Article Review

The Main Factors Causing the Incidence of Diarrhea in Children: A Meta-Analysis

Eny Rohmawati[1], R. Azizah[1*]

[1]Department of Environmental Health, Faculty of Public Health, Universitas Airlangga, Surabaya, Indonesia

(Correspondence author's e-mail, azizah@fkm.unair.ac.id / +62 858-5188-5999)

ABSTRACT

Environmental factors that cause diarrhea are still under-researched, so researchers are interested analyze the risk factors for the availability of clean water, hand washing, mother's knowledge and the latrine conditions that affect the incidence of diarrhea in toddlers. The meta-analysis method was used in this study with the PICOS technique. Some of the data sources used are Google Scholar, Research Gate and Plos ONE by looking at keywords such as "risk factors" and "diarrhea". 140 articles were obtained, and the articles obtained were then screened and sorted again using clear inclusion criteria. Using cross-sectional study design to filter the articles to the next stage. To process the meta-analysis data, the JASP Version 0.16.3.0 application was used. the findings show that the pooled PR value for the availability of clean water is $e\ 0.82 = 2.270$; hand washing of $e\ 0.57 = 1.768$; mother's knowledge of $e\ 0.56 = 1.751$; and latrine conditions of $e\ 0.53 = 1.699$. The results of the study also showed that there was a risk relationship between the variables Availability of clean water, hand washing, mother's knowledge, and latrine conditions on the incidence of diarrhea in toddlers. The variable availability of clean water is the variable that has the highest relationship and risk for the incidence of diarrhea in toddlers, followed by the hand washing, the mother's knowledge and the lowest is the latrine condition variable. Future research is expected to examine the in-depth relationship between the availability of clean water and hand washing by looking at the intermediary factors.

Keywords: Diarrhea, Latrine Conditions, Clean Water, Knowledge, Hand Washing.

INTRODUCTION

Diarrhea is the main disease that causes death in children, it is estimated that diarrhea has killed 558,000 children aged 1−59 months in 2013[1,2,3,4,5,6]. According to the World Health Organization, more than half a million under-five deaths worldwide are caused by diarrhea[7,8]. In 2019, diarrhea was responsible for around 7.4% of all global causes of death in children < 5 years[9]. About 90% of all diarrhea-related deaths occur in children under the age of five, especially in low- and middle-income countries[10].

Although deaths from diarrhea decreased dramatically annually among children <5 years between 1990 and 2017, the number of deaths from diarrhea remains highest in several developing countries[11]. According to data, Asia is one of the regions with the greatest rates of deaths from diarrhea[12,13]. Although cases of diarrhea occur in many developing countries,

developed countries also experience a significant burden due to diarrhea[13].

Diarrhea is usually defined as watery bowel movements occurring three or more times in a 24-hour period, and causing death by depletion of body fluids resulting in severe dehydration[14]. This disease can generally be easily treated and prevented[15,14,16]. The highest mortality in cases of diarrhea experienced by young children[17,18]. Toddlers (<1 year) occupy the first position affected by diarrhea[13,19]. Diarrhea can have an adverse impact on a child's cognitive growth and development[20]. There are several risk factors that may be responsible for causing diarrhea-related deaths in children. In addition to biological, social, environmental factors, factors such as lack of water supply, sanitation and hygiene are one of the main risk factors that contribute to the cause of death from diarrhea in toddlers[21,22,23,17,24].

In various developing countries, including Indonesia, the third contributor to child morbidity and mortality is diarrheal disease, because the child's immune system is still weak. Estimates of the occurrence of deaths from diarrhea by 3.2 million and 1.3 billion per year[25]. Clean water facilities and excrement disposal are environmental factors that have a major role in the spread of diarrheal diseases because they are directly related to human behavior. If these two factors do not meet the requirements, it will cause diarrheal disease[26]. Washing hands properly according to procedures with running water and using soap has a role in the occurrence of diarrheal disease in toddlers[27]. Efforts to prevent diarrhea in toddlers are expected from the mother's knowledge obtained through her own experience or that of others. Thus, mother's knowledge has a big role in preventing diarrhea in toddlers[28].

