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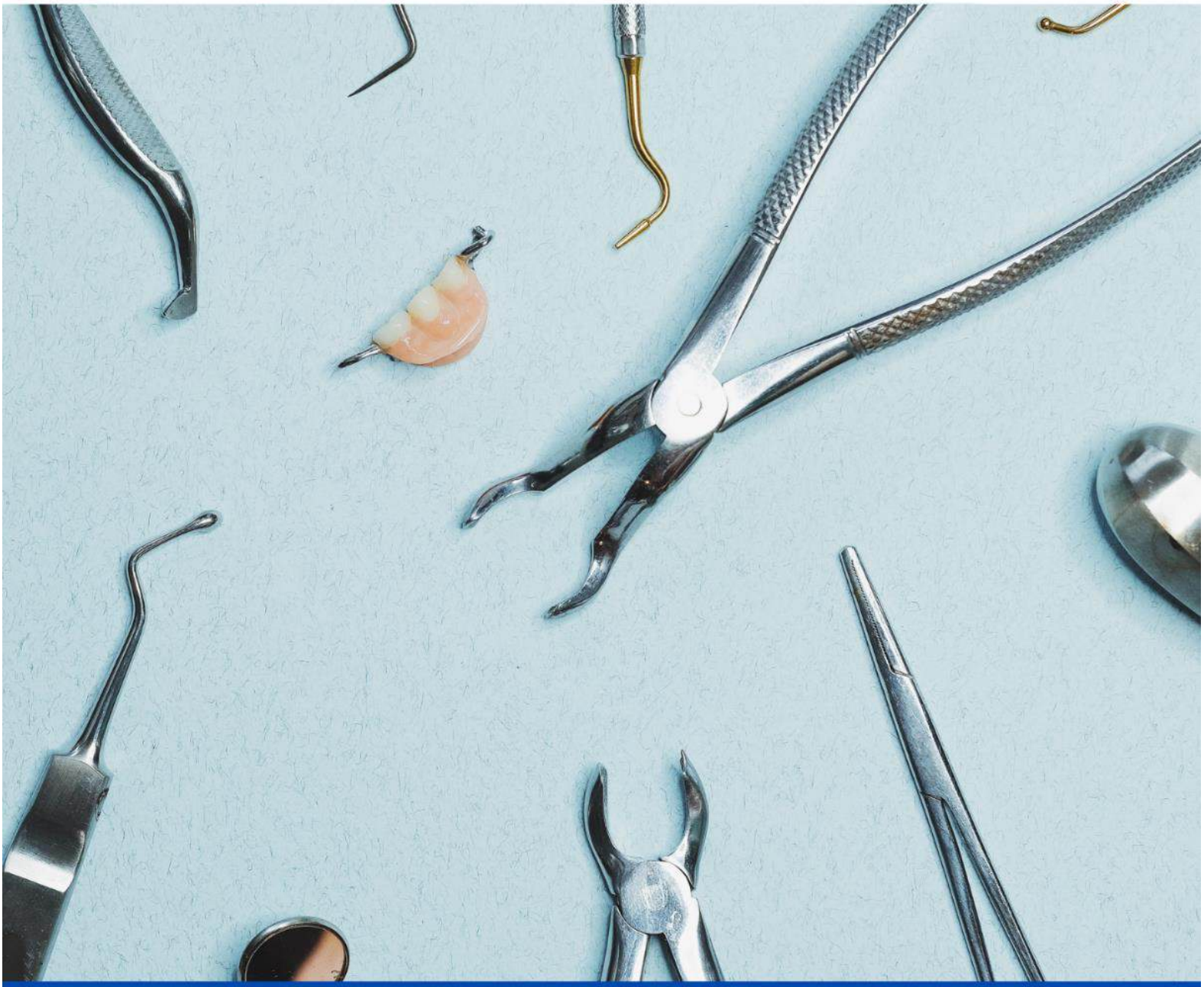

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RESEARCH ARTICLE

Clinical Characteristic and Severity of Molar-Incisor Hypomineralisation in 8-10 Years Old

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ABSTRACT

Background: *Molar Incisor Hypomineralization (MIH) is a qualitative developmental defect of tooth enamel that affects one or more permanent first molars and may involve incisors. The clinical features of MIH can include demarcated opacities, post-eruptive enamel breakdown, atypical caries, atypical restorations, and missing teeth due to MIH. Molar incisor hypomineralization is a common enamel defect with a relatively high prevalence worldwide, ranging from 9.2% to 14.2%. Data on the prevalence of MIH and clinical features of MIH in Indonesia are still minimal.* ***Objective:*** *To observe the distribution of clinical features and severity of molar-incisor hypomineralization in children aged 8-10 years in Kemanggisan urban village.* ***Materials and Methods:*** *This study used a descriptive observational study with a cross-sectional method. Data was collected through random sampling by examining 267 child subjects in the field.* ***Results:*** *The prevalence of MIH in Kemanggisan urban village was 29,2%. There was no significant difference in gender and age in the distribution of clinical features and severity levels. The highest prevalence of clinical features and severity levels were demarcated opacities and mild, at 9,6%.* ***Conclusion:*** *The most prevalent clinical feature and severity level was demarcated opacities and mild in children aged 8-10 years in Kemanggisan urban village.*

Keywords: *Children, Clinical Features, Molar Incisor Hypomineralization, Prevalence, Severity*

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INTRODUCTION

Molar Incisor Hypomineralization (MIH) is a common enamel defect with a relatively high prevalence worldwide.[1,2] It is a systemic and qualitative developmental defect of dental enamel that affects one or more first permanent molars (FPM), often involving the incisors.[3-5] This condition results from disturbances in amelogenesis, leading to enamel with reduced mineral content and increased porosity.[6,7] The diagnostic criteria of MIH were first introduced by the European Academy of Pediatric Dentistry (EAPD) in 2003, it includes clinical characteristics such as demarcated opacities, post-eruptive enamel breakdown (PEB), atypical caries, increased tooth sensitivity, and missing teeth due to MIH.[3,8]

The presence of MIH significantly impacts oral health, as affected teeth are more susceptible to dental caries and hypersensitivity and may also impact the quality of life.[5,9-11] Children with MIH experience challenges in maintaining oral hygiene, leading to an increased risk of restorative failures and requiring frequent dental visits.[12,13] The reduced mechanical properties of hypomineralized enamel make treatment difficult, often necessitating complex restorative approaches.[13,14]

MIH prevalence varies across countries and is estimated from 2.4% to 40.2%, with a global prevalence of approximately 9.2% to 14.2%.[3,15-17] Studies in Southeast Asia, including Thailand, Singapore, and Malaysia, have reported prevalence rates of 27.7%, 12.5%, and 16.9%, respectively.[1,18,19] A study conducted in Pasteur, Bandung, Indonesia, reported a prevalence of MIH is 19%.[20] Despite the growing concern over MIH, data on its prevalence and clinical characteristics in Indonesia remain scarce. The available data indicate high prevalence rates and may differ across regions in Indonesia, therefore requiring further research. The lack of comprehensive data on MIH and the lack of awareness among dental practitioners in Indonesia further contribute to delayed intervention and pose a challenge for early diagnosis and management.[21] These limitations lead to undetected early MIH cases, therefore, early prevention of MIH to prevent its adverse effects remains hampered. Understanding the prevalence, clinical manifestations, and severity of MIH in children is essential for developing preventive and treatment strategies, which are the purposes of this study focusing on Kemanggisan urban village, West Jakarta.

MATERIALS AND METHODS

Study design and research subjects

Ethical approval was granted by the Ethical Committee, Faculty of Dentistry, Universitas Trisakti (863/S1/KEPK/FKG/7/2024). This research is a descriptive observational study using a cross-sectional method. Stratified random sampling was used to determine subdistricts, urban villages, and schools. Three elementary schools were chosen in Kemanggisan urban village, West Jakarta, with a total sample of 267 students from SDN Kemanggisan 01 Pagi, SDN Kemanggisan 06 Pagi, and SDN Kemanggisan 08 Pagi. The inclusion criteria for subjects include children aged 8–10 years old with consent approval from guardians or parents for oral and dental examination and children with at least one permanent molar and more than one-third of the occlusal surface visible. Children with enamel defects due to trauma, those undergoing or having undergone orthodontic treatment, children with amelogenesis imperfecta, and uncooperative children were excluded.

Diagnostic criteria

The examiner (ED) was trained using a series of photographs. Kappa statistics revealed inter-examiner and intra-examiner agreements as very good (0.82) and good (0,8), respectively. This examiner conducted dental examinations on children aged 8–10 using EAPD criteria.[3]

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MIH is diagnosed from clinical characteristics, which are demarcated opacities, post-eruptive enamel breakdown, atypical caries and restoration, and missing teeth due to MIH. Demarcated opacities are abnormal conditions that appear as clearly defined opacities on the occlusal and buccal surfaces of the crown. The color of opacities ranges from white, cream, or yellow to brownish. Small defects measuring less than 1 mm are not reported. Post-eruptive Enamel Breakdown (PEB) refers to the post-eruptive enamel disintegration due to damage caused by masticatory pressure on fragile enamel, leading to dentin exposure and rapid caries development. Atypical restorations are restorations with sizes and shapes that do not conform to the typical caries pattern. In molars, restorations extend to the buccal or palatal surfaces or the cusp of the teeth, with opacities often visible at the restoration margins. Restorations on the labial surface of permanent incisors are not associated with trauma to primary teeth. Extracted teeth can be defined as cases of molar-incisor hypomineralization only when there are medical records or demarcated opacities on other permanent first molars. If such records are absent, the condition is not diagnosed as molar-incisor hypomineralization.[3,5]

The severity of molar-incisor hypomineralization (MIH), according to the European Academy of Pediatric Dentistry (EAPD), is classified by clinical appearance as follows: Mild symptoms are characterized by discoloration (white-yellowish, yellow, or brown) affecting the index teeth. Severe symptoms are defined by enamel loss accompanied by dentin exposure and/or atypical restorations on the permanent first molars or the permanent first molars with involvement of the incisors.[3,5] The examination is performed under wet conditions using a dental mirror and a flashlight for illumination.

These clinical characteristics in index teeth [4 first permanent molars (FPMs) and 8 permanent incisors (PIs)] were recorded using the short form examination format, which serves as a simple screening survey based on EAPD criteria.[5] The charting of EAPD index criteria is shown below:

Table 1. Diagnostic criteria[3]

Score	Definition
0	No defect enamel
1	Defect enamel, not MIH
2	Demarcated opacities
3	Post-eruptive enamel breakdown
4	Atypical restoration
5	Atypical caries
6	Missing due to MIH
7	Cannot be scored
I	Less than 1/3 affected
II	At least 1/3 but less than 2/3 of the tooth affected
III	At least 2/3 of the tooth affected
Mild	Tooth with demarcated opacities
Severe	Tooth with PEB. Atypical caries. atypical restoration, missing due MIH

Subjects examination

Prior to the examination, all children were provided with a fluoridated toothpaste and toothbrush. Students were instructed to use this product to clean their teeth, supervised by the examiner. The clinical examination was conducted by a trained examiner in a school classroom under adequate lighting, with the assistance of a headlamp. The teeth were assessed in a wet condition, and the remaining plaque and debris were further cleaned using a cotton roll to facilitate diagnosis. A dental mirror and WHO probe were utilized for the identification of HMI lesions, ensuring alignment with the guidelines established by the European Academy of Paediatric Dentistry (EAPD).

Data analysis

Data and intraoral photos of MIH, such as post-eruptive enamel breakdown, demarcated opacities, atypical restorations, and atypical caries, were recorded from the collected clinical MIH data. All clinical examination was performed by one examiner and kappa value

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was used for Calibration of intra-examiner reproducibility. The data were analyzed using univariate analysis for frequencies, distribution, severity, and clinical characteristics of MIH. Chi-squared tests were carried out to compare between distribution, severity of MIH according to sex and age using SPSS 23 statistical software with a level of significance set at $p<0.05$.

RESULT

The study was conducted in the Kemanggisan urban village across three public elementary schools, SDN Kemanggisan 01 Pagi, SDN Kemanggisan 06 Pagi, and SDN Kemanggisan 08 Pagi, from September 20 to November 16, 2024. The study aimed to determine the distribution of MIH clinical features and severity levels in Kemanggisan. A total of 267 children with the mean age was 8.85 (SD±0.748), consisting of 147 girls and 120 boys with mean age 8.72 (SD±0.710) and 9.00 (SD±0.767) respectively. These samples met the inclusion criteria, with the highest distribution observed among girls and 9-year-old children (41.9%) (Figure 1).

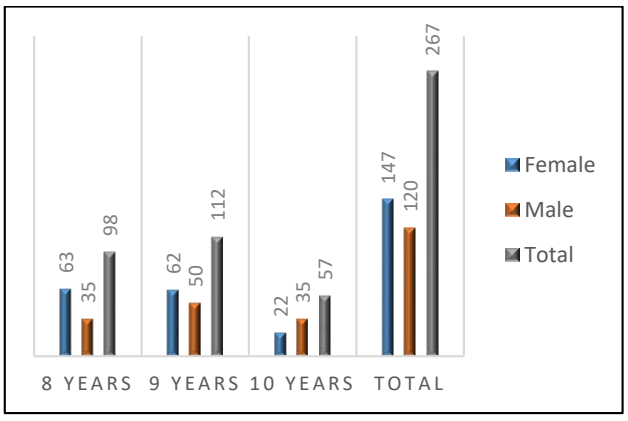

Figure 1. Age distribution according to sex

Figure 2 shows that the prevalence of MIH in children aged 8–10 years is 29.2% (N=78) out of a total sample of 267 children. Children who were not affected by MIH accounted for 70.8% (n=189). The highest distribution of MIH was found in boys, at 32.5% (n=39), but there was no significant difference between boys and girls (p>0.05) (Table 2).

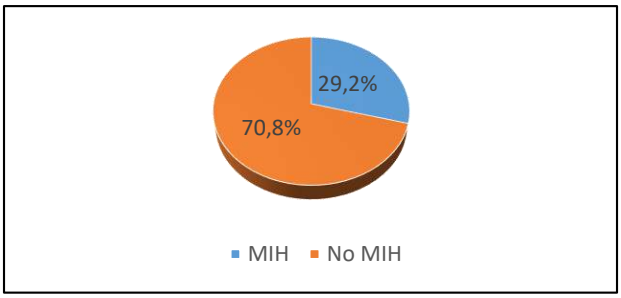

Figure 2. MIH distribution

Table 2. MIH distribution according to sex

Sex	MIH		No MIH		p-value
Male	39	32.5	81	67.5	0.351
Female	39	26.5	108	73.5	
Total	78	29.2	189	70.8	

The distribution of MIH by age group, with the highest prevalence observed in 10-year-old children (33.3%, n=19) and the lowest in 8-year-old children (26.5%, n=26). There was no significant difference in the distribution of MIH among children aged 8, 9, and 10 years (Table 3).

Table 3. MIH distribution according to age

Age	MIH		No MIH		*p-value*
	n	%	n	%	
8	26	26.5	72	73.5	0.666
9	33	29.5	79	70.5	
10	19	33.3	38	66.7	
Total	78	29.2	189	70.8	

Table 4 indicates that the highest occurrence of MIH was in the upper jaw at 16.5% (n=88), but there was no significant difference in MIH distribution between the upper and lower jaws (p>0.05). The distribution of clinical features of molars affected by MIH is shown in table 5. Demarcated opacities were the most frequently observed clinical feature in MIH patients, at 9.6% (n=102). In this study, no cases of missing teeth due to MIH were found.

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Table 4. MIH distribution according to arch

Jaw	MIH		No MIH		*p-value*
	n	%	n	%	
Upper Jaw	88	16.5	446	83.5	0.676
Lower Jaw	82	15.4	452	84.6	

Table 5. Clinical characteristic MIH in molars

Clinical features of MIH	Teeth no.									
	16		26		36		46		Total	
	n	%	n	%	n	%	n	%	n	%
Unerupted	2	0.7	1	0.4	0	0	0	0	3	0.3
Normal	215	80.5	216	80.9	225	84.3	220	82.4	873	81.7
Enamel defect. non MIH	7	2.6	7	2.6	2	0.7	3	1.1	19	1.8
Demarcated opacities	29	10.9	31	11.6	18	6.7	21	7.9	102	9.6
PEB	6	2.2	8	3.0	4	1.5	7	2.6	25	2.3
Atypical restoration	0	0	0	0	1	0.4	0	0	1	0.1
Atypical Caries	8	3.0	4	1.5	16	6.0	14	5.2	42	3.9
Missing due to caries	0	0	0	0	0	0	0	0	0	0
Can not be scored	0	0	0	0	1	0.4	2	0.7	3	0.3
Total	267		267		267		267		1068	

Table 6 presents the distribution of clinical features in incisors diagnosed with MIH. Similar to molars, demarcated opacities were the most commonly observed clinical feature in both the upper and lower incisors.

