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修 士 論 文

The association of child feces disposal, and Water, Sanitation, and Hygiene (WASH) toward child health in the urban slum, Indonesia
(インドネシア都市スラムにおける子どもの健康に向けた排泄処理と水、衛生環境、手洗いとの関連)

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保健科学専攻　保健科学コース

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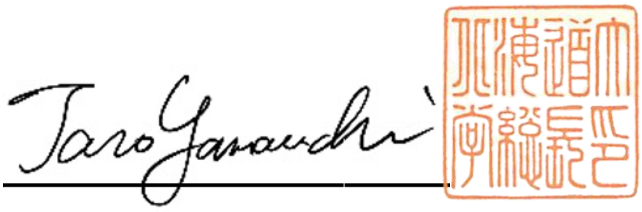

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修士課程のコース名称　　保健科学専攻 保健科学コース
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The association of child feces disposal, and Water, Sanitation, and Hygiene (WASH) toward child health in the urban slum, Indonesia

Abstract

Indonesia is one of low-middle income country that intended to resolve the problem about access to sanitation and hygiene as well as child malnutrition. Achieving goal for the provision of basic sanitation, Indonesia still face increasing number of households that performing unsafe child feces disposal. Furthermore, from the Indonesian Health Report in 2013, that proper handwashing rates at critical times in Indonesia only reached 47% even though handwashing facilities were found to cover more than 90% of the population. We involved 41 elementary school children and 183 mothers as main caregivers with under-five children living in an urban slum of Indonesia for study participants.

The master thesis devided into two studies; (1) handwashing skill, hand bacteria reduction and child nutritional status of elementary school children and; (2) unsafe child feces disposal as the risk factor of child stunting in an urban slum of Indonesia. The measures for the first study were: 1) handwashing skill observation using a checklist, 2) hand bacteria assessment before and after handwashing using a swab, and 3) child anthropometry (height and weight measurement). Moreover, we conducted an in-depth interview, measuring child’s height and observing child feces disposal and WASH for each household for the second study. The relationships between handwashing skill, bacterial assessment, and child nutritional status were analyzed using bivariate Spearman’s correlation tests and differences were studied using paired t-tests for the first study. On the other hand, we performed binary and multivariable logistic regression analysis for the contributing factors related unsafe child feces disposal and child stunting for the second study.

From the first study we aimed to evaluate elementary school children's awareness of handwashing skills based on WHO hand hygiene guidelines and their effectiveness in reducing total hand bacteria. We also aimed to analyze the relationship between handwashing skills and child nutritional status. Then for the second study, focusing on manifestation of socio-economic factors, child characteristic and environmental factors, this recent study tried to investigate the prevalence of unsafe child feces disposal, the risk factors of mother on performing unsafe child feces disposal and its effect to child stunting.

The result showed that handwashing reduced total bacteria by 0.70 log CFU/hand. Allocating time specifically to pouring water before lathering significantly lowered total bacteria after handwashing. Moreover, neglecting hand drying was identified as a potential factor that caused hand contamination and lowered child nutritional status. As the result form the second study, forty-five percent of mothers performed unsafe child faeces disposal. A multivariate logistic regression analysis revealed that unsafe child faeces disposal increased the risk of child stunting (AOR: 2.56; 95% CI: 1.10-5.96). Having a lower than secondary school education level (AOR: 2.85; 95% CI: 1.38-5.89) and using a shared toilet (AOR: 14.74; 95% CI: 2.49-87.17) increased the mothers' odds of performing unsafe child faeces disposal, as did children's age of lower than 2 years (AOR: 2.51; 95% CI: 1.25-4.99).

The conclusion of the first study are factors that affect total bacteria reduction after handwashing are: (1) time duration for handwashing, especially for wetting hands before lathering; and (2) performing comprehensive handwashing skills including drying hands with a single paper towel. In addition, improper hand drying which results in hand contamination may lead to a lowering of child nutritional status. Moreover, in the second study, low prevalence of unsafe child faeces disposal was insufficient preventing stunting. The provision of adequate sanitation systems for each household and using washable diaper or toilet training in an early age for young children might eliminate potential sources of faecal contamination that lead to child stunting.

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Chapter 1: Handwashing skills, hand bacteria reduction, and nutritional status of elementary school children in an urban slum of Indonesia

Abstract

Currently, Indonesia is a developing country with awareness of, and involvement in, a community-based total sanitation program. One pillar of this program is handwashing practice as a means of infectious disease prevention, with many studies having shown that a lack of handwashing behavior leads to bacterial contamination from hands. School children are the most vulnerable to bacterial contamination which can lead to nutritional problems. On the other hand, over population and poor-infrastructure are also contributing factors to a lack of sanitation and personal hygiene, and these play important roles in child behavior. Therefore, this study aims to analyze handwashing skills among school children based on WHO guidelines regarding total bacteria reduction and child nutritional status in an urban slum of Indonesia.

