July – September, 2024
Original Article
DOI: http://dx.doi.org/10.30867/action.v9i3.2022

Pages: 614 – 622

AcTion: Aceh Nutrition Journal
p-issn 2527-3310; e-issn 2548-5741

Water, sanitation, and hygiene (WASH) factors associated with stunting among under-fives: A hospital-based cross-sectional study in Banda Aceh, Indonesia

Faktor-faktor air, sanitasi, dan kebersihan yang berhubungan dengan stunting pada anak balita: Sebuah studi cross sectional berbasis rumah sakit di Aceh, Indonesia

Desi Purnama Sari[1], Sulaiman Yusuf[2*], Rusdi Andid[3], Dora Darussalam[4], Herlina Dimiati[5], Eka Yunita Amna[6]

[1] Department of Pediatrics, Faculty of Medicine, Universitas Syiah Kuala, Banda Aceh, Indonesia.
E-mail: dpurnama85@gmail.com
[2] Division of Gastroenterology and Hepatology, Department of Pediatrics, Faculty of Medicine, Universitas Syiah Kuala, Banda Aceh, Indonesia.
E-mail: sly.aceh@gmail.com
[3] Division of Endocrinology, Department of Pediatrics, Faculty of Medicine, Universitas Syiah Kuala, Banda Aceh, Indonesia.
E-mail: Andid_rusdi@yahoo.com
[4] Division of Neonatology, Department of Pediatrics, Faculty of Medicine, Universitas Syiah Kuala, Banda Aceh, Indonesia.
E-mail: herlinadimiati@usk.ac.id
[5] Division of Cardiology, Department of Pediatrics, Faculty of Medicine, Universitas Syiah Kuala, Banda Aceh, Indonesia.
E-mail: herlinadimiati@usk.ac.id
[6] Division of Nutrition and Metabolic Diseases, Department of Pediatrics, Faculty of Medicine, Universitas Syiah Kuala, Banda Aceh, Indonesia.
E-mail: eya.delima@gmail.com

***Correspondence Author:**
Division of Gastroenterology and Hepatology, Department of Pediatrics, Faculty of Medicine, Universitas Syiah Kuala, Jl. Teungku Tanoh Abee, Kopelma Darussalam, Kec. Syiah Kuala, Kota Banda Aceh, Aceh 24415 Indonesia. E-mail: sly.aceh@gmail.com

Article History:
Received: August 05, 2024; Revised: August 28, 2024; Accepted: September 10, 2024; Published: September 15, 2024.

Publisher:
Politeknik Kesehatan Aceh
Kementerian Kesehatan RI

Abstract

Stunting remains a major public health threat among children under five years of age in developing countries, including Indonesia. Studies have shown that water, sanitation, and hygiene (WASH) interventions are essential for reducing the prevalence of the disease. This study aimed to identify WASH-related risk factors associated with stunting among under-fives. This hospital-based cross-sectional study included 133 randomly sampled children who attended outpatient clinics or were admitted for treatment at *Rumah Sakit Umum Daerah* (Regional Public Hospital-RSUD) dr. Zainoel Abidin Banda Aceh between April and May 2024. Data were collected using structured questionnaires and anthropometric measurements. The chi-square test and logistic regression analysis were used to analyze the data, with a 95% confidence interval (CI). The results showed that the prevalence of stunting was 35,3% among children under fives attended RSUD dr. Zainoel Abidin Banda Aceh. Bivariate analysis showed that stunting was associated with the main source of drinking water (p=0,04; OR= 2,29). Multivariate regression analyses revealed the WASH-related risk factor for stunting, which was the child's fecal disposal (p= 0,03, OR= 0,26). In conclusion, child's fecal disposal is a WASH-related risk factor for stunting among children who attended RSUD dr. Zainoel Abidin Banda Aceh. This risk factor can be modified through health policies that consider WASH interventions to manage stunting prevalence.