Table 6. Clinical characteristic MIH in incisor

Gambaran Klinisi HMI	Teeth																
	12		11		21		22		32		31		41		42		Total
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Unerupted	8	10.3	0	0	0	0	11	14.1	4	5.1	0	0	0	0	5	6.4	28
Normal	59	75.6	62	79.5	58	74.4	54	69.2	71	91.0	70	87.7	70	89.7	70	89.7	514
Enamel defect non MIH	5	6.4	6	7.7	6	7.7	5	6.4	1	1.3	1	1.3	0	0	0	0	24
Demarcated opacities	6	7.7	8	10.3	8	10.3	7	9.0	2	2.6	5	6.4	8	10.3	3	3.8	47
PEB	0	0	2	2.6	2	2.6	1	1.3	0	0	2	2.6	0	0	0	0.0	7
Atypical restoration	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Atypical caries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Missing due to MIH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Can not be scored	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	78	100	78	100	78	100	78	100	78	100	78	100	78	100	78	100	624

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The distribution of MIH severity levels is shown in table 7. with the mild category being the most prevalent at 9.6%. By gender, the highest severity distribution of MIH was found in boys at 10.6% (n=51), but there was no significant difference in severity levels between boys and girls (p>0.05). Distribution severity according to age is shown in table 8. Mild MIH severity was highest among 8-year-old children at 10.2% (n=40), while severe MIH was most common in 10-year-olds at 7.9% (n=18). Table 9 also shows that there was no significant difference in MIH severity between age groups (p>0.05)

Table 7. Degree of severity according to sex

Sex	Severity Level of MIH						*p-value*
	No MIH		*Mild*		*Severe*		
	n	%	n	%	n	%	
Boys	396	82.5	51	10.6	33	6.9	0.435
Girls	502	85.4	51	9.7	35	6.0	
Total	898	84.1	101	9.6	68	6.8	

Table 8. Degree of severity according to age

Age(Years)	Severity of MIH						*p-value*
	Non MIH		*Mild*		*Severe*		
	n	%	n	%	n	%	
8	334	85.2	40	10.2	18	4.6	0.466
9	375	83.7	41	9.2	32	7.1	
10	189	82.9	21	9.2	18	7.9	
Total	898	84.1	102	9.6	68	6.4	

According to Table 9, most MIH patients had only one affected molar at 35.9% (n=28), while the lowest number of affected molars was 4 molar at 14.1% (n=11). Table 10 shows that the most common pattern was two affected molars with no affected incisors at 77.3% (n=17). This study found no increase in the number of affected incisors as the number of affected molars increased.

Table 9. Molar tooth involvement in MIH children aged 8-10 years old

Molars	MIH	
	n	%
1 molar	28	35.9
2 molars	22	28.2
3 molars	17	21.8
4 molars	11	14.1
Total	78	100

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Tabel 10. The distribution of incisor involvement according to the number of affected molars in children aged 8-10 years old with MIH.

MIH Molars	Incisive involvement																	
	0		1		2		3		4		5		6		7		8	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
1	17	60.7	7	25.0	1	3.6	3	10.7	0	0	0	0	0	0	0	0	0	0
2	17	77.3	1	4.5	2	9.1	2	9.1	0	0	0	0	0	0	0	0	0	0
3	10	58.8	3	17.6	2	11.8	2	11.8	1	5.3	0	0	0	0	0	0	0	0
4	7	63.6	0	0	2	18.2	0	0	1	9.1	0	0	0	0	0	0	1	9.1
Total	51	65.4	11	14.1	7	9.0	7	9.0	1	1.3	0	0	0	0	0	0	1	1.3

DISCUSSION

This study aims to determine the prevalence of MIH (Molar Incisor Hypomineralization) in children aged 8–10 years old in Kemanggisan, West Jakarta, as well as the clinical characteristics and severity levels. This area of population is one of the subdistricts in West Jakarta was chosen using a randomized method. Several MIH indices have been used in previous studies. In 1982, the FDI organization published the DDE index, identifying demarcated opacities, diffuse opacities, and hypoplasia.[8] In 1987, a prevalence study by Koch *et al.* did not use the Developmental Defect of Enamel (DDE) index but instead described enamel defects based on color and surface changes. In 1992, FDI introduced the mDDE index because the DDE index was considered too complex for practical use.[8] In 1996, Alaluusua *et al.* published two studies on enamel defects in FPM using the Alaluusua criteria index. In 2003, the European Academy of Paediatric Dentistry (EAPD) introduced diagnostic criteria for MIH because the mDDE index was deemed too complicated, time-consuming, and did not cover other clinical features such as post-eruptive breakdown (PEB), atypical caries, atypical restorations, and missing due to MIH.[4,22,23] In 2015, Ghanim *et al.* refined the MIH diagnostic criteria by combining the EAPD and mDDE indices, incorporating clinical features, lesion extent and severity levels. The EAPD officially standardized this index for epidemiological MIH studies.[23]

This study adopts the EAPD index as a standard for MIH epidemiological research, allowing its prevalence and severity results to be compared with studies from other countries using the same index. The prevalence of MIH in Kemanggisan similar results to a study at SDN Tomang 01 Pagi (28.9%) which in the same district West Jakarta.[24] However, it was relatively high compared to studies in Japan (19.8%) and Singapore (12.5%).[1,25] This study shows a higher MIH prevalence than a previous Indonesian study in Pasteur, Bandung (19%).[20] The similarity prevalence between Kemanggisan and Tomang, which is in the same district, West Jakarta, shows that it may be influenced by socioeconomic and also geographic or environmental factors.

MIH prevalence in Kemanggisan is higher than the global estimate (9.4–14.2%), with variations across regions possibly influenced by ethnicity, socioeconomic status, and cultural factors. Differences in results between studies could arise due to differences in diagnostic criteria, indices, sample sizes, age groups, examiner calibration, and data collection methods. Research has shown that using EAPD criteria results in higher prevalence values compared to other diagnostic criteria.[23] Studies in Iran found that MIH prevalence in Ardebil (24%) using the EAPD index was higher than in

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Zahedan (12.7%) using the DDE index.[26] The 8–10 year age group is the optimal time for MIH diagnosis, as standardized by the EAPD, when all first permanent molars and most permanent incisors have erupted. In older children, MIH-affected molars may be difficult to identify due to post-eruptive enamel breakdown (PEB) and previous restorative treatments.[23]

This study found that MIH was more prevalent in boys than in girls, but the difference was not statistically significant. Similar results were reported in Poland, Beijing, and India, while a study in Madrid found that girls had significantly higher MIH prevalence.[27-30] A meta-analysis by Schwendicke *et al.* confirmed that there is no significant difference in MIH prevalence based on gender.[31]

The highest age distribution in this study was in 10-year-old children at 33.3% (n=19), with no significant difference between ages. Studies in Barcelona reported that 9-year-olds had the highest MIH prevalence, while Madrid, Syria, and Nigeria found no significant differences between age groups.[3,32-34] A meta-analysis by Zhao *et al.* suggested that older children show lower MIH prevalence due to increased tooth loss over time.[16]

The most common severity level in this study was mild MIH at 9.6%, which aligns with findings from Fujairah, Lebanon, and Egypt.[35-37] The similarity in severity in these studies may be due to the same age group population, which is recommended by EAPD. Other studies in endemic fluorosis areas found higher severe MIH prevalence, possibly due to misdiagnosis between MIH and fluorosis. [38]

This study found no significant differences in MIH severity between boys and girls, consistent with studies in Lebanon.[36] Studies by Zhao D, Mishra, and Hamdan suggest that MIH severity increases with age due to greater masticatory pressure and caries risk.[16,29,37] This study supports that finding, with severe cases being most prevalent at age 10 and mild cases at age 8. Severe MIH increases plaque accumulation, gingival inflammation, and caries risk due to the porous nature of MIH-affected enamel, which leads to hypersensitivity.[39] Hypersensitivity may discourage children from brushing their teeth, leading to poor oral hygiene and increased plaque accumulation.[5,9,13] The decreased resistance and elasticity of MIH teeth also contribute to enamel breakdown and PEB, which further increases plaque buildup and caries risk.[9,10,39,40]

Previous studies have shown that first molars affected by MIH are more commonly found in the upper jaw than the lower jaw. This finding is consistent with the present study, where maxillary first molars had a higher MIH prevalence than mandibular first molars, though the difference was not statistically significant. A study by Gomez *et al.* in Barcelona reported similar findings, explaining that mandibular molars erupt earlier than maxillary molars, making them more susceptible to extensive caries which make difficulties in MIH diagnosis.[32] However, studies by R. Elzein *et al.* and S. Yannam *et al.* found different results. Chawla *et al.* noted that the mandible is easier to examine directly, whereas maxillary molars require indirect vision, increasing the likelihood of diagnostic errors.[36,41,42]

In this study, demarcated opacities were the most common MIH lesion, consistent with other studies.[43] This finding may be because demarcated opacities are easier to diagnose with direct visualization and adequate lighting. Demarcated opacities is an early lesion usually find in new erupted teeth. The severity will increase with age, which can change mild lesion to a severe lesion due to mastication and environmental factors. Other clinical features, such as PEB and MIH-induced caries, were harder to distinguish due to poor oral hygiene and high caries rates among participants. Extensive enamel damage also posed a challenge in differentiating MIH-related caries from regular caries.

In this study, the most commonly affected number of molars was one molar,

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whereas a study in Syria found that two molars were most commonly affected. Similar results were reported in studies in Sudan.[44] Variations in findings may be attributed to regional differences in habits and characteristics. This study was limited to one subdistrict area in West Jakarta, was conducted with a cross-sectional method and needs a cohort study with a larger area of population to obtain more accurate data about the MIH population. A cohort longitudinal observation is also needed to identify etiological factors in Indonesia.

CONCLUSION

The prevalence of molar incisor hypomineralization (MIH) in children aged 8-10 years in Kemanggisan is 29.2%. The most commonly observed clinical feature is demarcated opacities, accounting for 9.6%. The most common severity level of MIH is mild. These findings underscore the need for early diagnosis and appropriate management strategies to minimize the impact of MIH on children's oral health. Expanding the scope of research to other regions in Indonesia would help determine whether MIH prevalence, clinical features, and severity levels are affected by geographic or socioeconomic factors. Future studies should identify specific environmental and genetic risk factors contributing to MIH in Indonesia.

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RESEARCH ARTICLE

Effect of Areca Nut Extract Tooth Paste on Tooth Discoloration

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ABSTRACT

Background: *Areca nut extract is an active compound that can be used as an alternative toothpaste ingredient because it has antibacterial properties that can prevent cavities, but the tannin and flavonoid content in areca nut extract has the potential to cause discoloration of tooth.* ***Objective:*** *To determine the effect of areca nut extract (Areca catechu L.) toothpaste on tooth enamel color.* ***Materials and Methods:*** *This study was a true experimental laboratory type using pre test - post test with control group design. The study sample was 28 post-extraction human premolars who met the inclusion and exclusion criteria. The samples were divided into 4 treatment groups, 7 samples each in the group brushed using areca nut extract toothpaste concentrations of 1,5%, 3%, 4,5% and toothpaste without areca nut extract. Samples were brushed 2 times a day for 14 days. Measurement of color change using ColorFlex EZ spectrophotometer.* ***Results:*** *The results of data analysis obtained the average value of color change for toothpaste concentration of 1,5% of 4,38, 3% concentration of 5,40, 4,5% concentration of 7,37 and without areca nut extract of 0,98. The results of the One Way ANOVA test obtained a p value <0,05, meaning that there were a significant effect in each treatment group. The results of Post Hoc LSD analysis showed significant differences between all treatment groups, except between the treatment groups using 1,5% concentration of areca nut extract toothpaste and 3% concentration of areca nut extract toothpaste.* ***Conclusion:*** *areca nut extract toothpaste has an effect on the color of tooth enamel. The 4,5% concentration of Areca nut extract toothpaste has a significant effect on tooth discoloration.*

Keywords: *Areca Nut Extract, Tooth Discoloration, Tooth Paste*

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INTRODUCTION

Aesthetics is a very important aspect in human daily life. Aesthetics can affect the quality of human life, especially the appearance of teeth, which is influenced by several factors such as the color, position, alignment, and shape of the teeth.[1] Tooth color is one of the physical aspects that can affect appearance and for some individuals tooth color can directly affect quality of life (2). Changes in tooth color have a psychological impact on a person, namely the emergence of a lack of confidence and discomfort with the appearance of their teeth .[3]

Research conducted in Medan stated that of 70 Prima Indonesia University students, 31,4% were not confident with their smiles and 84,3% wanted to have brighter color of teeth.[4] Another study conducted in India regarding satisfaction with smiles, there were 201 women and 225 men involved and the results of the majority of subjects with a percentage of 57,7% were very satisfied with their smiles, more than a third of subjects with a percentage of 37,7% were satisfied and as many as 4,9% subjects were dissatisfied with their smiles. The component of the smile that causes dissatisfaction in the subject is the color of the teeth with a percentage level of 27,9%.[5] A person is dissatisfied with the appearance of his smile caused by tooth discoloration so that various ways are done to achieve a better smile.[3,6]

Tooth discoloration can be caused by intrinsic, extrinsic or both factors.[7] Intrinsic discoloration can be caused by stains present in enamel and dentin during odontogenesis or after tooth eruption.[8] Extrinsic discoloration is staining that occurs on the surface of tooth enamel, for example, staining caused by smoking, food, and drinks containing tannins .[10]

Some studies state that the tannin and flavonoid content contained in herbal plants (red betel leaves, coffee, green betel leaves, areca nut seeds, bay leaves) can cause discoloration of natural tooth enamel and artificial teeth. Research conducted by Amanda and Wahyuni stated that there was a color change in acrylic resin artificial teeth after being soaked in basil leaf extract.[10] Research conducted by Puspasari showed that there was a change in the color of premolar tooth enamel after extraction after being soaked in coffee solution for 14 days.[11] Research conducted by Kalasworojati et al stated that there was a color change in acrylic resin dentures after being soaked in red betel leaf essential oil boiling water.[12] Research conducted by Sovira et al on the effect of strawberry extract toothpaste on tooth discoloration states that there is a color change after applying toothpaste for 14 days.[13]

Areca nut (Areca catechu L.) seeds contain compounds such as alkaloids, tannins, quinones, terpenoids, saponins, and flavonoids that have antibacterial properties.[14] Research conducted by Afni et al stated that toothpaste of areca nut ethanol extract with concentrations of 1,5%, 3%, and 4.5% has inhibition against Sterptococcus mutans bacteria and Staphylococcus aureus bacteria with the greatest inhibition at a concentration of 4,5% .[15]

Based on the above background, areca seeds have the potential to be used as a toothpaste ingredient because they have antibacterial properties, but can also cause discoloration of tooth enamel. Based on the description above, the author is interested in examining the effect of areca nut extract toothpaste (Areca catechu L.) on the color of tooth enamel. This study aims to determine the effect of areca nut extract toothpaste (Areca catechu L.) on the color of tooth enamel.

MATERIALS AND METHODS

This research was a true exsperimental laboratory study with a pre test and post test research design with control group design conducted on 28 post-extraction human tooth samples. The manufacture of areca nut extract was carried out at the Organic Chemistry Laboratory, Faculty of Mathematics and Natural

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Sciences, Andalas University, the manufacture of areca nut extract toothpaste was carried out at the Pharmacy Laboratory, Andalas University, planting and brushing samples were carried out at the Microbiology Laboratory, Faculty of Medicine, Andalas University, and measurement of sample color before and after treatment was carried out at the Instrumentation Laboratory, Faculty of Agricultural Technology, Andalas University.

The research procedure commenced with the collection of areca nuts. Areca nut is cultivated throughout Indonesia; nevertheless, the largest distribution and primary export production centers are situated on Sumatra Island, specifically in Jambi Province and Aceh Province.[16] The Central Bureau of Statistics of West Sumatra Province states that West Sumatra is able to produce 8,048 tons of areca nut annually with Pasaman Regency in second place in producing 1,402 tons of areca nut annually.[17] Areca nuts that have been collected will be wet sorted then washed thoroughly with running water and dried using tissue, Areca nuts that have been cleaned are then split and the seeds are thinly sliced and then dried using sunlight for 5 days, Areca nuts that have been dried are then mashed using a blender so that they are powdered and sieved, Store the sieved powder in a tightly closed and clean container, and then sterilization of the tools to be used, then proceeds with the manufacture of areca nut extract. The extract was made by maceration method using 96% ethanol solvent, and continued by concentrating the extract with a rotary evaporator. Planting the sample is done using epoxy resin with the buccal part facing up and checking the initial color using ColorFlex Ez Sprectrophotometer. Areca nut extract toothpaste was made with concentrations of 1,5%, 3%, 4,5% and toothpaste without areca nut extract as treatment control. The samples were brushed for 10 seconds twice a day for 14 days and after brushing the samples were soaked in artificial saliva and stored in an incubator at 37^0C. Samples checked for final color using ColorFlex Ez Sprectrophotometer.

