SYSTEMATIC REVIEW

The Relationship of Water, Sanitation, and Hygiene on Stunting In Children Under Five: A Systematic Review

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ABSTRACT

Introduction: Stunting, a nutritional deficiency in children, remains a global concern. This study aimed to explore the relationship between water, sanitation, and hygiene (WASH) components and stunting in children under five. **Materials and methods:** A systematic review was conducted with sources from three databases, Scopus, PubMed, and CINAHL, used various combinations of keywords related to “water, sanitation, hygiene”, "WASH", and “growth disorders” or “stunting” or “stunted”. Inclusion criteria were published between 2019 and 2024, available in English or Indonesian, focused on families with children under five years old, and investigated the relationship between water, sanitation, and hygiene (WASH) factors with stunting in children. The articles were analysed using the PRISMA guidelines to ensure a comprehensive and systematic approach. **Results:** The review process involved screening titles and abstracts and a full-text review of potential studies. Of 389 articles, only 14 met the inclusion criteria of the study. Water components (access to clean water, water quality, and storage), sanitation components (facilities and sanitation status, disposal, and management of the sanitation), hygiene components (hygiene practice and handwashing, especially before eating and after using the toilet, handwashing with soap or ash and water, handwashing with water), environment components (household floor), and individual characteristics (knowledge and awareness of WASH) are associated with stunting in children under-five. **Conclusion:** This systematic review confirmed a relationship between various WASH factors and childhood stunting. Improving access to clean water, sanitation, and hygiene can significantly reduce stunting prevalence and improve child health and well-being.
Malaysian Journal of Medicine and Health Sciences (2025) 21(6): 1-9. doi:10.47836/mjmhs.v21.i6.1380

Keywords: Hygiene, Sanitation, Stunting, WASH, Water

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INTRODUCTION

The United Nations Sustainable Development Goals aim to achieve universal and equitable access to clean and inexpensive drinking water and adequate and equitable sanitation and hygiene by 2030 (1). Sanitation, contaminated drinking water and lack of hygiene lead to worsening health conditions in children, which indirectly causes stunting (2). Stunting is a nutritional condition defined by the body length-to-age or height-to-age ratio within the framework of anthropometric assessment of children's nutritional status. In this context, a Z-score between -2 and -3 SD indicates a short child, while a score below -3 SD indicates a severely stunted or very short (3). Globally, the prevalence of stunting increased from 21.3% in 2020 to 22% in 2021 and 22.3% in 2022 (4–6). Recent estimates suggest that 58% of diarrhoeal fatalities among children under the age of five worldwide could be avoided if all children had access to improved water, sanitation, and hygiene (WASH) (7).

Despite significant advancements, billions of people across the globe still need access to fundamental water, sanitation, and hygiene services. In 2022, 2.2 billion lacked safe drinking water, 3.4 billion lacked safe sanitation, and 2 billion lacked handwashing facilities. These stark statistics highlight the urgent need to address the global sanitation and hygiene crisis (8). The wealthiest people had access to more than twice as much clean water, sanitation, and hygiene as the poorest people in 27, 54, and 64 of the 105 countries for which data were available. Furthermore, research findings demonstrate how WASH programs reduce child malnutrition's likelihood and danger in households and communities (9).

Maternal and child nutrition and health are greatly affected by lack of access to adequate water, sanitation and hygiene (WASH), particularly in the first 1,000 days of a child’s life (from conception to age 2). Stunting is primarily caused by poor WASH, and unimproved

sanitation is the second largest cause (10). Previously, research found that sanitation determines stunting prevention (11). This systematic review aimed to explore the relationship between water, sanitation, and hygiene (WASH) components with stunting in children under five.

MATERIALS AND METHODS

Study design

This systematic review explored the correlation between water, sanitation, and hygiene (WASH) components and stunting in children under five. No review or registration protocol was carried out.

Search and research sources

Three databases, PubMed, CINAHL, and Scopus, were used to conduct a comprehensive search for relevant research. Various combinations of keywords related to “water, sanitation, hygiene” or "WASH" and “growth disorders” or “stunting” or “stunted” were explored. Studies were considered eligible for synthesis based on thoroughly comparing their characteristics with the planned group.