Keywords: Water, sanitation, hygiene, WASH, stunting, hospital-based study

Abstrak

Stunting masih menjadi masalah utama kesehatan masyarakat pada anak usia dibawah lima tahun di negara-negara berkembang termasuk Indonesia. Penelitian juga menunjukkan bahwa intervensi air, sanitasi, dan kebersihan (WASH) sangat penting untuk mengurangi prevalensi stunting. Penelitian ini bertujuan untuk mengidentifikasi faktor-faktor risiko tekait WASH yang berhubungan dengan stunting pada anak dibawah lima tahun yang berobat jalan atau dirawat di RSUD dr. Zainoel Abidin, Banda Aceh. Penelitian ini menggunakan pendekatan cross-sectional yang berbasis rumah sakit yang melibatkan 133 anak yang dipilih secara acak yang datang ke klinik rawat jalan atau dirawat di RSUD dr. Zainoel Abidin Banda Aceh antara April-Mei 2024. Data dikumpulkan menggunakan kuesioner terstruktur dan pengukuran antropometri. Uji chi-square regresi logistik digunakan untuk menganalisis data, dengan interval kepercayaan 95%. Hasil penelitian menunjukkan bahwa prevalensi stunting adalah 35,3% pada balita yang dirawat di RSUD dr. Zainoel Abidin. Stunting berhubungan dengan sumber utama air minum (p=0,04, OR= 2,29). Faktor risiko stunting adalah metode pembuangan feses anak (p= 0,03, OR= 0,26). Kesimpulan, metode

pembuangan feses anak merupakan faktor risiko stunting berhubungan dengan WASH pada anak yang berobat ke RSUD dr. Zainoel Abidin. Diyakini bahwa faktor risiko tersebut dapat dikontrol melalui kebijakan kesehatan yang mempertimbangkan intervensi praktik WASH.

Kata Kunci: Air, sanitasi, kebersihan, WASH, stunting, studi berbasis rumah sakit

Introduction

The World Health Organization (WHO) reported that there has been a steady decrease in stunting in children under five years of age over the last decade (WHO, 2023). However, according to the Joint Malnutrition Estimates (JME) released in 2023, the trend is still inadequate to achieve the 2025 World Health Assembly (WHA) global nutrition targets and the 2030 Sustainable Development Goal (SDG) 2 targets (Saxton et al., 2016). Globally, an estimated 148,1 million or 22,3% of the under-fives are stunted growth due to chronic nutrition deprivation in 2022 (WHO, 2023). They are mostly situated in the low- and middle-income countries of Asia and Africa (Silva et al., 2023).

Indonesia has also seen a reduction in stunting over the last decade, decreasing from 37,6% in 2013 to 21,6% in 2022 (Kemenkes, 2022). According to Kemenkes (2022), although the Aceh Province ranks fifth for the highest incidence of stunting in Indonesia, it also experiences a decrease in stunting. This shows a positive change, but the Indonesian government should continue working hard to reduce the prevalence rate to be less than 20% by 2025 in the country, as targeted by the WHO in its calls for global action to cut child stunting (WHO, 2018). The Indonesian government aims to lower the prevalence rate in Indonesia by targeting a reduction of up to 3,8% each year to be 14% by 2024 (Kemenkes, 2022). This action is consequential for future generations in the pursuit of achieving Golden Indonesia 2045; because stunting might result in cognitive disorders (De Onis & Branca, 2016; Handryastuti et al., 2022).

The WHO defines stunting as "the impaired growth and development that children experience from poor nutrition, repeated infection, and inadequate psychosocial stimulation." Children are regarded as stunted if their height-for-age z-score is less than negative two (HAZ < −2) or simply short for age (WHO, 2022). The impact of stunting is both short and long-term condition, such as the risk of child deaths and cognitive disorders. Children become more vulnerable to diseases, increase the risk of infections, and reduce productivity and economic capability in adulthood. The risk factors associated with stunting include constitutional factors (e.g., familial short stature and constitutional delay of growth and puberty), socioeconomic status, parents' education (Semba et al., 2008), food insecurity, maternal and child caring practices (Beal et al., 2018), and poor water, sanitation, and hygiene (WASH) practices (Modern et al., 2020). Studies have shown evidence that good WASH practices are central to the realization of the global elimination of stunting in children (Waller et al., 2020; Modern et al., 2020). Our observations as a pediatric resident and pediatricians working at *Rumah Sakit Umum Daerah* (Regional Public Hospital-RSUD) dr. Zainoel Abidin Banda Aceh show that patients with stunting especially under 5 years of age are regularly admitted. Prior studies investigating WASH-related risks at the hospital have not been found. However, other hospital-based international studies, such as in Tanzania indicate that stunting is associated with WASH-related risks (Modern et al., 2020).

Thus, this study aimed to identify the WASH-related risk factors associated with stunting among children < 5 years of age. The WASH-related risk factors of stunting have been analyzed in 133 children who attended outpatient clinics or were admitted for treatment at RSUD dr. Zainoel Abidin Banda Aceh.

Methods

This hospital-based cross-sectional study aimed to identify WASH-related risks of stunting among under-five children. These children attended outpatient clinics or were admitted for treatment at RSUD dr. Zainoel Abidin Banda Aceh between April and May 2024. The hospital was selected as the study site because it is the largest referral hospital in the Aceh Province. This means that it receives patients from all regions of Aceh.