We conducted a cross-sectional study on elementary school children in the urban slum of Bandung. Participants were 6th grade children (11 to 14 years old). Forty-one children (24 boys and 17 girls) participated in this study. Our measures were: 1) handwashing skill observation using a checklist, 2) hand bacteria assessment before and after handwashing using a swab, and 3) child anthropometry (height and weight measurement). The association among handwashing skill, handwashing's total time duration, and bacterial assessment were analyzed using bivariate Spearman's correlation tests, differences between total bacteria before and after handwashing, and between handwashing skill and child nutritional status were studied using paired t-tests and t-test.

Results showed that handwashing reduced total bacteria by 0.70 log CFU/hand. Allocating time specifically to pouring water before lathering significantly lowered total bacteria after handwashing. Moreover, neglecting hand drying was identified as a potential factor that caused hand contamination and lowered child nutritional status.

1. Introduction

Child mortality rates due to malnutrition are approximately 860,000 children per year and of those cases 50% feature unsafe water, inadequate sanitation, or insufficient hygiene as a cause of death (Prüss-Üstün et al. 2008). Having insufficient sanitation facilities with poor hygiene behavior will likely result in diarrhea and other related illnesses. In other words, sanitation and hygiene are inseparable in terms of their impact on human health (Cairncross et al. 2010). Even where access to sanitation facilities is available, bacterial contamination on children's hands occurs when handwashing practices are neglected (Greene et al. 2012). Therefore, in terms of the 2030 agenda for the United Nation's Sustainable Development Goals (SDGs), Water Sanitation and Hygiene (WASH) is a key driver of progress on many SDGs, especially child health and nutrition (IFPRI 2016).

Handwashing is one way to lower the risk of diarrhea and acute respiratory infection (Luby et al. 2010; Rabie & Curtis 2006). Unfortunately, only 19% of all people worldwide practice handwashing after contact with feces (Freeman et al. 2014). It was estimated that 297,000 deaths from diseases could be prevented by the promotion of hand hygiene (Prüss-Ustün et al. 2014). Recent studies have found that adult handwashing skill and duration relates to total bacteria reduction (Jensen et al. 2015; Lucet et al. 2002). However, there are limited studies of this nature conducted in children which investigate potential contamination processes in the context of actual living conditions (Pickering et al. 2010). Our latest study revealed that inadequate handwashing skills among children was a contributing factor towards impaired growth (Otsuka et al. 2018b).

Indonesia is one of developing countries dealing with water, sanitation, hygiene, and malnutrition problems (Indonesian Health Survey 2013). Recently, urbanization has led to a proliferation of slum areas which suffer from insufficient sanitation infrastructure and poor access to clean water, bringing challenges to the practice of good hygiene behavior (Tarigan et al. 2015). It was shown by the Indonesian Health Report (2013) that proper handwashing rates at critical times in Indonesia only reached 47% even though handwashing facilities were found to cover more than 90%

of the population. School is a crucial institution for encouraging the development of healthy and hygienic behaviors from the bottom-up, through children (UNICEF 2012). Therefore, having insufficient sanitation and hygiene infrastructure at school can lead to a failure in the wider development of good hygiene practices and behaviors.

This study aimed to evaluate elementary school children's awareness of handwashing skills based on WHO hand hygiene guidelines and their effectiveness in reducing total hand bacteria. We also aimed to analyze the relationship between handwashing skills and child nutritional status in an urban slum of Indonesia.

2. Methods

2.1 Study area

The study area was selected purposively as one of the urban slum areas in Bandung city. Bandung city is the capital of West Java, Indonesia, with a total population of 2,490,622 registered residents (BPS Bandung City 2017). We selected Bandung city because Bandung is currently facing issues related to environment and health. Bandung has challenges resulting from spatial and urban development. This is presenting problems including the proliferation of slum areas which suffer from limited sanitation, poor drinking water, inadequate solid waste management, and a lack of access to clean water (Tarigan et al. 2015). Kiaracondong, as the third highest populated district area *(Kecamatan)* in Bandung city with total population of 132,135 (BPS Bandung City 2017), was selected as the study area. This area has one elementary school located within the slums, with improper sanitation facilities and handwashing station; this became the research site. Detailed information on this research location are provided elsewhere (Otsuka et al. 2018a). The location of Kiaracondong, Bandung City, is indicated in the figure below (fig 1).

2.2 Study design and participants

This study collected data on children's handwashing skills, total hand bacteria (before and after handwashing) and child anthropometry (weight and height). This was a cross-sectional study with a purposive sampling method. Participants were elementary school children in grade 6, ranging from 11 to 14 years of age. Sixth grade students in elementary schools were selected because of their ability to follow the study procedure. A total of 41 elementary school children (24 boys and 17 girls) took part in this study. Their handwashing skills were observed using a checklist modified from WHO guidelines on handwashing for healthcare. Socio-economic status was ascertained through household monthly income and the total number of family members living in the household and observing school handwashing facility were also recorded as supplementary data.