Figure 1. (Color measurement with ColorFlex EZ spectrophotometer)

The results of the study were the difference in color changes before and after brushing. The data obtained were then analyzed with One Way ANOVA and Post Hoc LSD tests.

RESULT

The results showed a change in color that occurred on tooth enamel after brushing using toothpaste with areca nut extract concentrations of 1,5%, 3%, 4,5%, and toothpaste without areca nut extract. The average results of tooth sample color changes can be seen in Table 1.

Table 1. Average color change of tooth samples in treatment groups

Treatment	n	Tooth Discoloration		
		Mean ±SD	Min	Max
Areca Nut Extract Toothpaste 1.5%	7	4,3892± 0,6880	2,2465	7,5225
Areca Nut Extract Toothpaste 3%	7	5,4016± 0,5817	3,5600	8,0713
Areca Nut Extract Toothpaste 4.5%	7	7,3736± 0,8738	2,6966	10,3483
Toothpaste without Extract Areca Nut	7	0,9874± 0,1682	0,3002	1,6727

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The results of the univariate analysis in Table 1 show that the greatest color change occurred in the group that brushed their teeth using toothpaste of areca nut extract concentration 4,5% with an average of 7,37, while the smallest color change occurred in the group that brushed their teeth using toothpaste of areca nut extract concentration 1,5% with an average of 4,39.

The data from the univariate analysis were then processed statistically to analyze the effect of areca nut extract toothpaste on tooth enamel color. Bivariate analysis begins with a normality test, namely the Saphiro Wilk test with meaning (p>0,05) to determine whether the data is normally distributed. The results of the Shapiro Wilk test obtained a value of p>0,05 which indicates that the data is normally distributed. The Levene's test homogeneity test was carried out next to find out whether the data was homogeneous or not. The results of the Levene's test showed a value of p = 0.30 which means p>0,05 so that the data was declared homogeneous. Furthermore, the One Way ANOVA parametric test was carried out with the results of p < 0,01, which means that there was a significant effect of the value of changes in tooth enamel color before and after brushing using areca nut extract toothpaste and toothpaste without areca nut extract. Differences in color changes between treatment groups analyzed by the Post Hoc LSD test can be seen in Table 2.

Table 2. Post Hoc LSD Test Results

	Areca Nut Extract Tooth paste 1,5%	Areca Nut Extract Tooth paste 3%	Areca Nut Extract Tooth paste 4,5%	Tooth paste without Extract Areca Nut
Areca Nut Extract Tooth paste 1,5%		0,269	0,003*	0,001*
Areca Nut Extract Tooth paste 3%			0,038*	0,001*
Areca Nut Extract Tooth paste 4,5%				0,001*
Tooth paste without Extract Areca Nut				

Notes: *P value <0,05 (significant)

The results of the Post Hoc LSD test in Table 2 showed that there are significant differences between each treatment group except between the treatment groups using areca nut extract toothpaste concentrations of 1,5% and 3%.

DISCUSSION

The results of the average difference in color changes in each treatment group are influenced by the content of polyphenols (tannins and flavonoids) contained in each concentration.[18] Polyphenolic compounds are compounds that can be characterized by the presence of aromatic rings that carry more than one hydrogen ion. Polyphenolic compounds are divided into two groups, namely flavonoids (flavones, flavanols, flavanones, isoflavones anthocyanidins and chalcones) and tannins (phenolic acid polymers, catechins or isocatechins) .[19] Polyphenols are known as powerful antioxidants that can neutralize free radicals by donating hydrogen ions.[20] These compounds (polyphenols) are the color-producing compounds in areca nuts.[21]

These results are in line with research conducted by Annisa and Pintadi, (2013), stating that coffee with concentrated concentrations contains high polyphenols. Polyphenols have hydrogen ions (H) that can bind directly to the surface of tooth enamel, H ions in polyphenols will bind to the negative charge contained in the enamel. So, the higher the concentration of areca nut extract, the more H ions that bind to the surface of the enamel so that it will cause a

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darker color change in tooth enamel.[22] Another study stated that the difference in color produced by coffee, tea, and cola is due to differences in chromogen content (compounds that produce colored substances such as polyphenols) contained in each solution. The highest color difference is produced by coffee because of the high chromogen content contained in it.[23]

Significant color changes in each treatment group brushed using areca nut extract toothpaste are due to the content of polyphenolic compounds contained in areca nut. Areca seeds, which were originally brownish in color after being extracted, turned into a reddish brown.[24] Areca nut extract is acidic because it contains polyphenols, namely flavonoids and tannins. Tannins contained in areca nuts can produce a strong color and are water soluble so that they can cause discoloration of tooth enamel. The acid content contained in areca nuts helps discoloration by making the surface of the enamel rough so that the stain easily sticks and causes discoloration .[25]

Extrinsic stains occur outside the tooth surface or inside the pellicle protein. The mechanism of extrinsic stains is through denaturation of pellicle proteins by acidic tannins and the incorporation of chromogen compounds (colored compounds) into pellicle proteins. The acid contained in tannins has strong denaturation properties against pellicle proteins. Denatured pellicle proteins will then increase the ability to stain. The pellicle protein can selectively bind to the enamel surface through calcium bonds, the chromogen contained in areca nut then interacts with the pellicle through hydrogen bonds. Chromogen that binds to pellicle proteins will produce a color on the surface of the tooth enamel with the natural color of the chromogen itself.[26] The acidic properties contained in tannins can cause discoloration of tooth enamel both in vitro and in vivo. Previous study explained that the acidic nature of tannins can denature pellicle proteins and increase the ability to stain. The acid in tannins has a strong strength in denaturing pellicle proteins.[27]

The sample group brushed using toothpaste without areca nut extract also obtained a significant color change value. This result is because toothpaste without areca nut extract contains abrasive compounds (calcium carbonate) that cause erosion of the teeth. Dental erosion is the loss of hard tooth tissue by a nonbacterial chemical mechanical process, which results in the loss of superficial (outer) enamel and causes the color of the teeth to become yellower or darker.[28]

The insignificant difference between the tooth brushing treatment group using 1,5% concentration of areca nut extract toothpaste and tooth brushing using 3% concentration of areca nut extract toothpaste is caused by the color change value (ΔE) which is 1,00 (ΔE <2). ΔE is the value of changes in the color of tooth enamel before and after brushing using areca nut extract toothpaste. These results are in line with research conducted by Pani et al, (2015), which states that if the color change value (ΔE) is less than 2 then it cannot be seen with the naked eye (not significant). The average value of color change (ΔE) between other treatment groups shows a value (ΔE) >2 which means it can be seen with the naked eye (significant) .[29]

The significant results that occur between each treatment group are due to the higher concentration of areca nut extract in toothpaste, the greater the color change that occurs on tooth enamel. Discoloration of enamel can occur directly through chromogen compounds (colored compounds) attached to pellicle proteins. Chromogen compounds (colored compounds) can bind directly to the tooth surface through double bonds between H ions produced by tannins with enamel surfaces that have a negative charge. The charge produced by this enamel will absorb H ions through pellicle proteins. Pellicle protein is a glycoprotein compound that can be formed by conditioning the sample like the atmosphere in the oral cavity, namely by immersing the sample in artificial saliva. So, the more H ions that bind

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to the surface of the enamel, the greater the color change that occurs in tooth enamel .[29,30]

The results of this study indicate that areca nut extract toothpaste with concentrations of 1,5%, 3%, and 4,5% cannot be used as commercial toothpaste because it exceeds the threshold of color change values that can be seen by the human eye, namely ΔE>2.

CONCLUSION

Areca nut extract toothpaste has an effect on the color of tooth enamel. The 4,5% concentration of Areca nut extract toothpaste has a significant effect on tooth discoloration.

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RESEARCH ARTICLE

Effect of Edible Coating on Color Stability and Strength of Heat-Cured Acrylic Soaked in Tea

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ABSTRACT

Background: *Dentures are a standard treatment option for replacing missing teeth. One of the most essential components of dentures is the denture base. However, the acrylic resin has a weakness, namely that it has porosity, which can cause water absorption and colour changes. Water absorption in the acrylic resin can affect its colour stability, flexural strength, and hardness over a specific period. Tea is a drink often consumed in Indonesia. Black tea has undergone oxidation of several polyphenolic compounds (catechins). The fermentation process results in the oxidation of simple polyphenols, where tea catechins are converted into more complex and concentrated molecules that give black tea its characteristic colour. The edible coating is a thin layer made from consumable materials that acts as a barrier.* ***Objective:*** *To determine the effect of edible coating on heat-cured acrylic resin denture plates on colour retention, flexural strength, and hardness after soaking in black tea.* ***Materials and Methods:*** *This research utilized 25 heat-cured acrylic resin plates, divided into five groups with varying soaking times for the edible coating. The plates were then soaked in black tea for 15 hours, after which testing was conducted on the color resistance, hardness, and flexural strength of the heat-cured acrylic resin plates.* ***Results:*** *Acrylic resin plates with chitosan have better colour retention than acrylic resin not soaked with chitosan. Meanwhile, flexural strength and hardness values between groups did not differ significantly.* ***Conclusion:*** *Chitosan immersion affects the colour durability of the heat-cured acrylic resin denture base without significantly decreasing the hardness and strength values.*

Keywords: *Black Tea, Chitosan, Edible Coating, Acrylic Resin*

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INTRODUCTION

One of the components of a denture is the denture base. Heat-cured acrylic resin is used as a base.1 Heat-cured acrylic resin has various advantages, including aesthetics, easy polishing and manufacturing techniques, non-toxic, cheaper, and lighter.[1] However, the acrylic resin has the weakness of having a porosity that can cause water absorption and colour changes.[2,3] Water absorption in the acrylic resin can affect colour stability, flexural strength, and hardness over a certain period.[4,5]

Tea is a popular beverage often consumed in Indonesia. Tea is divided into four main groups based on processing method: green, black, white, and oolong, which are most commonly consumed in Indonesia. Black tea is a trendy tea that is widely consumed worldwide.[6,7] Black tea has undergone oxidation of several polyphenolic compounds (catechins). Catechins undergo oxidation to form their oxidation compounds, namely theaflavin, a yellow substance, and thearubigin, a brownish substance.[6] The fermentation process results in the oxidation of simple polyphenols, where tea catechins are converted into more complex and concentrated molecules, which give black tea its colourful, robust, and flavorful characteristics.[7]

The physical properties of acrylic resin can be affected by liquid absorption, which disrupts the polymer chain bonds and can impact the surface hardness of the acrylic resin over time.[2,5] The liquid absorption problem on acrylic plates can be overcome with a barrier against external factors by coating with an edible coating. An edible coating is a thin layer made from consumable materials that serves as a barrier.[3] The three main components of edible coating are hydrocolloids (proteins and carbohydrates), lipids (wax, acylglycerols, and fatty acids), and composites (mixtures). The edible coating is a natural polymer coating material that has biocompatible and biodegradable properties, so it can be used to overcome the weakness of the properties of heat polymerized acrylic resin, namely the absorption of coloured liquids in dentures, so that there is no liquid absorption, which will affect the colour resistance of heat-cured acrylic plates.[3,8]

Based on the properties of chitosan-based edible coatings, they are believed to reduce water absorption when soaked in a black tea solution, which will also affect their flexural strength and hardness.

MATERIALS AND METHODS

The research was conducted at the ITB Bandung and Dental Materials laboratories at Maranatha Christian University. The colour stability test used 25 plate acrylic resin samples measuring 20 mm x 20 mm x 3 mm, divided into five groups based on ADA specifications.

The flexural strength test utilized 25 plate-shaped acrylic resins, each with a length of 65 mm, a width of 10 mm, and a thickness of 2.5 mm, as specified in ADA No. 12. The hardness test employed a tube-shaped acrylic resin sample with a diameter of 5 mm and a thickness of 3 mm. Each test was divided into five groups, namely group 1 control, where samples were soaked using distilled water; group 2 samples were soaked in black tea for 15 hours and not coated with edible coating; group 3 samples were soaked in black tea for 15 hours and coated with edible coating for 15 hours and coated with edible coating for 3 minutes, group 4 samples were soaked in black tea for 15 hours and coated with edible coating for 4 minutes, and group 5 samples were soaked in black tea for 15 hours and coated with edible coating for 5 minutes.

Brewing black tea is made with a ratio of 2 grams of black tea to 100 ml of mineral water. 2,500 ml of mineral water is heated until it boils at a temperature of 100 ± 10 °C, with the aid of a water bath, and 50 grams of black tea leaves are then dissolved in it. After 3-4 minutes, the brewed black tea was filtered and then transferred into autoclave bottles, each containing 100 mL. The temperature was maintained at 37 °C using an incubator.

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The chitosan coating application was carried out by pouring 250 mL of Chitosan Edible Coating (Chitasil, PT. BIKI Indonesia) solution into a beaker. Then, the sample was added and left to sit for the specified time for each group. After coating the samples in groups 3, 4, and 5, they were placed in distilled water for group 1 and black tea for groups 2, 3, 4, and 5. The beaker containing the samples with distilled water and black tea was placed in the incubator at a temperature of 37 °C and soaked for 15 hours. After 15 hours, the sample was removed, wiped with a cloth, and left in the open air for 15 seconds.

The colour stability test was conducted by comparing the colour before and after immersion using the CIELab system with an FTIR spectrophotometer. The flexural strength test was conducted using the Universal Testing Machine Shimadzu AGSX flexural strength testing machine. The measurement results obtained are in MPa. The hardness test was carried out using the Vickers hardness test with a Shimadzu HMV-G21 machine. The load used is 100 g in 15 seconds. Each sample was tested for hardness at three random points.

RESULTS

Table 1 shows the results of the influence of chitosan immersion on colour retention on heat-cured acrylic. Based on the Shapiro-Wilk normality test results, the data used in this study were not normal, so data analysis was continued with the Kruskal-Wallis non-parametric test.

Table 1. Average Wave Number Results for Acrylic Resin Plates

No	Group	Number	Wave Number (cm-1)($\bar{x}$)
1.	Aquades	5	3446.79
2.	Black Tea	5	3449.56
3.	Black Tea + coatingchitosan 1 minute	5	3433.29
4.	Black tea + coating chitosan 2 minutes	5	3433.29
5.	Black tea + coating Chitosan 3 minutes	5	3433.29

Based on the results of hypothesis testing using data 1 (Kruskal-Wallis), the data used in this study have a p-value of 0.000, indicating that there is a significant effect of immersion in chitosan on the colour retention of heat-cured acrylic resin denture bases steeped in black tea. Hypothesis test data 2 (Kruskal-Wallis) yielded a p-value of 1, indicating that there is no significant difference in the duration of chitosan soaking on the colour retention of heat-cured acrylic resin denture bases in black tea brewing.

The results of the flexural strength test are presented in Table 2. The most significant value was in group 3. The one-way ANOVA test using MINITAB yielded a p-value of 0.218, indicating that the flexural strength between groups was not significantly different.

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Table 2. Mean and standard deviation of flexural strength (MPa)

No	Group	Mean	SD
1.	Aquades	584,3	147,6
2.	Black Tea	778,8	75,6
3.	Black Tea + coating chitosan 1 minute	792,4	185,0
4.	Black tea + coating chitosan 2 minutes	647,2	183,0
5.	Black tea + coating Chitosan 3 minutes	697,1	164,5

The results of the hardness test are presented in Table 3. The normality test for the hardness values yielded a p-value <0.05, so the test between groups was continued with the Kruskal-Wallis test, which resulted in a p-value of 0.069. Therefore, it can be concluded that there was no difference in hardness values between groups.