A stratified random sampling technique was employed to select participants. These samples were selected because they shared the

same attributes. In other words, they met the inclusion and exclusion criteria. The inclusion criteria were pediatric patients aged < five years of age who visited the outpatient clinic or were hospitalized in the children's ward of RSUD dr. Zainoel Abidin Banda Aceh. The children had no medical complications and their mothers provided consent to participate in the study. Children who were seriously ill were excluded from this study. This study collected data from 133 participants. According to the rule of thumb, the sample size is adequate for data analysis because it is between 5 and 50 times of the independent variables. There were 13 independent variables in this study. Thus, the sample size should be between 65 and 650 patients. The sample size of 133 in this study was because the focus here is only on patients who visited or admitted to RSUD dr. Zainoel Abidin, Banda Aceh between April and May 2024.

Primary data were obtained by interviewing mothers of children below five years of age according to the inclusion and exclusion criteria. They were asked to provide information on the household's composition, family income, parental education and employment, gender, age, other children's anthropometric measurements, and household's WASH practice. Data collection was conducted using a structured questionnaire assisted by Kobotoolbox.

The data extracted from Kobotoolbox in the form of an Excel file were checked, coded, and exported to the Statistical Package of Social Science (SPSS) version 25.0 for data analysis. Bivariate and multivariate analyses were performed. Bivariate analysis using the chi-square test was used to identify the relationship between independent variables (the main source of drinking water, source of water for other needs, distance to water source, drinking water treatment, toilet facility, toilet sharing, child's use of toilet, child's fecal disposal, family garbage disposal, use of soap for hand washing, washing hands with running water, diarrhea status, and recurrent diarrhea status) and the dependent variable (stunting). The explanatory variables were selected on the basis of previously reported associations with the outcome variable presented in WASH-related studies (Kwami et al., 2019; Modern et al., 2020; Saxton et al., 2016; Silva et al., 2023).

Variables with a p-value< 0.25 from the bivariate analysis were retained and enrolled in the multivariate analysis (Mengesha et al., 2020; Zewdu & Halala Handiso, 2020). It has been argued by statistician that the cutoff P value of 0.25 is to minimize the possibility that a variable might be individually insignificant but in multivariable setup is significant (Malhotra, 2020). Thus, this study did not adopt the cutoff for p-value < 0,05. Multivariate analysis using a binary logistic regression test was used to determine WASH-related risks of stunting. The tests used odds ratio (OR) values with a 95% CI) and a p-value < 0,05 to declare statistical significance.

This study was approved by the Ethics Committee of RSUD, dr. Zainoel Abidin Banda Aceh (no. 092/ETIK-RSUDZA/2024). Oral informed consent has also been obtained from the mothers of patients participated in the study.

Result and Discussion

The 133 participants shown in table 1 were spread across five age groups, with 33,80% aged 1-12 months, 24,80% aged 13-24 months, and so on. In terms of sex, the children were evenly divided, of which 66 (49,60%) were male and 67 (50,40%) were female. The majority of the participants' mothers and fathers' education was senior high school at 43,60% and 51,10%, respectively. Regarding employment, the majority of respondents' mothers were housewives (82,70%) and fathers were self-employed (47,40%). Most respondents' family income was below IDR. 3,500,000 (62,40%), although 2,3% earned ≥ IDR. 7,000,000 and IDR. 10,000,000 and 0,8% earned above IDR. 10,000,000. Regarding the child's clinical status, out of 133 children, 40 (30,10%) had diarrhea, while 93 (69,90%) had no diarrhea. Moreover, only 24 children (18%) experienced recurrent diarrhea and 109 children (82%) did not experience recurrent diarrhea. Based on the incidence of stunting, 47 children (35,30%) were in the stunting group, whereas 86 (64,70%) were in the non-stunting group.

The prevalence of diarrhea (30,10%) is not much different from that reported by another hospital-based study conducted by Modern et al. (2020) in Tanzania with 430 children <5 years of age. The study found that the incidence of diarrhea in children <5 years of age was 24%. However, the results of this study are much higher than the prevalence of diarrhea reported by the Ministry of Health in Indonesia, where the prevalence of diarrhea in 2018 was 11% and 13,8% in Aceh Province (Kemenkes, 2022).

