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# 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 in the oral cavity that causes damage to the tooth structure and has an increasing prevalence in developing countries from year to year. 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. **Objective**: Determine the correlation between salivary pH and plaque index on the occurrence of caries in permanent first molars in adolescents aged 17–20 years. Method: 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**: Salivary pH, plaque index, and caries tests 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). **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

## 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]

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.[3–8]

Plaque and bacteria will start working 20 minutes after eating.[7] Dental plaque is a habitat where microbial metabolism occurs, affecting carious lesions' development.[9] 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.[10–12] 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.[6,10,11]

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.[6] 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.[4,5,12,13] The relationship between salivary characteristics, which include salivary pH, and plaque biofilms will play a role in the overall management of dental caries.[14] 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.

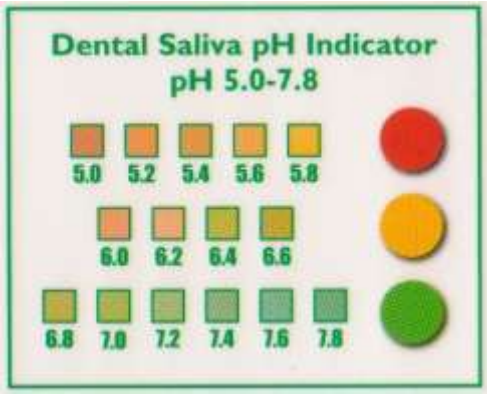
## RESEARCH METHODS

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 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. 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. Values 5.0–5.8 indicates low pH, 6.0–6.6 indicates a moderate pH, and 6.8–7.8 indicates a high pH.

*pH test strip* color result table (GC Corporation, Tokyo, Japan)




**Plaque Index Check**

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[15], is as follows:

| | |
|---|---|
| 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 1.

| | Mean | SD |
|---|---|---|
| Plaque Score | 25.36 | 23.38 |
| Ph | 2.872 | 0.37 |
| Permanent first molars Caries | 0.9359 | 1.15 |

Table 1: Mean and Standard Deviation of Plaque Score, pH, and Caries M1

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 2.

Table 2: Correlation of Salivary pH and Plaque Index to M1 Dental Caries

| | Correlation | p-value |
|---|---|---|
| Salivary pH | 0.144 | 0.208 |
| Plaque index | 0.245 | 0.031 |

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.[16] 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.[17]

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.[2,18] 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.[12,19] In the literature, it was found that pH indicates a high prevalence of caries.[12] 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 mole 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.[12] Under research conducted previously by Choudhary (2022), there is no statistically significant correlation between pH and caries index.[20]

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.[2,21] 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.[2,19,21]

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.*[22] In forming biofilms and dental plaque, microorganisms are essential in influencing the initiation and development of dental caries.[12]

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.[22] This can happen because microorganisms can attach to other microorganisms.[23]

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.[22] 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.[22,24]

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.[25] Dental plaque contains glucans (10–20%), fructans (1–2%), bacterial and salivary proteins (40%), fluoride, lipids, phosphorus, calcium, magnesium, and water up to 80%.[22]

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 experience an increase in microbial diversity dominated by the gram-negative microbe anaerobic, which will potentially make plaque pathogens and cause disease occurrence.[26–28] An imbalance of microbial communities will cause changes in dental plaque that exhibit cariogenic properties.[26]

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.[29] An increase in the proportion of Streptococcus mutans in dental plaque is closely related to the development of dental caries since this bacterium is considered the main etiological factor for the occurrence of dental caries.[30] 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.[12,31]

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.[32] This can occur due to dysbiotic changes in dental plaque that cause the pH to become acidic.[28] 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 ($Ca_{10}$ ($PO_4$) $_6$($OH)_2$), which then causes dental caries.[23,29]

Therefore, maintaining good oral hygiene is very important to prevent caries.[31] 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.[33]

## CONCLUSION

The dental plaque index significantly correlates with permanent first molar caries in adolescents aged 17–20. The incidence of caries does not have a significant relationship with the pH value of saliva in the oral cavity.

