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The Relationship Between Well Water Quality andCognitive Function in Well Water Users

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Abstract

Aims: to explore the relationship between consuming contaminated well water and cognitive function among well water users in Jember Regency; to understand the sociodemographic characteristics based on age, gender, and education level; to assess the quality of well water used by residents; and to describe the cognitive function of well water users.

Study Design: this study employed an observational analytical approach with a cross-sectional design.

Place and Duration of Study: this research was carried out in a village in JemberRegency, Indonesia from September to November 2023

Methodology: well water samples were measured by the polluted index (IPj) method as well as the cognitive function was measured by MMSE. There were 46 respondents who met the inclusion and exclusion criteria and obtained 29 well water samples.

Results: 1 well water sample (3.45%) was found to be in good condition, while 20 well water samples (69%) were categorized as lightly polluted. Additionally, 5 well water samples (17.24%) were moderately polluted, and 3 well water samples (10.24%) were heavily polluted. Regarding cognitive function, 30 respondents (65.2%) fell into the normal category, 11 respondents (23.9%) were classified as having Mild Cognitive Impairment (MCI), and 5 respondents (10.9%) were diagnosed with dementia. Statistical analysis revealed a significant correlation (p-value = 0.001) between well water quality and cognitive function in well water users, with a correlation coefficient of -0.473.

Conclusion: There is a clear relationship between contaminated well water and cognitive function in well water users. Deteriorating water quality correlates with a decline in cognitive function.

Keywords: aquatic neurotoxins, waterborne contaminants, brain health, environmental determinants ofcognitive impairment.

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Introduction

Water is an important element for humans. One source of water that can be used is the well water. Well water is the waterthat comes from shallow groundwater which generally has a depth of ± 15 meters. According to data from the Central Statistics Agency for 2020, approximately 18% of the Indonesian population still relies on well water for their daily needs. In East Java Province, as many as 21.46% of people use well water and in Jember

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Regency almost half of the peopleuse well water, namely 45.63%. This figure shows that Jember Regency is the third largest user of well water in East Java after Pamekasan and Blitar Regencies [1, 2].

Research Problem

Water can be contaminated through various sources, including industrial waste, agriculture, mining, etc. Contaminants that are not properly managed are absorbed through the soil and contaminate the surrounding water. Mercury is one of the pollutants found in water. Mercury is often used as component for the gold amalgamation process which is considered a toxic environmental pollutant and has neurotoxic effects on organisms, even at lowconcentrations. Exposure to mercury is linked to central nervous system disorders, which can lead to a decline in cognitive function [3, 4].

Research Focus

Cognitive function is crucial as it significantly impacts the ability to process information in daily life. Decreased cognitive function ranges from mild (mild cognitive impairment) to severe (dementia). The decline incognitive function is mainly influenced by the age. Additionally, the decline in cognitive function can also be influenced by demographic, psychological, lifestyle, and environmental factors, including the quantity and quality of water consumption. Water can enter the body either via the oral or dermal route, with oral consumption being the most influential, particularly through daily intake of well water. The processes underlying cognitive function's decline related to the qualityof daily intake of water are divided into two, namely neuroinflammation and oxidative stress [5, 6].

Research Aim and Research Questions

However, there is still not much research conducted by experts regarding the quality of well water and its impacton cognitive function. Though, a hypothesis is posited suggesting a correlation between the quality of well water and cognitive function. In a village in Jember Regency, there are residents' houses which are used as independent gold processing facilities. Based on preliminary research, waste from the gold processing site was disposed of near residents' homes, potentially impacting their well water. This research aimed to investigate the correlation between the consumption of contaminated well water and cognitive function among residents of Jember Regency. Additionally, it sought to explore sociodemographic characteristics based on age, gender, and education level, assess the quality of well water among users, and describe the cognitive function of individuals using well water.

Research Methodology

General Background

This research employed an observational analytical approach with a cross-sectional research design. It was conducted from September to November 2023 in a village located in the southern part of Jember Regency. A cross sectional study was used in the search as the sample was only taken at one predetermined time. The data obtained was primarydata in the form of water quality parameters measured using a water quality checker (WQC) and cognitive functionmeasured using MMSE.