Tabel 1. Demographic characteristics

Characteristics	n (%)
Age	
1-12 months	45 (33,80)
13 – 24 months	33 (25,80)
25– 36 months	27 (20,30)
37 – 48 months	11 (8,30)
49 – 59 months	17 (12,80)
Gender	
Male	66 (49,60)
Female	67 (50,40)
Mother's education	
Primary	6 (4,50)
Junior high school	19 (14,30)
Senior high school	58 (43,60)
Undergraduate	49 (36,80)
Postgraduate	1 (0,80)
Father's education	
Primary	6 (4,50)
Junior high shool	(14,30)
Senior high school	68 (51,10)
Undergraduate	37 (27,80)
Postgraduate	3 (2,30)
Mother's employment	
Farmer	1 (0,75)
Self-employed	5 (3,76)
Private sector employee	10 (7,52)
Civil servant	7 (5,26)
Housewive	110 (82,71)
Father employment	
Farmer	23 (17,30)
Self-employed	63 (47,40)
Private sector employee	24 (18,00)
Civil servant	12 (9,00)
Unemployed	11 (8,30)
Family income	
IDR <3.500.000	83 (62,41)
IDR ≥3.500.000 - 5.000.000	29 (21,80)
IDR ≥5.000.000 - 7.000.000	17 (12,78)
IDR ≥7.000.000 - 10.000.000	3 (2,26)
IDR ≥10.000.000	1 (0,75)
Diarrhea status	
Yes	40 (30,10)
No	93 (69,90)
Recurrent diarrhea status	
Yes	24 (18,00)
No	109 (82,00)
Stunting status	
Yes	47 (35,30)
No	86 (64,70)

For recurrent diarrhea, the percentage of 18% is much higher than the results of a study conducted in Ghana with a sample of 240 children <5 years old (Danso & Appiah, 2023). They reported that the prevalence of recurrent diarrhea was 35,41%. However, the prevalence of recurrent diarrhea found in this study was almost twice that reported in a previous study conducted in Western Maharashtra, India (Avachat et al., 2011). Their reported rate was 9,80%. The present study did not find accurate data regarding the prevalence of recurrent diarrhea in Indonesia or Aceh Province. Both diarrhea and recurrent diarrhea are presented here because these clinical statuses are independent variables in this study, which sought to establish the relationship between these two variables and stunting incidence.

In the present study, the percentage of stunting was 35,30%. This figure is better than the prevalence of stunting reported in Tanzania (45,60%) (Modern et al., 2020). However, the incidence of stunting in this study was higher than the prevalence of stunting in Indonesia in 2022 reported by the Indonesian Ministry in Health (21,6%) (Kemenkes, 2022). The figures in this study were even higher than the one reported in a study conducted in Ghana, where the prevalence of stunting in children <5 years old was 12,50% (Danso & Appiah, 2023). Actually, the data presented in this study are consistent with studies that have pointed out that Indonesia is still experiencing higher prevalence of stunting (Semba et al., 2008).

Bivariate Analysis

Cross-tabulations and chi-square tests were conducted for 13 variables related to WASH-related practices against stunting status. Out of 13 variables, as per table 2, there was no significant relationship between the source of water for other needs (p = 0,089), distance to water source (p = 1,000), drinking water treatment (p = 0,819), toilet facilities (p = 0,176), toilet sharing (p = 0,400), child's use of toilets (p = 0,400), child's fecal disposal (p = 0,257), garbage disposal (p = 0,246), washing hands with soap (p = 0,297), washing hands with running water (p = 1,000), diarrhea status (p = 0,802), and recurrent diarrhea status (p = 1,000) with the incidence of stunting.

Out of the 13 independent variables, only the main source of drinking water had a significant relationship with the incidence of stunting in children aged <5 years (p = 0,049), with an increased risk (OR) of 2,29 times (CI 1,07 - 4,89).