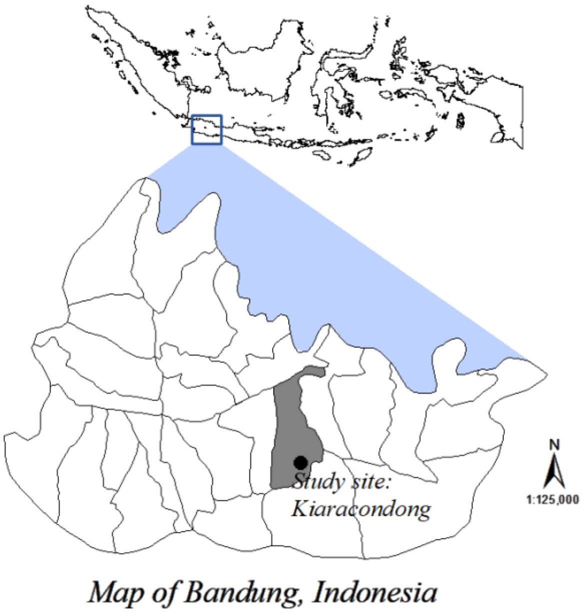


Figure 1 Study site location, Kiaracondong, Bandung, Indonesia

2.3 Procedure and measurements

i. Handwashing skill

Children were asked to perform their daily handwashing practice. All materials such as tap water, a water bucket with scoop, bar soap, liquid soap, and paper towels were provided by the researcher. The outer side of the liquid soap container and the bar of soap, as well as the inside of the bucket and scoop, were cleaned with water before performing handwashing but were not sterilized. We did not control either water temperature or water quality for handwashing and consider those as real conditions of the participants' living environment. The handwashing checklist was based on a modification of the hand hygiene guidelines for health care from the WHO (figure 2), as explained elsewhere (WHO 2009). We used the checklist for every step followed by children in their handwashing behavior and used this to provide a score (maximum of 10). The amount of time (1^{st} step, 3^{rd}-8^{th} step, and 9^{th} step) for hand washing behavior was measured using a stopwatch.

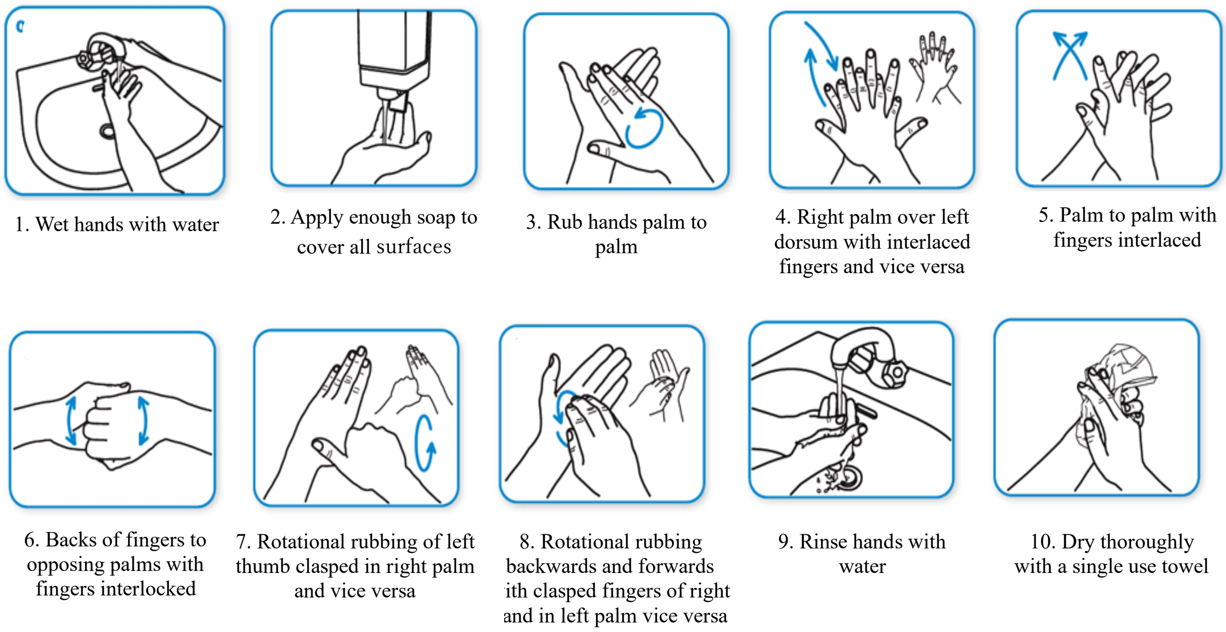


Figure 2 Modification WHO hand hygiene guidelines for health care (2009)

ii. Total bacteria measurements

Hand bacteria were collected before and after handwashing using a wiping kit which contained a cotton swab and 10 mL of sterile phosphate buffered saline (PBS) in a test tube (Swab test ST-25PBS; Elmex, Japan). Before children demonstrated their handwashing skill, a cotton swab moistened with sterile PBS was rolled on the surface of the dominant hand of each child (i.e., palm, backside, and fingers). All samples were kept on ice and transported to a field laboratory within 4 hours after sampling. Total bacteria analysis was conducted at the Research Unit for Clean Technology, Indonesian Institute for Science (LPTB-LIPI), Bandung. Samples were processed in the laboratory by membrane filtration to detect E. coli. Under aseptic conditions, each sample (10 mL) was divided into low and high volumes (1.0 and 9.0mL, or 0.5, 1.0 and 8.5mL), and passed through a 47-mm-diameter 0.45-µm cellulose filter. After filtration, the filter was placed on XM-G growth media (XM-G; Nissui Pharmaceutical Co., Japan) and incubated at 37°C for 20±2h. The bacterial load on each media was read as colony forming unit (CFU) counts per hand. E. coli was determined by size and color of the colony (i.e., a blue and purple colony bigger than 1 mm). The *E. coli* bacteria count was converted to log CFU per hands. The changing of bacteria count was (the bacteria count before performed handwashing – the bacteria count after handwashing). The bacterial reduction was marked as positive results, while bacterial increased was marked as negative results.

