

PUFA Index Assessment of Dental Caries Severity in Children Living in Wetland Environments

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ABSTRACT

Background: Dental caries is a multifactorial disease that is a health problem in children. Children 5-9 years old have the highest caries prevalence. Untreated dental caries can be measured using the PUFA/pufa (pulpal involvement (P), ulcer (U), fistula (F), and abscess (A)) index. Sungai Kupang Village has acidic water with pH values ranging from 3.09-6.45 and an iron (Fe) content above the maximum allowable level of 1.044mm/ltr. Most people use wetland water in their daily lives, including for gargling after brushing their teeth. Brushing teeth with acidic water can reduce the surface hardness of tooth enamel, thereby increasing the risk of dental caries.

Method: The study employed a descriptive-analytical research design. The sampling technique used was purposive sampling. The sample of 148 children aged 5-9 years was visually examined with a dental mirror to assess the severity of dental caries using PUFA/pufa index criteria, including pulp involvement (P/p), ulceration (U/u), fistula (F/f), and Abscess (A/a). The research data were analyzed descriptively and presented as percentages and average PUFA/pufa.

Result: PUFA/pufa index of untreated dental caries in the form of pulp involvement (P/p) was 3.0; ulceration (U/u) was 0.06; fistula (F/f) was 0.1, and abscess (A/a) was 0.02. The caries severity of untreated dental caries based on the PUFA/pufa index was 3.1. The 7-year-old age group and female gender had the highest average PUFA index.

Conclusion: According to the average PUFA/pufa index, children 7 years old and female have the most severe untreated dental caries.

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INTRODUCTION

Dental caries is a common oral and dental problem among both children and adults. Dental caries is a multifactorial disease that poses a health problem for a large portion of the global population. According to 2025 World Health Organization (WHO) survey data (2025), 60-90% of children worldwide experience caries. Globally, untreated dental caries continues to be one of the most common health conditions. The Global Burden of Disease Study (2025) shows that dental caries in permanent teeth remains the most common condition worldwide, affecting 2.3 billion individuals, while caries in primary teeth affects over 530 million children. Dental caries is a disease that can occur due to several interconnected factors: the host, microorganisms, substrate, and time. Besides *Streptococcus mutans*, the bacteria that cause caries, saliva is another factor that influences tissue susceptibility to the intensity of the caries process. The dental environment can also be acidified by salivary flow rate, viscosity, and pH.^{1,2,3}

Factors that directly cause caries are identified as risk factors. Several factors that can facilitate the development of caries are predisposing factors. Predisposing factors for dental caries that contribute to caries severity include caries experience, socioeconomic status, age, gender, dental health behaviors, and geographic location. In some regions in Indonesia, such as South Kalimantan Province, water quality has become a problem due to natural environmental hazards and anthropogenic activities. One waterborne disease that can cause permanent damage to health is dental caries. The physical environment that influences dental caries is water as a daily drinking water source. Water conditions in South Kalimantan have a fluoride content of 0.00 ppm and a pH below 6.5. Fluoride levels below 1 ppm and a pH below 6.5 can cause low tooth resistance, thereby increasing the risk of dental caries. Several environmental factors that significantly influence the occurrence of caries include drinking water quality and the socioeconomic culture of the population. A population's income and higher education will influence dietary patterns and dental care habits, thereby reducing the prevalence of dental caries. There is a relationship between socioeconomic status and caries prevalence. From childhood to old age, the relationship between socioeconomic status (income, occupation, and education level), prevalence, and severity of oral disease is clear and consistent. A strong association between high caries prevalence in children and low family socioeconomic status, as well as parental occupation, has been observed. Factors influencing these differences include education and income, which are related to diet, dental care habits, and other factors.^{4,5,6}

Dental caries, if left untreated, will result in a demineralization process that continues down to the dentin and pulp layers of the tooth. Some problems that arise from untreated caries are pulpitis, ulceration, fistulas, and abscesses. Untreated dental caries can be measured using the PUFA/pufa index. The PUFA/pufa index is used to assess the condition of the oral cavity caused by untreated dental caries. The PUFA index is used for assessment in permanent teeth, while the PUFA index is used for assessment in primary teeth. The PUFA index in permanent teeth has a score between 0-32, while the PUFA index in primary teeth has a score between 0-20.⁵ P/p: Pulp involvement is recorded when the opening of the pulp chamber is visible or when the coronal tooth structure has been destroyed by the carious process and only the root or root fragments remain. No probing is performed to diagnose pulp involvement (Figure 1.a). U/u: Traumatic ulceration from sharp tooth fragments is recorded when the sharp edges of a dislodged tooth with pulpal involvement or root fragments have caused traumatic ulceration of the surrounding soft tissues, for example, the tongue or buccal mucosa (Figure 1.b). F/f: Fistula is scored when there is a pus-draining sinus tract communicating with a tooth with pulpal