The novelty of this study is that researchers are trying to combine all studies from 2012 to 2022 to see the relationship between factors that cause diarrhea. The purpose of this study was to analyze the risk factors for the availability of clean water, the risk factors for hand washing, the risk factors for mother's knowledge and the risk factors for latrine conditions that affect the incidence of diarrhea in toddlers.

METHOD

The meta-analysis method used in this study is the PICOS technique, which combines two or more similar research results to obtain a combination of quantitative data with the same hypothesis to reach a conclusion[29]. Furthermore, meta-analysis is quantitative in nature as it uses numerical and statistical calculations for practical purposes, i.e. collecting and extracting information from large volumes of data[30]. The data source for this study uses Google Scholar, ResearchGate, PlosONE. The keywords used in this research are "risk factors" and "diarrhea". Downloaded articles are articles that have an abstract and full text. The research articles found in this research are 140 journal articles. Then the articles were screened and sorted again using clear inclusion and exclusion criteria. Researchers used a cross-sectional study design to screen for the next stage. The variables of clean water availability, hand washing, mother's knowledge and latrine conditions are the selected variables that influence the incidence of diarrhea in toddlers in Indonesia. Secondary data types from selected articles are used in this study. The incidence of diarrhea in toddlers is the dependent variable, while the risk factors for the availability of clean water, the risk factors for hand washing, the risk factors for maternal knowledge and the risk factors for latrine conditions are the independent variables in this study. The following is a PRISMA flowchart from this study.
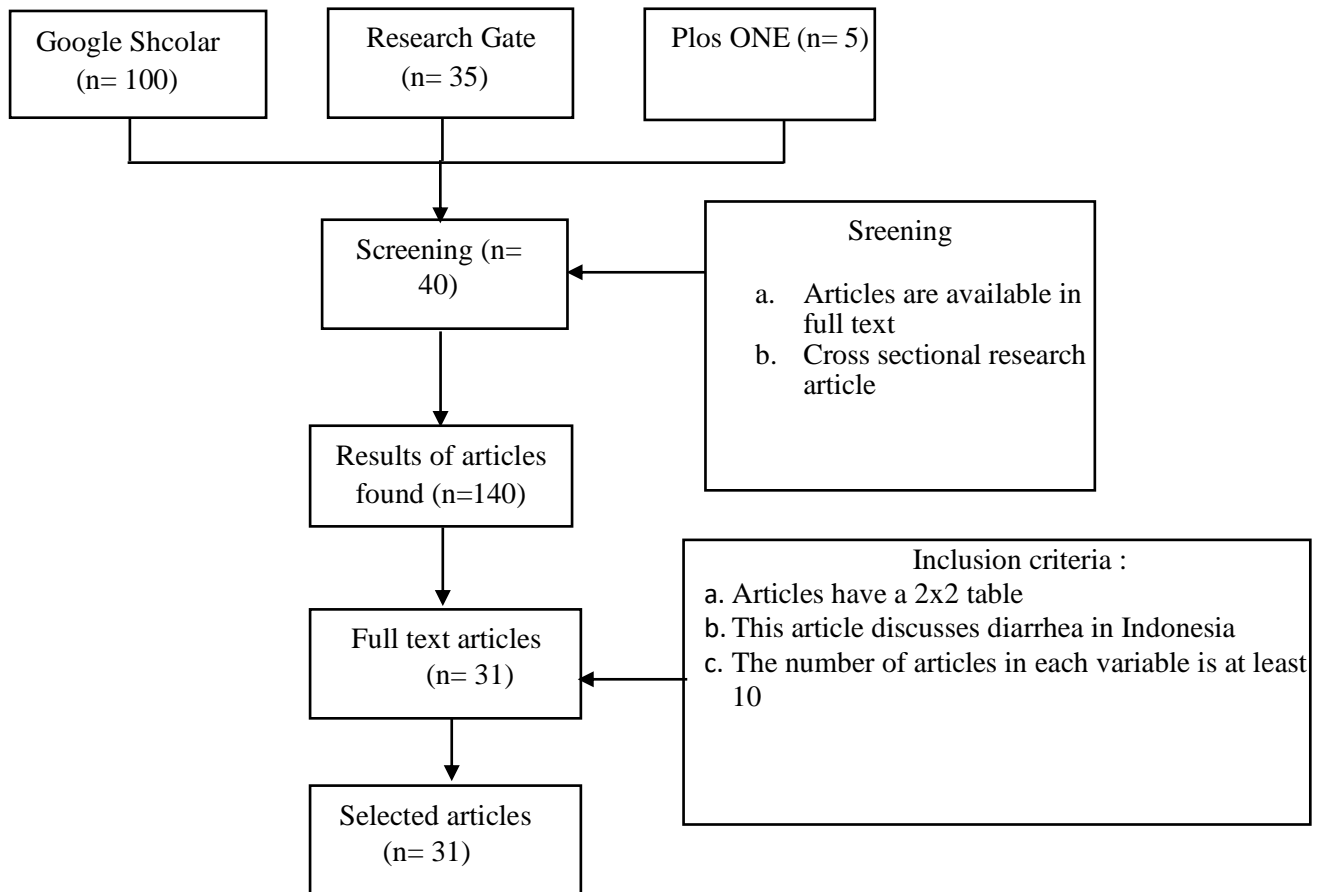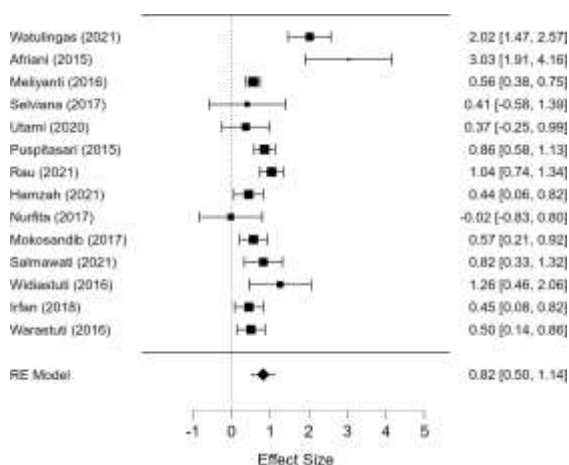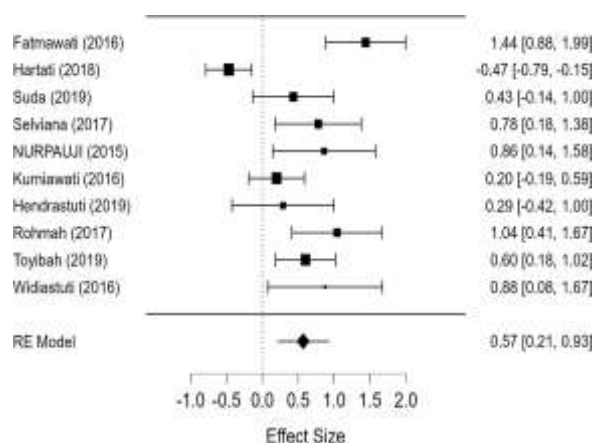
Figure 1. Prisma Flowchart.