iii. Body measurements for nutritional status

Body weight and height for all children were measured to calculate their nutritional status. Height was measured to the nearest 0.1 cm using a stadiometer (Seca 213; Seca, Germany), and body weight to the nearest 0.1 kg using a digital weighing scale (BC-754-WH; Tanita, Japan). With reference to WHO growth data, for children above 5 years old and adolescents, child nutritional status is determined by using z-scores from height for age (HAZ), weight for age (WAZ), and BMI for age (BMIAZ). However, to prevent under-estimation of child nutritional status in the Indonesian context, we used the first Indonesian growth chart as standards from Batubara et al. (2006) to calculate z-scores. From this, we classified children based on categories such as a z-score of less than -2 (Standard Deviation: SD) as reflecting under-nutrition, between -2 SD until 2 SD as normal, and of more than 2 SD as over-nutrition. Low HAZ was used to indicate risk of stunting, low WAZ for risk of wasting, and BMIAZ for risk of either underweight (low) or overweight/obesity (high).

2.4 Statistical analysis

First, we conducted descriptive analysis of mean values and percentages or prevalence. Second, the associations between handwashing skill or bacteria measurement with child nutritional status were assessed using Spearman correlation for bivariate analysis. Third, comparisons of each group were done using paired t-tests. Statistical analyses were performed using IBM SPSS 23 for Windows.

2.5 Ethical considerations

This study was approved by the Ethical Review Committee of The Faculty of Health Sciences, Hokkaido University (No.17-13). This study was carried out under a Memorandum of Understanding (MoU) between the Research Institute of Humanity and Nature and the Indonesian Research Institute (LIPI). All purposes and contents of this study were explained to participants. Parents allowed their children to participate in this study by replying with written informed consent.

3. Results

3.1 Characteristics of participants

Children were 6th grade elementary school students with age ranging from 11 to 14 years. Approximately 9.8% children were more than 12 years of age while most were between 11 and 12 years. Approximately 73% of children lived in households with a monthly income of less than 2,000,000 rupiahs (139.02 USD) per month and 56% lived in an extended family (data not shown). Referring to the first Indonesian growth chart, child nutritional status fitted approximately within the normal range on this chart for both male and female participants while female children tended to have higher nutritional status than male children. Moreover, only 6% of underweight and 4% of overweight children were male (table 1). In addition, we did not find a significant association of either child handwashing skills or nutritional status with socio-economic conditions.

Figure 3 Bathroom condition at school

In general, children used two sites for handwashing in school: (1) in the bathroom using a water bucket and scoop, and (2) using tap water outside the bathroom, also without a sink. One sink that used to be a common handwashing site was found broken and lacking in maintenance. Obtaining clean water in the school was also difficult since we found the water pump was broken. Furthermore, two bathrooms that often have been used as handwashing site were in poor condition. The bathrooms were also used by school security for washing clothes and dishes, thus became dirt and lacked space (fig. 3).

Table 1 Participants characteristics

Category	Male (N = 24)	Female (N =17)	WHO (2009)*
Age	12.06	11.88	
Height for age z-score (HAZ)	-0.35	-0.02	
Weight for age z-score (WAZ)	-0.50	-0.30	
BMI for age z-score (BMIAZ)	-0.72	2.06	
Prevalence of child underweight (%)	6.00	0.00	
Prevalence of child overweight (%)	4.00	1.00	
Before (log CFU/hand)	1.69	1.58	
After (log CFU/hand)	1.23	0.99	
Bacterial reduction (log CFU/hand)	0.70 ± 0.45		
	0.65 ± 0.44	0.79 ± 0.48	
Bacterial increased (log CFU/hand)	- 0.59 ± 0.38		
	- 0.81 ± 0.45	- 0.38 ± 0.16	
Handwashing score (step)	5.60	6.17	10
Total time of duration (sec.)	48.87	53.00	40-60
Time 1st step (sec.)	4.70	4.76	NA
Time 3rd-8th steps (sec.)	7.17	7.65	15-20
Time 9th step (sec.)	14.95	13.06	NA

*WHO hand hygiene guidelines for health care (2009)
Bacterial reduction was among children who had reduced total of *E. coli* count after handwashing
Bacterial increase was among children who had increased total of *E. coli* count after handwashing

3.2 Child handwashing skills

Our results showed that children had greater skill in first five steps of handwashing, which is wetting hands before lathering up, until palm to palm with fingers interlaced. Skill then decreased sharply for the three later steps (table 2). Unfortunately, not all children could accomplish hand drying after rinsing their hands with water following lathering. Children had different preference for tools and soap for handwashing. Regarding tool preferences, 85% of children chose tap water and 15% of children chose a water bucket with scoop. Regarding soap preferences, 59% of children chose bar soap while 39% chose liquid soap. However, their preference for tools or soap had no significant association with the *E. coli* count on hands after handwashing.