involvement (Figure 1.c). A/a: Abscess is scored when there is a pus-filled swelling communicating with a tooth with pulpal involvement (Figure 1.d).^{7,8,9} Indonesia's wetlands cover 20.6 million hectares. Kalimantan Island has 9.75 million hectares of wetlands, and South Kalimantan has 1.48 million hectares. Wetlands play a vital role in human life, serving as a direct source of life support, such as a source of drinking water. According to the Ramsar Convention, wetlands are "areas of swamp, brackish water, peatland, and water, whether permanent or temporary, with water that is stagnant or flowing, fresh, brackish, or salt; including areas of marine water the depth of which at low tide does not exceed six meters." Swamp water flowing into rivers can acidify the water, with an acidity level between 3.5 and 4.5. Acidic water conditions are a cause of tooth decay. Brushing your teeth with acidic water can reduce the surface hardness of tooth enamel, leading to tooth decay.^{8,9}

Dental and oral problems were among the top ten diseases at the Gambut District Community Health Center in South Kalimantan in 2020. Gingivitis and periodontal disease ranked eighth with the most cases, followed by tooth growth and eruption disorders in sixth place, and pulp and periapical tissue diseases in fourth place. According to the Banjar Regency Central Statistics Agency in 2020, Sungai Kupang Village does not yet have a hospital, community health center, sub-community health center, polyclinic, or pharmacy. According to data from the Gambut District Central Statistics Agency in 2020, there are no general practitioners or paramedics. The pH value of the water in the Gambut District area is also said to be acidic, ranging from 3.09 to 6.45. The iron (Fe) content in the water consumed by the Banjar Regency community is 1,044 mm/liter, which is above the maximum allowable level of 0.3 mm/liter.^{10,11} This study aimed to develop a PUFA index to assess the prevalence and severity of oral health conditions in children in Sungai Kupang Village, Gambut District, Banjar Regency, where the majority of residents still use river or swamp water in their daily lives.

RESEARCH METHOD

The research began with obtaining a research permit and ethical clearance from the Faculty of Dentistry, University of Lambung Mangkurat, No. 059/KEPKG-FKGULM/EC/V/2022. The study employed a descriptive-analytical research design to determine the frequency distribution of untreated dental caries severity, as measured by the PUFA/pufa index, by age and gender. The study population comprised children aged 5-9 years old in Sungai Kupang Village, Gambut District, Banjar Regency, because the majority of the Kupang River community uses river/swamp water for their daily lives. The sample size can be calculated using a categorical descriptive formula, so that 148 samples are obtained. The sampling technique for this study was purposive. Purposive sampling involves selecting members of the population who meet the inclusion criteria. The sample size can be calculated using a categorical descriptive formula, so that 148 samples are obtained. The inclusion criteria for this study were: (1) Boys and girls aged 5-9 years in Sungai Kupang Village; (2) Cooperative children; (3) Children with parental/guardian consent. The exclusion criteria for this study were children who did not want to be examined.

The tools used in this study were a dental mirror, stationery, and personal protective equipment. The research materials used in this study were head coverings, gowns, medical masks, hand sanitizers, face shields, hand sanitizers, informed consent forms, and dental examination status cards. Research data were obtained from oral examinations of subjects. To assess the severity of untreated dental caries, the PUFA/pufa index criteria were used. The PUFA index includes P/p, U/u, F/f, and A/a. P/p represents pulp involvement, which can be noted if the pulp chamber can be seen. No probing was performed in this pulp involvement examination. U/u

is an ulceration that can be noted if there is a traumatic ulcer due to sharp edges of dislocation with pulp involvement or root fragments. F/f is a fistula, which can be indicated if pus comes out of the sinus tract associated with teeth with pulp involvement. A/a is an abscess that can be noted if there is swelling accompanied by pus associated with pulp involvement (**figure 1**). This assessment was carried out visually without the use of any other aids other than a dental mirror. PUFA/pufa score per person, which is a number using the same method as DMF-T/def-t & represents the number of teeth included in the PUFA/pufa diagnostic criteria. Capital letters are used for permanent teeth & lowercase letters are used for deciduous teeth. Scores for deciduous & permanent teeth are recorded separately, so for an individual score, the PUFA/pufa score range is based on 0-20 for deciduous teeth, & 0-32 for permanent teeth. PUFA/pufa prevalence is calculated as a percentage of the population using one or more PUFA/pufa scores.