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## Bukti melakukan review yang pertama (09 Januari 2024)

Reviewer(s)' Comments to Author:

Reviewer: 1

Comments to the Author
- Please add explanation in the introduction why you chose subject adolescent 17-20 years old in introduction
- Please add information about informed consent and when did you collect saliva in the methods
- Is there an influence of the circadian rhythm of saliva on this study? If there is, you should add an explanation. It is suggested to add the effect of subject age to this study.

Reviewer: 2

Comments to the Author
Please see all of the comments and revise them point-by-point. Follow the guidelines to revise it, such as how to cite the references in the text.
1. abstract
Add the value of the significance level of the relationship and mention the statistical analysis.
How can the author conclude that there was a significant correlation between pH and plaque index, but there is no data on PI in the result.

2. Introduction/General:
Follow the guidelines for citation in the text.
Change from superscript 1 to bracket (1), and put the citation before the end of the text... (1).

3. Material and methods:
Put the figure appropriately. change to ...pH (Fig. 1).
You can improve on the plaque index check. I suggest you change to plaque index score interpretation.

According to O'Leary15, is as follows:..I suggest you present the variable in table.

4. Results:
You can merge tables I and II, or you can improve your data to make it easier for readers to interpret in table I, such as:
1. How many samples in carries?
2. How many sampels have PI scores?
3. present by gender or groups

And in Table II, you can present the mean and SD with a significant value, or in Figure.

5. Conclusion:
How can the author conclude like this? There was no specific mention that 17–20 year olds have a correlation, but in general.

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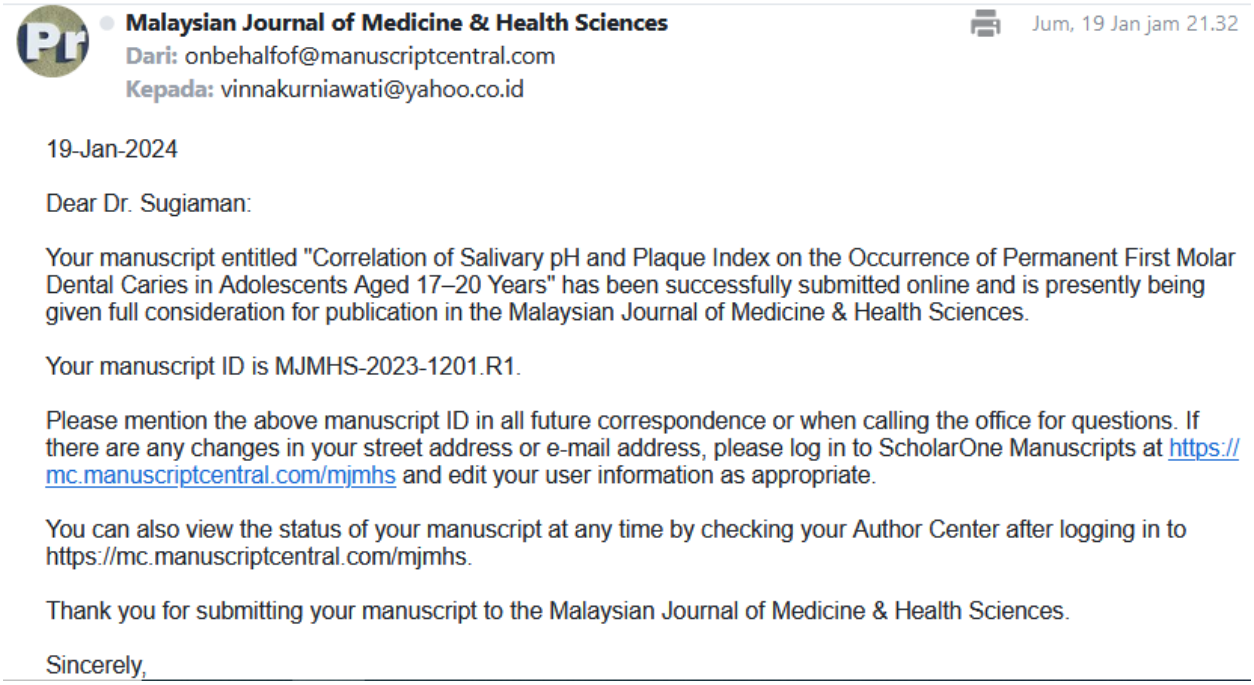