Table 2 Children handwashing step accomplice

Handwashing step	Observed N (%)	Not observed N (%)
Step 1	37 (90)	4 (10)
Step 2	39 (95)	2 (5)
Step 3	37 (90)	4 (10)
Step 4	25 (61)	16 (39)
Step 5	23 (56)	18 (56)
Step 6	1 (2)	40 (98)
Step 7	2 (5)	39 (95)
Step 8	2 (5)	39 (95)
Step 9	41 (100)	0
Step 10	32 (78)	9 (22)

3.3 Handwashing time duration, *E. coli* count, and nutritional status

Our findings showed that a longer time duration for wetting hands with water before lathering (step 1) was significantly associated with lower *E. coli* count after handwashing (table 3). Handwashing was proven to significantly change *E. coli* count on children's hands (fig. 4), where the mean value of log *E. coli* count reduction is 0.70 log CFU/hand for participants who decreased total bacteria. Unexpectedly, we found that in 14.6% children handwashing increased the *E. coli* count. Such children were found to not perform the hand drying step and tended to dry their hands using their school uniform.

Table 3 Time allocation for handwashing practice and total bacteria after handwashing

Outcome	Variables	Mean	Correlation
E. coli count after handwashing (log CFU/hand)	Time 1st step (sec.)	4.70	- 0.33*
	Time 3 - 8 step (sec.)	7.40	0.06
	Time 9th step (sec.)	14.20	0.13
	Total time duration (sec.)	50.60	-0.28
	Handwashing score (step)	5.80	-0.15

*significant correlation by Spearman correlation test, $p < 0.05$

The difference mean value of child nutritional status such as HAZ, WAZ, and BMIAZ for children who performed and not performed hand drying after handwashing (table 4). Children who dried their hands properly with a single clean paper towel after handwashing had a significantly higher nutritional status in terms of HAZ and WAZ than children who skipped this step. A similar trend was indicated for BMIAZ but this was not significant.

Table 4 Child nutritional status in relation to performing step 10

Outcome	Step 10		p-value
	Observed	Not observed	
HAZ	-0.03	-0.89	0.02
WAZ	-0.24	-1.03	0.04
BMIAZ	-0.50	-1.26	0.18

*significant difference by t-test

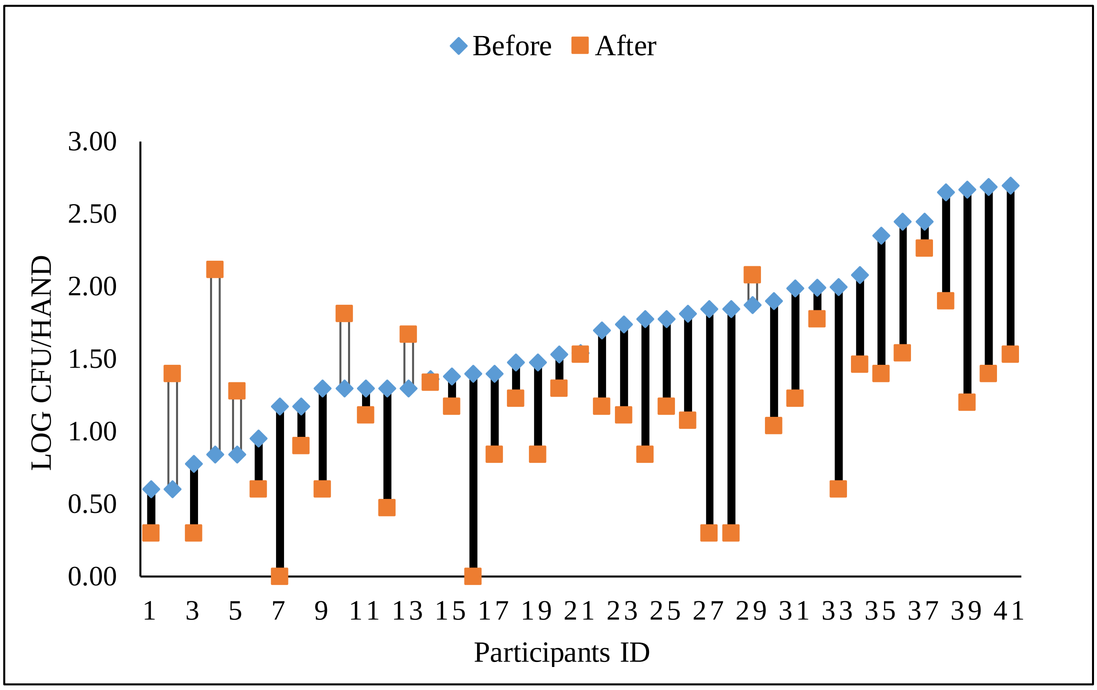
4. Discussions

4.1 Children's handwashing skills

Our results showed that 90%, 61%, and 56% of children were accomplished in handwashing skills from the third until the fifth step, respectively. This then declined sharply through steps 6 to 8 to 2%, 5%, and 5% respectively (table 2). A similar study conducted in medical staff (nurses, physicians and auxiliaries), found a similar pattern with greater handwashing skill in the initial steps, then decreasing for further steps to approximately 70.6%, 30.3%, and 40.9% (Arias et al. 2016). However, elementary school children in this study showed much lower overall levels of handwashing skill than those medical staff. This may be because elementary school children rarely perform this skill in their daily life because of forgetfulness or lack of time (Lopez-Quintero et al. 2009). This result showed that elementary school children's awareness of handwashing steps is low and that handwashing guidelines from the WHO are not well implemented in elementary school children.