Sample / Participants / Group

The study population comprised village residents who relied on well water for their daily needs. Well water samples were collected using purposive sampling to select the subjects for the study. Each villager's house was visited, and interviews were carried based on inclusion and exclusion criteria so that appropriate respondents wereobtained. The inclusion criteria for the sample were individuals aged 18-64 years who had been using well water for at least 1 year. Exclusion criteria for the sample included individuals with a history of intracranial lesions and those who consumed alcohol at least once a month.

Instrument and Procedures

The independent variable in this research was the quality of well water which was interpreted using the pollution index method (IP_j). The pollution index (IP_j) method is one of the water quality analysis methods applied in Indonesia. Thismethod is a relative calculation between the results of observations and the applicable quality standards. The water parameters used in this research included temperature, total dissolved solids, conductivity, pH, dissolved oxygen, and salinity. These parameters were measured using a water quality checker (WQC) and interpreted into three categories, namely good condition, mild pollution, and severe pollution. The dependent variable in this research was the respondent's cognitive function which was measured using the MMSE. This research has been approved by the Ethics Commissionof the Faculty of Dentistry, Jember University with certificate No.234/UN25.8/KEPK/DL/2023.

Data Analysis

The research results were analysed using the IBM SPSS Statistics 25 application which consisted of univariate andbivariate analysis. The univariate analysis was used to describe the characteristics of age, gender, and level of education.

The bivariate analysis was carried out using the Spearman correlation test to see the correlation between well water quality and cognitive function. P-value with a significance result <0.05 which indicates there was a relationship between two variables.

Research Results

Univariat Analysis

The Characteristic of Respondents

Table 1. The Characteristics of Respondents

	n	(%)
Age		
17-25 years	3	6,52
26-35 years	8	17,4
36-45 years	12	26
46-55 years	14	30,4
56-65 years	9	19,68
Gender		
Male	10	21,7
Female	36	78,3
Level of education		
None of school	3	6,52
Elementary school	11	23,9
Junior high school	15	32,6
Senior High school	13	28,7
College	4	8,28

The characteristics of research participants included age, gender, and highest level of education. Based on the Table 1 at the age point, the youngest respondent was 20 years old and the oldest was 64 years old. The majority of respondents were in the age range of 46 to 55 years, namely 14 people (30.4%) with an average age of 44 years.

According to the gender distribution presented in Table 1, there were 10 male respondents (21.7%) and 36 female respondents (78.3%), the majority of respondents in this study were female. Based on the level of education pointed in the table 1, it is known that the level of education of respondents was divided into 5 levels. A total of 3 respondents in the study were not in school (6.52%). There were 11 respondents with elementary school graduates (23.9%), 15 respondents with junior high school graduates (32.6%), 13 respondents with senior highschool/vocational school graduates (28.7%), and there were 4 respondents with college graduates (8.28%).

Bivariat Analysis

In this study, bivariate analysis was conducted using the Spearman correlation test. Research data is considered significant in the Spearman correlation test if the p-value is less than 0.05. The strength of the correlation can be seen from the results of the correlation coefficient (r). An r value between 0.00 – 0.25 indicates a very weak correlation; r values between 0.26 – 0.50 indicate sufficient correlation; r values between 0.51 – 0.75 indicate a strong correlation; r values between 0.76 – 0.99 indicate a very strong correlation; and an r value equal to 1.00 indicates there is the perfect correlation.

Table 2. The Relationship between Well Water Quality and Cognitive Function

	Cognitive Function (MMSE Score)					
	Normal	MCI	Dementia	Total	*p-value*	Correlation coefficient (r)
Well water quality						
Good condition	1	0	0	1		
Lightly polluted	22	3	1	26	0,001	-0,473
Moderately polluted	4	4	2	10		
Heavily polluted	2	5	2	9		
Total	29	12	5	46		

Based on Table 2, it is visible that among respondents who used well water in the good category, there was 1 respondent (2.17%) who had normal cognitive function. Of the respondents who used well water in the mildly polluted category, there were 22 respondents (47.82%) with normal cognitive function, there were 3 respondents(6.52%) in the MCI category, and there was 1 respondent (2.17%) in the dementia category. Of the respondents whoused well water in the moderately polluted category, there were 4 respondents (8.7%) in the normal cognitive function category, there were 4 respondents (8.7%) in the MCI category, and there were 2 respondents in the dementia category. Of the respondents who used well water in the heavily polluted category, there were 2 respondents (4.34%) with cognitive function in the normal category, there were 5 respondents (10.86%) in the MCI category and there were 2 respondents (4.34%) in the dementia. The correlation test results show that the p-value is 0.001 with a correlation coefficient of -0.473. It means that there is a significant relationship between well waterquality and cognitive function with sufficient negative correlation strength.