Table 2. Risk factors associated with stunting in children aged < 5 years

Variables	Status		OR	95% CI	P-value
	Stunting n (%)	Non-Stunting n (%)			
The main source of drinking water			2,29	1,07 – 4,89	0,049
Unimproved	20 (48,80)	21 (51,20)			
Improved	27 (29,30)	65 (70,70)			
Source of water for other needs			2,10	0,96 – 4,59	0,089
Unimproved	35 (41,2)	50 (58,80)			
Improved	12 (25,00)	36 (75,00)			
Distance to water source			0,91	0,26 – 3,19	1,000
Within minutes	4 (33,30)	8 (66,70)			
Water on premises	43 (35,50)	78 (64,50)			
Drinking water treatment			0,85	0,40 – 1,79	0, 819
Untreated	30 (34,10)	58 (65,90)			
Treated	17 (37,80)	28 (62,20)			
Toilet facility			3,00	0,80 – 11,21	0,176
Unimproved	6 (60,00)	4 (40,00)			
Improved	41 (33,30)	82 (66,70)			
Toilet sharing			1,67	0,66 – 4,21	0,400
Yes	10 (45,50)	12 (54,50)			
No	37 (33,30)	74 (66,70)			
Child's use of toilet			0,60	0,24 – 1,52	0,400
Yes	10 (45,50)	12 (66,70)			
No	37 (33,30)	74 (54,50)			
Child's fecal disposal			0,49	0,18 – 1,35	0,257
Unsafe	38 (33,00)	77 (69,00)			
Safe	9 (50,00)	9 (50,00)			
Garbage disposal			1,64	0,79 – 3,39	0,246
Unsafe	22 (42,30)	30 (57,70)			
Safe	25 (30,90)	56 (69,10)			
Washing hands with soap			1,69	0,74 – 3,89	0,297
Yes	37 (38,50)	59 (61,50)			
No	10 (27,00)	27 (73,00)			
Washing hands with running water			0,84	0,38 – 1,83	1,000
Yes	7 (35,00)	13 (65,00)			
No	40 (35,40)	73 (64,60)			
Diarrhea status					
Yes	13 (32,50)	27 (67,50)	0,84	0,38-1,83	0,802
No	34 (36,60)	59 (63,40)			
Recurrent diarrhea status					
Yes	8 (33,30)	16 (66,70)	0,89	0,35-2,29	1,000
No	39 (35,80)	70 (64,20)			

Childhood malnutrition remains a major public health issue and a major cause of declining health and increasing mortality rates in developing countries (Semba et al., 2008). Risk factors for stunting in children are diverse and changing over time, place, and season (Danso & Appiah, 2023). However, research has shown that there are various social and economic factors that influence the risk of stunting and other forms of malnutrition in children (Kwami et al., 2019; Owoaje et al., 2014). Both of these factors influence access to and practices of WASH at the household level. It is generally accepted that safe drinking water, effective sanitation, and adequate hygiene services or WASH practices are the main factors directly related to improved health and reduced stunting among children (Modern et al., 2020).

From the bivariate statistical analysis above, there was no direct relationship between water for other needs, distance to water source, drinking water treatment, toilet facilities, toilet sharing, children's use of toilets, children's fecal disposal, garbage disposal, washing hands with soap, washing hands with running water,

diarrhea status, and recurrent diarrhea status with the incidence of stunting. Research by Modern et al. (2020) in Tanzania, which analyzed the same variables, also did not find a direct relationship between these factors and the incidence of stunting. Although both of these did not find a direct relationship between WASH practices and the incidence of stunting, as highlighted by Kwami et al. (2019) and Owoaje et al. (2014), the fact that WASH practices are directly related to the incidence of stunting. Researchers believe that a different research design can be applied in the context of this study to find more compelling evidence, such as case controls. (Zamzamy et al., 2024).

Of all the WASH variables, only the main source of drinking water was identified as a risk factor for stunting. This is significantly associated with stunting. A similar finding was reported in a study by Wicaksono et al. (2021), which stated that external factors such as the main source of drinking water and poor sanitation facilities contribute to stunting. Therefore, based on the evidence found in the study on WASH practices and their relationship to stunting, Kwami et al. (2019) recommended efforts to improve the quality of WASH practices, such as handwashing behavior in mothers and children with a focus on access to clean water. Another study conducted by Girma et al. (2021) in Ethiopia also revealed that improving WASH practices among communities had a positive impact on reducing the incidence of stunting.

In this study, the incidence of diarrhea and recurrent diarrhea were also analyzed for their relationship with stunting. Bivariate analysis showed that these two factors were not significantly associated with stunting. This contrasts with the findings reported in Novianti & Nurjaman (2022) that a history of diarrhea is a risk factor for stunting. Danso & Appiah (2023) who conducted research in Ghana, also found a significant relationship between recurrent diarrhea and stunting. The different results in this study could be due to the cross-sectional design of this study. Therefore, further research should consider different research designs to provide stronger evidence regarding the relationship between diarrhea and recurrent diarrhea with stunting. A larger sample size and community-based research should also be considered in future studies.

Multivariate Analysis

Before multivariate analysis, a simple logistic regression analysis was performed for the independent variables. Only independent variables with a p-value <0,25 were included in the multivariate analysis to assess the influence of risk factors simultaneously on the incidence of stunting in children aged <5 years (table 3).