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19-Jan-2024

Dear Dr. Sugiaman:

Your manuscript entitled "Correlation of Salivary pH and Plaque Index on the Occurrence of Permanent First Molar Dental Caries in Adolescents Aged 17–20 Years" has been successfully submitted online and is presently being given full consideration for publication in the Malaysian Journal of Medicine & Health Sciences.

Your manuscript ID is MJMHS-2023-1201.R1.

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Sincerely,

| | | | | |
|---|---|---|---|---|
| a revision has been submitted (MJMHS-2023-1201.R2) | Contact Journal<br>ADM: Jamaludin, Amirah Farzana<br>• Minor Revision (05-Feb-2024)<br>• a revision has been submitted<br>view decision letter | MJMHS-2023-1201.R1 | Correlation of Salivary pH and Plaque Index on the Occurrence of Permanent First Molar Dental Caries in Adolescents Aged 17–20 Years<br>View Submission | 19-Jan-2024 |

## Bukti melakukan review yang kedua (05 Februari 2024)

Reviewer(s)' Comments to Author:

Reviewer: 1

Comments to the Author
Thank you for revising your manuscript, but you need to paraphrase a sentence in the abstract for a minor revision.

Reviewer: 2

Comments to the Author
Thank you for your revision
1. Please delete some sentences that you have already revised
2. Please add information the exact time to collect saliva sample

## Bukti konfirmasi submit artikel yang telah revisi kedua (13 Februari 2024)

**Malaysian Journal of Medicine & Health Sciences** Sel, 13 Feb jam 22.06
**Dari:** onbehalfof@manuscriptcentral.com
**Kepada:** vinnakurniawati@yahoo.co.id

13-Feb-2024

Dear Dr. Sugiaman:

Your manuscript entitled "Correlation of Salivary pH and Plaque Index on the Occurrence of Permanent First Molar Dental Caries in Adolescents Aged 17–20 Years" has been successfully submitted online and is presently being given full consideration for publication in the Malaysian Journal of Medicine & Health Sciences.

