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Analyzing the Factors Affecting Adolescents' Ability to Provide First Aid for Burns; A Cross-Sectional Study at SMP Muhammadiyah 8 Surakarta

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ABSTRACT

Introduction: Burns are among the most common types of injuries that occur in daily life, whether at home, school, or in the surrounding environment. The mortality and morbidity rates due to burns in developing countries are estimated to be approximately 11.6 per 100,000 population. These injuries most frequently occur at home, school, or the workplace, with children and adolescents being the most vulnerable groups to burn injuries resulting from daily activities.

Methods: This study employed a cross-sectional design to analyze factors affecting adolescents' ability to provide first aid for burns. A total of 100 respondents were selected using a purposive sampling technique, and the data were analyzed using logistic regression tests.

Results: The majority of respondents were aged 11–14 years (46%), with 54% having a junior high school education. A total of 70 respondents (70%) obtained information from social media or the internet, 44 respondents (47%) had good knowledge, and 73 respondents (73%) had previously experienced burn injuries. In addition, 42 respondents (42%) administered first aid using running water, and 66 respondents (66%) were capable of providing burn first aid. The logistic regression test results showed that the source of information produced a p-value of 0.035 with an OR of 1.929 and a 95% CI of 1.048–3.551. The source of information was identified as the most dominant factor influencing adolescents' ability to provide first aid for burns, as it showed the highest odd ratio compared to other variables.

Conclusion: Adolescents' ability to perform burn first aid is influenced by several factors, including age, educational level, sources of information, knowledge level, history of burn injuries, and frequency of first aid practices. Among these, the source of information was identified as the most important factor enhancing adolescents' ability to provide burn first aid. Adolescents with access to reliable sources of information, such as materials developed by healthcare professionals, school modules, or formal education, are more likely to acquire the ability to administer burn first aid earlier compared to those without such access.

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INTRODUCTION

Adolescence is a stage of development marked by dynamic changes, including in the awareness of health and safety. One important aspect that is often overlooked is adolescents' ability to perform first aid, particularly in cases of burns. Burns are one of the most common types of injuries encountered in daily life, whether at home, school, or in the community, and can have serious consequences if not treated properly. A lack of knowledge and skills in managing burn injuries can lead to improper treatment, thereby increasing the risk of further complications (1).

The World Health Organization (WHO) in 2021 estimated that approximately 265,000 deaths occur worldwide each year due to burns, with the majority of cases taking place in low- and middle-income countries. Data from the Global Burn Registry (2017–2021) also indicate that among all recorded pediatric and adolescent burn patients, 13% were aged 13–18 years, although children aged 1–5 years dominated the overall pediatric cases. Most of the data came from lower-middle-income countries (2). The 2018 Basic Health Research (Riskesdas) in Indonesia reported that 1.3% of all types of injuries were burn-related injuries. The national proportion of burn incidents was recorded at 1.4%. According to the World Health Organization (2023), burns cause an estimated 180.000 deaths annually worldwide, with the vast majority occurring in low and middle countries. These injuries most commonly occur at home, in schools, or in workplaces, with children and adolescents being particularly vulnerable due to their daily activities (3).

Adolescents are an age group that is actively engaged in various activities, both at home, at school, and within their social environment. They are at risk of experiencing or witnessing burn injuries, whether due to kitchen accidents, exposure to hot objects, or other activities involving heat and fire. However, many adolescents still lack sufficient understanding of the correct first aid measures for burn injuries (1). Common mistakes in treating burns such as applying toothpaste, butter, or other inappropriate substances are still frequently made due to a lack of education on proper burn care (4).

A cross-sectoral study involving a sample from the general community in Saudi Arabia revealed that although approximately 62.9% of participants had a good level of knowledge about burn first aid, only around 8.7% correctly applied first aid practices such as rinsing the burn with running water for 10 to 15 minutes. These findings highlight a gap between khowledge and practice that may also occur among adolescents, underscoring the importance of early, school based first aid education to translate knowledge into appropriate burn management behaviors. Meanwhile, the majority still relied on traditional remedies, such as applying toothpaste or honey (61.6%), and only 15.6% were aware of the importance of cooling the burn for a minimum of 10 to 15 minutes. In addition, variables such as formal education or first aid training experience were found to significantly improve practice scores ($p<0.05$). However, overall formal education level did not show a strong correlation with first aid practices within a population where the majority had at least a secondary or higher level of education (5).