Untreated caries or PUFA/pufa can be calculated using the formula:⁷

$$\frac{PUFA/pufa}{D+d} \times 100\%$$

Note:

D: Number of teeth with caries in permanent teeth

d: Number of teeth with caries in primary teeth

The data analysis in this study is descriptive, aiming to provide an overview of the severity of untreated dental caries among children aged 5-9 years in Sungai Kupang Village. Descriptive analysis is analyzing data by describing or describing the data that has been collected without making conclusions that apply to the public. Data analysis in this study involves grouping, tabulating, and presenting data collected from the examination of respondents' oral cavities. The data needed for this study are age, gender, and PUFA/pufa index score. Based on this data, the results will be presented as frequency, percentage, and the average PUFA/pufa index in decimal form, and then entered into a Microsoft Excel table.

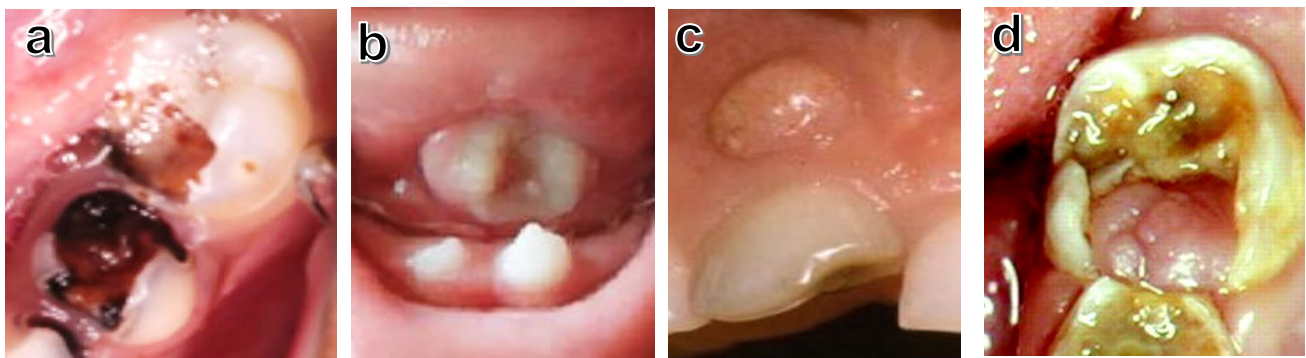


Figure 1. Assesment criteria based on the PUFA index: (a) Pulp involvement (P/p), visible pulp chamber hole or damaged coronal tooth structure due to caries; (b) Ulceration (U/u), traumatic ulceration of soft tissue (tongue and mucosa), caused by tooth or root fragments; (c) Fistula (F/f), a channel that drains pus originating from an abscess and opens into the oral cavity; Abscess (A/a), dentoalveolar abscess.

RESULTS

This study aimed to develop a PUFA index to assess the prevalence and severity of oral conditions in children in Sungai Kupang Village, Gambut District, Banjar Regency. The following are the results of the study

related to the description of the severity of dental caries and untreated dental caries based on the PUFA/pufa index in children aged 5-9 years in Sungai Kupang Village, Gambut District, Banjar Regency, with a sample size of 148 people.

Table 1. Distribution of Respondents' Characteristics by Age

Variable	Frequency	Percentage
Age (years)	(n)	(%)
5	29	19.59%
6	31	20.95%
7	36	24.32%
8	27	18.25%
9	25	16.89%
Total	148	100%

Table 1 shows the distribution of respondent characteristics based on age. The age groups in this study were divided into 5 groups, namely children aged 5, 6, 7, 8, and 9 years. The largest number of respondents was 7 years old, namely 36 children (24.32%), followed by 6 years old with 31 children (20.95%), 5 years old with 29 children (19.59%), 8 years old with 27 children (18.25%), and 9 years old with 25 children (16.89%). The balanced number of respondents consisted of women with 74 children (50%), followed by men with 74 children (50%) (Table 2).