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Sincerely,

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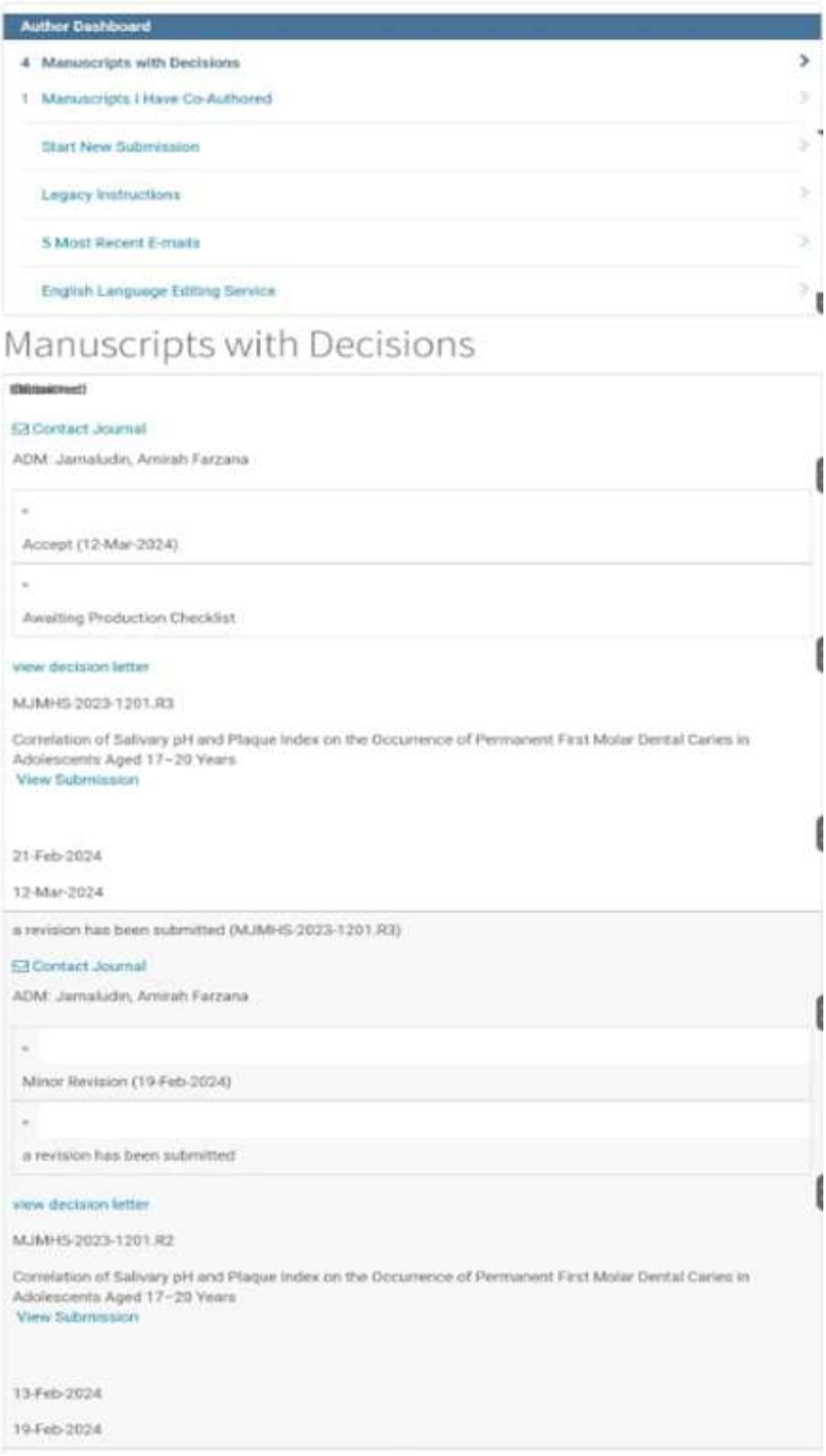
|---|---|---|---|---|
| a revision has been submitted (MJMHS-2023-1201.R3) | Contact Journal<br>ADM: Jamaludin, Amirah Farzana<br>• Minor Revision (19-Feb-2024)<br>• a revision has been submitted<br>view decision letter | MJMHS-2023-1201.R2 | Correlation of Salivary pH and Plaque Index on the Occurrence of Permanent First Molar Dental Caries in Adolescents Aged 17–20 Years<br>View Submission | 13-Feb-2024 |

## Bukti konfirmasi artikel diterima (12 Maret 2024)

| | | | |
|---|---|---|---|
| Contact Journal<br>ADM: Jamaludin, Amirah Farzana<br>• Accept (12-Mar-2024)<br>• Awaiting Production Checklist<br>view decision letter | MJMHS-2023-1201.R3 | Correlation of Salivary pH and Plaque Index on the Occurrence of Permanent First Molar Dental Caries in Adolescents Aged 17–20 Years<br>View Submission | |

## Bukti Galery Proof Manuscript



a revision has been submitted (MJMHS-2023-1201.R2)

Contact Journal

ADM: Jamaludin, Amirah Farzana

-

Minor Revision (05-Feb-2024)

-

a revision has been submitted

view decision letter

MJMHS-2023-1201.R1

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

19-Jan-2024

05-Feb-2024

a revision has been submitted (MJMHS-2023-1201.R1)

Contact Journal

ADM: Jamaludin, Amirah Farzana

-

Major Revision (09-Jan-2024)

-

a revision has been submitted

view decision letter

MJMHS-2023-1201

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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15-Oct-2023

09-Jan-2024

# Bukti Publiksi Online Artikel (28 Juni 2024)