Eligibility criteria

This systematic review applies the PICO framework to define the study scope. The population (P) includes children under five years old, while the intervention/exposure (I) focuses on water, sanitation, and hygiene (WASH). As this review does not involve a direct comparison group, the comparison (C) is not applicable. The primary outcome (O) assessed is stunting in children. Incorporating this framework ensures a systematic approach in identifying and analyzing relevant studies related to WASH and its association with stunting. The studies that were collected underwent a selection process based on specific inclusion criteria. Only cross-sectional, trial, cohort, or case-control studies were included. Furthermore, research required to meet the following criteria: Issued between 2019 and 2024, available in English or Indonesian, it examined the relationship between child stunting and water, sanitation, and hygiene (WASH) determinants, with a particular focus on households with children under five. The exclusion criteria included studies that were not peer-reviewed, qualitative studies, reviews, editorials, conference abstracts, or grey literature. Additionally, studies that did not explicitly assess the relationship between WASH determinants and stunting in children under five were excluded. Using the reference management software, titles and abstracts were screened in two steps as part of the selection process, and all remaining articles were then thoroughly reviewed. Any discrepancies identified during the process were resolved through further examination.

Screening process and data extraction

After eliminating duplicates, the selection process was conducted in three stages following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. First, papers that could be relevant based on their titles were identified. Second, papers that could be relevant based on their abstracts were identified. Finally, full texts were evaluated against the eligibility criteria to determine relevant papers. At each stage, two independent reviewers (V.A and Y.S.A) conducted the screening, with discrepancies resolved through discussion or consultation with a third reviewer (S.D.W).

The results of individual studies syntheses were tabulated and visually displayed using summary tables, providing a clear view of the relationship between WASH components and stunting. Synthesised narrative synthesis was used due to the heterogeneity of the studies included. The choice of narrative synthesis was made to account for varied outcomes across the survey. Subgroup analysis explored possible causes of heterogeneity among the study results, mainly focusing on the specific WASH components examined. Additionally, the effect measure used in this study was primarily the p-value for each outcome.

Evaluation of the quality of studies

In this systematic review, the quality of the included papers was critically assessed using accepted procedures. In particular, the Quality Assessment tool and the Joanna Briggs Institute (JBI) Critical Appraisal Checklist were carefully used to determine the possibility of bias in each chosen study. Subsequently, two reviewers (V.A and Y.S.A) embarked on a critical appraisal phase, meticulously examining each included study's quality and potential biases.

RESULTS

Searches and selection of studies

Relevant studies were identified using a comprehensive search method. A thorough search of three databases produced a total of 389 items. Using reference management software (Mendeley), duplicate records (n = 69). Subsequently, titles and abstracts of the remaining studies (n = 320) were screened by reviewers to assess eligibility. Studies were included based on predefined criteria, and 14 articles were selected based on title and abstract suitability.

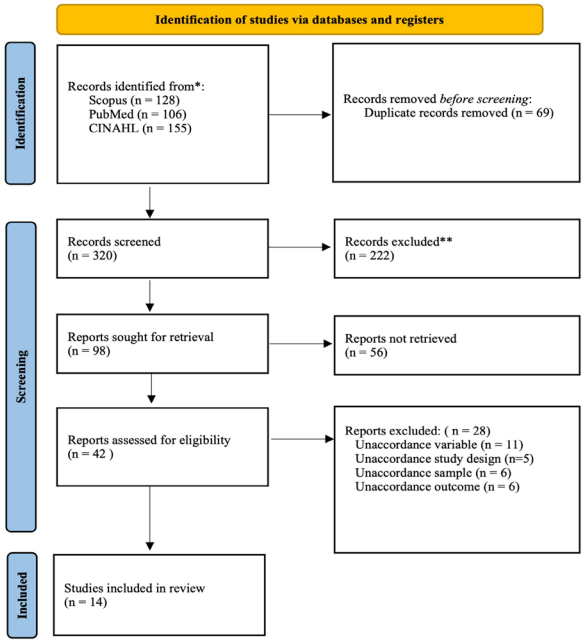

Figure 1: PRISMA flow diagram

Based on Table I, the quality of the included studies was assessed using the Joanna Briggs Institute (JBI) checklist. Among the 14 studies, 11 were rated as high quality, while three were rated as moderate quality due to limitations in addressing confounding factors.