Table 3. Mean and standard deviation of hardness (VHN)

No.	Group	N	Mean	SD
1.	1 (Aquades)	15	25,52	9,55
2.	2 (Black Tea)	15	26,97	6,30
3.	3 (Black Tea + coating chitosan 1 minute)	15	31,05	9,13
4.	4 (Black tea + coating chitosan 2 minutes)	15	33,24	9,32
5.	5 (Black tea + coating Chitosan 3 minutes)	15	31,17	10,68

DISCUSSION

An FTIR spectrophotometer is used to determine the color changes that occur by examining the water absorption of the acrylic resin plate. Based on the results, there are significant differences in the effect of water absorption between groups. Modern colourimetric spectrophotometers measure the light reflected or transmitted from an object. The data are sent to a processor, where it is multiplied by standard illuminant and standard observer functions to yield the XYZ tristimulus values. Absorption of colored fluids on the acrylic resin base can affect the transmission and reflection of light, influencing the intensity of light that passes through the acrylic resin. The more colour liquid the acrylic resin base absorbs, the more concentrated the acrylic resin base will be, and the less light intensity can be transmitted because the acrylic resin base reflects some of the light intensity.[10] Based on the FTIR spectrophotometer result, it can be concluded that the acrylic resin plate soaked with chitosan (groups 3,4,5) has better colour durability than acrylic resins that are not soaked with chitosan (groups 1 and 2).

In this study, heat-cured acrylic resin plates were soaked in black tea for 15 hours. This followed previous research, where the colour change in heat-cured acrylic resin was most significant on acrylic resin plates that were soaked in black tea for 15 hours or consumed black tea for three months.[11] The soaking time for a heat-cured acrylic resin plate can affect the water absorption of the plate because the longer the acrylic resin is in contact with water, the more water molecules will penetrate the polymer and occupy the space between the polymer chains.[12] Black tea contains acidic tannins, which can disrupt the polymer chain bonds of acrylic resin and increase its porosity.[13,14] Black tea contains theaflavin and thearubigin, which can cause more profound colour changes in the denture base.[11]

A heat-cured acrylic resin denture base soaked in chitosan can reduce water absorption and discoloration because the chitosan-coated denture base forms a layer on the surface of the heat-cured acrylic resin denture base. Chitosan and acrylic resin have different properties. Chitosan has basic properties, while PMMA or acrylic resin contains COOH and acidic properties. From these differences in properties, the interaction between chitosan and acrylic resin can occur through electrostatic interactions. The electrostatic interaction between positively charged chitosan and the

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negatively charged acrylic resin surface will form a solid ionic bond.[15-17]

Chitosan has hydrophobic properties, allowing it to form a hydrophobic bond with the material's surface, thereby reducing water absorption in the material, including heat-cured acrylic resin.[18] Soaking chitosan in a heat-cured acrylic resin plate can form a protective layer on the surface and inhibit water absorption on the plate of heat-cured acrylic resin, so that the chitosan-soaked denture base exposed to black tea can experience reduced water absorption and thus reduce discolouration. This study is in line with previous research where chitosan coating affects the water resistance of heat-cured acrylic resin denture base materials.[4]

Applying chitosan by immersion influences the absorption of coloured liquids, but the effectiveness of soaking acrylic resin plates in chitosan is similar. Soaking with chitosan can create even distribution throughout the base surface of the acrylic resin, occupying porous areas and potentially preventing the absorption of coloured liquid through these areas. [4]

The application of chitosan influences water absorption, which indicates the adsorption and absorption that occur when the material is used. Water absorption in the acrylic resin can act as a plasticizer, causing discolouration and decreased mechanical properties of acrylic resin, such as hardness, transverse strength, and fatigue limit. [19]

In this study, immersing chitosan in a heat-cured acrylic resin plate forms a protective layer on the surface, inhibiting water absorption and preventing a decrease in hardness and flexural strength values compared to the control. Nonetheless, a study by Adiana et al. suggested that high-molecular-weight chitosan Nano gel might preserve the colour stability of heat-polymerized PMMA DBR. Less water absorption and fewer leftover monomers may result in better colour stability. This is because the characteristics of the polymer material are restored upon the addition of nano-chitosan gel as a filler.[23]

CONSLUSIONS

Chitosan immersion affects the colour durability of the heat-cured acrylic resin denture base without significantly decreasing the hardness and strength values.

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RESEARCH ARTICLE

Effect of Glass Fiber Reinforcement on the Mechanical Properties of Acrylic Resin Denture Base

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ABSTRACT

Background: *Acrylic resin dentures are frequently reported to experience damage within a few years after fabrication. Intraorally, repeated masticatory forces can lead to fatigue failure and fracture, while high extraoral impact forces, such as accidental drops, may also lead to fractures of the denture base.* ***Objective:*** *To determine the optimal concentration of glass fibers reinforcement that provides the highest values of impact strength, transverse strength, and hardness in acrylic resin.* ***Materials and Methods:*** *A total of 48 acrylic resin samples were divided into four groups based on glass fiber concentration: 0%,6%,9%, and 12%. Each group was tested for impact strength, transverse strength, and hardness. Samples dimension for impact strength: 65 mm x 10 mm x 2.5 mm, 80 mm x 10 mm x 4 mm for transverse strength, and tube-shaped with a diameter of 5 mm and a thickness of 3 mm for hardness test. Testing equipment for impact strength: Charpy testing machine (Resil Impactor Ceast 6958.000), Universal Testing Machine (Shimadzu AGS-X 10kN for transverse strength, and Vickers machine (HMV-G) for hardness test.* ***Results:*** *The highest impact strength was observed in the group with 0% glass fibers. Meanwhile, the addition of 12% glass fibers exhibited the highest transverse strength exhibited and the highest hardness was achieved in samples containing 6% glass fibers.* ***Conclusion:*** *The addition of 12% glass fiber enhances the transverse strength of acrylic resin but decreases impact strength. Meanwhile, adding 6% glass fiber improves the hardness of acrylic resin.*

Keywords: *Acrylic Resin Base, Impact Strength, Transverse Strength, Hardness*

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INTRODUCTION

Tooth loss is currently one of the most common oral health issues in Indonesia.[1,2] According to the 2018 Basic Health Research (Riskesdas) report, 19% of Indonesians have experienced tooth loss, with the highest prevalence found in individuals aged over 65 (30.6%), followed by those aged 55–64 (29%).[3] Dentures are commonly used to replace missing teeth. Generally, there are two types of dentures: fixed dentures and removable dentures. The most widely used material for denture-based is heat-polymerization acrylic resin[4], due to its numerous advantages, including good aesthetics, low water absorption, favorable thermal conductivity, biocompatibility, ease of handling and repair, and cost-effectiveness. [5–7]

However, heat-polymerized acrylic resin dentures are susceptible to cracking or fracturing after extended use, particularly as a result of repeated impacts. These materials have certain mechanical limitations, especially in terms of impact strength, compressive strength, and transverse strength. Biomaterials used in the fabrication of dentures, denture bases, bridges, and similar prosthetic devices are subjected to complex stress patterns during use, including combinations of compressive, tensile, and shear forces. Therefore, analyzing flexural strength is essential in evaluating the durability and performance of these prostheses.[8–10] Fracture is the most common problem encountered by both patients and dentists in relation to polymethyl methacrylate (PMMA) denture bases. According to Johnston et al., impact failure accounts for nearly 68% fractures observed in acrylic denture bases a few years after fabrication.[10] To enhance the mechanical properties of denture base materials have been improved by adding a polyfunctional crosslinking agent, rubber phase, metal wires or meshes, and fibers have been explored. [4,11]

Surface characteristics such as roughness, hardness, and wettability also play a critical role in denture-associated stomatitis. Rougher denture surfaces are more likely to harbor microorganisms, contribute to halitosis, and are more prone to discoloration than smoother surfaces, thereby decreasing patient comfort.[4,12]

MATERIALS AND METHODS

The research was conducted in the Laboratory of the Faculty of Dentistry, Maranatha Christian University for the transverse strength and hardness tests, while the impact strength tests were performed at the Bandung Institute of Technology Laboratory between May and July 2024. The study used a laboratory-based experimental design with a post-test-only control group design. The tools used in this research are a Charpy testing machine (Resil Impactor Ceast 6958.000) to test impact strength and a universal testing machine (Shimadzu AGS-X 10kN) to test transverse strength, and Vickers hardness tester to test hardness (HMV G). Specimens were divided into three groups tested for impact and transverse strength: Group 1: heat-polymerized acrylic resin with 6% glass fibers; Group 2: heat-polymerized acrylic resin with 9% glass fibers; Group 3: heat-polymerized acrylic resin with 12% glass fibers.

The procedures of spesimen's preparation include the fabrication of heat-polymerized acrylic resin specimens with and without glass fiber reinforcement, followed by testing for impact strength, transverse strength, and hardness. Then, the glass fiber was added to the acrylic powder before mixing with the liquid monomer. The glass fiber concentrations used were 6%, 9%, and 12%, calculated as follows: as a base mixture, 9 grams of polymer was added to 4.5 ml of liquid monomer to get a result of 13.5 g. Then 13.5 g is multiplied by 6% to get a result of 0.81 g of glass fiber (Group 1). Meanwhile, the percentage of 9% is 13.5 multiplied by 9% to get a result of 1.215 g of glass fiber (Group 2). For a percentage of 12%, that is 13.5, multiplied by 12% to get a result of 1.62 g of glass fiber (Group 3).

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The heat-polymerized acrylic resin specimens were prepared after immersing the glass fibers in liquid monomer. Six samples were prepared with dimensions of 80 mm x 10 mm x 4 mm for the impact strength test for each Group (ISO No. 806 104 377514). Next, six samples were prepared with dimensions of 65 mm x 10 mm x 2.5 mm for the transverse strength test (ISO No. 20795). Then, six samples were prepared with dimensions a tube-shaped with 5 mm diameter and 3 mm thickness (ADA specification No. 12) for the hardness test. The following are the sample-making stages: Prepare the cuvette, prepare the wax pattern with dimensions of 65 mmx10mmx2.5mm and 80 mmx10mmx4mm, stir the plaster, then pour it into the cuvette above the vibrator. Place the wax pattern that has been made on the plaster cast evenly before it hardens. After the plaster cast hardens, apply a thin layer of vaseline to the surface of the cast using a brush. Fill the top cuvette by inserting the cast plaster and lock the cuvette by pressing it using a pressing machine. Then clean the excess cast and do the boiling out.

After the plaster has hardened, open the cuvette, apply Cold Mold Seal (CMS) evenly using a brush, put the heat polymerized acrylic mixture into the cavity, then insert the mold, then line it with cellophane and press with a pressing machine, lock the cuvette, and boil the cuvette.

The impact strength test procedure is as follows: the researcher ensures that the sledgehammer is in the zero position when the sledgehammer hangs freely at an angle of 45 degrees; the sample is placed on a support and ensures that the sledgehammer hits the center of the notch; raise the sledgehammer slowly until the sledgehammer shows the initial angle (the sledgehammer is automatically locked); press the lock release button so that the sledgehammer will swing down and break the sample; after the sample is broken, observations are made and data is recorded.

The transversal strength test procedure is as follows: the sample is placed on the bottom plate of the machine, and the universal testing machine will apply a compressive force at a speed of 20 mm/minute. After pressing the data parameters on the monitor, it will display the results of the test process. Hardness testing was carried out using a Vickers indenter in the form of a pyramid-shaped diamond.

Prepare the sample with ground flat with a thickness of 2.5 ± 0.5 mm andburied in clear resin for Vickers hardness tes, this is inaccordance with the ADA standard AAT hardness test. The test specimens were sanded using grade 120, 240, and 400 sandpaper to obtain a flat shape and surface and accurate results. Next, the specimen was placed on the Vickers working platform and loaded (300 grams) with a loading time of 10 seconds. The minimum indenter distance is 1 mm on the surface of the polished material. Next step is the machine calculates the microhardness value digitally.

The data were analyzed using the *One-way* ANOVA and *post-hoc* LSD. Furthermore, the *Scanning Electron Microscope* (SEM) (JEOL JSM IT-200) was used to evaluate the surface characteristics of the heat-polymerized acrylic resin with glass fibers.

RESULTS

Table 1. The transverse strength results were evaluated based on the addition of glass fibers at varying concentrations.

Transversal Strength	Glass Fiber 0%	Glass Fiber 6%	Glass Fiber 9%	Glass Fiber 12%
Specimen 1	201.601	233.419	250.511	309.282
Specimen 2	222.065	223.081	285.972	255.580
Specimen 3	187.582	245.347	286.192	258.650
Specimen 4	229.471	267.924	232.106	256.266
Specimen 5	236.558	276.960	237.780	245.135
Specimen 6	166.512	219.563	212.047	216.152

Table 1. shows Group 3 contained 12% of glass fibers had the highest result of transverse strength, 309.282 N/mm^2.

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Meanwhile, Group 3 showed the lowest impact strength compare to the other groups (Table 2).

Table 2. The impact strength results were evaluated based on the addition of glass fibers at varying concentrations.

Impact Strength	Glass fibers 0%	Glass fiber 6%	Glass fibers 9%	Glass fibers 12%
Specimen 1	12.404	11.435	7.519	8.569
Specimen 2	12.485	12.314	7.033	9.079
Specimen 3	13.634	9.427	7.339	8.428
Specimen 4	14.050	9.346	7.028	9.042
Specimen 5	14.408	14.235	6.996	8,055
Specimen 6	10.325	9.118	6.641	7.304

Table 3. The hardness results were evaluated based on the addition of glass fibers at varying concentrations.

Hardness	Glass fibers 0%	Glass fibers 6%	Glass fibers 9%	Glass fibers 12%
Specimen 1	21,0; 19,2; 21,1	10,6; 11,5 ;9,0 1	20,6; 21,3; 21,9	14,8; 15,8 ;14, 1
Specimen 2	20,9; 19,0; 18,4	13,4; 12,7; 12,6	19,7; 19,5; 20,4	10,1; 10,2; 10,3
Specimen 3	10,9; 9,83; 10,7	11,1; 12,2; 11,6	14,3; 12,6 ;11, 8	16,5; 16,1; 17,2
Specimen 4	21,3; 20,7; 20,4	11,1; 10,7; 12,4	12,1; 11,9; 11,7	11,3; 11,5; 11,6
Specimen 5	13,6; 13,8; 13,4	12,6; 12,9; 12,1	12,9; 13,5; 12,2	19,5; 17.8; 19.0
Specimen 6	12,8; 11,8; 12,2	10,4; 10,9; 10,5	13,7; 13,9; 14,3	13,7; 13,1; 15,6

Table 3 shows that Group 2 contained 9% of glass fibers performed the highest average of hardness compared to the other groups, except the control group. Meanwhile, Group 1 contained 6% of glass fibers showed the lowest hardness compared to the other groups.

Table 4. The statistical analysis of the impact strength and the transversal strength

	Total square	dk	Mean square	F Value	Significance
Impact strength test					
Between groups	120.902	3	40.301	23.030	<0.001
In groups	34.998	20	1.750		
Total	155.900	23			
Transversal strength test					
Between groups	8928.993	3	2976.331	3.837	0.025
In groups	15515.312	20	775.766		
Total	24444.305	23			

Table 4 shows data the impact strength and transverse strength were proven to be normally distributed and homogenous, so the process used next was *One-Way ANOVA*.

Table 5. The statistical analysis of the hardness

	Total square	dk	Mean Square	F Value	Significance
Hardness test					
Between group	203.054	3	67.685	3.671	0.030
In group	368.744	20	18.437		
Total	571.798	23			

Tabel 5 proven that the hardness was normally distributed and homogeneous, so the process used next was One-Way ANOVA.

Table 6. Comparison test results data of impact strength test (*post-hoc* LSD)

	SK0	SK6	SK9	SK12
SK0		0.021	0.001	0.001
SK6			0.001	0.003
SK9				0.099
SK12				

Tabel 6 shows that the next data analysis carried out was *post-hoc Tukey* LSD. The purpose of this analysis was to determine the most significance differences between all specimens. The smallest mean in *post-hoc Tukey* LSD can be determined to be the most significance difference. The most significant impact strength results are at 0% glass fiber to 9% glass fiber, 12%, 6% glass fiber to 9% glass fiber because it shows a result of 0.001. Meanwhile, the least significant is 9% glass fiber

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to 12% glass fiber because it showed the value was 0.099.

Table 7. Comparison test results data of transverse strength test (*post-hoc* LSD)

	SK0	SK6	SK9	SK12
SK0		0.032	0.014	0.006
SK6			0.695	0.447
SK9				0.710
SK12				

Tabel 7 In terms of transverse strength, significant forces were associated with glass fiber content ranging from 0% to 12%. Conversely, the least significant forces were observed in the same range, with glass fiber content ranging from 9% to 12%.

Table 8. Comparison test results of hardness test data (*post-hoc* LSD)

	SK0	SK6	SK9	SK12
SK0		0.004	0.106	0.045
SK6			0.132	0.277
SK9				0.657
SK12				

In the hardness test, the most significant results were obtained from 0% to 6% glass fiber, indicating a value of 0.004. Conversely, the least significant results were observed from 9% to 12% glass fiber, resulting in a value of 0.657.