The process of doing a meta-analysis typically contains some parts, the first of which is the formulation of the study topic. The next steps are literature gathering based on the planned objectives and evaluation.
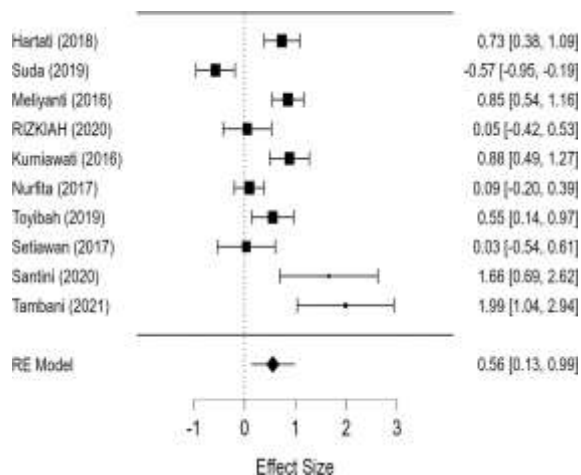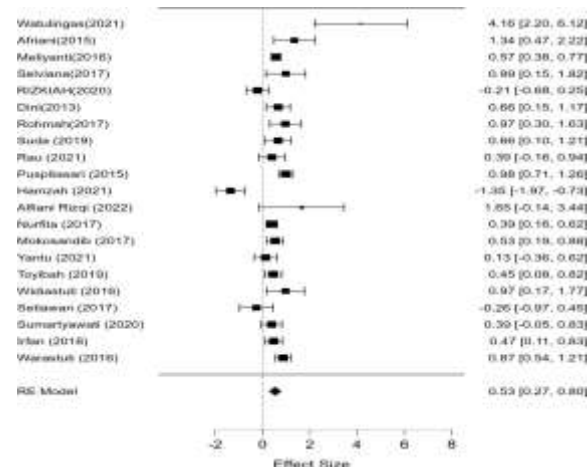
RESULTS