The provision of first aid for burn injuries within the community is still frequently performed incorrectly, such as through the use of household items and cosmetic products. The effectiveness of burn first aid is highly influenced by an individual's level of knowledge. Inappropriate first aid practices can lead to harmful consequences (6). For instance, applying ointments, creams, lotions, or oils to the affected burn area can increase the risk of infection. Additionally, the use of traditional or non-conventional remedies without proper guidance may delay and hinder the wound healing process (7).

A strong understanding of first aid for burn injuries is a key factor in minimizing the impact of the injury and accelerating the recovery process. Therefore, this study fills an important gap by providing setting specific evidence from an Indonesian junior high school and by using multivariable regression analysis to examine information sources as predictors of burn first aid ability among adolescents. Through this research, it is expected that a clearer picture of adolescents' preparedness in dealing with burn incidents can be obtained. This, in turn, can serve as a foundation for developing more effective educational programs or training initiatives to improve first aid skills among adolescents.

Preliminary, exploratory observations conducted at SMP Muhammadiyah 8 Surakarta suggested that the majority of students lacked an accurate understanding of the correct steps for administering first aid for burn injuries. These observations were exploratory in nature and were not part of the formal study design. Among 10 students who were randomly interviewed, only six correctly identified running water as the appropriate initial treatment for minor burns. The remaining students still believed that substances such as toothpaste, cooking oil, or even butter were effective first aid solutions. SMP Muhammadiyah 8 Surakarta, as the research site, comprises an adolescent population with diverse characteristics. By examining variables such as age, level of knowledge, sources of information, history of burn injuries, and the frequency of previous first aid actions, this study aims to contribute meaningfully to the improvement of health education within the school setting.

METHOD

The type of research used is descriptive analytic with a cross-sectional study design. The study was conducted in the working area of PD Nasyiatul 'Aisyiyah Surakarta, one of which is SMP Muhammadiyah 8 Surakarta in May 2025, involving 100 respondents. Data collection was carried out using a questionnaire for the independent variables and an observation sheet for the dependent variable. The independent variables in this study include age, education, sources of information, level of knowledge, history of burn injuries, and frequency of actions commonly performed in treating burns, while the dependent variable is the ability to provide first aid for burn injuries.

Research Type

This research is a quantitative descriptive study that aims to analyze the factors affecting adolescents' ability to provide first aid for burns at SMP Muhammadiyah 8 Surakarta.

Population and Sample

The sampling technique employed in this study was purposive sampling, conducted among 100 adolescents from grades VII, VIII, and IX at SMP Muhammadiyah 8 Surakarta.

Research Location

The study was conducted at SMP Muhammadiyah 8 Surakarta, which operates under the supervision and community programs of PD Nasyiatul 'Aisyiyah Surakarta.

Instrumentation or Tools

This study used a questionnaire to collect data on the factors influencing adolescents' ability to provide first aid for burns at SMP Muhammadiyah 8 Surakarta. The purpose of the questionnaire was to identify respondents' characteristics, including age, education level, sources of information, level of knowledge, history of burns, frequency of commonly performed actions, and first aid ability.

Data Collection Procedures

Data were collected through a series of activities as shown in Table 1, which included the following:

1. Coordination with the School
   Coordination was carried out with the principal, guidance counselor, and homeroom teachers at SMP Muhammadiyah 8 Surakarta to obtain research permission and determine the schedule for data collection.
2. Questionnaire Development and Trial
   The questionnaire was developed based on a review of the literature and theories related to factors influencing adolescents' ability to provide first aid for burns, including age, level of education, sources of information, level of knowledge, history of burns, frequency of actions commonly performed, and first aid skills. The questionnaire was validated using Pearson product moment correlation. All items showed significant item total correlations, with r values ranging from 0.45 to 0.72, exceeding the r table value at a significance level of $p < 0.05$, indicating adequate content validity. Internal concistency reliability was assessed using Cronbach's alpha a value 0.78, which indicates acceptable reliability.
3. Data Processing and Analysis
   Data from the questionnaires were collected, checked for completeness, and then analyzed to determine the relationship between the factors (age, level of education, sources of information, level of knowledge, history of burns, frequency of commonly performed actions, and first aid skills) and the ability to provide first aid in burn management. Logistic regression analysis was then conducted to identify which factor had the most significant influence on the provision of first aid for burns.