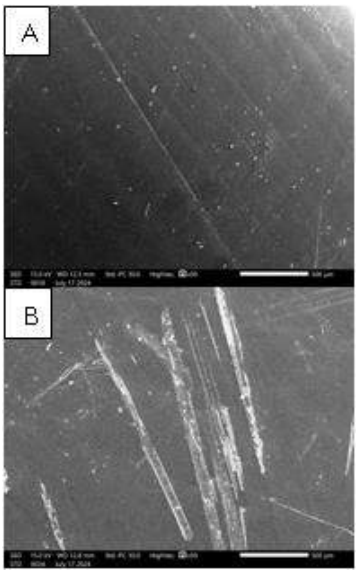

Figure 1. (A) Scanning electron microscope of acrylic without glass fiber; (B) acrylic with 12% glass fiber.

Scanning electron microscope in Figure 1 shows agglomeration of glass fibers in acrylic.

DISCUSSION

Table 6 and 7 showed varying values were caused by several factors, including the uncontrolled sample manipulation, manufacturing process, one of which was due to the mixing of monomer and polymer in heat polymerization denture base materials. Manual mixing techniques tend to trap air in the heat polymerized acrylic resin denture base. The presence of this porosity (Figure 1) affects the strength of the heat polymerized acrylic resin denture base[13], therefore in this study a vacuum mixer was used to mix the monomer, polymer, and glass fiber. Lee et al. (2012) noted that previous studies often compared impact strength with transverse and fracture resistance. However, they found a weak correlation between impact strength and transverse strength or modulus of elasticity. Zappini et al. reported that impact strength only showed a moderate correlation with fracture resistance.[15]

It is possible to draw the conclusion, based on the findings of the tests that were carried out, that the composition of the glass fibers has an effect on the impact strength, transversal strength, and hardness of the heat polymerized acrylic resin denture base. Glass fiber, a fiber composed of fine glass fibers containing silica dioxide (Si_2O_3), exhibits strong covalent bonds and isotropic chemical structures. These characteristics contribute to its denser and stronger structure, enabling it to absorb loads generated by heat polymerized acrylic resins. Moreover, the addition of boron trioxide enhances the hydrolytic stability of the glass fiber surface, reducing water absorption. Consequently, the water absorption by the heat-polymerized acrylic resin denture base is indirectly minimized, leading to improved impact and transverse strength. Because the heat polymerized acrylic resin denture base achieved maximum transversal strength at 12% of

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309,282 N/mm2. The addition of 12% glass fiber was the most effective for increasing the transversal strength.[14] Nirwana (2005) stated that there was an increasing in transverse strength significantly after the addition of glass fiber in hybrid acrylic resins. The glass fiber's SiO2 content is what gives glass fiber its strength and ability to absorb the RAPP denture base material's loads, both those that come from chewing and from inside the mouth and those that come suddenly when the denture base falls.[15]

Goguta et al. (2006) reported that there was an increase in the impact strength of heat-polymerized acrylic resin with the addition of rod and woven glass fibers.[15] The addition of glass fiber to the heat polymerized acrylic resin denture base for impact strength can be said to be not optimal if it is added by 6% at 9,865 kJ/m2 or more because the results obtained show a lack of strength compared to without the presence of glass fiber and compared to the addition of glass fiber 3 %.12 Impact strength continues to decrease at 9% by 9,068 kJ/m2 and at 12% by 9,472 kJ/m2. This happens because glass fiber has stiff properties so that as glass fiber is added to the acrylic resin material, it will weaken the impact strength if added too much. The value of this test result may vary due to several factors that cannot be controlled during this research, one of which is the distribution of fibers that spread out through the mold resulting in reduced fiber concentration.[15,16]

The role of glass fiber in this research is as a filler. The reaction of glass fiber with hot polymerization acrylic resin, namely the silicon dioxide content, causes the glass fiber to become denser and stronger.[15,17]

The addition of glass fiber in a concentration of 6% showed the highest increase in hardness (Table 8), then decreased at 9% and 12%. Therefore, both the impacts of the included fibers and the decreased amount of resin matrix may be to blame for the bulk reinforced acrylic resin's decreased surface hardness.[18] Figure 1 shows agglomeration of glass fibers in acrylic on sampel with 12% glass fiber. On the other hand, the interparticle distance decreases with increasing filler loading, allowing for more agglomeration. When the reinforcing agent's content reached the ideal amount, agglomeration occurs. Stress is created at clumped particles, reducing the material's mechanical qualities.[19]

CONSLUSION

Incorporating 12% glass fiber enhances transverse strength; however, it negatively affects impact strength. Meanwhile, a 6% glass fiber addition increases the hardness of the material.

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RESEARCH ARTICLE

Fluoride Concentration in Anchovy *(Stolephorus commersonnii)* Nanopowder and Its Potential in Dental Caries Prevention

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ABSTRACT

Background: *Dental caries is a common infectious disease that leads to the demineralization and structural degradation of the tooth's hard tissues, caused by acid-producing bacteria such as S. mutans through carbohydrate fermentation. One of the essential strategies for caries prevention is using fluoride to inhibit bacterial activity and enhance enamel remineralization. Anchovy Stolephorus commersonnii, widely found in Indonesian waters, were rich in calcium and fluoride, particularly in the form of calcium fluoride (CaF_2), which may offer potential benefits in preventing dental caries.* ***Objective:*** *This study aimed to assess the fluoride concentration in S. commersonnii nanopowder to evaluate its potential as a natural source of fluoride for dental caries prevention.* ***Materials and Methods:*** *This research was a descriptive laboratory-based experimental study. The sample was Stolephorus commersonnii (S. commersonnii). The sample was prepared through drying, acid maceration, and high-energy milling to produce nanoparticle powder. Fluoride content was measured using two methods: a colorimetric method with a spectrophotometer and a portable fluoridemeter based on the SPADNS method.* ***Results:*** *The results showed that the fluoride concentration was 21.05 mg/100 g (21.05 ppm) by spectrophotometry and 20.0 ppm using the SPADNS method. The S. commersonnii nanopowder contained 1,305.80 mg/100 g calcium, 281.60 mg/100 g phosphorus, and 91.5% of particles were in the nano size.* ***Conclusion:*** *S. commersonnii nanopowder contains a considerable amount of fluoride and minerals, suggesting its potential as a natural dietary source of fluoride in supporting dental caries prevention strategies.*

Keywords: *anchovy, dental caries, fluoride, natural source, Stolephorus commersonnii*

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INTRODUCTION

Dental caries is a common infectious disease that leads to the demineralization and structural degradation of the tooth's hard tissues. Among the key pathogens in dental caries is *Streptococcus mutans (S. mutans)*, which metabolizes sugars into acid that demineralizes tooth enamel.[1-3] Effective caries prevention involves reducing sugar intake and inhibiting the activity of cariogenic bacteria, especially *S. mutans*.[4,5] In addition to commonly used synthetic agents such as sodium fluoride or stannous fluoride, researchers are increasingly exploring natural sources, such as plants, marine organisms, and minerals, for their potential in preventing dental caries.

Fluoride plays a crucial role in caries prevention through three primary mechanisms. First, fluoride ions in the oral cavity help regulate calcium and phosphate ions within demineralized enamel, promoting remineralization. Second, fluoride can replace hydroxyl ions in hydroxyapatite crystals, forming fluorapatite, which is more resistant to acid and thus protects the teeth from demineralization.[6] Third, fluoride acts therapeutically on bacterial cells by penetrating their membranes and disrupting carbohydrate metabolism and the production of adhesive polysaccharides, which are essential for bacterial attachment to dental plaque.[7] Fluoride inhibits the metabolism of plaque bacteria that ferment carbohydrates, and it enhances the transformation of hydroxyapatite ($Ca_{10}(PO_4)_6(OH)_{2)}$ into fluorapatite ($Ca_{10}(PO_4)_6F_{2)}$, which is more resistant to acid attacks at pH levels below.[4,5,8] The formation of fluorapatite reduces enamel solubility in acidic conditions, accelerates the remineralization process, and exhibits antimicrobial activity by inhibiting bacterial enzymes such as enolase, thereby preventing acid production within the biofilm.[9,10] However, the antibacterial effect of fluoride is relatively limited. The growth and metabolism of cariogenic bacteria are influenced only when the fluoride concentration exceeds 10 ppm. In the context of caries prevention, fluoride is primarily effective by promoting remineralization of initial carious lesions and preventing the demineralization that leads to the initiation and progression of caries. Fluoride is effective when present in the oral cavity and is not effective when ingested systemically.[11]

The search for natural sources of fluoride has gained interest. One such potential source is anchovy (*Stolephorus sp.*), a small marine fish commonly found in Indonesian waters.[10] According to data from FishBase, there are 19 species of anchovy identified in Indonesian waters. *Ikan teri nasi* (*Stolephorus commersonni*) has known locally as *ikan teri Medan* or Medan anchovy, is a well-known traditional food product from Medan city, which is often brought home by visitors as a signature local delicacy. It is known for its small size and rich mineral content, making it a potential natural source of fluoride.[12]

Anchovies are considered high-quality food because the entire body—including the bones—is edible, making them a rich source of protein, calcium, and micronutrients. Anchovy bones are particularly valuable for their calcium and fluoride content, essential for tooth development in children. Every 100 grams of fresh anchovy provides approximately 77 kilocalories of energy, along with 16 grams of protein, 1 gram of fat, and essential minerals such as 500 milligrams of calcium, 500 milligrams of phosphorus, and 1 milligram of iron. Moreover, anchovies contain various essential vitamins, particularly vitamin A and B-complex groups.[10]

A study by Agustanti et al. using an ion-selective electrode method found that fresh *Stolephorus insularis* contained 12.935–13.381 ppm of fluoride, while the dried form had higher concentrations ranging from 15.416 to 24.914 ppm.[13] A recent study by Prahasti and Yuanita demonstrated the successful fabrication of nanoscale *Stolephorus* sp. powder using a top-down approach through high-energy milling. The process involved drying the fish, sieving the

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resulting powder, and subjecting it to milling durations of up to 24 hours. The resulting powder was found to be rich in bioactive components, including 28,912 mg/kg calcium and 1,924 mg/kg magnesium, indicating its potential application as a natural source of bioactive minerals.[14] These findings suggest that anchovy could serve as a natural and bioavailable source of fluoride for dental applications, making it a promising candidate for further exploration in caries prevention strategies.

Despite these findings, no specific studies have been conducted to quantify the fluoride content in *S. commersonnii*. Therefore, this study aimed to evaluate the fluoride content of *S. commersonnii* processed into nanopowder and to explore its potential use in dental caries prevention.

MATERIALS AND METHODS

This research was a descriptive laboratory-based experimental study conducted in April 2025. The anchovy samples were obtained from local fishermen in Tanjung Tiram Village, Batubara Regency, North Sumatra Province (3.2361° N, 99.5902° E). It was then sent to the Animal Systematics Laboratory, Faculty of Mathematics and Natural Sciences, Universitas Sumatera Utara, for taxonomic identification. Based on the official identification letter No. 25/UN5.2.1.11/KRK/ 2024, the local fish known as ikan teri Medan was taxonomically confirmed as *Stolephorus commersonnii*. This study received ethical approval from the Ethics Committee of Sumatera Utara, Medan-Indonesia, with reference number 327/KEPK/USU/2025.

A total of 1 kg of anchovy was used in this study, selected through purposive sampling based on freshness and absence of strong odor. The sample size was determined based on the minimum quantity required to perform the necessary laboratory analyses. It was boiled at 80°C for one hour to eliminate pathogens and reduce odor, and then washed and sun-dried for one day. After drying, 100 g of anchovy was macerated in 1 M hydrochloric acid (HCl) for 2 hours to help dissolve certain components, followed by rinsing with distilled water until the pH was neutral. The sample was then oven-dried at 50°C for 36 hours to ensure complete dehydration. The dried anchovy was ground using a mortar and sieved through a 60-mesh filter to obtain a uniform powder. The powder was further processed using High Energy Milling (HEM) for 7 hours at 600 rpm with 4 mm-diameter stainless steel grinding balls to produce nanoparticle-sized anchovy powder, and was measured using a Particle Size Analyzer (PSA) with a Fritsch Analysette 22 NanoTec.

The fluoride content in *S. commersonnii* nanopowder was measured using two different analytical methods. The first method was conducted at the Industrial Research and Consultation Agency (BPKI) Surabaya using a colorimetric method with a spectro-photometer. The second method used a portable fluorimeter (Hanna Instrument HI739) based on the SPADNS method (sodium 2-(parasulfophenylazo)-1,8-dihydroxy-3,6-naphthalene disulfonate). SPADNS reacts with zirconyl chloride solution to form a red complex, which is then decolorized in the presence of fluoride ions. This color change is measured using a colorimeter.

The procedure using the portable fluoridemeter was as follows: The instrument was turned on by pressing the ON/OFF button. When “Add C.1” appeared with a blinking “Press” icon, 2 mL of HI739AS reagent was added to a cuvette using a syringe, followed by filling to the mark with HI739BS reagent (Figure 1). The cuvette was sealed, inverted several times to mix, and inserted into the checker for zeroing by holding the ON/OFF button. After zeroing, the cuvette was removed, and 1 mL of sample was added, mixed, and reinserted. The measurement was then initiated by pressing and holding the button again, and the fluoride concentration was displayed in ppm.

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Figure 1. Step-by-step fluoride analysis procedure using Hanna Checker Fluoride HR. (A) Addition of 2 mL Reagent A (HI739AS) into a 10 mL cuvette. (B) Addition of Reagent B (HI739BS) until the cuvette reaches the 10 mL mark, resulting in a red-colored solution. (C) *S. commersonnii* was added to the reagent solution using syringe. (D) The cuvette containing the test mixture is inserted into the Hanna Checker Fluoride HR device for fluoride concentration measurement.

RESULTS

According to The Animals Systematics Laboratory USU, *S. commersonnii* is characterized by a maximum body length of 7-8 cm and a body height of 1-2 cm. The fish has a light brown translucent body, a slightly compressed shape with a somewhat rounded abdomen, no anal spines, and 21-22 soft anal fin rays. The belly bears 0-5 small prepelvic scutes resembling needles. The upper jaw is pointed, reaching or slightly exceeding the posterior margin of the preopercle. The lower gill rakers number 23-28. Small teeth present on the upper edge of the hyoid bone. The isthmus musculature tapers evenly forward to the posterior edge of the branchial membrane. The tips of the pelvic fins reach below the anterior dorsal fin, and the anal fin is short, with three unbranched rays and 18-19 branched rays.

The Particle Size Analyzer (PSA) measurement revealed that the nanoparticle powder of *S. commersonnii* had a mean particle size of 43.88 nm. The median particle size was recorded at 26.20 nm, while the mode (the most frequently occurring particle size) was 11.36 nm. The mean-to-median ratio of 1.67449 indicates a relatively homogeneous distribution within the nanoparticle size range. The particle size distribution graph shows that the majority of particles fall below 100 nm, confirming the success of the nanoparticulation process (Figure 1).

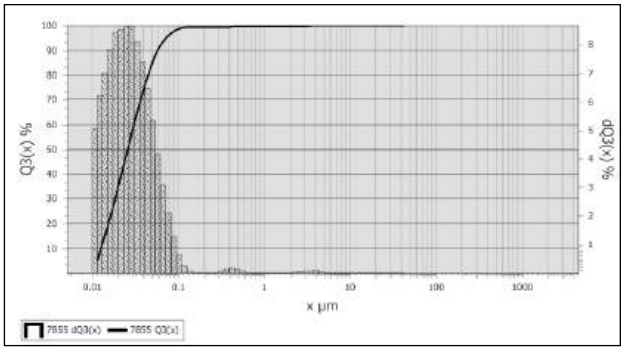

Figure 2. Particle Size Analyzer of *S. commersonnii* Nanopowder

The analysis revealed that the fluoride concentration in the anchovy was 21.05 mg/100 g, or 21.05 ppm, indicating a significant natural fluoride content suitable for potential use in caries prevention, particularly in topical applications. Alongside fluoride, the chemical composition analysis also indicated the presence of 1,305.80 mg/100 g of calcium, 281.60 mg/100 g of phosphorus, and 3.14 mg/100 g of iron. Furthermore, 91.50% of the particles were confirmed to be in the nano range, supporting the suitability of the powder for nanoparticle-based applications (Table 1).