Table I: Quality assessment using a JBI quality assessment tool for cross-sectional studies.

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Overall Quality of the study
Batool et al. (2023) (19)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
Sahiledengle et al. (2022) (12)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
Shrestha et al. (2020) (20)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
Ainy et al. (2021) (22)	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Moderate
Ademas et al. (2021) (13)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
Kuddus et al. (2022) (24)	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Moderate

CONTINUE

Table I: Quality assessment using a JBI quality assessment tool for cross-sectional studies. (CONT.)

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Overall Quality of the study
Saaka et al. (2021) (15)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
Otsuka et al. (2019) (7)	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Moderate
Lin and Feng (2023) (18)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
Lee et al. (2021) (21)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
Gizaw et al. (2022) (16)	Yes	Yes	Yes	Yes	Yes	Unclear	Yes	Yes	High
Kwami et al. (2019) (14)	Yes	Yes	Yes	Yes	Yes	Unclear	Yes	Yes	High
Soe et al. (2023) (17)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
Jubayer et al. (2022) (23)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High

Study Characteristics

Table II displays the articles a journal has published over the past five years; publication numbers were most significant for 2022 and 2021. The articles were collected from eight countries, including Bangladesh, China, Ethiopia, Ghana, India, Indonesia, Myanmar, and Nepal. Most of the studies that were conducted used a cross-sectional study methodology. The sample sizes varied considerably, ranging from less than 200 participants to over 10,000 participants. The studies included in the analysis used a combination of secondary data, direct measurements, or both.

Table II: Study Characteristics

Components	Author	Frequency
Publishing Year		
2019	(7,14)	2
2020	(20)	1
2021	(13,15,21,22)	4
2022	(12,16,23,24)	4
2023	(17–19)	3

CONTINUE

Table II: Study Characteristics

Components	Author	Frequency
Country		
Indonesia	(7,22)	2
Bangladesh	(23,24)	2
Ethiopia	(12–14,16)	4
China	(18)	1
India	(21)	1
Ghana	(15)	1
Nepal	(20)	1
Pakistan	(19)	1
Myanmar	(17)	1
Study Method		
Cross sectional	(7,12–24)	14
Sampling Technique		
Stratified two stage cluster sampling technique	(12)	1
Multi-stage sampling	(17,20)	2
Consecutive sampling	(22)	1
Simple random sampling technique	(13,15,16,24)	4
Convenience sampling	(7)	1
Multi-stage stratified cluster random sampling	(18,21)	2
Multistage cluster sampling with purposive	(14)	1
Non specific	(19,23)	1
Sample Size		
<200	(24)	1
<500	(7,16,19,22,23)	5
<1000	(13)	1
<10,000	(14,17,18,20,21)	5
>10,000	(12,15)	2

The Correlation Between Water, Sanitation And Hygiene (WASH) Components with Stunting

Water Components

Based on Table III, which explains the influence of WASH (Water, Sanitation, and Hygiene) on stunting. In this review, specifically in the water aspect, there are three components: water access, water quality, and storage. From the review results, most articles stated that drinking water sources were related to stunting, with seven articles discussing this (7,12–16). Children consuming water from unimproved sources, such as unprotected wells, surface water, or contaminated supplies, were more likely to experience stunting. This is likely due to the increased exposure to pathogens, leading to recurrent diarrhea and reduced nutrient absorption, which are well-established risk factors for stunting. Also, the distance to fetch water mentioned in 2 articles is relevant to stunting (12,17) a longer distance to fetch water was associated with higher stunting prevalence, and drinking water services in households in this view are also related to stunting (12). Access to clean and safe water at home reduces the risk of waterborne diseases and improves overall child health. For the quality component, clean water is related to stunting (18). However, two studies say that water quality and water purification are unrelated to stunting, suggesting that other factors, such as contamination during storage or handling, might influence outcomes (19,20). Water storage is correlated with stunting, contaminated water storage practices can lead to bacterial growth, increasing the risk of infections and gastrointestinal diseases in children. (13).