Data Analysis

Data analysis was carried out in several stages. The first stage was univariate analysis, which was presented in the form of frequency distribution tables. This was followed by bivariate analysis using the Chi-Square test, and then a logistic regression analysis was performed to identify the most dominant factors influencing the ability to provide first aid for burns. All data in this study were analyzed using quantitative methods with the assistance of SPSS version 27.0.

Informed Consent

Written informed consent was obtained from the parents, and assent was also obtained from the adolescents themselves. The study was conducted in accordance with research ethical standards. Each respondent was given an explanation regarding the purpose, benefits, and procedures of the study, as well as their rights to refuse or withdraw from participation at any time without any negative consequences. The respondents were also assured that the data collected would remain confidential and be used solely for research purposes.

Ethical Approval

This study was carried out in accordance with established ethical research principles and received approval from the Research Ethics Committee of Universitas 'Aisyiyah Surakarta (Letter Number : No. 530/VII/AUEC/2025). Participation in the study was entirely voluntary, with all respondents providing informed consent prior to involvement. All collected data were used exclusively for research purposes, and strict measures were implemented to maintain the confidentiality and anonymity of participants throughout the study.

Table 1. Schedule of Research Implementation

Activities	***Date of activity March to June 2025***			
	March	*April*	*May*	*June*
Preparation of research instruments				
Coordination with school and obtaining research permission				
Data collection				
Data processing and analysis				
Report writing and conclusion preparation				

RESULTS

This study involved 100 adolescents from SMP Muhammadiyah 8 Surakarta and was conducted in May 2025. The demographic characteristics of the respondents are presented in Table 2, while the results of the logistic regression analysis are shown in Table 3.

Table 2. Respondents Characteristics

Respondent Characteristics	Category	Total N (%)
Age	11 – 14 years	65 (65)
	15 – 17 years	35 (35)
Total		100
Grade Level	Grade VII	54 (54)
	Grade VIII	27 (27)
	Grade IX	19 (19)
Total		100
Source of information	Social media / Internet	70 (70)
	Peers	16 (16)
	Parents	14 (14)
Total		100
Level of knowledge	Good	47 (47)
	Fair	29 (29)
	Poor	24 (24)
Total		100
History of burn injury	Ever	73 (73)
	Never	27 (27)
Total		100
Frequency of commonly performed actions	Running water	42 (42)
	Toothpaste	35 (35)
	Lotion	13 (13)

Respondent Characteristics	Category	Total N (%)
	Ice water	10 (10)
Total		100
Ability to Provide First Aid	Able to provide first aid	66 (66)
	Unable to provide first aid	34 (34)
Total		100

Based on Table 2, the data shows that the majority of respondents in this study are aged 11–14 years, totaling 65 respondents (65%). There are 35 respondents (35%) aged 15–17 years. In terms of grade level, the majority of respondents are at the grade level VII, with 54 individuals (54%), followed by 27 respondents (27%) at the grade level VIII, and 19 respondents (19%) at the grade level IX.

The results of the frequency distribution for sources of first aid information show that 70 respondents (70%) obtained information through social media or the internet. This is followed by 16 respondents (16%) who received first aid information from peers, and 14 respondents (14%) who received it from their parents. Regarding the category of knowledge level, it was found that 47 respondents (47%) have a good level of knowledge, 29 respondents (29%) have a fair level of knowledge, and 24 respondents (24%) have a poor level of knowledge.

Based on Table 2, the frequency distribution of respondent characteristics regarding burn injury history shows that 73 respondents (73%) have experienced a burn injury, while 27 respondents (27%) have never experienced a burn injury. For the frequency distribution based on the ability to provide first aid for burn injuries, it was found that 66 respondents (66%) reported being able to perform burn first aid, while 34 respondents (34%) reported not being able to perform burn first aid. Furthermore, the frequency distribution of actions commonly taken during burn first aid shows that 42 respondents (42%) used running water, 35 respondents (35%) used toothpaste, followed by 13 respondents (13%) who used lotion, and 10 respondents (10%) who used ice water.