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Table 1. Chemical Composition of *S. commersonnii* nanopowder

Parameter	Unit	Result
Calcium (Ca)	mg/100 g	1,305.80
Fluoride (F^-)	mg/100 g	21.05
Phosphorus (P)	mg/100 g	281.60
Iron (Fe)	mg/100 g	3.14
Particle size (nano)	%	91.50

Source: Certificate of Analysis, BPKI Surabaya, Report No. 09315/KI/V-2025

Although calcium was found to be the most abundant mineral in *S. commersonnii*, this study specifically focused on fluoride due to its well-established role in the prevention of dental caries. Fluoride contributes directly to the inhibition of cariogenic bacteria and the enhancement of enamel remineralization. While calcium is also essential for tooth structure, its effect is largely supportive, whereas fluoride exerts a more active, targeted role in caries prevention. Therefore, quantifying the fluoride content was prioritized to assess the potential of *S. commersonnii* as a natural source for dental caries preventive topical agent.

The analysis using a portable fluoridemeter (Hanna Instruments HI739), based on the SPADNS method, showed a fluoride concentration of 20.0 ppm in the anchovy sample. This result aligned well with the standard laboratory method, confirming the accuracy and reliability of both approaches in determining fluoride levels (Figure 3).

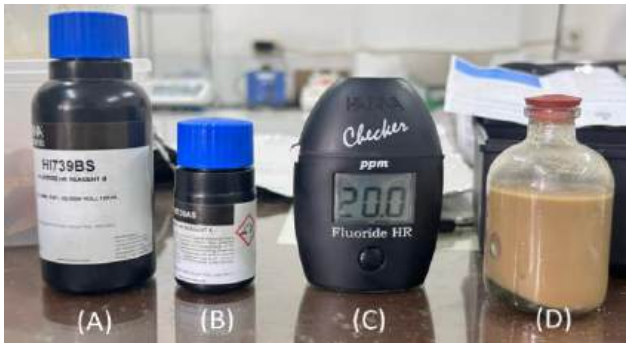

Figure 3. Fluoride analysis setup using the Portable Fluoridemeter (Hanna Checker Fluoride High Range). (A) HI739BS Fluoride HR Reagent B, (B) HI739AS Fluoride HR Reagent A, (C) Fluoride HR digital reader showing 20.0 ppm, and (D) anchovy (*Stolephorus commersonnii*) extract sample used for fluoride detection.

DISCUSSION

The morphological identification of *S. commersonnii* confirmed characteristic features consistent with existing taxonomic descriptions. These morphological traits validate the accurate identification of the species used in this study, ensuring the reliability of the sample source for further chemical and nanoparticle analysis. Accurate species identification is crucial, as mineral composition, including fluoride content, may vary significantly among different anchovy species.

This study demonstrated that *S. commersonnii* contains a relatively high fluoride concentration, measured at 21.05 ppm. This value is notable when compared to other commonly consumed natural sources of fluoride, such as tea leaves, seafood, or drinking water in fluoridated areas. The presence of fluoride in anchovies is likely associated with their habitat in marine environments, where seawater and sediment can influence fluoride accumulation in fish tissues and bones. The relatively high fluoride level suggests that *S. commersonnii* could serve as a viable source of natural fluoride, particularly for the development of alternative or supplementary topical agents for dental caries prevention.

In addition to fluoride, the powder was found to contain high levels of calcium (1,305.80 mg/100 g) and phosphorus (281.60 mg/100 g), both of which are essential minerals for maintaining enamel integrity and facilitating remineralization processes. While calcium is abundant, its bioavailability and direct role in caries prevention are not as pronounced as fluoride's antimicrobial and remineralizing effects. Therefore, fluoride was selected as the primary focus of this study, despite calcium being more dominant in quantity.

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An important finding in this study is that over 91% of the anchovy nanopowder within the nanoparticle range. Nanoparticles are known to enhance the bioavailability and surface reactivity of bioactive compounds. In the context of fluoride delivery, nano-sized particles may offer improved penetration into enamel micropores and increased contact surface area, which could lead to enhanced remineralization potential.

These findings align with previous studies, Agustanti et al. reported that fluoride concentrations ranging from 15.7 to 38.33 ppm in anchovy species such as *Stolephorus insularis*,[13] while Gunawan et al., and Sakinah et al. demonstrated the enamel-strengthening effects of anchovy-derived fluoride in animal models.[15,16] Supporting this, a study by Yuanita analyzed nano brown anchovy powder and found a fluoride content of 19.81 ppm, calcium at 1,310 mg/100 g, iron at 8.96 mg/100 g, and nano particle distribution at 81.80%.[17] These results further confirmed the potential of anchovies as a reliable natural fluoride resource. Moreover, the study also emphasized that the antibacterial activity of the nano brown anchovy powder, particularly its effect against oral pathogens, complements its fluoride content in caries prevention.[18] The slightly higher values in this study may result from differences in species, sample preparation, or milling processes.

Further supporting evidence comes from a series of studies by Wardani and colleagues that explored the antibacterial effects of *Stolephorus insularis* extract. The effectiveness observed in these studies can be partially attributed to the fluoride content naturally present in anchovies. Fa'izah et al. found that anchovy extract significantly inhibited the growth of *S. mutans*, a major contributor to dental caries. The mechanism likely involves fluoride's ability to disrupt bacterial metabolism and inhibit the enolase enzyme, thereby reducing acid production and biofilm formation.[19] Similarly, Mahendra et al. demonstrated antibacterial activity against *Enterococcus faecalis*, a pathogen commonly involved in persistent root canal infections. The presence of fluoride may contribute to bacterial membrane disruption and impaired energy metabolism in this species.[20,21] Additionally, Wardani and Listya observed the extract's inhibitory effects on *Pseudomonas aeruginosa*, a resilient bacterium associated with oral infections and antibiotic resistance. These findings suggest that the natural fluoride content in anchovy plays a crucial role not only in enamel remineralization but also in exerting broad-spectrum antimicrobial effects against pathogenic oral bacteria.[22]

The high calcium content (1,305.80 mg/100 g) observed in this study is consistent with the nutritional profile reported by Syah Putri and Zakaria, who found anchovy to be a rich source of calcium and protein. These nutrients are crucial for dental development, especially in children, making anchovy-based products a promising candidate for pediatric oral health applications.[10]

The high nano-sized particle distribution (91.5%) observed in this study is particularly relevant to modern dental applications. Nanotechnology has been shown to improve fluoride uptake by enamel, prolong fluoride retention, and enhance penetration into enamel microstructures.[23] This opens potential for anchovy-derived products to be formulated as advanced fluoride delivery systems, such as varnishes, gels, or even nano-coating agents for tooth surfaces.

Natural sources of fluoride, like anchovy, present several advantages: they are cost-effective, biocompatible, and culturally acceptable in fluoride-deficient or low-resource regions. Marine fish bones, especially from anchovy, have been identified as bioavailable sources of fluoride and calcium, supporting the formulation of sustainable and accessible caries-preventive agents.

This study adds to the growing body of literature that supports the use of marine-derived ingredients in oral health. Given the high fluoride content, nano-scale particle size, and supportive evidence from previous studies, *S.*

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commersonnii anchovy powder holds significant promise for use in preventive dentistry. Comparatively, the fluoride level found in this study is within the range of fluoride concentrations reported in some fish species used for fluoridated supplements, indicating that *ikan teri Medan* could serve as a base material for the development of natural fluoride

CONCLUSION

This study identified that *S. commersonnii* (anchovy) contains a notable concentration of natural fluoride (21.05 ppm) alongside high levels of calcium and phosphorus. The majority of the processed powder particles were within the nano range, indicating its potential suitability for further development in dental applications. Fluoride plays critical role in inhibiting cariogenic bacteria and enhancing enamel remineralization. The presence of fluoride in anchovy nanopowder suggests its promise as a natural source in caries prevention strategies. Further research is needed to explore its bioavailability, safety, and efficacy in clinical settings, as well as formulation studies to develop anchovy-based fluoride agents that meet safety and regulatory standards.

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RESEARCH ARTICLE

New Variant of Oral Candida in Intensive Care Unit Patients Using Endotracheal Tube: Observational Study

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ABSTRACT

Backgroud: *Candida species are the most common cause of systemic and mucosal diseases. Candida species cause bloodstream infections that are more than 90% fungal.* ***Objective:*** *There are variations of candida worldwide, and 15 different species recognize pathogens and cause human diseases. The aim of the of the study to identify variation of Candida in patient installation of Endotracheal Tube in intensive care unit.* ***Materials and Methods****: We conducted this research using a cross-sectional design. The collect sample during 6 months perform by single oral medicine specialist. Identification variety of Candida using VITEK 2® compact. Result: Data was obtained using a sample of 83 patients who installed an endotracheal tube unit in Dr. Ramelan Naval Hospital from March until August 2024.* ***Results:*** *There was a sample of 51 (61.4%) infected with Candida, with various candida being Candida albicans 39 (76.5%), Candida Tropikalis 6 (11.8%), Candida ciferri 3 (5.9%), Candida Lucitaniae 2 (3.9%), and Candida Gullermondii 1 (1.9%).* ***Conclusion:*** *This study identified Candida Ciferii as a new variant of Candida in this locus, known as a new resisten of fluconazole.*

Keywords: *Oral Candida, Endotracheal tube, Intensive Care Unit*

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INTRODUCTION

In recent years, there has been a notable rise in the incidence of fungal infection in human, attributed to a broader array of species, including numerous varieties of fungi not previously linked to human diseases[1]. This growth can be attributed to a variety of factor, including advancements in laboratory diagnostic technique for fungal identification and environmental changes associated with rising temperatures that may influence fungus habitats.[1]

The most common cause of systemic and mucosal disease is *candida* species. *Candida* species cause bloodstream infections that are more than 90% fungal.[2] *Candida albicans* is known as the most common cause of nosocomial invasive candidiasis. However, in the past decade an increased prevalence of Non-Albicans Candida (NAC) species. including *C. parapsilosis*, *C. glabrata, C. krusei, C. tropicalis, C. sojae, C. auris,* and *C. ciferrii,* has been reported. The variation depends on type of population geographic region, and antifungal exprossure[3,4].

The one most common bloodstream infection in ICU patients cause increase mortality rate and hospital cost is a Candidemia[3]. The worldwide mortality rates reaching 70 %[5]. Candidemia is an invasive fungal infection cause by *candida*, one of the initial symptoms is oral candidiasis[2]. Candida is a one of flora normal in the oral cavity that transform into pathogen when the host immunocompromised[6]. The risk of candidemia increases 6-10 times when patients installation of Endotracheal Tube (ETT)[7] due to surface of tube ETT both inner and outer surface of the ETT will form biofilm and development into pathogen among 24-72 hours.[8,7]

The purpose of the study was to identification new variation of *Candida* species from intraoral patients, especially related intensive care unit with ETT intubation, and present a characteristic of patient's demographic.

MATERIAL AND METHODS

This investigation observational analytic study with cross sectionals approach. The protocol of study received approval from the Institutional Review Board of Dr. Ramelan Naval Hospital under protocol number 17/EC/KEP/2024. This endorsement was granted based on the adherence of the study to the ethical principles outlined in the Declaration of the World Medical Association in Helsinki.

Data collection transpired over a six-month period, commencing in March until August 2024. The sample of the study included the patient in the ICU with 4th day ETT installation, over the age 50 years old. The medical record of the patient including age and underlying disease like Intracerebral Hemorrhagic, Septicemia, diabetes mellitus, pneumonia, kidney failure, malignancy, Guillan Bare Syndrome and senility was recorded. The excluding criteria was patients with ETT had died before 4th days and the age under 50 years old.

To collect the sample, perform by single oral medicine specialist using oral swab technique using cotton swab stick swabbed on the patient's tongue, the inserted into Amies transport media. Then samples were sent to laboratorium of microbiology then identification variety of candida using an identification tool in the form of a VITEK 2® compact.

Informed consent procedures involved a detailed explanation by the researcher to the family members. Key aspects covered during the informed consent process included elucidation of the study's objectives, the voluntary nature of participation, assurance of confidentiality regarding gathered information, and a comprehensive overview of the procedures employed throughout the study. Consent was obtained after ensuring a clear understanding of these elements by the legal representatives. The obtained data were compiled, and frequency distribution and chi-square test were determined using *Statistical Package for Social Sciences*

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(SPSS) software version 23 (SPSS Inc., Chicago, IL, USA).

RESULTS

The study involved 83 respondents from patients ETT installation at Dr Ramelan Naval Hospital, March-August 2024. There are three samples excluded due to age below 50 years. Fifty-one samples (61.4%) showed positive oral findings of Candida, including *Candida albicans* 39 (76.5%), *Candida tropicalis* 6 (11.8%), *Candida ciferri* 3 (5.9%), *Candida lucitaniae* 2 (3.9%), and *Candida gullermondii* 1 (1.9%) (Table 2)

Within this cohort, males exhibited a higher incidence rate (53%) compared to females (47%). The dominant age group was 61-70 years old containing 40% (33/83) of cases (Table 1).

Tabel 1. Characteristic of Respondent

Characteristic	Percentage of samples (%)
Gender	
Male	44(53.%)
Female	39 (47%)
Ages (year)	
50-60	30 (36%)
61-70	33 (40%)
71-83	20 (24%)
Underlying Disease	
Intracerebral Haemorrhage	36 (43%)
Septicemia	20 (24%)
Kidney Failure	6 (7%)
Malignancy	8 (9%)
Pneumonia	8 (9%)
Guillan Barre Syndrome	1 (1%)
Diabetes Mellitus	2 (2,5%)
Senility	2 (2,5%)

Table 2. Incidence of Candida

Incidence Oral Finding Candida	Percentage of samples (%)
Positive	51 (61.4%)
Negative	32 (38.6%)
Variety Candida Species	Percentage of samples (%)
Candida Albicans	39 (76.5%)
Candida Tropicalis	6 (11.8%)
Candida Ciferii	3 (5.9%)
Candida Lusitaniae	2 (3.9%)
Candida Gullermondii	1 (1.9%)

DISCUSSION

In this study, out of 83 samples, it was discovered that 51 (61,4%) had positive candida oral finding. That results of this study are in line with clinical practice guideline for the management candidiasis by infectious disease society of America, that more than 90% of fungal bloodstream infections (BSIs) are caused by *Candida*[9]. They are placed fourth in the United States and seventh in Europe among BSIs documented in these regions. Among hospitalized patients, organisms of the *Candida* genus are the most frequently isolated fungal pathogens in bloodstream infections[2].

All study subjects had chronic underlying diseases such as, Intracerebral Hemorrhage, Septicemia, Kidney Failure, Malignancy, Pneumonia, Guillan Barre Syndrome, Diabetes Mellitus, Senility. These patients suffer from immunocompromise and receive care in the intensive care. This oral finding candida condition typically arises due to immune suppression, which can be either local or systemic[10]. Factors contributing to this include age extremes, such as in newborns or the very elderly, as well as immunocompromising conditions like HIV/AIDS or severe illness[10].

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The findings of variety of oral finding candida in this study align with the findings of Setyaningtyas et al.'s research. which identified *Candida albicans* 39 (76.5%) as the most prevalent species of candida infection. However, this study also identified *Candida Ciferri* 3 (5.9%), *Candida Tropikalis* 6 (11.8%), *Candida Lucitaniae* 2 (3.9%), and *Candida Gullermondii* 1 (1.9%)[11].

Until recently, *Candida albicans* was considered the most prevalent species responsible for oral candidiasis, primarily due to its higher virulence compared to other candida species, as reported in several studies[12]. The pathogenicity of Candida albicans is largely attributed to its ability to undergo morphogenetic switching between yeast and hyphal forms more efficiently than other members of the genus, a feature closely linked to tissue invasion and immune evasion[13]. However, in recent decades, there has been a significant shift in the epidemiological landscape of Candida-related infections, with an increasing prevalence of non-albicans Candida (NAC) species, including *Candida glabrata, Candida tropicalis, Candida Gulliermondii* and *Candida lusitaniae*[14]. Collectively, these non-albicans Candida species are now responsible for approximately 90% of fungal infections in certain clinical settings[14].

Candida glabrata is currently recognized as the second most common cause of candidemia in the United States and the third most prevalent in Europe[15]. Thus, opportunistic yeast possesses several virulence factors, including phospholipases, lipases, and hemolysins, which contribute significantly to its pathogenic potential [16]. Furthermore, *Candida Glabrata* could forming biofilms, which is represent a major clinical challenge due to their association with enhanced antifungal resistance and increased evasion of host immune responses[15]. The ability to form biofilms not only renders the organism more tolerant to commonly used antifungal agents[15]. Moreover, biofilm development on the surface of medical devices, including endotracheal tubes, can serve as a reservoir for future infections, increasing the risk of device-associated candidemia[16].