Table 3. Determinant factors associated with stunting in children aged < 5 years

Determinants	OR	95% CI	P-value
Main source of drinking water	1,56	0,64 – 3,82	0,330
Sauces of water for other needs	1,86	0,74 – 4,67	0,189
Toilet facility	1,79	0,44 – 7,32	0,419
Child's fecal disposal	0,26	0,08 – 0,85	0,026
Garbage disposal	1,16	0,52 – 2,61	0,714
Washing hand with soap	2,33	0,86 – 0,35	0,098

The results of the above analysis shows that there are six risk factors that meet the statistical requirements (p<0,25) for multivariate analysis: the main source of drinking water, source of water for other needs, toilet facilities, child's fecal disposal, garbage disposal, and washing hands with soap. Multivariate analysis with logistic regression revealed a significant influence of children's fecal disposal {p=0,026, OR 0,26 (95% CI= 0,08 - 0,85])} on the incidence of stunting in children aged <5 years. Thus, the WASH-related determinant risk factor for stunting in children aged <5 years was child's fecal disposal.

The results of this study did not differ from those of Beal et al. (2018) and previous studies before them of Torlesse et al. (2016). Both studies have also concluded that the use of poor sanitation facilities is a determinantal risk factor for stunting, along with the use of untreated main sources of drinking water. Ademas et al. (2021) who have conducted research in Ethiopia also pointed out that the use of poor sanitation facilities is a determinant of stunting risk. Walker

et al. (2013) reported that lack of access to good and safe WASH practices was the main cause of children's health and nutrition problems. Therefore, Danaei et al. (2016) concluded that WASH was the primary cause of stunting. Indeed, as shown by Cumming & Cairncross (2016) that poor sanitation is the second cause of stunting worldwide. They highlighted that poor access to the WASH can affect child growth.

In this study, the incidence of diarrhea and recurrent diarrhea were also analyzed using multivariate analyses, but no significant effect was found on the incidence of stunting. In fact, both factors did not go through the initial selection process, where only independent variables with a p-value <0,25 were included in the multivariate analysis to assess the influence of risk factors simultaneously on the incidence of stunting. This finding is inconsistent with those presented in Ademas et al. (2021), Danso & Appiah (2023), Kwami et al. (2019), and Saxton et al. (2016). All these studies reported that diarrhea and recurrent diarrhea were determinants of stunting. The results of a systematic review and meta-analysis conducted on nine studies also showed that toddlers with a history of diarrhea have a 1.21 times risk of experiencing stunting than toddlers who did not have a history of diarrhea (Firmansyah et al., 2023). A systematic review and meta-analysis conducted by Silva et al. (2023) also revealed the same result that the incidence of diarrhea was a determinant risk factor of stunting. In particular, it has been emphasized that the effect of diarrhea on stunting is significant during the first 1000 days of a child's life (Mansori et al., 2018). Walker et al. (2013) also stated that recurrent diarrhea episodes of five or more during the age of two years contribute to a quarter of stunting in children. This means that the odds of child stunting increases with the incidence of diarrhea and recurrent diarrhea (Avachat et al., 2011).

The results of this study provide a clear picture of WASH-related determinants of stunting that can be used in the design of policies for stunting reduction, especially in the context of Indonesia especially in the Aceh Province. This study suggests that, in order to be more effective, policies and programs to overcome stunting in Indonesia must pay more attention to WASH interventions (Ademas et al., 2021; Danso & Appiah, 2023).This is because; there is increasing evidence emerging nationally and internationally that shows the relationship between WASH practices and stunting in toddlers (Modern et al., 2020). However, it should be noted that stunting cannot be overcome by addressing WASH factors alone; because other studies have also found many other risk factors that were not examined in this study, including nutritional status, exclusive breastfeeding, parental education, family socioeconomics, and vaccinations (Abd El-Ghaffar et al., 2022; Dadras et al., 2024). Regarding nutritional status, the government of Indonesia and health authorities need to adapt or promote nutrition-related interventions, such as educational awareness regarding the use of family planning services. Ultimately, this study provides a picture, especially for Aceh Province of the influence of WASH factors on stunting. Thus, it is useful for overcoming stunting problems in this region.

Conclusion

WASH-related risk factors for stunting among children < 5 years of age who attended outpatient clinics or were admitted for treatment at RSUD dr. Zainoel Abidin Banda Aceh was child' fecal disposal. Of course, combating WASH-related risk factors alone is not enough to reduce the prevalence of stunting. However, evidence from this study suggests that WASH-related factors are paramount to be included into an integrated approach to tackling stunting. Therefore, it is important to introduce health promotion policies that prioritize WASH-related strategies that help improving access to clean water sources, child feces disposal, policies on WASH interventions, and sustainable funding and support.