Table 3. The Relationship between Age and Cognitive Function

	Cognitive Function (MMSE Score)					
	Normal	MCI	Dementia	Total	*p-value*	Correlation coefficient (r)
Age						
17-25 years	2	1	0	3		
26-35 years	8	0	0	8		
36-45 years	7	5	0	12	0,010	-0,375
46-55 years	8	4	2	14		
56-65 years	3	3	3	9		
Total	28	13	5	46		

Based on Table 3, the age grouping was divided into an age range of 17 to 65 years. In the age range of 17 to 25 years, there were 2 respondents (4.34%) with normal cognitive function, and there was 1 respondent (2.17%) in the MCI category. In the age range of 26 to 35 years, there were 8 respondents (17.4%) with normal cognitive function. In the age range of 36 to 45 years, there were 7 respondents (15.22%) with normal cognitive function, and there were 5 respondents (10.86%) with cognitive function in the MCI category. In the age range of 46 to 55 years, there were 8 respondents (17.4%) with normal cognitive function, 4 respondents (8.7%) with cognitive function in the MCI category, and 2 respondents (4.34%) with cognitive function in the MCI category.

In the age range of 56 to 65 years, there were 3 respondents (6.52%) with cognitive function in the normal category, 3 respondents (6.52%) with cognitive function in the MCI category, and 3 respondents (6.52%) with cognitive function in the normal category.

The correlation test results showed that the p-value was 0.010 with a correlation coefficient of -0.375. It means that there was a significant relationship between age and cognitive function with sufficient negative correlation strength.

Table 4. The Relationship between Gender and Cognitive Function

	Cognitive Function (MMSE Score)					
	Normal	MCI	Dementia	Total	*p-value*	Correlation coefficient (r)
Gender						
Male	3	5	2	10	0,019	0,346
Female	26	7	3	36		
Total	29	12	5	46		

Based on the Tabel 4, in the male gender, there were 3 respondents with normal cognitive function, there were 5 respondents (10.86%) with cognitive function in the MCI category, and there were 2 respondents (4.34%) with cognitive function in the dementia category. In the female gender, there were 26 respondents (56.52%) with normal cognitive function, there were 7 respondents (15.22%) with cognitive function in the MCI category, and there were 3 respondents (6,525) with cognitive function in the dementia category. The results of the correlation test show that the p-value is 0.019 with a correlation coefficient of 0.346. It means that there is a significant relationship between gender and cognitive function with sufficient positive correlation strength.

Table 5. The Relationship between Level of Education and Cognitive Function

	Cognitive Function (MMSE Score)					
	Normal	MCI	Demenia	Total	*p-value* (r)	Correlation coefficient (r)
Tingkat Pendidikan						
None of school	1	0	2	3		
Elementary school	2	7	2	11		
Junior high school	10	4	1	15	0,000 (0,592)	0,592
Senior high school	12	1	0	13		
College	4	0	0	4		
Total	29	12	5	46		

Based on the Tabel 5, respondents who did not experienced school, there was 1 respondent with normal cognitive function and there were 2 respondents with cognitive function in the dementia category. Of the respondents who graduated from elementary school, there were 2 respondents with cognitive function in the normal category, therewere 7 respondents with cognitive function in the MCI category, and there were 2 respondents with cognitive function in the dementia category. Of the junior high school graduate respondents, there were 10 respondents withnormal cognitive function, there were 4 respondents in the MCI category, and there was 1 respondent with cognitivefunction in the dementia category. Of the respondents who graduated from senior high school/vocational school,there were 12 respondents with cognitive function in the normal category and 1 respondent in the MCI category. Ofthe college graduate respondents, there were 4 respondents with normal cognitive function. The results of the correlation test showed that a p-value of 0.000 was obtained with a correlation coefficient of 0.592. It means that there is a significant relationship between education level and cognitive function with a strong positive correlation.