Table 2. Distribution of Respondents' Characteristics by Gender

Gender	(n)	Percentage (%)
Male	74	50%
Female	74	50%
Total	148	100%

Table 3. Severity Table of Untreated Dental Caries Using PUFA Index Based on Age Frequency Distribution

Age	Frequency (n)	%	P/p	U/u	F/f	A/a	Indeks PUFA
5	29	19.59%	22	0	2	1	3,1
6	31	20.95%	31	1	2	0	3,1
7	36	24.32%	57	0	0	0	3,6
8	27	18.25%	13	1	0	0	2,3
9	25	16.89%	16	1	1	0	3,0
Total	148	100%	139	3	5	1	3,1

Based on Table 4, research on children aged 5-9 years shows that the 7-year-old age group had the highest average PUFA/pufa index, at 3.6, due to the largest number of children in this age group. The age group with the lowest average PUFA/pufa index was 8 years old, at 2.3. The average value was obtained by summing the teeth in the P/p, U/u, F/f, and A/a categories, then dividing by the number of respondents by age group.

Table 4. The Severity Level of Untreated Dental Caries Using PUFA Index Based on Gender Frequency Distribution

Gender	Frequency (n)	%	P	U	F	A	Indeks PUFA
Male	74	50%	55	1	4	0	3,0
Female	74	50%	84	2	1	1	3,3
Total	148	100%	139	3	5	1	3,1

Based on Table 3, it is known that children of females have an average PUFA/pufa index of 3.3. Meanwhile, a child with a male gender has an average PUFA/pufa index of 3.0. This average result was calculated by summing the teeth with the categories P/p, U/u, F/f, and A/a, then dividing by the number of respondents from the study. Based on the PUFA/pufa index calculation, females have higher values than males.

Table 5. Frequency Distribution Table of Dental Caries

Dental Caries	PUFA/pufa		Sum
	With PUFA/pufa	Without PUFA	
Permanent (D)	56	48	104
Primary (d)	92	156	248
Total	148	204	352

Table 5 shows that primary teeth have more dental caries than permanent teeth; there are 248 teeth with 92 pufa teeth and 156 without pufa. Table 5 shows the total number of teeth with caries in children aged 5-9 years in Sungai Kupang Village, as many as 352 teeth. Teeth that experienced severity based on the PUFA/pufa index were 148, consisting of permanent teeth and primary teeth. PUFA/pufa *ratio* is calculated using the formula Tarigan in 2020.¹³ Based on the results of the PUFA / pufa *ratio* calculation, a result of 42 was obtained, meaning that for every 100 teeth that are caries, 42 teeth experience severity due to untreated dental caries and cause pulp involvement, *traumatic ulcers*, fistulas, and abscesses (PUFA / pufa) in children aged 5-9 years in Sungai Kupang Village.

Table 6. PUFA Index Average

Category	Sum	Average
P/p	139	3
U/u	3	0.06

F/f	5	0.1
A/a	1	0.02
PUFA/pufa	148	3.1

Based on Table 6, it shows the average severity of dental caries that are not treated in children aged 5-9 years in Sungai Kupang Village and cause the involvement of pulp (P/p), ulcers (U/u), fistulas (F/f), and abscesses (A/a). The severity of dental caries that is not treated based on the PUFA/pufa index in children aged 5-9 years in Sungai Kupang Village has an average of 3.1.

DISCUSSION

Research conducted in a wetland area, specifically in Sungai Kupang Village, on children aged 5-9 years to assess the severity of dental caries using the PUFA index showed that the severity of untreated dental caries based on the PUFA index was highest in females. The severity of dental caries among children aged 5-9 years in Sungai Kupang Village is indicated by the highest PUFA/pufa index in the 7-year age group, at 3.6. The results of this study are in line with Tarigan in 2020 research, which found that children aged 7 years have the highest severity of untreated dental caries, with a PUFA/pufa index of 2.06.¹³ The results of the same study were also obtained in a study by Sumual in 2016, which stated the frequency distribution of children with untreated dental caries severity based on the highest PUFA / pufa index in children aged 7 years of 1.8.¹² Children with an age group of 6-7 years tend to consume a lot of cariogenic and sticky foods, such as chocolate, sweets, sugar, and cakes. In addition, children aged 6-7 tend not to be able to maintain proper oral hygiene regularly.^{13,14} According to Sumual's research in 2016, the severity of dental caries in schoolchildren aged 6-9 can be caused by the large number of children who have firstborn teeth. Damage to deciduous teeth spreads faster and more severely than permanent teeth. This is because the enamel structure on deciduous teeth is thinner and less dense. The higher prevalence of dental caries in primary teeth compared to permanent teeth may be due to the lower calcium content in primary teeth and structural differences that can increase susceptibility to caries, as reported by Vasavan in 2022. In addition, a factor that affects the health of the teeth and mouth is behavior. According to the American Academy of Pediatric Dentistry (AAPD) (2025), children with caries are caused by parents who are less able to carry out primary prevention, resulting in the child's lifestyle and diet being out of control. Given that the age range of 6 to 10 years is a critical transitional phase in child development, marked by changes in eating habits and hygiene behaviors, it is important to understand how these factors interact and contribute to the risk of extensive dental caries.^{15,16,17}

