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**DIFFERENCES IN DMF-T INDEX OF PDAM WATER AND RIVER WATER USERS
 IN THE BLACKSMITH INDUSTRY AREA**

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ABSTRACT

Background: Caries is a disease of the oral cavity that affects the hard tissues of the teeth, enamel, dentin, and cementum. Caries is a multifactorial disease or is caused by many factors. One factor that influences the incidence of caries is the water used for daily purposes. Water containing high concentrations of metals can affect the incidence of caries, one of which is iron. Ferrum or iron contained in water can cause caries by increasing H^+ ions and then continuing to decrease pH, resulting in a demineralization or dissolution process of hydroxyapatite. Caries occurrence can be measured using the DMF-T index. **Purpose:** This study aims to determine the difference in the DMF-T index of students using PDAM water and river water in the iron industry area of Sungai Pinang Village. **Methods:** The method used was analytic observational with a cross-sectional design. Respondents in this study were 36 for each group, with a total of 72 respondents. **Results:** The results of the unpaired T-Test test showed a significance value of $0.00 < 0.05$, so H_0 was rejected. **Conclusion:** There is a significant difference in the DMF-T index of river water PDAM water users in the blacksmith industrial area of Sungai Pinang Village.

Keywords: Caries, DMF-T Index, Iron, Water.

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INTRODUCTION

Basic Health Research (Riskesdas) in 2018 stated that 57.6% of Indonesians experienced dental and oral problems.¹ The most common oral problem found in Indonesian society is caries. The prevalence of dental caries in Indonesia has a high degree of severity, 88.8%.² The prevalence of caries in South Kalimantan has a percentage of 37.62%.¹ Caries is a disease of the teeth and mouth with a multifactorial etiology. The environment is one of the factors that can cause caries, namely the type of water used to fulfill daily needs, especially for activities that have direct contact with the oral cavity.² People use various types of water depending on the availability, ease of access, and the economic level of the community. Based on the rules of Health Law No. 23 of 1992, paragraph 3, drinking water consumed by the public must meet the requirements. Minister of Health Regulation (Permenkes) no. 416 of 1990 explains the requirements and supervision of water quality. Water requirements are physical, chemical, bacteriological, and radioactive requirements within the limits set by the government.²

This regulation aims to ensure that the water used does not have adverse side effects on health.³ Water Supply Company is one of type water widely used by the community to fulfill their daily lived. Based on laboratory testing of Water Supply Company water conducted in previous studies, it is known that Water Supply Company water meets the requirements of clean water. Water Supply Company water has a metal content that is within normal limits: manganese 0.03 mg/L, iron 0.006 mg/L, and lead 0.002 mg/L. The Water Supply Company water used by this community has gone through a coagulation and filtration process to neutralize the pH of the water. The acidity level of the Water Supply Company water is standard, with a pH of 7.51.⁴

Many people also use river water to fulfill their daily water needs. Although some rivers have been polluted by various wastes from human activities, including waste from industrial activities, in the form of organic and inorganic components but some people still use them.⁵ Hulu Sungai Selatan is one of the South Kalimantan Province districts with much of blacksmith industries on the areas. The area is Sungai Pinang Village, where most of the community

works as blacksmith. The iron processing process in the blacksmith industry produces solid waste in the form of iron crust resulting from crumb during the heating proces and liquid waste in water used for hot iron baths. The waste produced is then disposed of into nearby waters. Some people in Sungai Pinang Village use river water in the blacksmith industry area to fulfill their activities.

The results of a preliminary study conducted in the form of testing the level of iron (Fe) contained in river water in the blacksmith industry area showed that the iron content contained was 0.46 mg/L or exceeded the standard limit of <0.3 mg/L. Research conducted by Fahmi and Salamah in 2017 stated that water containing a lot of copper, iron (Fe), and manganese would cause the frequency of caries to be high.⁶ Water with a high iron content can cause an increase in H⁺ ions so that the pH of the water drops.⁷ The low pH of water, when in continuous contact with the oral cavity, will cause a decrease in salivary pH. The critical pH state of saliva is a suitable growth site for acidogenic bacteria, including *S. mutans*, which can cause caries.⁸

The severity of caries can be determined using the DMF-T index. The DMF-T index is the sum of *Decay* /D (carious teeth or cavities), *Missing* / M (teeth removed), and *Filling* / F (teeth patched).⁹ The DMF-T index examination in this study was conducted on students aged 10-12 years because children aged 10-12 years are at the right age for the DMF-T index examination. This follows the statement by WHO, which states that children aged 12 years are the age of global monitoring or used as an indicator. It is considered that all permanent teeth have erupted except the third molar.¹⁰ Children aged 10-12 years can communicate well so that the DMF-T index examination can be carried out. This study analyzed the differences in caries incidence in Water Supply Company and river water users in the blacksmith industry area by comparing the DMF-T index obtained from the calculation results through direct observation. This is expected to contribute to science for dentistry and society about the effect of water containing iron (Fe) on caries, as well as data and considerations for the health department in determining community water use policies.