Risk factors for the availability of clean water on the occurrence of diarrheal disease in toddlers.

Risk factors for washing hands on the occurrence of diarrheal disease in toddlers

Risk Factors Mother's knowledge of the occurrence of diarrheal disease in toddlers.

Risk factors for the condition of latrines for the occurrence of diarrheal disease in toddlers.

Figure 2. Forest plot Risk Factors Availability of Clean Water, Mother's Knowledge of Handwashing, and Latrine Conditions for the occurrence of diarrheal disease in toddlers.

The Restricted ML (RE) model value of the Forest plot on the variable availability of clean water illustrates a Prevalence Ratio (PR) value of 0.82 with values ranging from 0.50 to 1.14 which is a 95% Confident Interval (CI) value. Pooled PR value = e0.82 = 2.270 So it is concluded that the incidence of diarrhea in toddlers has a risk of 2.270 times greater if the variable availability of clean water does not meet the requirements. This is in line with research [31] who stated that diarrhea was mostly affected by poor sanitation facilities and scarcity of clean water being the main cause. Other studies have shown that in 2007–08 in India, improved sanitation and piped drinking water helped reduce diarrhea in children[32].

The Restricted ML (RE) model value of the Forest plot on handwashing without soap and running water variables illustrates a Prevalence Ratio (PR) value of 0.57 with values ranging from 0.21 to 0.93 which is a Confident Interval (CI) value of 95 %. Based on Figure 4, the value of pooled PR = e0.57 = 1.768 is obtained, this shows that the risk is 1.768 times greater for diarrhea in toddlers due to hand washing without soap and running water. The Restricted ML (RE) model of the Forest plot of the mother's knowledge variable illustrates the Prevalence Ratio (PR) value of 0.56 with values ranging from 0.13 to 0.99 which is a 95% Confident Interval (CI) value. Based on Figure 6. The forest plot shows the value of pooled PR = e 0.56 = 1.751. So it can be concluded that

diarrhea is 1.751 times more likely to occur in toddlers due to poor mother's knowledge. Studies in India have shown that mothers with good knowledge of hand hygiene can prevent diarrhea by 38.88.% [33,34] and washing hands with soap removes potentially pathogenic organisms from hands as a result of previous toilet washing activities[33]. In Ethiopia, 65.2% of mothers have good knowledge about prevention and management of diarrhea at home in children under five [35,36] and promotion of handwashing with soap has prevented diarrhea[37].