Table 3. Final Logistic Regression Results on Adolescents' Ability to Provide First Aid for Burns

Variabel	*B*	*p-value*	*Exp (B)OR*	*95% CI for Exp (B)*
Source of information	0,657	0,035	1,929	1,048 – 3,551
Frequency of commonly performed actions	0,544	0,026	1,723	1,066 – 2,785
Level of knowledges	-0,630	0,043	0,533	0,289 – 0,981

As presented in Table 3, the most dominant factor influencing the ability to provide first aid for burns is the source of information, as it has the highest OR or Exp (B) value of 1.929 with a 95% CI of 1.048–3.551, compared to other variables such as frequency of practice and level of knowledges. The source of information was identified as the most influential factor affecting the ability to provide first aid in burn management. Meanwhile, the variables of age, education, and history of burns were excluded from the logistic regression analysis, as their bivariate analysis results showed p-values greater than 0.25. Variables with a p value ≤ 0.25 in the bivariate analysis were included in the multivariable logistic regression model. This cutoff was used to avoid excluding potentially important variables at an early stage and to control for possible confounding factors, as recommended in standard regression modeling guidelines.

DISCUSSION

Age

The majority of respondents in this study are in the age range of 11–14 years (46%), which is considered the early stage of adolescence, also known as early adolescence. At this stage, individuals begin to experience rapid physical, emotional, and cognitive changes. Early adolescents start to develop their identity and show significant improvement in abstract and logical thinking abilities. Therefore, this age group is particularly important for educational interventions, especially those related to health and safety, including knowledge and the ability to provide

first aid for burn injuries. This stage is also known as a vulnerable period, during which adolescents are highly influenced by their environment and external sources of information—both positive and negative (8).

Furthermore, the World Health Organization (WHO) categorizes adolescence into three stages: early adolescence (10–14 years), middle adolescence (15–17 years), and late adolescence (18–21 years). The 11–14 age group falls under early adolescence, which is characterized by active learning behavior but is still heavily influenced by parental and teacher guidance. Children in this age range tend to have a high level of curiosity but are not yet fully capable of independently evaluating the accuracy of information. Therefore, it is important to deliver first aid information using educational and visual approaches that are easy to understand. Interventions at this age have been proven effective in forming long-term positive habits, indicating that early adolescent education can significantly improve understanding and health practices (9).

Grade Level

The majority of respondents have a grade level VII (54%), followed by grade level VIII (27%), and grade level IX (19%). This is consistent with the age distribution of participants, most of whom are in the junior high school age range (11–14 years). Junior high school education is typically attended at this age, according to UNESCO standards and the classification of formal education levels. Grade level is a significant factor influencing an individual's ability to provide first aid, as higher levels of education are generally associated with improved cognitive abilities, better health literacy, and greater access to accurate medical information (10).

Respondents with higher levels of education tend to have broader access to information and more advanced critical thinking skills. Educational level is positively correlated with an individual's ability to recognize emergency situations and respond appropriately with first aid. This indicates that respondents with a senior high school or higher education background generally have better first aid capabilities compared to those with only a junior high school education (11). Higher grade levels among junior high school students are associated with better cognitive development, which supports improved understanding and application of appropriate first aid measures. The effectiveness of first aid education is greatly influenced by the participants' level of education, as well as the delivery methods that align with their cognitive abilities (12).

Source of information

Based on the study results, the majority of respondents obtained information about first aid from social media or the internet (71%), followed by peers (15%) and parents (14%). These findings indicate that digital media has become the primary source of health education for adolescents today. School-age adolescents are more likely to obtain health information from social media than from formal sources. Accessibility, convenience, and the visual appeal of digital content such as short videos and infographics are strong reasons why social media has become the dominant channel for disseminating health information among students. Sources of information are an influential factor in adolescents' ability to provide burn first aid. Quasi-experimental and observational studies in school settings have shown increased knowledge scores and readiness to practice following audiovisual education, confirming that visual media facilitates the understanding of essential procedures (13).

However, the high reliance on social media also poses the risk of misinformation or the acceptance of inaccurate information if not balanced with adequate digital literacy. Therefore, it is essential for healthcare professionals and educators to utilize digital platforms as tools for structured and validated health education, especially for first aid topics that require accurate actions. In addition, the involvement of parents and teachers in guiding children when accessing information from the internet is crucial to help filter and strengthen correct understanding. Social media can be an effective tool in public health campaigns, provided it is developed with an educational approach and supported by scientific evidence (14).