As shown above, this study only found one significant WASH-related risk factor of stunting. This might have been caused by the cross-sectional nature of the study design. This methodology mostly rely on self-reporting information that subject to recall bias which may affect participants to produce incorrect information in significant ways, such as for water treatment, household sanitation, and hand washing with soap and running water. Another limitation of this study was due to the cross-sectional nature of the data. It only provides a snapshot and cannot be used to establish cause-and-effect relationships. Therefore, this study recommends future researchers to use a case control design. A longitudinal research with a comparison group may also be a better approach to find the WASH-related risk factors of stunting.

Acknowledgements

The authors would like to acknowledge and thank the respondents who participated in this study, the reviewers whose insightful comments have improved the paper significantly, and Editor-in-Chief, who has eased the publishing process of this paper

References

Abd El-Ghaffar, Y. S., Shouman, A. E., Hakim, S. A., El Gendy, Y. G. A., & Wahdan, M. M. M. (2022). Effect of zinc supplementation in children less than 5 years on diarrhea attacks: A randomized controlled trial. *Global Pediatric Health*, *9*, 2333794X221099266.

Ademas, A., Adane, M., Keleb, A., Berihun, G., & Tesfaw, G. (2021). Water, sanitation, and hygiene as a priority intervention for stunting in under-five children in northwest Ethiopia: a community-based cross-sectional study. *Italian Journal of Pediatrics*, *47*(1), 174.

Avachat, S. S., Phalke, V. D., Phalke, D. B., Aarif, S. M. M., & Kalakoti, P. (2011). A cross-sectional study of socio-demographic determinants of recurrent diarrhea among children under five of rural area of Western Maharashtra, India. *The Australasian Medical Journal*, *4*(2), 72.

Beal, T., Tumilowicz, A., Sutrisna, A., Izwardy, D., & Neufeld, L. M. (2018b). A review of child stunting determinants in Indonesia. *Maternal & Child Nutrition*, *14*(4), e12617. https://doi.org/https://doi.org/10.1111/mcn.12617

Cumming, O., & Cairncross, S. (2016). Can water, sanitation and hygiene help eliminate stunting? Current evidence and policy implications. *Maternal & Child Nutrition*, *12*, 91–105.

Dadras, O., Suwanbamrung, C., Jafari, M., & Stanikzai, M. H. (2024). Prevalence of stunting and its correlates among children under 5 in Afghanistan: the potential impact of basic and full vaccination. *BMC Pediatrics*, *24*(1), 436.

Danaei, G., Andrews, K. G., Sudfeld, C. R., Fink, G., McCoy, D. C., Peet, E., Sania, A., Smith Fawzi, M. C., Ezzati, M., & Fawzi, W. W. (2016). Risk factors for childhood stunting in 137 developing countries: a comparative risk assessment analysis at global, regional, and country levels. *PLoS Medicine*, *13*(11), e1002164.

Danso, F., & Appiah, M. A. (2023). Prevalence and associated factors influencing stunting and wasting among children of ages 1 to 5 years in Nkwanta South Municipality, Ghana. *Nutrition*, *110*, 111996.

De Onis, M., & Branca, F. (2016). Childhood stunting: a global perspective. *Maternal & Child Nutrition*, *12*, 12–26.

Firmansyah, R. R. T., Murti, B., & Prasetya, H. (2023). A Meta-Analysis of Correlation between Diarrhea and Stunting in Children Under Five. *Journal of Epidemiology and Public Health*, *8*(1), 88–97.

Girma, M., Hussein, A., Norris, T., Genye, T., Tessema, M., Bossuyt, A., Hadis, M., van Zyl, C., Goyol, K., & Samuel, A. (2021). Progress in water, sanitation and hygiene (WASH) coverage and potential contribution to the decline in diarrhea and stunting in Ethiopia. *Maternal & Child Nutrition*, e13280.

Handryastuti, S., Pusponegoro, H. D., Nurdadi, S., Chandra, A., Pramita, F. A., Soebadi, A., Widjaja, I. R., & Rafli, A. (2022). Comparison of cognitive function in children with stunting and children with undernutrition with Normal stature. *Journal of Nutrition and Metabolism*, *2022*(1), 9775727.

Kemenkes, R. I. (2022). Buku Saku Hasil Survei Status Gizi Indonesia (SSGI) 2022. *Badan Kebijakan Pembangunan Kesehatan Kementerian Kesehatan RI*.