The Restricted ML (RE) model value of the Forest plot of the latrine condition variable does not meet the requirements describing a Prevalence Ratio (PR) value of 0.53 with values ranging from 0.27 to 0.80 which is a 95% Confident Interval (CI) value. Based on Figure 8, the value of pooled PR = e0.53 = 1.699 is obtained, this shows that toddlers experience diarrhea 1.699 times greater if the latrine conditions do not meet the requirements. Exposure to human feces increases the risk of diarrheal infection [38] and increased inflammation in the gut[39,40,41]. Diarrheal disease contributes to stunting, reduced cognition, and increased child mortality[42]. Latrines allow for the safe disposal of human waste and reduce the transmission and ingestion of faecal-oral pathogens [43] Open defecation facilitates transmission of diarrheal pathogens and is associated with a high risk of intestinal parasite infection. Progress in improving sanitation in

developing countries has been slow, although studies have shown latrines to be effective in reducing diarrheal diseases by around 30% 9 and increasing child growth[44]. According to research [45] Among rural and urban families, lack of latrines was associated with history (odds ratio[OR] = 1.23, 95% confidence. interval [CI] = 1.18–1.29, P < 0.0001; OR = 1.20, 95% CI = 1.13–1.27, P < 0.0001) and under-five mortality (OR = 1.29, 95% CI = 1.25–1.31, P < 0.0001; OR = 1.22, 95% CI = 1.12–1.32, P < 0.0001).

Table 1. Heterogeneity test table for independent variables on the occurrence of diarrhea in toddlers.

Variable heterogeneity of availability of clean water on the occurrence of diarrhea in toddlers.

	Q	df	p
Omnibus Test Model Coefficients	25.609	1	<0,001
Heterogeneity Test Residue	58.813	13	<0,001

Heterogeneity Meta-Analysis of Knowledge of Mothers with Diarrhea in Toddlers.

	Q	df	p
Omnibus Test Model Coefficients	6.424	1	0.011
Heterogeneity Test Residue	67.791	9	< .001

Heterogeneity of hand washing variables with the occurrence of diarrhea in toddlers.

	Q	df	p
Omnibus Test Model Coefficients	9.725	1	0,002
Heterogeneity Test Residue	51.980	9	<0,001

Heterogeneity Meta-Analysis of Latrine Conditions and the Occurrence of Diarrhea in Toddlers.

	Q	df	p
Omnibus Test Model Coefficients	15.617	1	<0,001
Heterogeneity Test Residue	91.989	20	<0,001

In the heterogeneity test of articles with the variable availability of clean water, it was found that the p-value was less than α (0.05), namely p = <0.001, (availability of clean water, hand washing behavior, mother's knowledge, and latrine conditions) which indicated that variations in research articles used is heterogeneous so that the Restricted ML model is used in the analysis of this study.

Table 2. Egger test variable availability of clean water, hand washing, mother's knowledge, and latrine conditions on the occurrence of diarrheal disease in toddlers.

Egger test variable availability of clean water on the occurrence of diarrheal disease in toddlers.

	z	p
Sei	1.490	0.136

Egger test of mother's knowledge variable on the occurrence of diarrheal disease in toddlers.

	z	p
Sei	2.224	0.026

Egger test variable Hand washing against the occurrence of diarrheal disease in toddlers.

	z	p
Sei	2.176	0.030

Egger test of latrines condition variables on the incidence of diarrhea in toddlers

	z	p
Sei	2.473	0.013

Based on the Egger test in Table 2, it shows that there is no publication bias in this study because the p-value = 0.136 which means it is greater than the value of α (0.05). These results are in accordance with the funnel plot in

Figure 3, namely symmetry. The meta-analysis shows that the occurrence of diarrhea in toddlers is 2.270 times greater if the variable availability of clean water does not meet the requirements. This risk value is greater than previous research conducted by [46] In this study, the pooled PR value found was 1.85 (95% CI: 1.44 to 2.38), which means that the availability of clean water can be a risk factor for diarrhea in toddlers. It also has the same meaning as research conducted in Indonesia which has the same results, namely the increased risk of diarrheal disease in children under five is influenced by the availability of clean water that does not meet the requirements with a p-value of 0.00[47].