Infections caused by *Candida tropicalis* have been associated with higher mortality rates compared to other non-Candida albicans (NAC) species. Reported mortality rates have ranged from 55% to 60% in certain clinical settings. One of the key virulence factors of *C. tropicalis* is its ability to form biofilms, which contributes to its resistance to azole, antifungal agents. Clinical isolates of *C. tropicalis* are frequently obtained from immunocompromised individuals, further emphasizing its clinical relevance*[17].*

Candida lusitaniae is a rare opportunistic pathogen that is typically part of the normal mycobiota in animals but has been isolated in approximately 1% of human candidemia cases, predominantly in low-birthweight neonates and immunocompromised patients[18]. Although infrequently encountered, *C. lusitaniae* is clinically significant due to its intrinsic or acquired resistance to polyene antifungals, particularly amphotericin B, which complicates treatment and may contribute to therapeutic failure[18]. Similarity, *Candida guilliermondii* has been identified as the sixth most common cause of invasive candidiasis in the largest global surveillance study of *Candida* isolates[19]. Studies have reported that *C. guilliermondii* exhibits reduced susceptibility to triazole antifungals compared to other *Candida* species[20].

Candida ciferrii was identified in this study as a new species, accounting for three cases (5.9%). [11] Also known as *Stephanoascus ciferrii* or *Trichomonas ciferrii, Candida ciferrii* was named in honor of *Raffaele Ciferri*, the Italian mycologist. It has been isolated from human samples worldwide, except Australia and the Antarctic continent. In Asia, the highest number of *S. ciferrii* (66%), China shows the highest isolation percentage (61%). In recent years, scientists have become increasingly aware of *Candida ciferii* due to its resistance to multiple drugs and its ability to cause both localized and systemic infections[1]. According to

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a review of the literature, azoles, the first-line treatment for both systemic and local candidiasis, as well as for the prevention of invasive candidiasis in intensive care units, are ineffective against approximately 75% of *Candida ciferrii* complex isolates.

CONCLUSION

The types of fungi found in the oral cavity of ICU patients with ETT at Dr Ramelan Naval Hospital Surabaya from March to August 2024 were dominated by *Candida Albicans.* Other species identified included *Candida Ciferri* 3 (5.9%), *Candida Tropikalis* 6 (11.8%), *Candida Lucitaniae* 2 (3.9%), and *Candida Gullermondii* 1 (1.9%)[11].*Candida Ciferii* represents as a newly identified Candida species at this locus. It is known for its resistance to fluconazole.

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RESEARCH ARTICLE

The Influence of Parental Knowledge Level During Pregnancy with Child's Dental Caries Risk at RSGM-P Nala Husada

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ABSTRACT

Background: *Awareness and understanding among pregnant women regarding the importance of maintaining oral and dental health play a crucial role in preventing Early Childhood Caries (ECC). Caries risk assessment is an essential part of a comprehensive and age-appropriate patient care approach. This evaluation aims to estimate the likelihood of an increase in caries incidence over time, as well as the potential progression or activity of existing lesions.* ***Objective:*** *to analyze the relationship between parental knowledge during pregnancy about oral and dental health and risk of the dental caries risk in children at RSGM-P Nala Husada.* ***Materials and Methods:*** *This study employed an analytical observational design with a cross-sectional approach. A total of 45 samples were collected from patients at the integration clinic of RSGM-P Nala Husada. Child patients aged 3-5 years were assessed iin dental caries using CAMBRA, while the patient's mother was given a questionnaire to find out what information was known during pregnancy regarding oral and dental health. The Spearman correlation test was chosen because the data used was ordinal.* ***Results:*** *The Spearman correlation test revealed a significant value ($p < 0.05$) with a strong correlation coefficient (0.666).* ***Conclusion:*** *A strong relationship exists between parental knowledge during pregnancy and the risk of caries in pediatric patients at RSGM-P Nala Husada. Higher levels of maternal knowledge were associated with lower caries risk in children.*

Keywords: *Level of knowledge, pregnancy, caries risk, CAMBRA*

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INTRODUCTION

According to the World Health Organization (WHO), integrating oral health into maternal and child health programs is essential for the effective prevention and management of oral diseases. Healthcare professionals are expected to provide guidance and information on the safety and benefits of medical and dental care during pregnancy, with the goal of improving maternal oral health. Such education is intended to enhance pregnant women's knowledge and awareness of the importance of maintaining oral and dental health, thereby helping to prevent Early Childhood Caries (ECC) [2]. Furthermore, the Indonesian government, through Regulation No. 89 of 2015, emphasizes oral health care during pregnancy as part of oral and dental health promotion efforts, thereby reinforcing the importance of providing education on oral health throughout pregnancy.[3]

Knowledge and awareness of maintaining oral and dental health are important factors in preventing various diseases that can arise in the oral cavity, including dental caries. Limited awareness of oral care is often reflected in poor oral conditions, insufficient understanding of proper oral hygiene practices (both verbally and in writing), and low utilization of dental health services. The results of research by Saheb, reveal that oral and dental health promotion programs are needed to cover the knowledge gap among mothers regarding the oral care of their children.[4] Education plays an important component of oral health care in the prenatal period and is expected to have a significant effect on maternal and child oral health. Counseling in the early stages of pregnancy includes topics directed towards all patients. For example, eating habits, prevention of injuries, as well as changes in the oral cavity that may occur during pregnancy and the baby's oral healthcare. Research has documented that early oral health promotion that begins during pregnancy can lead to sustained and long-term improvements in children's oral health. This program includes care before, during, and after pregnancy.[5]

The aim of caries risk assessment is to evaluate the probability of a rise in caries occurrence over time—whether through the development of new lesions or the progression of existing ones, including changes in their size and activity. With the ability to detect caries at an early stage (such as non-cavitation lesions or white spots), medical personnel can play a role in preventing cavitation from occurring as early as possible.[6] By conducting a caries risk assessment, such as CAMBRA dentists can comprehensively develop prevention and treatment plans based on the child's age. This activity can be started on the first visit of the child, around the age of one year.[7] This caries risk assessment should be carried out in every child as a routine basic examination.[8] A combination of several factors, including the child's dietary patterns, frequency of fluoride exposure, susceptible hosts, and microflora interacting with various other factors such as social, cultural, and behavioral are involved in the current caries risk assessment process.[7]

By increasing the knowledge of pregnant women, it is hoped that the prevention of dental caries begins before the baby is born, continuing at the neonatal, infant stage and so on until the child is independent enough to prevent dental caries. This study aims to determine the relationship between the level of parental knowledge during pregnancy regarding oral and dental health and the risk of children's dental caries at RSGM-P Nala Husada.

MATERIALS AND METHODS

The study was conducted over a three-month period, from April to June 2025, at the integration clinic of RSGM-P Nala Husada, Surabaya. This research has been declared ethically feasible and has received an ethics feasibility certificate with the number EC/002/KEPK. RSGMNH/IV/2025 dated April

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28, 2025, by the Health Research Ethics Committee of RSGM-P Nala Husada.

An analytical observational method with a cross-sectional design was applied in this research, and the participants were selected using simple random sampling. A total of 45 research samples participated in this study. The research was conducted using a questionnaire to collect primary data on the level of parental knowledge during pregnancy. The questionnaire was divided into two sections: the first covered patient biodata, while the second included 30 questions related to issues that mothers should be aware of during pregnancy. These 30 questions are divided into three sub-questions: six questions about changes in the oral cavity that will be experienced during pregnancy, 10 questions about oral and dental care for pregnant women and 14 questions about information about early childhood dental care. Before being administered, the 30 items underwent validity and reliability testing and were deemed suitable for respondents.

The level of knowledge of parents during pregnancy, will be classified into: high, medium and low. Previously, researchers determined the scores on 30 answers in questionnaire using the Likert scale. Respondents answers scored between 1-5. To determine the highest score of 30 answers, multiplied by 5 and the lowest multiplied by 1, the highest score is 150 and the lowest score is 30 x 1 = 30. Based on the highest and lowest values, an interval range of 40 is then determined, so that the following criteria are obtained:

Table 1. Criteria in level of knowledge during pregnancy

Level of knowledge during pregnancy	Criteria
30 – 70	Low
71 - 110	Moderate
111 - 150	High

The results of Pearson's Validity test show that all questionnaires used as measuring tools have valid or significant results with a Sig value of < 0.05, while the results of the Reliability test (Cronbach's Alpha) show that all questionnaires used as measuring tools have valid or significant results with a value of > 0.60

Before conducting primary data collection, the researchers provided an explanation about the research objectives, research benefits, data collection procedures and benefits for respondents. After the explanation is given to the respondent, the researcher, the respondent and the witness sign the informed consent. Filling out the questionnaire takes about 10 - 15 minutes and is accompanied by dental co-ass students at RSGM-P Nala Husada. The researcher provides an opportunity for respondents to ask questions if there are questions that are not understood in order to get the most accurate data possible. The answers to the 30 questions in the questionnaire will be classified into high, medium and low levels of knowledge.

In addition, the patient's caries risk examination also uses primary data. The researchers used the CAMBRA form aged 0 - 5 years to see the risk of caries in patients. The results of caries risk calculation are classified into: high risk, medium risk, and low risk

RESULT

In this research, 45 eligible samples were collected based on inclusion and exclusion standards. The sample comprised 100% women, reflecting the objective of examining pregnant women's level of knowledge.

In some of the tables below, the distribution of patients based on age, education and also the occupation of the 45 study respondents will be presented.

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Table 2. Classification of patients by age group

Age Group	Number of Respondents	Percentage
≤20 years old	1	2,2%
21 – 30 years old	16	35,6%
31 – 40 years old	18	40%
41 – 50 years old	9	20%
>50 years old	1	2.2%

Table 3. Patient distribution according to educational level

Education	Number of Respondents	Percentage
SD	6	13,3%
SMP	9	20%
SMA	17	37.9%
Diploma/D3	2	4,4%
S1	9	20%
S2	2	4,4%

Table 4. Distribution of patients based on occupation

Occupation	Number of Respondents	Percentage
House-wife	31	68,9%
Employee	5	11,1%
Self employed	4	8,9%
Lecturer/Teacher	4	8,9%
Nurse	1	2,2%

The results of the questionnaire calculation of 45 respondents regarding the level of knowledge of the mother during pregnancy were obtained as follows:

Table 5. Level of knowledge during pregnancy

Level of Knowledge	Number of Respondents	Percentage
High	31	31.1%
Moderate	5	62.2%
Low	4	6,7%

In this study, in addition to taking data on the level of parental knowledge, caries risk measurements were also carried out in children (whose mothers had filled out questionnaires) to see the patient's caries risk. The measured pediatric patients were 3-5 years old. The following results of the calculation of 45 respondents regarding the risk of caries in patients aged 3-5 years were obtained as follows:

Table 6. Child's Caries Risk in patients

Child's Caries Risk	Number of Respondents	Percentage
Low	11	24,5%
Moderate	19	42,2%
High	15	33,3%

The data obtained on the level of parental knowledge during pregnancy and the results of the calculation of the risk of caries in pediatric patients were carried out in a correlation test using Spearman. The Spearman correlation test indicated that the variables demonstrated statistical significance ($p < 0.05$) and had a strong correlation coefficient (0.666), which means that there was a strong relationship between the level of parental knowledge during pregnancy and the risk of dental caries in patients aged 3–5 years at RSGM-P Nala Husada.

Table 7. Correlation analysis using Spearman's test

			Level of Know ledge	Caries Risk
Spearman's rho	Level of Knowledge	Correlation Coefficient	1.000	.666**
		Sig. (2-tailed)	.	.000
		N	45	45
	Caries Risk	Correlation Coefficient	.666**	1.000
		Sig. (2-tailed)	.000	.
		N	45	45

**Correlation is significant at the 0.01 level (2-tailed).

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DISCUSSION

Comprehensive care during pregnancy and optimal oral health of pregnant women during pregnancy will affect the degree of health and well-being in the child.[9,10] The relationship between the oral cavity health status of parents, pregnancy conditions and the health of the child's oral cavity is very close. Various studies reveal that the oral health status of parents is a predictor of their child's health and mouth in the future. Over the past few years, various efforts to maintain oral and dental health during pregnancy have received attention and recognition from educators, clinicians, policy makers, and also national organizations.[10] The Government of Indonesia through Permenkes No. 89 of 2015 has regulated oral and dental health services for pregnant women. Oral and dental health services for pregnant women include: health counseling in the form of providing Communication, Information and Education (KIE) regarding oral and dental health, especially during pregnancy; early detection of oral and dental disorders/diseases in pregnant women; and referring pregnant women in terms of the condition of the teeth and mouth of pregnant women requires a curative approach.[3]

Knowledge, attitudes, awareness and participation of parents in carrying out the habits of maintaining oral health will affect the health of the child's oral cavity.[11] Oral health and its relationship to overall health are considered to be key factors that contribute to the health of pregnant parents, their babies, and toddlers.[10,12] Maintain dental health during pregnancy, for example doing regular checkups, going to the dentist for preventive care, and applying how to maintain good oral hygiene at home. These things aim to reduce risks and optimize overall health during pregnancy. Dentists have an important role in maintaining dental and oral health for pregnant women and unborn babies. [13] In the first part of the questionnaire, the researcher asked questions about changes in the oral cavity that occur in pregnant women and in the second part about oral health care during pregnancy. It is hoped that from this question, it can be known that the process of maintaining optimal oral and dental health for pregnant women is expected to have an impact on the good growth and development of the fetus.

Poor oral health during pregnancy is also associated with problematic birth processes, including low birth weight and prematurity.[14] This will certainly cause health problems for parents and children, so attention to oral health needs to be considered, especially during the prenatal period.[10] Pregnant women are more susceptible to oral cavity problems because during pregnancy there are changes in hormone levels, such as estrogen and progesterone which will lead to changes in habits and behavior in maintaining the cleanliness of the oral cavity. In the future, this problem will have a negative impact on children's oral health.[15] Hormonal changes in pregnant women are the etiology of the occurrence of oral lesions that may occur during pregnancy. Increased production of progesterone and estrogen will cause dilatation of blood vessels in the gingival region. This will trigger edematous in the gingival tissue. In pregnancy, there are also changes that come from the normal flora of the oral cavity, this change comes from discomfort and nausea that is often felt during pregnancy so that pregnant women will reduce the frequency of brushing their teeth and have an impact on the cleanliness of their oral cavity. Hormonal changes and changes in the normal flora of the oral cavity in pregnant women will contribute to the appearance of bleeding and inflammation or temporomandibular disorders.[16] The immune system will undergo adjustments during pregnancy that can affect the body's ability to respond to oral infections. From Yilmaz's (2024) research, it was shown that the pH of unstimmulated saliva will decrease significantly during pregnancy. Some studies report that the cause of lower saliva pH is due to the effect of progesterone on plasma bicarbonate levels

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during pregnancy. In addition, changes in the frequency of more frequent meals, differences in oral hygiene patterns in pregnant women and changes in taste can also be reasons for lower saliva pH during pregnancy. Increased levels of chorionic gonadotropin in pregnant women will result in reduced saliva production during pregnancy. So in this study, it was also found that the rate of unstimmulated saliva flow in pregnant women in the 3rd trimester will be lower than in pregnant women in the 1st trimester.[17]

In the third part of the questionnaire, the researcher asked questions about how to maintain the cleanliness of the oral cavity in infants (ages 0-1 years). Pregnant women who know how to clean the oral cavity are expected to apply their knowledge to their children. During the early period of life, the main role in maintaining the child's cleanliness and mouth is greatly influenced by the participation of parents or caregivers. This is because most of the child's time will be spent by parents/caregivers, especially mothers. [4,18] In this study, 100% of the sample was women and 68.9% of them worked to take care of the household (not working) and accompanying their children. Mothers have significantly higher knowledge than fathers about their children's oral and dental health problems.[19] The dependence of toddlers on parents requires parents to have high knowledge and awareness of conditions that affect oral health, how to maintain the health and cleanliness of the child's oral cavity, healthy eating habits and appropriate behavior to maintain oral health. [4]

In this study, all children who were examined for dental caries risk were under 71 months old. Age selection is related to the overview of the incidence of early dental caries. Dental caries in children specifically, it is known globally as Early Childhood Caries (ECC). Early Childhood Caries (ECC) is defined as the presence of one or more decayed, missing, or filled primary teeth in children aged 71 months (5 years) or younger. Based on the Bangkok Declaration, it is defined as the discovery of one or more caries in the primary tooth, it can be in the form of early stage caries (non-cavitation lesions) or cavities have formed, the primary teeth are lost due to a history of caries and teeth cannot be restored or the surface of the primary teeth is patched in children under the age of six.[20] There have been many studies that show that the occurrence of ECC in pre-school children is related to various types of factors. These factors include age, socioeconomic status, good way to brush your teeth with parental supervision, fluoride exposure, duration of breast milk drinking or use of milk bottles, dietary habits, oral hygiene care at home, previous exposure to caries, active caries, the number of plaques, enamel defects and the composition of microorganisms in saliva/ *s.mutants.*[21]

In the results of the study, a strong relationship was found between the level of parental knowledge during pregnancy and the risk of dental caries in patients aged 3-5 years at RSGM-P Nala Husada, namely the higher the level of parental knowledge during pregnancy related to the lower risk of child caries in the future.