4.2 Children's handwashing time duration and *E. coli* count

Handwashing was proven effective in eliminating *E. coli* on hands (fig. 4) since in 85% of children total bacteria were reduced after performing handwashing. We found that a longer total time duration to complete all steps of handwashing tended to produce larger reductions in *E. coli* count, although significant differences were not observed (table 3). We found children typically spent less than 20 seconds on lathering, lower than the time found in a previous study (Jensen et al. 2017). Thus, it made bacteria reduction in this study also lower than that study. According to that study, 20 seconds spent on lathering using antimicrobial soap reduced total *E. coli* bacteria on hands by 1.95 log CFU/hand. A similar study in school children revealed an *E. coli* bacteria reduction of 0.66 log CFU/hand after rubbing hands with non-antimicrobial soap for 15 second (Pickering et al. 2010). Therefore, allocating sufficient time for handwashing using antimicrobial soap is necessary for greater bacteria reduction (Pickering et al. 2010).



*paired t-test; $p<0.05$

Figure 4 *E. coli* count on hand before and after handwashing for all children

Moreover, spending more time pouring water onto hands before applying soap and before lathering significantly lowered *E. coli* count after handwashing (table 3). The mean value for this first step was 4.7 seconds in the current study, although there are no specific guidelines available. Considering this result, 39% children spent less than 5 seconds on pouring water and 10% of them skipped the first step and went directly to the second step. In other words, children needed to spend more time pouring water to perform both hand wetting before handwashing, and rinsing hands after lathering, in order to further reduce bacteria. Therefore, children need to apply more water for a longer total duration of handwashing to prevent contamination exposure from fecal-hand or fecal-mouth transmission (Oswald et al. 2008). However, Bandung even not facing water scarcity, but having problem with access to sufficient quantities of water (Marcotullio, 2007). This matter also presents a challenge for children to perform thorough handwashing.

4.3 Drying hands, *E. coli* count, and child nutritional status

Result showed six cases where children had increased *E. coli* count after handwashing (fig. 4). Those children were observed not performing step 10 correctly and drying their hands with their school uniforms (table 2). The main possibility for the source of contamination is their school uniforms, which are exposed to bacteria while playing outdoors. A similar concern was found in a study of nursing students who had bacterial contamination during their shift in the hospital; not changing their uniform increased contamination (Callaghan 1998). Furthermore, wet hands after insufficient drying can encourage bacteria to develop more rapidly after touch-contact bacterial transfer, even after handwashing (Huang et al. 2012). Therefore, hand drying should not be neglected as an integral step of handwashing (WHO 2009) and we suggest using a single clean paper towel to dry hands for the most effective reduction of bacteria (Huang et al.2012).

Moreover, children who were observed performing hand drying had better nutritional status in terms of height for age (HAZ) and weight for age (WAZ), but not in terms of BMI for age (BMIAZ) (table 4). Since children who failed to perform hand drying had fecal bacteria contamination on their hands, they also have a higher possibility of fecal oral transmission that leads to repeated gastroenteritis or severe diarrhea. Thus, it could cause nutrient malabsorption resulting in faltering growth (Korpe & Petri, 2012). This finding is also in line with that of our previous study, where not performing hand drying significantly increased the risk of child stunting (Adjusted Odds Ratio (AOR): 2.37; 95% CI: 1.13-4.96) (Otsuka et al. 2018b). Therefore, fully accomplished handwashing skills are entirely necessary to prevent bacteria transfer from hands which results in lower child nutritional status.

4.4 Limitations

This study was conducted mainly through observation and direct assessment. It was able to address scientific questions in relation to handwashing skills, total hand bacteria, and the nutritional status of elementary school children. However, there were some limitations to this study. First, as a cross-sectional study with a small sample size we could not determine causal relationships for all variables related to the study indicators. Second, we did not record children's illnesses for previous years as a direct cause of lower child nutritional status. Despite this, we believe that further studies on hand hygiene and child nutritional status are potential fruitful research areas since handwashing is not only critical for healthcare workers but also for children. Further research with a larger sample size, using a longitudinal study design, and assessing children's hygiene behavior, is needed to provide more robust data with regards to the importance of handwashing skills for child health.

5. Conclusions

This study revealed that the available guidelines are not well understood or implemented. WHO hand hygiene guidelines are too complex for elementary school children. Factors that affect total bacteria reduction after handwashing are: (1) time duration for handwashing, especially for wetting hands before lathering; and (2) performing comprehensive handwashing skills including drying hands with a single paper towel. Although handwashing is not directly related to child nutritional status, improper hand drying which results in hand contamination may lead to a lowering of child nutritional status.