The gender distribution among respondents was balanced, with 74 males (50%) and 74 females (50%). Achieving a balanced sex composition can minimize potential bias and ensure that results accurately represent both sexes. Previous studies have emphasized that maintaining sex balance is particularly important in studies involving preschool-aged children, as sex-related biological and behavioral differences may influence growth patterns and oral health outcomes. Therefore, the balanced gender distribution in this study strengthens the validity and generalizability of the findings.¹⁸

Research by Tarigan in 2020 and Sumual in 2016 also indicated that the severity of untreated dental caries based on the PUFA index was highest in females.^{19,20} These results are consistent with the theory described by Volker and Russell, which states that females have a higher prevalence of dental caries than

males because the eruption of females' teeth is faster, so females' teeth stay longer in the oral cavity. Teeth that are longer in the oral cavity are more likely to be associated with risk factors for caries. According to a study by Listrianah in 2018, hormonal factors in females also affect the occurrence of caries. If estrogen levels in females increase, the number of caries also increases. The biochemical composition of saliva and the flow rate of saliva are affected by hormonal fluctuations, which result in a more cariogenic state of the female oral cavity than that of males. Milhahn- Turkeheim states that dental caries in the first molar teeth in females is higher than that of males. Furthermore, people living in wetlands tend to use them in their daily lives, including bathing and gargling while brushing their teeth. Wetland water has a low pH of around 3–4.5, which tends to be acidic. This acidic condition, when used in daily life, especially when gargling while brushing teeth, can lead to demineralization of the enamel, making it brittle and prone to caries if consumed with cariogenic foods and poor dental hygiene.²¹⁻²³

The overall average PUFA index in this study was 3.1. According to Suwargiani's study in 2023, there are significant differences between the behavior of rural and urban communities regarding dental health. Environmental factors contribute to differences in the behavior of rural and urban communities. Residence influences a person's knowledge. People living in villages have less knowledge about dental and oral health compared to people living in cities. Knowledge about dental health in rural areas remains uneven. People living in remote villages are still unaware of the benefits of maintaining dental health and lack the motivation to go to the dentist. In addition, influencing factors include community behavior in seeking health services, distance and location of residence to health services, and difficulty in accessing transportation.^{22,23}

A child's quality of life can be significantly affected by untreated caries. Furthermore, the correlation between untreated caries and low socioeconomic status emphasizes the importance of integrated oral health policies with social policies, such as health promotion programs. Furthermore, environmental factors specific to wetland areas, such as peatlands, also contribute substantially to caries development. Peatland wetland water, with a mean pH of 3–4.02, fails to meet drinking-water quality standards and may promote microbial colonization in the oral cavity. Furthermore, the prevalent dietary pattern observed in the peatland community, characterized by low protein intake and high consumption of simple carbohydrates, further reinforces a cariogenic environment. The combination of acidic saliva, fragile enamel structure, and sugar-rich eating habits creates an oral ecosystem highly conducive to progressive dental deterioration.^{21,23}

Promoting oral health and demonstrating good oral health practices is a top priority so that parents and others understand and appreciate the importance of oral health and disease prevention. The effectiveness of protective approaches promoted through oral hygiene training must be enhanced to reduce dental caries and halt its progression, thereby achieving the WHO regional goals. Dentists, as healthcare professionals, play a crucial role in preventing dental caries as early as possible, so that the increasing number of dental and oral problems can be addressed quickly and effectively. They lead the oral health team and emphasize oral health prevention and maintenance.^{24,25,26}

Among the limitations of this study, the most prominent is the lack of assessment of the consumption of cariogenic food and drink, which may also contribute to dental caries. Considering these variables may provide a better understanding of the progression and deterioration of carious lesions in the population under study. Finally, it is important to note that because this study's data was obtained from a single village in Banjarmasin, South Kalimantan, these findings may have limited external validity and should be interpreted

cautiously when extrapolating to other settings or contexts. Regional variations in socioeconomic conditions and access to dental care services are also important considerations. Therefore, further research conducted in various environments is needed to confirm and extend these findings.

CONCLUSION

In the group of children aged 5-9 years studied, a very high proportion of children with untreated dental caries had PUFA symptoms. It is important to emphasize the importance of preventive dental care and treatment of dental caries in primary teeth, as well as education on the use of wetland water in everyday life.

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