METHODS

This research is an observational analytic study conducted using a *cross-sectional* method. This research has been declared ethically sound by the Ethics Commission of the Faculty of Dentistry, Lambung Mangkurat University, with No. 110/KEPKG-FKGULM/EC/X/2023. This Population in this study were all MIN 13 HSS students aged 10 - 12 years, totaling 92 children. After Calculating the sample, the number of respondents from this study was 36 children for each group, so the total number of respondents was 72. Each research subject was grouped into two groups for comparison based on the type of water used for daily activities directly related to the oral cavity (brushing teeth and daily consumption). The first group is a group of river water users in the blacksmith industry area that contains iron (Fe) contamination. The second group is a group of Water Supply Company water users.

The tools and materials used in this study are *diagnostic sets* (consisting of *dental mirrors*, *tweezers*, and *probes*), *nierbeken*, *flashlights*, *personal protective equipment* (*handscoon*, *medical masks*, and *gowns*), *alcohol*, *sodium hypochlorite* for sterilizing tools, *sterile pouches*, *hand sanitizers*, *questionnaire sheets*, *water type usage sheets*, *informed consent sheets*, *caries examination sheets*, *cameras*, and *stationery*. Measure river water samples in the blacksmith industrial area by directly taking water samples into the river and testing them in the laboratory. Caries incidence with the DMF-T index can be assessed by directly examining the oral cavity using the WHO-modified DMF-T.

Decay assessment is carried out on carious teeth that can still be patched, secondary caries on teeth with fillings, and teeth with temporary fillings. *Missing* assessment was carried out on permanent teeth extracted due to caries and carious teeth with an indication for extraction. *A filled* evaluation is performed on teeth with fixed fillings. The summed examination results will be categorized as follows:

- a. Very low : 0,0 - 1,1
- b. Low : 1,2 - 2,6
- c. Medium : 2,7 - 4,4
- d. High : 4,5 - 6,5
- e. Very high : > 6,6.¹¹

Data on the DMF-T index values of students from the examination were tested for normality using *Kolmogorov-Smirnov* and data analysis continued using the *unpaired T-test method*.¹²

RESULTS

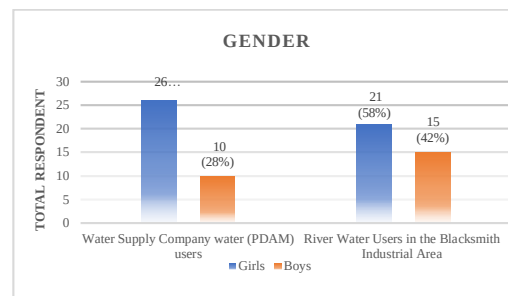


Figure 1. Gender of Respondent

The diagram (Figure 1) shows that out of 72 respondents, most were girls: 47 (65%) were girls, and 25 (35%) were boys.

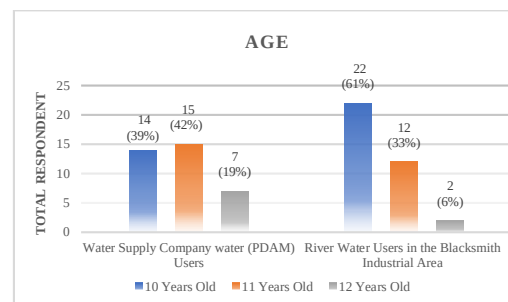


Figure 2. Age of Respondent

The diagram (Figure 2.) shows that out of 72 respondents, most of the research respondents were 10-year-old children. A total of 36 respondents (50%) were 10 years old, 27 respondents (37%) were 11 years old, and 9 respondents (13%) were 12 years old.

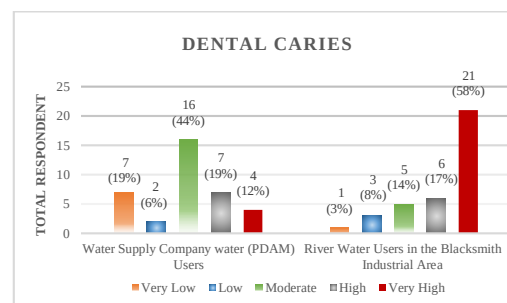


Figure 3. Dental Caries

The diagram (Figure 3) shows that most Water Supply Company water users are in the moderate caries category, namely 16 respondents (45%), seven respondents (19%) in the very low caries category, two respondents (6%) in the low caries category, seven respondents (19%) in the high caries category, and four respondents (11%) in the very high category. In river water users in the blacksmith industry area most of the very high categories were 21 respondents (58%), one respondent (3%) was in the very low caries category, three respondents (8%) were in the low caries category, five respondents (14%) were in the medium caries category, and six respondents (17%) were in the high caries category.