Kwami, C. S., Godfrey, S., Gavilan, H., Lakhanpaul, M., & Parikh, P. (2019a). Water, sanitation, and hygiene: linkages with stunting in rural Ethiopia. *International Journal of Environmental Research and Public Health*, *16*(20), 3793.

Malhotra, R. K. (2020). Errors in the use of multivariable logistic regression analysis: an empirical analysis. *Indian Journal of Community Medicine*, *45*(4), 560–562.

Mansori, K., Shadmani, F. K., Mirzaei, H., Azad, R. V., Khateri, S., Hanis, S. M., & Moradi, Y. (2018). Prevalence of stunting in Iranian children under five years of age: Systematic review and meta-analysis. *Medical Journal of the Islamic Republic of Iran*, *32*, 103.

Mengesha, H. G., Vatanparast, H., Feng, C., &

Petrucka, P. (2020). Modeling the predictors of stunting in Ethiopia: analysis of 2016 Ethiopian demographic health survey data (EDHS). *BMC Nutrition*, *6*, 1–11.

Modern, G., Sauli, E., & Mpolya, E. (2020). Correlates of diarrhea and stunting among under-five children in Ruvuma, Tanzania; a hospital-based cross-sectional study. *Scientific African*, *8*, e00430.

Novianti, S., & Nurjaman, A. (n.d.). *The Relationship of Environmental Factors and A History of Diarrhea to The Incidence of Stunting in Baduta Aged 6-23 Months*.

Organization, W. H. (2018). *Reducing stunting in children: equity considerations for achieving the Global Nutrition Targets 2025*.

Organization, W. H. (2023). *Levels and trends in child malnutrition child malnutrition: UNICEF/WHO/World Bank Group Joint Child Malnutrition Estimates: Key findings of the 2023 edition*. World Health Organization.

Owoaje, E., Onifade, O., & Desmennu, A. (2014). Family and socioeconomic risk factors for undernutrition among children aged 6 to 23 Months in Ibadan, Nigeria. *The Pan African Medical Journal*, *17*.

Saxton, J., Rath, S., Nair, N., Gope, R., Mahapatra, R., Tripathy, P., & Prost, A. (2016a). Handwashing, sanitation and family planning practices are the strongest underlying determinants of child stunting in rural indigenous communities of Jharkhand and Odisha, Eastern India: A cross-sectional study. *Maternal & Child Nutrition*, *12*(4), 869–884.

Semba, R. D., de Pee, S., Sun, K., Sari, M., Akhter, N., & Bloem, M. W. (2008). Effect of parental formal education on risk of child stunting in Indonesia and Bangladesh: a cross-sectional study. *The Lancet*, *371*(9609), 322–328.

Silva, J. R. M., Vieira, L. L., Abreu, A. R. M., de Souza Fernandes, E., Moreira, T. R., da Costa, G. D., & Cotta, R. M. M. (2023). Water, sanitation, and hygiene vulnerability in child stunting in developing countries: a systematic review with meta-analysis. *Public Health*, *219*, 117–123.

Torlesse, H., Cronin, A. A., Sebayang, S. K., & Nandy, R. (2016). Determinants of stunting in Indonesian children: evidence from a cross-sectional survey indicate a prominent role for the water, sanitation and hygiene sector in stunting reduction. *BMC Public Health*, *16*, 1–11.

Walker, C. L. F., Rudan, I., Liu, L., Nair, H., Theodoratou, E., Bhutta, Z. A., O'Brien, K. L., Campbell, H., & Black, R. E. (2013). Global burden of childhood pneumonia and diarrhoea. *The Lancet*, *381*(9875), 1405–1416.

Waller, A., Lakhanpaul, M., Godfrey, S., & Parikh, P. (2020). Multiple and complex links between Baby WASH and stunting: an evidence synthesis. *Journal of Water, Sanitation and Hygiene for Development*, *10*(4), 786–805.

WHO. (2022). *Stunting in a nutshell*.

Wicaksono, R. A., Arto, K. S., Mutiara, E., Deliana, M., Lubis, M., & Batubara, J. R. L. (2021). Risk factors of stunting in Indonesian children aged 1 to 60 months. *Paediatrica Indonesiana*, *61*(1), 12–19.

Zamzamy, H. Z., Suminah, S., & Sumardiyono, S. (2024). Risk factors of under-fives stunting in low-income households. *AcTion: Aceh Nutrition Journal*, *9*(2), 247–258.

Zewdu, D., & Halala Handiso, Y. (2020). Under-nutrition of 2–5 years old children and associated factor among employed and unemployed women: comparative cross-sectional study. *Cogent Food & Agriculture*, *6*(1), 1801215.