of research subjects had a high pH ranging from 6.8–7.8, but as many as 51.28% of people examined had caries in their first molars. This condition also aligns with several studies that state that salivary pH is insignificant in causing or aggravating dental caries (14). Under research conducted previously by Choudhary (2022), there is no statistically significant correlation between pH and caries index (22).

In addition to salivary pH in the oral cavity, saliva also has various roles, and changes in salivary composition can significantly affect the health of the teeth and mouth. The phosphate, calcium, fluoride, salivary flow rate, and salivary pH content affect its cariostatic properties (2,23). Salivary flow rate and buffer capacity also play an essential role in the occurrence of dental caries. A decrease in salivary flow can manifest with the occurrence of increased caries. The salivary buffer capacity is also identified as one of many factors that can affect a person's risk of caries through the content of bicarbonate ions (2,21,23).

Saliva production and secretion can be influenced by circadian rhythms which have an important role in the body's defense mechanisms, such as maintaining oral health and regulating the microbiome in the oral cavity. Saliva can also play a role in maintaining tissue in the oral cavity, especially in controlling infection. The circadian rhythm of the salivary glands also has an important role in controlling the amount of saliva flow, the type of saliva, and the content/composition of saliva ions. This will influence and be directly related to the health status of the tissues in the oral cavity (24,25).

In addition to the previous, it is known that the etiology of dental caries is also multifactorial; it can be endogenous or exogenous. It was later discovered that dental caries are directly related to certain bacterial species that play a role in sucrose metabolism and produce organic acids. The main bacteria involved in the pathogenesis of dental caries are *Streptococcus mutans,* salivary group *streptococci,* and *lactobacilli* (26). In forming biofilms and dental plaque, microorganisms are essential in influencing the initiation and development of dental caries (14).

In order to play their role, bacteria must adhere to

and colonize the tooth's surface. Therefore, efficient colonization by forming biofilm and dental plaque is required. Initially, *Streptococcus mutans* played an essential role by producing glucan polymers supported by other species (26). This can happen because microorganisms can attach to other microorganisms (27).

Glucan is a polysaccharide produced due to the action of the enzyme glucosyltransferases (Gtfs), which is a biofilm matrix that supports bacterial attachment and accumulation. Furthermore, it provides a structural framework for biofilms and increases the acidity of the biofilm matrix, which plays a role in the maturation of dental plaque (26). Therefore, *Streptococcus mutants*, which produce GTFs, glucans, biofilms, and dental plaque, are the main etiological factors involved in the occurrence of dental caries pathogenesis. This is due to the spread of bacteria on the tooth's entire surface (26,28).

This higher salivary pH value is associated with increased proteolytic activity in microorganisms, thus supporting the deposition of calcium phosphate and affecting dental plaque formation and mineralization (29). Dental plaque contains glucans (10–20%), fructans (1–2%), bacterial and salivary proteins (40%), fluoride, lipids, phosphorus, calcium, magnesium, and water up to 80% (26).

Substantial changes due to dental plaque in the local environment can cause dysbiotic changes in the composition and metabolic activity of dental plaque on the tooth surface. As is known, mature plaques will experien an increase in microbial diversity dominated by the gram-negative microbe anaerobic, which will potentially make plaque pathogens and cause disease occurrence (30-32). An imbalance of microbial communities will cause changes in dental plaque that exhibit cariogenic properties (30).

This condition can occur due to changes in plaque ecosystems, including aciduric characteristics and an increase in the number of aciduric bacteria such as *Streptococcus mutans* and Lactobacillus (33). An increase in the proportion of *Streptococcus mutans* in dental plaque is closely related to the development of dental cari since this bacterium is considered the main etiological factor for the occurrence of dental caries (34). An increase in the number of *Streptococcus mutans* will undoubtedly lead to an increased risk of early incidence of caries in childhood and increased susceptibility to caries in the future (14,35).

Plaque is considered the most critical factor in the occurrence and development of carious lesions compared to saliva. Thus, the pH of dental plaque is considered to have a direct effect on the occurrence of the demineralization process on the tooth surface (36). This can occur due to dysbiotic changes in dental plaque that cause the pH to become acidic (32). When the pH of dental plaque drops below 5.0–5.2, it will cause salivary buffers to be unable to keep pace, and this will cause the dissolution of minerals, mainly hydroxyapatite (Ca10 (PO4) 6(OH)2), which then causes dental caries (27,33).

Therefore, maintaining good oral hygiene is very important to prevent caries (35). A simple method that can be used to control dental plaque is by brushing teeth, which aims to remove dental plaque from the surface of tooth enamel (37).

CONCLUSION

The dental plaque index significantly correlates with permanent first molar caries but the incidence of caries does not have a significant relationship with the pH value of saliva in the oral cavity.

ACKNOWLEDGEMENT

We thank the Faculty of Dentistry, Maranatha Christian University for its support.

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