Table III: The Correlation between WASH Components with Stunting

WASH Components	Author	Statistic Test	P-Value	Correlation
Water				
Access				
Source of drinking water	(12)	Logistic regression	<0.001	Significantly correlated
	(13)	Logistic regression	<0.001	Significantly correlated
	(7)	Logistic regression	0.042	Significantly correlated
	(14)	Linear regression	<0.001	Significantly correlated
	(21)	Logistic regression	0.72	Not correlated
	(15)	Logistic regression	<0.05	Significantly correlated
	(16)	Logistic regression	Reported as significant based on AOR & CI	Significantly correlated
Distance to fetch water				
<15 min	(17)	Logistic regression	<0.01	Significantly correlated
15-30 min	(12)	Logistic regression	<0.001	Significantly correlated
	(13)	Logistic regression	0.953	Not correlated
	(17)	Logistic regression	0.02	Significantly correlated
31-60 min	(12)	Logistic regression	<0.001	Significantly correlated
	(13)	Logistic regression	0.953	Not correlated
>60 min	(12)	Logistic regression	<0.001	Significantly correlated
Household drinking water service				
Limited	(12)	Logistic regression	<0.001	Significantly correlated
Poor	(12)	Logistic regression	<0.001	Significantly correlated
Quality				
Water Quality	(19)	Pearson's Chi-Square	0.607	Not correlated

CONTINUE

Table III: The Correlation between WASH Components with Stunting (CONT.)

WASH Components	Author	Statistic Test	P-Value	Correlation
Water				
Water purification	(20)	linear regression	0.87	Not correlated
Clean water	(18)	Poisson regression	<0.001	Significantly correlated
Storage				
Water storage	(13)	Logistic regression	0.006	Significantly correlated
Sanitation				
Toilet Facilities and sanitation status				
Toilet in the house	(19)	Pearson's Chi-Square	0.816	Not correlated
location	(14)	Linear regression	0.567	Not correlated
Unimproved sanitation	(12)	Logistic regression	<0.001	Significantly correlated
Open defecation	(12)	Logistic regression	<0.001	Significantly correlated
	(16)	Logistic regression	Reported as significant based on AOR & CI	Significantly correlated
Unimproved sanitation	(13)	Logistic regression	0.001	Significantly correlated
	(21)	Logistic regression	0.006	Significantly correlated
Unhealthy environment sanitation	(22)	Chi-Square	<0.001	Significantly correlated
	(16)	Logistic regression	Reported as significant based on AOR & CI	Significantly correlated
Improved sanitation availability	(20)	Linear regression	0.28	Not correlated
Either one improved	(12)	Logistic regression	<0.001	Significantly correlated
Unimproved water + unimproved sanitation	(12)	Logistic regression	<0.001	Significantly correlated
Disposal				
Child stool disposal	(12)	Logistic regression	<0.001	Significantly correlated
	(14)	Linear regression	0.659	Not correlated
Solid waste disposal in open field	(13)	Logistic regression	<0.001	Significantly correlated
Solid waste disposal with dump into pit	(13)	Logistic regression	0.159	Not correlated
Waste water disposal	(17)	Logistic regression	<0.01	Significantly correlated
Management				
Treatment for toilet sewer	(7)	Logistic regression	0.127	Not correlated
Sanitation services level	(17)	Logistic regression	<0.01	Significantly correlated
Hygiene				
Practice				
Hygiene practice	(13)	Logistic regression	<0.001	Significantly correlated
Handwashing				
Before eating	(14)	Linear regression	0.024	Significantly correlated
After defecation	(14)	Linear regression	0.010	Significantly correlated
Use of soap after defecation	(14)	Linear regression	0.116	Not correlated
Use of soap before eating	(14)	Linear regression	0.08	Not correlated
Handwashing with Soap or Ash and Water	(14)	Linear regression	0.006	Significantly correlated
Handwashing with water only	(14)	Linear regression	0.0001	Significantly correlated
Soap and water availability	(20)	Linear regression	0.39	Not correlated
Hygienic toilets	(18)	Poisson regression	<0.001	Significantly correlated
Environment				
Household flooring	(12)	Logistic regression	<0.001	Significantly correlated
Household Characteristics				
Pets in the house	(19)	Pearson's Chi-Square	0.637	Not correlated

CONTINUE

Table III: The Correlation between WASH Components with Stunting (CONT.)