Caries Risk Assessment (CRA) is very important, especially in the 1000 days of a child's life, for the quality of hard tissue in the next life. The caries risk assessment forms that can be used in children are the Caries-Risk Assessment Tool (CAT), Caries Management By Risk Assessment (CAMBRA), American Dental Association (ADA) Caries-Risk Assessment, and Cariogram.[20] Caries risk assesment instrument with CAMBRA has been proven to be valid and reliable as a standard for diagnosing caries risk in children aged 0-5 years in Indonesia based on research by Amalia, et al. in 2018 [22]. Research on children aged 13-14 who have been calculated for caries risk using CAMBRA, proves that CAMBRA is proven to measure caries accurately in terms of sensitivity of 47.62% and specificity of 80%. [23]

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Risk factors for caries are variables that either directly contribute to its development (such as the presence of cariogenic microflora) or have been shown to correlate with its occurrence, for example, persistent poverty or limited health knowledge. Commonly identified risk factors include reduced salivary flow, visible dental plaque, frequent sugar intake, use of intraoral appliances, general health problems, sociodemographic conditions, limited access to dental care, and cariogenic microorganisms. Meanwhile, protective factors in the risk of caries are conditions that can reduce the occurrence of dental caries, for example, children consume fluoride drinking water, brush their teeth daily with fluoride toothpaste, receive topical fluoride application from health professionals regularly and visit the dentist for regular dental care.[24,25] Five disease indicators related to caries risk in early childhood can be assessed using the CAMBRA method. These indicators are dentin-limited caries lesions, restoration in the last three years, plaque count, salivary pH conditions, and the discovery of white lession as an early form of dental caries. [26]

Most pregnant women are not yet aware that poor oral hygiene during pregnancy will have an impact on them, on the baby that is being conceived and on the pregnancy process itself. Pregnant women's knowledge of the process of transmission of pathogens in the mouth, diet during pregnancy, and habits of maintaining oral hygiene are closely related to the etiology of the occurrence of dental caries in children and are the basis for the prevention of oral and dental diseases.[27] In newborns, the baby's oral cavity is in a sterile condition or only has a few bacteria due to the birth process. However, parental behaviors especially between mother and child that allow saliva exchange such as the use of shared cutlery or kissing the child on the mouth will contribute to the development of the oral cavity and oral microbiome during childhood.[28]

Streptococcus mutans is the main bacteria that causes human dental caries that has a fundamental role in the etiology of the disease. The process of transmission of dental caries can occur vertically when it is transferred from mother to child, for example, when sharing household utensils such as spoons and forks, giving a bottle of milk to the baby after it is put in the mother's mouth, or in general whenever there is a transfer of saliva from an adult to the child's mouth.[29] Mothers who have poor oral hygiene and a high number of karyogenic bacteria in the oral cavity will increase the risk of dental caries in their newborns, making children more susceptible to early childhood caries.[30] The oral cavity must be cleaned from birth to prevent bacterial colonization in the oral cavity from an early age and prevent the development of early childhood caries. the incidence of ECC and lower levels of *Streptococcus mutans* are obtained than in infants from mothers who receive oral health care since prenatal.[31]

Health protection for the mother and the unborn baby is an absolute thing during pregnancy, so pregnant women must comply with all rules during pregnancy, During this period, mothers can protect dental and oral health by carrying out preventive care as early as possible so that serious problems in the oral cavity can be prevented.[32] Pregnant women should be aware of dental problems that may arise during pregnancy. Optimal dental and oral health for the developing mother and baby in the womb can be achieved by increasing knowledge and effective preventive measures.[13] Structured education programs to parents regarding oral and dental health can greatly enhance their knowledge and facilitate the development of behaviors in maintaining better oral and dental health among children. Expanding this program to the entire community will have a significant impact on improving children's oral health in the long term.[33]

CONCLUSION

As the results of this study, a strong relationship was found between the level of

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parental knowledge during pregnancy and child's dental caries risk in patients aged 3-5 years at RSGM-P Nala Husada, namely the higher the level of parental knowledge during pregnancy related to the lower risk of child caries in the future. It is hoped that in the future the level of knowledge in pregnant women can be improved by providing education through various media and also direct education from dental health workers. With the increase in knowledge of pregnant women, it is hoped that it can intervene in factors that affect the calculation of the risk of child caries.

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RESEARCH ARTICLE

The Relation Between Oral Health Maintenance Knowledge and Junior High School Students's Age and Gender in Denai District Medan

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ABSTRACT

Background: *Oral and dental health play a crucial role in maintaining overall body function. Therefore, proper knowledge and behavior regarding oral hygiene are essential to ensure its preservation.* ***Objective:*** *This study aims to examine the relationship between oral health knowledge and the age and gender of junior high school students in the district****. Materials and Methods:*** *His study employed a correlative descriptive approach using a cross-sectional design. The sample was selected through proportional stratified random sampling with the aid of a proportion estimation formula. A total of 248 students participated, consisting of 124 from An-Nizam Middle School and 124 from Hikmatul Fadhillah Middle School. Data were collected using a 15-item questionnaire designed to assess knowledge regarding oral and dental health maintenance. The chi-square test was applied to evaluate the association between students' oral health knowledge and their age and gender.* ***Results:*** *The findings revealed a significant association between knowledge levels and students' age and gender ($p < 0.05$).* ***Conclusion****: The age and gender of junior high school students at Hikmatul Fadhillah and An-Nizam were found to be correlated with their understanding of personal oral health maintenance.*

Keywords: *Age, Gender, Knowledge, Oral Health Maintenance*

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INTRODUCTION

Body health plays an important role in carrying out daily activities both physically and psychologically. One of the important parts of body health is teeth and mouth. The teeth in the mouth are organs that have several functions that can affect overall health. A person who is said to be healthy is a person whose body and oral cavity are healthy. Proper oral hygiene can be achieved through adequate knowledge and appropriate behavior in maintaining oral health. Knowledge about oral health is obtained through a complex process. Good knowledge will have an impact on healthy behavior, otherwise, lack of knowledge will have an impact on the wrong behavior in maintaining oral health.[1,2,3]

Adolescents are among the groups most vulnerable to oral and dental health problems. According to RISKESDAS 2018, 55.6% of adolescents aged 10–14 years and 51.9% of individuals aged 15–24 years were found to suffer from oral and dental health problems. Similarly, the Centers for Disease Control and Prevention (CDC, 2013) noted that dental caries is one of the most common chronic conditions, affecting 25% of children aged 6–11 years and 59% of adolescents aged 12–19 years. Although 98.5% of individuals aged 15–24 years reported practicing proper toothbrushing, only 3.3% did so at the recommended times—after breakfast and before bedtime. In addition, the mean DMF-T index in 2018 for 12-year-olds was 1.9, a figure that still exceeds the target set by the 2020 National Action Plan for Dental and Oral Health Services, which aimed for a DMF-T index of 1.26 in this age group.[2,4]

A person's knowledge has a great influence in reducing the occurrence of tooth decay. Knowledge is a precipitating factor for behavior change. A behavior tends to be sustained when it is grounded in knowledge. Such knowledge may be acquired either naturally or through structured educational processes. Research by Gayatri (2017) on students of SDN 2 Kauman Malang regarding oral health maintenance revealed that 82.3% of students demonstrated a most participants possessed good knowledge regarding dental health, with just 17.1% categorized as having low knowledge levels.[2,3,5]

Adolescence represents a crucial stage in the human life cycle, serving as a transitional phase from childhood to maturity. The World Health Organization (WHO) defines adolescents as individuals aged 10–19 years, with early adolescence encompassing those aged 12–15 years, who are generally at the junior high school level. At this stage, oral and gingival health problems are common, largely due to the increased prevalence of dental caries. The 12–15-year age group has been designated by WHO as a key indicator in the *Global Goals for Oral Health 2020*, because it marks a critical period for monitoring oral and dental diseases, coinciding with the stage when nearly all permanent teeth used as indices in such studies have fully erupte.[6,7,8]

There is an increased risk for oral health problems in adolescents due to the freedom to decide for themselves the choice of consuming foods that contain a lot of sugar and choosing fast food menus. The types of food that are often consumed are fried chicken and french fries and the types of drinks consumed are *soft drinks* which result in several changes regarding dental hygiene. In addition, the phenomenon in the adolescent group aged 12-14 years is a change in social patterns. During adolescence, the activities carried out tend to be more outside the home, such as school, tutoring and extra-curricular activities. In adolescence, socializing is important in daily life, so they need to spend a lot of time with peers. Dental health in adolescents is based on the social environment and is often influenced by parents, schools and social levels. Although there is no exact data in Indonesia, the situation can be used as a mirror in society, that this age is a group of students.[9,10,11,12]

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MATERIALS AND METHODS

Data collection was conducted in March 2022 at Private Junior High School of An-Nizam and Private Junior High School of Hikmatul Fadhillah. The study population consisted of 499 students from both institutions. Participants were eligible if they were 12–15 years old, male or female, and provided informed consent to take part in the study.Sampling was conducted using a proportional stratified random sampling technique, considering the unequal number of students in each class. This method ensured that the distribution of sample members across classes was balanced, thereby producing more representative results.

The sample size was calculated using the proportion estimation formula and obtained a sample size of 248 students, then the sample was divided across the two schools with each sample in each school totaling 124 students. After that the sample will be divided equally for each grade level, so that the sample size for VII grade students is 41 samples, VIII grade students are 41 samples and IX grade students are 42 samples. This research instrument uses a questionnaire consisting of 15 questions to measure the level of knowledge of oral health maintenance. The questionnaire was validated, yielding an r-count greater than the t-table value of 0.361, and a Cronbach's Alpha value of 0.89 indicated that the tool was highly reliable.

The correct answer is given point 1 and the wrong answer is given point 0. The results are then included in three classes according to Arikunto, namely the level of knowledge is good, sufficient, and lacking. The limit of good category values is with a range of 11-15, sufficient 8-10, and less 0-7. Data processing was carried out using Microsoft excel and SPSS tools then the the study's result were presented in form of tables with frequencies and percentages along with narratives. Chi-square analysis was applied to the categorical data to examine the correlation between oral health maintenance knowledge and respondents' age and gender, with significance set at $p < 0.05$. The study was authorized by the Faculty of Dentistry, University of North Sumatra, and conducted in the designated schools. Ethical clearance was secured from the University of North Sumatra Health Research Ethics Commission (347/KEPK/USU/2022).

RESULT

Based on the study findings, Table 1 presents the distribution of respondents by gender and age. A total of 122 were male and 126 were female. In terms of age, the respondents were evenly distributed, with 62 students each at 12, 13, 14, and 15 years old. (Table 1)

Table 1. Respondent Characteristics

Variables	Number (n)	Percentage (%)
Gender		
- Male	122	49,2
- Female	126	50,8
Total	248	100
Age		
- 12 years	62	25
- 13 years	62	25
- 14 years	62	25
- 15 years	62	25
Total	248	100

The findings presented in Table 2 indicate that among the 62 respondents aged 12 years, it was found that among the respondents, the most respondents had a sufficient level of knowledge, namely 13.7%. However, the respondents aged 13 years had the highest level of knowledge, which was 11.3%. Of the respondents aged 14 years, 14.5% of respondents already had an adequate level of knowledge regarding oral health maintenance and the respondents aged 15 years had the most good level of knowledge, namely 16.1%. The statistical test results show a *p-value* of 0.029 indicating a statistically significant difference between the level of knowledge and the age of the respondent. (Table 2)

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Table 2. Statistical Test Results of Level of Knowledge on Dental and Oral Health Maintenance by Age

Age (Years)	Knowledge level regarding oral health maintenance								Test results statistics
	Good		Simply		Less		Total		
	n	%	n	%	n	%	n	%	
12	23	9,3	34	13,7	5	2	62	25	0,029*
13	28	11,3	30	12,1	4	1,6	62	25	
14	36	14,5	23	9,3	3	1,2	62	25	
15	40	16,1	22	8,9	0	0	62	25	
Total	127	51,2	109	44	12	4,8	248	100	

Furthermore, Table 3 illustrates that among the 122 male respondents, the largest proportion (25.4%) demonstrated a sufficient level of knowledge regarding oral health maintenance. In contrast, among the 126 female respondents, 29.8% exhibited a good level of knowledge in maintaining oral health. Statistical analysis yielded a p-value of 0.048, indicating a significant difference in oral health maintenance knowledge between male and female students (Table 3).

Table 3. Statistical Test Results of Level of Knowledge on Dental and Oral Health Maintenance by Gender

Gender	Knowledge level regarding oral health maintenance								Test results statistics
	Good		Simply		Less		Total		
	n	%	n	%	n	%	n	%	
Male	53	21,4	63	25,4	6	2,4	122	49,2	0,048*
Female	74	29,8	46	18,6	6	2,4	126	50,8	
Total	127	51,2	109	44	12	4,8	248	100	

DISCUSSION

Several factors contribute to the development of knowledge, and age is one of the key determinants influencing this process. Age has a close relationship with a person's level of knowledge. (Khasanah, dkk. 2019). As students progress to higher grade levels, their increasing age is associated with greater knowledge about oral health. The findings of this study revealed a p-value of 0.029, indicating a significant relationship between age and the level of oral health maintenance knowledge (Table 2). Specifically, the proportion of students with higher knowledge rose with age, from 9.3% at 12 years, 11.3% at 13 years, 14.5% at 14 years, and 16.1% at 15 years (Table 2). The knowledge of 15-year-olds is better than that of younger children because the higher the age, the greater the level of curiosity so that with increasing age, the ability to capture and think will be more developed and the knowledge obtained will be better.[12]

Adolescents aged 11 years and above are able to develop their formal thoughts to be able to achieve logical and directed thinking.[8] Huclock stated that increasing age is associated with greater maturity as well as improved cognitive and work capacity. Experience also affects a person's knowledge, the older a person is, the more experience he will have so that the better his knowledge. Mubarak said that the factors that influence knowledge are age, education, occupation, exposure to information and experience. Experience is an event that a person has gone through in interacting with the environment. The experience of a 15-year-old

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child is more than a 12-year-old child, so the knowledge of a 15-year-old child is better than the age of the child below.[8,13-15]

The results of statistical analysis indicated a significant association between oral health maintenance knowledge and gender, with a p-value of 0.048 (Table 3). The findings revealed that most female students demonstrated a good level of knowledge, with 74 respondents (29.8%), whereas the majority of male students showed a sufficient level of knowledge, totaling 63 respondents (25.4%) (Table 3). These results suggest that female students possess better knowledge of oral health maintenance compared to male students, reflecting superior oral health care practices among girls. This pattern may be explained by the tendency of girls to exhibit higher concern and awareness regarding the aesthetic significance and importance of oral hygiene, which leads them to be more consistent in maintaining their teeth and mouth. Well-maintained teeth not only improve physical appearance but also increased self-confidence among females. [13]

Gender roles are not only determined by a person's sex but also by the environment and other factors. The environment that The environment that influences children's knowledge includes the environment of playmates, parents, or the surrounding community. The environment is a place where a child will learn good and bad things depending on the nature of the group he is in so the environment has a considerable influence on a person.[16] Parental knowledge and attitudes play a crucial role in shaping children's understanding of dental and oral hygiene, as these parental influences may either support or hinder proper practices. Children's attitudes often mirror the level of knowledge possessed by their parents. If parents do not pay attention to their knowledge in dental and oral health care, children who still have the habit of imitating their parents' attitudes will be very vulnerable to dental and oral diseases due to poor self-habits in maintaining oral hygiene and health.[17,18] An experience gained from the environment will affect a person's way of thinking.[19] The findings of this study differ from those reported by Selvataj et al., who conducted research on 288 respondents in India. Their results showed no statistically significant difference in oral health knowledge between male and female participants (p = 0.096), suggesting that gender is not a determining factor influencing knowledge levels.[20] Knowledge is shaped by internal factors including education, occupation, age, and external factors such as environmental conditions and socio-cultural influences.[12,16]

CONCLUSION

A significant association was found between oral health maintenance knowledge and respondent characteristics, namely age and gender. Children aged 15 years have a better level of knowledge than children under the age of 15 because the mindset and capacity of 15-year-old children is better and girls have a better level of knowledge than boys because girls have more awareness of the importance of beauty so they have better knowledge to maintain oral hygiene.

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