Table 1. Caries Occurrence Based on Gender

Gender	Caries					DMF-T Index
	Very Low	Low	Moderate	High	Very High	
Girls	5 (7%)	3 (4%)	15 (21%)	9 (13%)	15 (21%)	5,34
Boys	3 (4%)	2 (3%)	6 (8%)	5 (7%)	9 (12%)	5,08

Based on the table above, it is known that the highest caries based on gender is in the group of children with female gender with a DMF-T index of 5.34, while the group of male children has a DMF-T index of 5.08.

Table 2. Caries Occurrence by Age

Age	Caries					DMF-T Index
	Very Low	Low	Moderate	High	Very High	
10 Years Old	4 (6%)	2 (3%)	12 (17%)	4 (6%)	14 (19%)	5,58
11 Years Old	2 (3%)	2 (3%)	5 (7%)	9 (12%)	9 (12%)	5,4
12 Years Old	2 (3%)	0	4 (6%)	2 (3%)	1 (1%)	4

Based on the table above, it is known that the highest average caries age group is the 10-year-old group with a DMF-T index of 5.58 (high caries). 11-year-olds have a DMF-T index of 5.4, and 12-year-olds have a DMF-T index of 4.

Table 3. Differences in Caries Occurrence Based on the Use of Water Type

Types of Water	Caries					p Value
	Very Low	Low	Moderate	High	Very High	
Water Supply Company water (PDAM) Users	7 (19%)	2 (6%)	16 (45%)	7 (19%)	4 (11%)	0,00
River Water Users in the Blacksmith Industrial Area	1 (3%)	3 (8%)	5 (14%)	6 (17%)	21 (58%)	

Based on the table above, it is known that the most extensive distribution of respondents was in river water users in the blacksmith industrial area who experienced very high caries, namely 21 respondents or 29% of the total sample. The results of the statistical analysis test obtained a value of p value = 0.00 ($p > 0.05$), meaning that there is a significant difference in the incidence of caries between Water Supply Company water users and river water users in the blacksmith industry area.

Table 4. Differences in DMF-T Index Based on the Use of Water Type

DMF-T	Water Supply Company water (PDAM) Users			River Water Users in the Blacksmith Industrial Area		
	Total Teeth (n)	Percentage (%)	DMF-T Index	Total Teeth (n)	Percentage (%)	DMF-T Index
Decayed	118	91%	3,58	230	92%	6,97
Missing	11	9%		21	8%	
Filled	0	0%		0	0%	
Total	129	100%		251	100%	

Based on the table above, the highest DMF-T index was obtained in the river water user group in the blacksmith industrial area, which amounted to 6.97 (very high caries) with cavities due to caries (D) as many as 230 teeth (92%), missing teeth due to caries (M) as many as 21 teeth (8%), and no teeth filled due to caries (F). In the group of Water Supply Company water users, the DMF-T index was 3.58 (moderate caries) with 118 teeth (91%) cavities due to caries (D), 11 teeth (9%) missing due to caries (M), and no teeth filled due to caries (F).

DISCUSSION

The caries index in girls is higher than that of boys because women have a higher risk of caries than men.¹³ Research by Maria et al. states that women are more likely to experience caries than men because tooth eruption in girls is faster than boys. Hence, girls' teeth are exposed to factors that cause caries (microorganisms, cariogenic food and drinks, and so on).¹³ Another factor that influences the incidence of caries in girls higher than in boys is that girls tend to prefer sweet foods and drinks that have the potential to cause caries.¹³ Hormonal factors also affect the incidence of caries in girls. Hormonal factors also affect the incidence of caries in girls. Hormonal changes in girls are a sign of the puberty phase, which starts from the age of 8-10 years.¹⁴ These hormonal changes cause a

decrease in salivary secretion and IgA.¹⁵ The role of IgA in the oral cavity is to prevent adhesion (attachment) of *S. mutans* on the surface of the teeth, which prevent glucan to form, and there is no demineralization process (melting of minerals) in the teeth so that it can reduce the risk of caries.¹⁶