Discussion

The Characteristics of Respondents

In this study, the distribution of respondents based on age was divided into the age range of 17 to 65 years, following the age classification set by the Ministry of Health. The research results showed that the largest age group of respondents was in the range of 46 to 55 years with 14 respondents (30.4%). This is in accordance with the research results of Andriati et al. [7] that the majority of respondents who used well water (30%) were in the age range of 46 to 55 years. Apart from that, the results of research on well water quality by Astuti also showed that the characteristics of those belonging to the productive age ranged from 37 to 57 years. The age range of 46-55 years is categorised as early old age. This period is a transition period from late adulthood to late old age, which is followed by a decline in cognitive function due to the influence of age and the number of hormones in the body [7,8, 9].

In this study, the majority of respondents' characteristics according to gender were female, namely 36 respondents (78.3%). This is in line with the research conducted by Astuti that the majority of well water users were female (85%) because women do more household activities than men [8].

In this study, the characteristics of respondents according to their last level of education were divided from notcompleting elementary school (no school) to college graduates. The highest level of education characteristic in thisstudy was junior high school graduates with 15 respondents (32.6%). This is in accordance with research conducted by Amnan & Naelasari [10] which states that the majority of respondents who use well water are junior high school graduates (63.7%). Education level is one of the factors that plays a role in respondents' knowledge of the quality of well water used daily and its impact on health. This is in accordance with research by Afifah et al. which states thatthe diversity of education distribution is in accordance with regional progress and is related to community health conditions. Apart from that, people who have a higher level of education generally care more about health issues for themselves and their families [10, 11].

The Relationship between Well Water Quality and Cognitive Function in Well Water Users

Illegal gold processing activities in a village in Jember Regency are activities that have been carried out for twoyears with public complaints regarding changes in water quality, namely in terms of smell, colour and taste. The waste produced by this activity has not been managed properly and flows into water channels around residents' homes sothat it seeps into the ground and has potential to pollute the residents' well water. The main waste produced in gold processing is the heavy metal mercury due to the amalgamation process and if water contaminated with mercury is consumed long term (≥1 month) it can cause toxicity to the nervous system [12].

The results of Spearman's analysis showed that there was a significant relationship between well water quality andcognitive function in well water users with sufficient negative correlation strength. This shows that the greater the IPj value is (indicating the worse water quality) the greater is the possibility of dementia (decreased cognitive function). These results are in accordance with the research conducted by Pan et al. which states that there is a significant relationshipbetween drinking water quality and cognitive function. However, this cross-sectional study cannot explain the causal relationship between these two variables because the onset of cognitive decline requires follow-up of more than 10years. Additionally, this is consistent with the findings of the follow-up study conducted by Zhai et al. [14], which indicated that individuals who use well water exhibit lower cognitive function compared to those who use tap water. It is well-established that tap water typically boasts superior quality compared to other water sources due to undergoing various purification processes [13, 14].

There are various kinds of substances that can cause well water pollution, including industrial waste. In the shale gas industry, a fracking technique is employed to extract gas, resulting in the production of hydrocarbons like methane, ethane, and propane. These substances have the potential to leak and contaminate shallow groundwater. Additionally, agricultural waste poses a significant environmental concern. The runoff from materials used in agriculture often ends up in water sources, such as pesticide and fertiliser residues. These contaminants can seep into ground water, potentially polluting well water. Apart from these sources, agents in the form of drugs can enter the aquatic environment as well. According to the CDC, as much as 48.7% ofthe population uses at least one drug every 30 days and some of these chemicals gradually enter water sources. This can happen because waste water management installations are unable to degrade these compounds so that theycan escape into water sources [15].

Well water, namely water that comes from surface water, is very easily contaminated by surrounding contaminants compared to other water sources, so it can induce a decline in cognitive function due to various factors. Heavy metal pollutants, such as mercury, lead, aluminium, copper, fluor, and arsenic which are neurotoxic are considered to bethe main cause of this relationship although the results are still controversial. Apart from heavy metals, the presence of pollutant sources originating from various places allows the accumulation of these substances according to thesource of origin of the pollutant.

Substances that can accumulate in groundwater include pesticide and fertiliser residues; acrylamide; bisphenol A (BPA); drugs; and others [14, 15].

The presence of pollutants in well water can change its physical and chemical properties. Theseproperties can influence other properties of well water. For example, mercury metal can lower the pH so that theacidity level of water increases. Mercury metal that accumulates in water can cause an increase in temperature and increasing temperature can have an effect on reducing dissolved oxygen (DO).