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Chapter 2: Unsafe child feces disposal as a risk factor of child stunting in an urban slum of Indonesia

Abstract

OBJECTIVE: To examine the risk factors of child stunting in an urban slum of Indonesia, focusing on mothers' behaviour on unsafe child faeces disposal.

METHODS: We conducted a cross-sectional study of 183 pairs of mothers and their under-five children. The primary data were obtained through conducting in-depth interviews on child faeces disposal; maternal and child factors; and water, sanitation, and hygiene practices in each household. We calculated the z-score for children's length/height for their age (L/HAZ) using the WHO Anthro Software. We then performed binary and multivariable logistic regression analyses to determine the factors contributing to unsafe child faeces disposal and child stunting.

RESULTS: Forty-five percent of mothers performed unsafe child faeces disposal. A multivariate logistic regression analysis revealed that unsafe child faeces disposal increased the risk of child stunting (AOR: 2.56; 95% CI: 1.10-5.96). Having a lower than secondary school education level (AOR: 2.85; 95% CI: 1.38-5.89) and using a shared toilet (AOR: 14.74; 95% CI: 2.49-87.17) increased the mothers' odds of performing unsafe child faeces disposal, as did children's age of lower than 2 years (AOR: 2.51; 95% CI: 1.25-4.99).

CONCLUSIONS: In an urban slum of Indonesia, low prevalence of unsafe child faeces disposal was insufficient preventing stunting. The provision of adequate sanitation systems for each household and using washable disposable diaper or toilet training in an early age for young children might eliminate potential sources of faecal contamination that lead to child stunting.

1. Introduction

Child malnutrition is a major contributing factor to child mortality worldwide, especially in low-to-middle income countries (30). Infants and young children are among the most vulnerable groups to infection and malnutrition (1,2) – annually, more than 400,000 malnutrition-related deaths of children under five years old are linked to diarrhoea and intestinal infections associated with unsafe drinking water and inadequate sanitation and hygiene practices (3). Therefore, improving water, sanitation, and hygiene might be able to reduce the risk of diarrhoea leading to child malnutrition (4,5).

Indonesia successfully achieved the Millennium Development Goal related to accessing basic sanitation for the population, with approximately 71% of the population having access to either a private or public toilet in 2015 (6). This number had been increasing from 57% in 2007 to 69.3% in 2012 (7,8). Provision of basic sanitation facilities aimed not only for preventing adult practicing open defecation but also for preventing households disposed child faeces unsafely (9,10). However, despite access to basic sanitation in Indonesia was improved, the proportion of the population engaging in unsafe child faeces disposal practices has increased from 29% to 35% on the same time period (7,8) while no recent data available. Unsafe child faeces disposal is considered a harmful practice, having been proven to cause enteric infections that influence child growth (11).

Unfortunately, there is relatively limited research exploring the linkage between unsafe child faeces disposal and child malnutrition, particularly child stunting. Stunting is considered as the result of long-term malnutrition and disease infection, which could represent the effect of long-term effect of unhealthy environment (11,12). Stunting in childhood might develop to overweight, low adult intellectual ability and work capacity (11,13). Rather than weight that fluctuated due to short term-malnutrition, height could be the strong markers for child healthy growth (37). Stunting due to repeated infections caused by environmental factors is considered preventable if the associated risk factors are eliminated (14).

Study about the effect of unsafe child faeces disposal were found conducted using national demographic data in India and Indonesia as a caused of child diarrhoea (15,16). Another cohort study in rural Bangladesh also mentioned about the effect of unsafe child faeces disposal environmental enteropathy and result in child underweight and thinness (17). Those studies revealed the effect of unsafe child faeces disposal in short term period. Using multi-countries data analysis, one study found interlinkage between unsafe child faeces disposal to child faltering growth by their height (18). That study also distinguished the effect of disposing child faeces into improved or unimproved toilet. However, no study considered sanitation chain (sewer system) for categorizing the child faeces disposal and only classified the research area into urban and rural area, while not identified urban slums area. Furthermore, not adjusting to other factors may over-estimate the effect of unsafe child faeces disposal.

Urban slums are defined as densely populated areas with narrow living spaces, high poverty rates, and low educational levels among residents, all of which increase the likelihood of child health problems (19). Indonesia, Bandung urban slum area had fully access to improved sanitation facility, but had a problem with inadequate sewer system (20). Thus, this study categorized child faeces disposal considering not only the type of toilet but also the type of sanitation chain. Moreover, most studies did not consider children that used disposable diapers, which means that they neglected the disposal of child faeces using disposable diapers in open dumps or open body of water without treatment. Rather than using common category, we included as unsafe for mothers who disposed child faeces into improved toilet with unsafe sanitation chain, into open ditch and via a disposable diaper in an open dump or open ditch.

Therefore, with a focus on socioeconomic factors, child characteristics, and environmental factors, we investigated the prevalence of unsafe child faeces disposal in an urban slum in Indonesia and the factors related to such disposal practices. Furthermore, we also examined the risk factors of child stunting, focusing on mothers' unsafe child faeces disposal practices.