WASH Components	Author	Statistic Test	P-Value	Correlation
Individual Characteristics				
Individual Hygiene				
Hygiene condition of child	(19)	Pearson's Chi-Square	0.390	Not correlated
Hygiene condition of mother	(19)	Pearson's Chi-Square	0.390	Not correlated
WASH Status (Improved/ Un-improved)	(23)	Multiple linear regression	0.72	Not correlated
Knowledge and Awareness				
Knowledge of WASH	(24)	Chi-Square	0.027	Significantly correlated
Practice of WASH	(24)	Chi-Square	0.011	Significantly correlated

Sanitation Components

In sanitation, three key components include facilities and sanitation status, disposal, and management. The presence of unimproved toilets, open defecation, unimproved sanitation, and unhealthy environment sanitation have been found to correlate with stunting (12,13,16,21,22). Children living in households practicing open defecation or using unimproved sanitation facilities are more likely to experience repeated infections, leading to malnutrition and stunting. Additionally, improved sanitation was associated with lower stunting prevalence (12). Regarding disposal, the findings revealed divergent results regarding child stool disposal in the present study (12,14). However, open-field solid waste disposal and wastewater disposal were found to be correlated with stunting, likely due to increased environmental contamination and disease transmission (13,17). In sanitation management, the level of sanitation services correlates with stunting (17). Households with higher levels of sanitation management, including waste treatment and clean surroundings, reported lower rates of child stunting.

Hygiene Components

Related aspects include hygiene practices, handwashing after defecation, handwashing before eating, handwashing with soap or ash and water, handwashing only with water, and hygienic toilets (13,14,18). Proper toilet hygiene minimizes exposure to fecal contamination, reducing the risk of infections that contribute to malnutrition.

Others Components

Another environmental aspect, specifically household flooring, is associated with stunting (12). Households with poor flooring conditions (e.g., dirt floors) were associated with higher stunting rates. This may be due to increased exposure to pathogens and parasites. While WASH status improved or unimproved not correlated with stunting (23). Individual knowledge and awareness characteristics related to WASH are also associated with stunting, households with better understanding and implementation of WASH interventions had lower rates of child stunting (24). In contrast, the hygiene condition of the mother and child shows no correlation (19).

DISCUSSION

In this review, water access, quality, and storage correlate to stunting. Water access is a crucial factor in preventing stunting, as it directly impacts the availability of clean water for cooking, drinking and personal hygiene. Water drinking sources are an important factor in preventing stunting. Clean water supports optimal health and prevents waterborne diseases. In addition, access to clean water sources covered wells, and tap water can reduce the risk of disease transmission and improve overall health. Safe and clean drinking water is crucial for young children's health. It helps them fight illnesses because their bodies still develop strong defences against infections (25).

Distance to fetch water is another critical factor that determines the accessibility and convenience of water sources. However, some people had to walk a considerable distance to get water, which could reduce the amount of water accessible in the home for maintaining good health and cleanliness, leading to stunting (26). According to Pickering and Davis (2012), walking 15 minutes less each way to get water has several positive effects. These include a significant decrease (around 41%) in the average number of diarrhoea cases, better indicators of how well-nourished children are (based on weight and height measurements), and a reduction of about 11% in the number of deaths of children under five (27).

Household drinking water service is an essential indicator of water access and quality. Limited or poor water service can lead to health issues and increased vulnerability to waterborne diseases, contributing to stunting (26). Water quality is a significant concern in many communities, especially low-income ones. Stunting can be prevented by ensuring that clean water is available and using efficient water purification methods to improve water quality and lower the risk of waterborne illnesses (19). Another important component of water access is water storage, which ensures water availability in situations where supplies are limited or nonexistent. Water quality can be maintained, and contamination can be reduced using proper storage techniques. On the

other hand, poor storage can lead to health problems and make you more susceptible to waterborne diseases, resulting in stunted growth (28).