Apart from that, the presence of mercury metal can have an effect on increasing conductivity levels and total dissolved solid (TDS) in well water sothat this will also increase the water pollution index [16].

The pollutant substances that can accumulate in water, which have been explained in the discussion above, have neurotoxic properties, making them dangerous for the health of the nervous system. The body has a blood brainbarrier system which can filter both blood and components in the systemic circulation that enter the brain.

Its high density means that not all substances can penetrate the brain, thereby protecting it from potentially harmful chemicals. But, in the condition of a person who is continuously exposed to exogenous substances, this will trigger theimmune system to increase the response of microglia to stimulate the cell repair by producing excessive pro- inflammatory cytokines; this can cause neuroinflammation and neuronal dysfunction. In addition, when the body has an excess of exogenous substances, they will be degraded, and reactive oxygen species (ROS) will be produced. Thisexcess ROS can trigger oxidative stress which leads to neuronal dysfunction. On the other hand, neuroinflammation and oxidative stress are also related to each other. An increase in pro-inflammatory cytokines can trigger mitochondrial dysfunction which causes an imbalance in the antioxidant system in the body and this process canultimately lead to oxidative stress. An increase in ROS in the body can trigger protein inactivation and cell damage.As compensation, the body will stimulate tissue repair and remove cell debris by increasing inflammatory responses.In addition, increased ROS can activate transcription factors that will express various genes including activation of inflammatory responses. These two mechanisms (neuroinflammation & oxidative stress) can ultimately cause impaired cognitive function [15].

In this research the cognitive function was calculated using the MMSE. MMSE is one of the initial screeningtools for cognitive function that is often used in clinical practice. However, MMSE is not used as a diagnostic tool for cognitive disorders but is only used as a support in it. The diagnosis of cognitive decline is still carried out comprehensively starting from anamnesis, physical examination, and supporting examinations if necessary.

The Relationship between Age and Cognitive Function in Well Water Users

The results of statistical analysis showed that there was a significant relationship between the age and the cognitive functionin well water users with sufficient negative correlation strength. This means that the older a person gets, the greater the chance of experiencing dementia is. The research findings indicated that the most significant decline in cognitive function occurred within the age groups of 46 to 55 years and 56 to 65 years, each comprising 3 respondents (6.52%). These findings align with the study conducted by Zhou et al., which suggested that individuals aged 50 years or older typically experience a decline in cognitive function. Additionally, Lestari et al. found that among 60 subjects aged 45 to 59 years, 55% exhibited decreased cognitive function. However, research conducted by Firdaus presented a different perspective, indicating that out of 28 respondents aged less than 75 years, 64% displayed normal cognitive function [17, 18, 19].

A person's cognitive function can be influenced by the age factors because as age increases, structural changes occurin neurons, such as a decrease in both the number of axons and dendrites, as well as changes in the length ofdendrites and significant loss of synapses. These structural changes are associated with a decrease in cognitive function. The basic cognitive functions most affected by the age are attention and memory. Apart from that, complexcognitive functions also depend on a series of executive functions that regulate and coordinate other cognitive functions. Research by Brito et al. stated that there are morphological and functional changes due to aging that occurat cortical synapses in the dorsal lateral prefrontal cortex (an area that functions in working memory and executivefunction) and the hippocampus (an important area for learning and memory [20, 21].

The Relationship between Gender and Cognitive Function in Well Water Users

The results of statistical analysis showed that there was a significant relationship between gender and cognitive functionin well water users with sufficient positive correlation strength. This is in accordance with Rustanti's research that gender is a factor that influences cognitive function where females have a greater risk of experiencing a decline incognitive function compared to men [22]. Evidence regarding differences in cognitive function based on gender is not yet fully understood. Women suffer from Alzheimer's disease or other types of dementia more often than men at almost all ages because of biological and social differences. Biologically, the E4 allele of the apolipoprotein E gene, a variant that is susceptible to Alzheimer's disease, has a stronger effect on women than men, while socially, women's access to education which is still limited in certain countries influences the decline in cognitive function.

Research carried out by Zhao & Crimmins indicates that lower levels of education among women, compared to men, contribute to decreased cognitive function and an increased risk of cognitive impairment in women.

Previous studies suggest that women may possess a greater cognitive reserve but also undergo cognitive decline more rapidly than men.