Level of knowledge

The results of the study show that the majority of respondents have a good level of knowledge regarding first aid for burn injuries, with 47 respondents (47%) falling into this category, followed by 29% with a moderate level and 24% with a low level of knowledge. These findings illustrate that although the majority of adolescents already understand the basics of first aid, a significant proportion still have limited knowledge. Children and adults are considered high-risk groups for burn injuries. Burns commonly occur during activities such as cooking, heating, and using electrical appliances. In addition, industrial accidents also contribute to burn incidents. Adolescents' level of knowledge is closely related to health behaviors, particularly in emergency situations such as burn injuries. At present,

the practice of burn first aid remains relatively low. In schools, burn first aid management often involves applying toothpaste or other herbal remedies due to the cooling sensation they provide on the wound (15).

Improving knowledge through structured education can enhance adolescents' preparedness and confidence in performing first aid independently. Conversely, adolescents with low levels of knowledge are more likely to take incorrect actions, often influenced by environmental habits or inaccurate information from social media. Therefore, it is important to implement educational interventions that focus on increasing knowledge, supported by participatory learning methods such as simulations, group discussions, and the use of audiovisual media. By improving their knowledge, adolescents' first aid behavior is expected to become more accurate, safe, and effective in preventing further complications from burn injuries (16).

History of burn injury

The results of the study show that the majority of respondents, namely 73 individuals (73%), have experienced a burn injury. The high percentage of adolescents with a history of burns indicates that burn injuries are relatively common during adolescence, whether due to accidents at home, in the school environment, or during daily activities. Personal experience with burn injuries can serve as a motivation for adolescents to take a greater interest in learning first aid measures. Such personal experiences are closely related to increased awareness in seeking information and improving first aid responses. Individuals with a history of burn injuries are more likely to be motivated to seek information about first aid (17).

Furthermore, adolescents who have experienced burn injuries generally have firsthand experience of the importance of proper initial treatment, which can contribute to the development of better first aid skills. Previous exposure to emergency situations can enhance both conceptual understanding and practical skills in providing first aid. Therefore, experience-based educational interventions, such as simulations or role-playing, are highly recommended to improve adolescents' preparedness especially for those who have previously experienced burn injuries so they can provide first aid that is quick, accurate, and safe (18).

Frequency of Commonly Performed Actions

The results of the study indicate a variety of actions taken by respondents when providing first aid for burn injuries. Most respondents (42%) performed the correct action, which was using running water to cool the burned area, as recommended by the World Health Organization. However, some respondents still used inappropriate methods, such as toothpaste (35%), lotion (13%), and ice water (10%), which can worsen the condition of the burn and increase the risk of infection.

These findings are consistent with studies showing that out of ten questions given to respondents to assess their attitude toward burn first aid, 40.7% agreed that water is the most commonly recommended burn first aid measure. Meanwhile, 89.9% of respondents stated that burn first aid is a basic skill that everyone should know. The majority of respondents, 73.8%, demonstrated a positive attitude toward burn first aid (19).

Children are the most vulnerable group, with 17% to 18% of childhood burn cases in Pakistan resulting in disability due to inadequate first aid. Misconceptions and the use of inappropriate home remedies, such as toothpaste and burn creams, burden the healthcare system with problems that are actually preventable. Following a burn injury, the standard of first aid provided immediately has been proven to affect outcomes in terms of both morbidity and mortality. The protocol of using cool running water as the initial management of acute burns has been established by several studies. In this study, only 42% of participants selected cool running water as the best first aid measure, while the most common response was toothpaste (35%) (20).

Ability to Provide First Aid for Burns

Out of a total of 100 respondents, 66 individuals demonstrated the ability to provide first aid for burn injuries, while 34 were unable to do so. These finding underscores substantial variability in first aid competency among adolescents, consistent with previous literature. This ability is most likely influenced by previous experiences, the level of knowledge acquired, as well as easily accessible sources of information such as social media or school-based training. Social media is a source of information that has the potential to raise awareness but can also lead to mistakes if the content is inaccurate (21).

The ability to provide first aid greatly depends on a combination of theoretical knowledge, practical skills, and firsthand experience. First aid training that involves direct simulation and participatory approaches has been proven effective in enhancing students' ability to make quick and accurate decisions in emergency situations. Therefore, it

is essential to continuously strengthen educational interventions in schools through practice-based learning, as first aid skills are not only learned but also need to be regularly trained in order to become ingrained as safe and appropriate reflex actions (22).