Maintaining health and preventing the spread of disease depend on the availability of sanitation facilities. Access to good sanitation can help prevent stunting compared to no access to sanitation and open defecation (12). Other important access to sanitation is wastewater disposal, solid waste disposal, and child disposal. (12,13,17). Stunting can be caused by the behaviour of throwing garbage in the open so that it can pollute the environment, such as the water environment, which can increase the risk of waterborne diseases (13). The level of sanitation services is essential to maintain clean water sources and improve public health (17). Sanitation remains an important predictor of stunted growth in late stages, emphasising the potential value of integrating WASH care (29). Improved access to sanitation has an impact on lowering the risk of death, diarrhoea, and children's growth related to stunting in children. Although improved water access primarily reduces the risk of diarrhoea and stunting, it does not appear to impact mortality (27) strongly.

Hygiene practices are crucial for maintaining personal and public health (14). The availability of water and soap for hand washing and promoting good hygiene practices can reduce the risk of infectious diseases and improve general health, which can help prevent stunted growth in children under five years (30). In the environmental aspect, household floors are related to stunting. This is in line with research by Grace et al. (2012), which shows that the type of house floor is very important, the results show that children who live in houses with dirt floors are more likely to experience stunting (31). These research findings suggest that children who grow up in houses with dirt floors are more likely to become stunted. According to a previous systematic review, the specific hazards in dirt floors that lead to stunting have yet to be identified (32). In individual characteristics, knowledge and WASH practice correlate to stunting (24). This aligns with a study by Ilham et al. (2023), which found a correlation between level of education and WASH practices (33). Knowing the importance of a clean environment can help avoid contamination risks to children's health (34).
However, the relationship between WASH factors and stunting can be influenced by various confounding factors. One of the main confounders is socioeconomic status. Families with higher incomes tend to have better access to sanitation facilities, clean water, and adequate nutrition, reducing the risk of stunting (35). Conversely, lower-income families often live in areas with poor sanitation infrastructure, limited access to safe water sources, and restricted food security, which can increase stunting risks (36). Another critical confounding factor is maternal education. Mothers with higher education levels are more likely to be aware of the importance of hygiene, nutrition, and sanitation, which positively impacts their children's health (37). Previous studies have shown that mothers with lower education levels tend to have poorer hygiene practices, increasing the risk of infections among their children (38).

This systematic review highlights a strong correlation between WASH components and stunting. However, some limitations are important to consider. The studies included diverse populations from eight different countries. Variations in socioeconomic factors, environmental conditions, and dietary patterns might influence the observed associations. Future research should address these limitations by employing longitudinal study designs, controlling for confounding variables more rigorously, and exploring the social and behavioural aspects of WASH practices. This will provide a more comprehensive understanding of how WASH interventions can be effectively implemented to reduce stunting in children under five.

CONCLUSION

This systematic review has confirmed a relationship between various WASH (Water, Sanitation, and Hygiene) components and stunting. Access to water, the quality of water, and how water is stored are all significant in preventing stunting. The source of water, the distance to fetch water, and household water service are all important aspects of water access. Clean water sources and proper storage are crucial for preventing waterborne diseases. Sanitation facilities and practices significantly impact stunting rates. Improved sanitation facilities and adequate waste disposal are essential for preventing contamination and disease. Hygiene practices such as handwashing are vital for maintaining health and reducing the risk of stunting. Knowledge and awareness of WASH practices are associated with reduced stunting. Water, sanitation, and hygiene can significantly improve children's health and well-being and play a critical role in addressing childhood stunting.

ACKNOWLEDGEMENT

We want to express our sincere gratitude to Universitas Airlangga for providing access to their research facilities and database search tools. These resources have been invaluable in supporting the development of this study. We greatly appreciate the institution's commitment to fostering academic research and excellence.

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