This happens partly due to the influence of hormones. In elderly women, there will be a decrease in the hormone estradiol, while estradiol functions as a neuroprotective agent. This hormone has receptors in the brain which function to regulate learning and memory functions. That way, when they reach old age, women have a lack of neuroprotective agents so that nerve cells are more easily damaged, which can lead to a decline in cognitive function [23, 24].

The Relationship between Education Level and Cognitive Function in Well Water Users

The results of statistical analysis show that there is a significant relationship between education level and cognitive function in well water users with a strong positive correlation. This means that the higher a person's level of education, the less likely they are to experience dementia. The research results showed that the greatest decline incognitive function (both MCI and dementia) occurred in elementary school graduates, namely 9 respondents (19.56%). This is in line with research conducted by Nindela et al. [25] that there is a significant relationship between education level and cognitive function. This study also showed that respondents with <12 years of education experienced a decline in cognitive function and of respondents with an education of ≥12 years only a small percentage (35.3%) experienced a decline in cognitive function. These results are also supported by Rizky who found a significant relationship between the level of education and cognitive function from 40 research respondents [25,26].

Most studies state that there is a direct relationship between education and cognitive changes in old age, so that a lower level of education is associated with a greater risk of decline in cognitive function. Education is one of thelife experiences that can stimulate intellectuals so that it influences a person's cognitive function. Education can fosterthe knowledge, skills, and abilities needed for daily activities so that a person is able to maintain their cognitive function better. However, the mechanisms underlying the effects of education that can reduce the risk of cognitivedecline due to aging are still unclear. Apart from that, the level of education is a determining factor in the occurrenceof dementia. A person with a higher level of education has a higher peak level of cognitive function so that a person has a longer time to reach the threshold for dementia. People living in communities with less education, especially non-urban areas could be disproportionately exposed to chronic and stressful life conditions that generate hazards,such as few employment opportunities and low incomes. This situation results in a lack of social resources (socialclubs and neighbourhood organisations) and safe physical resources, including gyms. In the current study, the limitedresources in non-urban areas compared with those in urban areas could be associated with the increased incidenceof dementia [27, 28, 29].

Conclusions and Implications

There is relationship between contaminated well water and cognitive function in well water users. The deterioration of water quality is linked to a decline in cognitive function. Most ages are 46-55 years with an average of 44 years; most of the respondents were female, and the majority had completed junior high school. Most of thewell water quality in well water users is mildly polluted and most of the cognitive functions in well water users areincluded in the normal category. This study had limitations. Firstly, being a cross-sectional study, it only captured data over a certain period, while the decline in cognitive function typically occurs over an extended duration. Furthermore, the specific contaminants present in well water were not analysed, which could introduce bias to the study. Future researchers are encouraged to explore additional factors that may influence research variables, identify specific contaminants, and employ cohort or case-control approaches to mitigate bias in their research.

Declarations

Author Contributions

Conceptualisation, Ancah Caesarina Novi Marchianti and Clarisa Izza Gelsanda; methodology, Ancah Caesarina Novi Marchianti and Clarisa Izza Gelsanda; software, Clarisa Izza Gelsanda; validation, Ancah Caesarina Novi Marchianti and Yudha Nurdian; formal analysis, Clarisa Izza Gelsanda; investigation, Ancah Caesarina Novi Marchianti and Clarisa Izza Gelsanda; resources, Ancah Caesarina Novi Marchianti, Clarisa Izza Gelsanda, and Yudha Nurdian; data curation, Clarisa Izza Gelsanda; writing—original draft preparation, Clarisa Izza Gelsanda; writing—review and editing, Ancah Caesarina Novi Marchianti, Yudha Nurdian, and Clarisa Izza Gelsanda; visualization, Clarisa Izza Gelsanda; supervision, Ancah Caesarina Novi Marchianti and Yudha Nurdian; project administration, Ancah Caesarina Novi Marchianti; funding acquisition, Ancah Caesarina Novi Marchianti. All authors have read andagreed to the published version of the manuscript.

Data Availability Statement

- Data sharing not applicable: No new data were created or analyzed in this study. Data sharing is not applicableto this article.

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Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Commissionof the Faculty of Dentistry, Jember University with certificate No.234/UN25.8/KEPK/DL/2023 and approved on December 4th 2023 for studies involving humans.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Conflicts of Interest

The author declares that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, doublepublication and/or submission, and redundancies have been completely observed by the authors.

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