The results of the study conducted by (23) the study identified that nearly half of the participants relied primarily on the internet and websites as their main sources of information about burn first aid, whereas only a small percentage (19.5%) indicated formal training courses as their reference. The research further examined participants' knowledge and their inclination toward the use of home remedies in managing burn injuries. Of the 371 individuals surveyed, 43.3% reported using ice, 41.6% mentioned toothpaste, and 38.5% noted potato as preferred treatments. In terms of attitudes, 214 respondents (57.7%) demonstrated a moderate perspective, while 157 respondents (42.3%) exhibited a positive outlook toward burn first aid. The analysis also revealed statistically significant associations between participants' attitudes and factors such as their residential location, educational attainment, and prior exposure to first aid training.

An observational study in Indonesia reported that knowledge and practices related to burn first aid remain inadequate among rural communities, where the use of traditional yet non-evidence-based remedies such as applying toothpaste was still common, potentially increasing the likelihood of complications. These results align with findings from international systematic reviews, which emphasize disparities in first aid competencies and underline the significant influence of prior training, educational attainment, and access to credible information on the ability to deliver appropriate burn first aid (24).

Based on the above findings, several factors influence the ability to provide burn first aid, namely age, education, sources of information, level of knowledge, history of burn injury, and frequency of action. The results of the logistic regression analysis showed that the most dominant variable was the source of information, as it had the highest OR or Exp (B) of 1.929 with a 95% CI of 1.048–3.551, indicating that the source of information is the most influential factor in determining the ability to perform burn first aid.

Sources of information are an important factor that enhance adolescents' ability to provide burn first aid, consistent with previous studies showing that access to accurate information (through educational media, training, leaflets, videos) is significantly associated with knowledge and practice of burn first aid. For instance, in a 2023 survey conducted in Iran, respondents' knowledge of burn first aid was strongly associated with their training history and the sources of information they accessed. Thus, adolescents with access to reliable sources of information such as materials developed by healthcare professionals, school modules, or formal education are more likely to acquire competence in providing burn first aid earlier than those without such access (25).

Study Limitations

Although this study provides insights into the factors influencing adolescents' ability to provide first aid for burns at SMP Muhammadiyah 8 Surakarta, several limitations should be noted. This study did not include direct assessment of practical skills, so adolescents' abilities were measured only through knowledge and self-reported data, rather than actual observation. Additionally, the sample was limited to a single junior high school, which restricts the generalizability of the findings to the broader adolescent population in Surakarta or other regions.

Importance of the Study Findings

The findings of this study highlight the importance of understanding the factors that affect adolescents' ability to provide first aid for burns. The results can serve as a foundation for schools, families, and healthcare professionals to develop appropriate educational programs and training, enabling adolescents to be more prepared and competent in emergency situations. Furthermore, these findings offer guidance for future research to assess the effectiveness of interventions in enhancing adolescents' knowledge and first aid skills.

CONCLUSION

Based on the interpretation of the data, it can be inferred that access to information sources represents the most decisive factor influencing students' ability to provide burn first aid at SMP Muhammadiyah 8 Surakarta. This factor was found to have a stronger impact compared to other variables, including age, educational background, level of knowledge, history of burn injuries, and frequency of first aid practices.

AUTHORS' CONTRIBUTIONSSTATEMENT

Conception and design of study ; Irma Mustika Sari, Erika Dewi Noorratri, Rini Widarti, Hesty Winda Hapsari, Dwi Sri Wahyuningsih
Acquisition of data ; Irma Mustika Sari, Erika Dewi Noorratri
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Drafting the manuscript ; Irma Mustika Sari
Revising the manuscript critically for important intellectual content ; Irma Mustika Sari, Erika Dewi Noorratri, Rini Widarti, Hesty Winda Hapsari, Dwi Sri Wahyuningsih
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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

The authors acknowledge that no generative artificial intelligence (AI) or AI-assisted technologies were used to generate, analyze, or interpret the research data. However, tools such as ChatGPT were employed only to enhance language quality, improve readability, and ensure grammatical accuracy of the manuscript.
The authors confirm that the entire research process, data interpretation, and manuscript development were conducted by the authors themselves. The use of AI tools was limited, transparent, and ethically responsible, ensuring compliance with academic integrity principles and maintaining accountability for all aspects of the published work.

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