The group of children with the highest average caries based on age is the group of 10-year-old children with a DMF-T index of 5.58, which is included in the high caries category. This follows previous research, which states that children aged 8-10 years are more prone to caries. Children aged 8-10 years pay less attention to their oral health, so their health behavior is also low.¹⁷ Children aged 8-10 also prefer cariogenic (caries-triggering) foods such as chocolate, candy, and other sweet foods. Sugary food rich in sucrose are a vulnerable medium for the growth of microorganisms, increasing the risk of plaque buildup that slowly erodes tooth enamel and lead to caries.^{17,18} The high caries rate in 10-year-old children is also related to the level of knowledge. Previous research explains that a person's level of expertise will determine whether a person's oral health behavior is good or bad, affecting oral health, including caries.¹⁹ Children aged 10 years have lower knowledge than children aged 11 and 12. This follows previous research, which explains that a person's age affects the level of maturity and strength in thinking and receiving information (cognitive development).²⁰ Dental caries in children who use Water Supply Company water in Sungai Pinang Village, Hulu Sungai Selatan Regency, is dominated by moderate category caries with a DMF-T score of 3.69. This is based on H.L. Blum's theory, which is influenced by four factors: heredity, environment, health facilities, and behavior.²¹ Most respondents had poor dental health behavior includes not brushing teeth regularly, consuming cariogenic foods and drinks, and not regularly visiting the dentist.²² The habit of children not brushing their teeth routinely and high consumption of sweet foods causes sticky sweet foods debris to remain in the oral cavity and can ferment into acid, causing plaque on the teeth, which can increase the risk of dental caries.²³

Dental caries in children using river water in the blacksmith industrial area of Sungai Pinang Village, South Daha District, Hulu Sungai Selatan Regency is dominated by very high category caries with a DMF-T number 6.97. Several factors, including environmental factors, can influence this high caries rate. According to H.L. Blum's theory, environmental factors that can affect caries incidence include the physical, socio-economic, and political environment.²⁴ The physical environment factor is type of water used for daily purposes and in direct contact with the oral cavity, such as brushing teeth, rinsing, cooking, and consumption. Drinking water consumption is a factor that affects the incidence of caries in the community. This follows research by Ameriagitri, which explains a relationship between children's DMF-T index and the type of water used for daily purposes.²⁵ Clean water standards that the community can use must meet physical, chemical, bacteriological, and radioactive requirements.²

Chemical substances contained in water include iron and flour. A preliminary study conducted to test the iron (Fe) level in river water in the blacksmith industry area showed that the contained iron was 0.46 mg/L or exceeded the standard limit. Maximum limit of iron content in water for daily use set by the government. Through PERMENKES is <0.3 mg/L.² High iron content or exceeding normal limits will cause an increase in H^+ ions, which can cause a decrease in pH in water.⁷ The low/critical pH state of water and prolonged contact with the oral cavity due to brushing, rinsing, and consumption activities will cause a decrease in the pH of saliva in the oral cavity.⁸ Saliva at a critical pH of 5.5 can dissolve minerals in the teeth, especially the mineral hydroxyapatite (disolushydroxyapatite).²⁶

This process is also known as the demineralization process. Demineralization that occurs continuously without obstacles causes demineralization to progress to a more severe stage. Demineralization at more severe stage will cause the enamel not to get enough support from the underlying tissue to form a cavity.⁸ The cavities that form in this hard tooth tissue are referred to as caries. In the oral cavity, the high iron content affects the incidence of increased oxidative stress. This oxidative stress can stimulate biofilm formation in the oral cavity, leading to tooth decay.²⁷ In vitro, oxidative stress due to high iron content in contact with the oral cavity also causes a decrease in remineralization. It inhibits the formation of hydroxyapatite crystals, increasing the risk of caries.²⁸

The results of the statistical test analysis showed a significant difference between the DMF-T index in children who use Water Supply Company water and children who use river water in the blacksmith industry area. The results of this study align with previous research by Made in 2019, which explains the influence between the type of drinking water used and the incidence of caries.²⁹ The results of this study also explain that all types of drinking water have the potential to cause caries except refilled drinking water and tap water.²⁹ This study also explains that the cause of water can affect caries due to the chemical content contained in water. Water that is good for use not be contaminated either bacteriologically or chemically so that it does not cause health problems, such as dental caries.²

Apart from iron, another chemical element found in water that affects the caries index of its users is flour. The results of this study follow previous research by Naufi in 2021, which explains that flour has three mechanisms as caries control, namely increasing remineralization, inhibiting demineralization, and inhibiting the process of processing glucose into acids that dissolve minerals in teeth (glycolysis).²⁹ Fluorine can also be contained in drinking water consumed by the community. Fluorine deficiency can cause tooth decay, susceptibility to dental

caries (*caries dentin*), and discoloration of children's teeth.³⁰ In conclusion, this study showed the most of the Sungai Pinang Village community has caries in a very high category with a DMF-T index of 6.97.

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