Based on the Egger test in Table 2, it shows that there is a publication bias in the variables of hand washing, knowledge and latrines conditions because the p-value $<\alpha$ (0.05). This result is in accordance with the funnel plot in the image, namely asymmetry. The results of the meta-analysis showed that washing hands without soap and running water had a 1.768 times greater risk of experiencing diarrhea in toddlers. This risk value is greater than previous research conducted by [46], In this study, the pooled PR value found was 1.12 (95% CI: 0.78 to 1.62), which means that hand-washing habits can be a risk factor for diarrhea in toddlers. Also has the same meaning as research conducted by [48], from the results of the study, it was found that the PR value = 2.4 which means the PR value is more than 1.

The results of the meta-analysis calculation showed that the mother's poor knowledge variable had a 1.751 times greater risk for toddlers experiencing diarrhea. This research is in line with research conducted by [49] which states that the mother's knowledge variable has a significant relationship with the incidence of diarrhea in toddlers, this is indicated by the p-value of 0.012. The meta-analysis shows that the occurrence of diarrhea in toddlers is 1.699 times greater if the latrine condition variable does not meet the requirements. This research is in accordance with research from Adani, 2021, that the risk ratio of latrine conditions in increasing the incidence of diarrhea in toddlers is 1.840 (95% CI: 0.48 to 0.75) which means that latrine conditions have a significant relationship to the incidence of diarrhea in toddlers. Also has the same meaning as research conducted by [48],From this study, it was obtained that the value of p = 0.014 and the value of PR = 2.05, which means that the value of PR> 1.

Table 3. Results of the meta-analysis of risk factors for the availability of clean water, hand washing, mother's knowledge, and latrines for the occurrence of diarrhea in children under five in Indonesia.

No	Variable	N	Fixed/Random effect Models	
			PR	95% CI
1	Availability of clean water	14	2,270	0,50 - 1,14
2	Washing hands	10	1,768	0,21 - 0,93
3	Mother knowledge	10	1,751	0,13 - 0,99
4	Latrine conditions	21	1.699	0,27 - 0,80

Based on the results of table 3, the variable availability of clean water is the highest risk factor for diarrheal disease in toddlers in Indonesia. The availability of clean water has a pooled PR value of $e^{0.82} = 2.270$. So it can be concluded that the risk of diarrheal disease in Indonesia is 2,270 times greater due to the availability of clean water that does not meet the requirements.

Table 4. Sensitivity Test Comparison of Fixed Effect Models and Random Effect Models Pooled Prevalence Ratio Fixed Effect Models and Random Effect Models.

No	Variable	N	Heterogenity (pvalue)	Fixed effect Model		Random Effect Model	
				PR	95% CI	PR	95% CI
1	Risk factors for the availability of clean water diarrheal disease in toddlers	14	< 0,001	1,448	0,21-0,53	2,270	0,50-1,14
2	Risk factors for handwashing on diarrheal disease in toddlers	10	< 0,001	1,448	0,21-0,53	1,768	0,21-0,93
3	Risk factors for mother's knowledge of the occurrence of diarrheal disease in toddlers	10	< 0,001	1,537	0,30-0,56	1,751	0,13-0,99
4	Risk factors for latrines to diarrheal disease in toddlers	21	< 0,001	1,699	0,44-0,61	1,699	0,27-0,81

From Table 4 it can be seen that the fixed effect model and the random effect model have different pooled prevalence ratio values. In both models there are also differences in the Internal Confident (CI) range values, this shows that there are variations between studies. There is an increase in PR on the variables of availability of clean water, hand washing and mother's knowledge. Whereas in the latrine condition variable there was no increase in the PR value there was only a difference in the CI value.

CONCLUSION

The findings show that the variable that has the highest relationship and risk of diarrheal disease in children under five in Indonesia is the availability of clean water followed by hand washing; mother's knowledge, and latrine conditions. Of the four variables above, only the variable availability of clean water has no bias. So that it can be ascertained that clean water is an important factor in the incidence of diarrhea. Future research is expected to examine the in-depth relationship between the availability of clean water and hand washing by looking at the intermediary factors.

CONFLICTS OF INTEREST:
The authors declare no conflict of interest.

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