2. Methods

2.1 Study population and data collection

We conducted a cross-sectional study in selected urban slums of Bandung city, West Java Province, Indonesia. The population density in the selected area was 21,498 people/km^2, and household access to sanitation facilities varied from 'limited' to 'safely managed'. We selected households living in densely populated area with narrow streets, where there is limited access to sufficient living space and adequate sanitation facilities (21). From these households, we recruited 183 mothers who were the main caregivers for their under-five children. We defined under-five children in this study as children aged 0–59 months. One child from each household was randomly recruited and measured for the data collection process. To collect data, we conducted in-depth interviews guided by questions related to mothers' preferred child defecation site; common methods of child faeces disposal; the child's characteristics; household sociodemographic characteristics; and water, sanitation, and hygiene (WASH) practices in the households. Furthermore, we also conducted on-site observation for usual child faeces disposal site and sanitation facility in the household.

2.2 Variables

The main outcome measure of this study was children's height for age z-score (L/HAZ), which was used to detect child stunting. Calculation of the L/HAZ used the World Health Organization (WHO) growth chart standard (2008), which is included in the WHO Anthro Software (version 3.2.2). We defined stunting as having an L/HAZ of less than -2 standard deviations (SD) from the mean or lower, while a normal L/HAZ was between -2 SD and +2SD.

The primary independent variables were child faeces disposal practices, sociodemographic factors, and WASH practices (household sanitation service level, drinking water, and handwashing site). Commonly used categories for child faeces disposal – that is, classifying it as safe and unsafe based on access to improved or unimproved toilets – are not sufficient, since we found the entire community had full access to improved sanitation facilities. Therefore, the improved sanitation facilities were distinguished further for having safe sanitation chain or having unsafe sanitation chain. Sanitation chain refers to WHO guidelines (22) were distinguished as; 1) safe sanitation chain for who had septic tanks or closed piped sewer system; and 2) unsafe sanitation chain for who had open sewer system without treatment.

Specifically, child faeces disposal was categorized as unsafe if the faeces was disposed via a disposable diaper without concealment in an open space or ditch; being rinsed into an improved toilet with an open sewer system; or being directly placed into an open ditch. Safe disposal was defined as rinsing child faeces into an improved toilet with a closed sewer system or at least via a disposable diaper through proper concealment to prevent leaking in controlled waste disposal. The questions on the WASH facilities concerned the household drinking water, household sanitation service level, and mother' handwashing site. Regarding the sanitation service level, we used the definition of the Joint Monitoring Program (JMP): limited, basic, or safely managed (23). Household drinking water was categorized as tank water, tap water, and jerrycan water/other, while mothers' handwashing site was classified as sink and other than sink.

Sociodemographic data and children's characteristics were included as potential confounding variables. For sociodemographic data, we considered settlements (native settlers or non-native settlers), parental educational level (middle to lower education and secondary to higher educational level), household monthly income; <2,000,000 Indonesian Rupiahs (IDR), 2,000,000–4,000,000 IDR, and >4,000,000 IDR), and home status (rental, parent's house, and private house). We also evaluated parental age, number of family members living together, and number of children.

The child's personal and health-related characteristics included their age, gender, birth weight, breastfeeding duration, and symptoms for diarrhoea over the past two weeks. We also measured the body height for ambulatory children and length for infants and pre-ambulatory children. Height was measured to the nearest 0.1 cm using a stadiometer (Seca 213; Seca, Germany) and infants' length was defined using a mobile mat (Seca 210; Seca, Germany). Child's age was defined as ≤2 years old and >2 to 5 years old, and child birth weight as low (<2.5 kg) and normal (≥2.5 kg). Breastfeeding duration was defined as <2 years, 2–3 years (proper age), and >3 years. We defined diarrhoea as three or more loose or liquid stools per day, which is more than usual (37). Infant loose stools due to breastfeeding were not categorized as diarrhoea.

2.3 Statistical analysis

We developed two multivariate logistic models in this study. The first model focused on child faeces disposal as a risk factor of child stunting, while the second model focused on the risk factors of mothers' performing unsafe child faeces disposal. For the first model, we proceeded through two steps to obtain the final model. First, we performed a binary logistic analysis as a univariate analysis to obtain crude odds ratios (COR). Second, variables found to be significant in the binary logistic regression or $p < 0.25$ and known confounders of child stunting such as child's age, gender, and breastfeeding duration were included in a stepwise regression analysis using the backward entry method. The independent variables found to be significant in the stepwise analysis included a multivariate logistic regression model. In the multivariate regression analysis, factors with p-values of less than 0.05 were considered significant, and the results are displayed in terms of adjusted odds ratio (AOR). The same process was performed to obtain second model to assessing the risk factors of unsafe child faeces disposal. All statistical analyses were performed using JMP 13.1.0 software.

2.4 Ethical considerations

This study was conducted under a memorandum of understanding (MoU) between the Research Institute of Humanity and Nature (RIHN) and the Indonesian Institute of Science (LPTB-LIPI) and was supported by the Sanitation Value Chain Project. The study protocol and methods were reviewed and approved by the ethics review committee of the Faculty of Health Sciences, Hokkaido University (No. 18-12). Respondents received an appropriate explanation of the purpose and methodology, which they indicated they understood by filling out an informed consent form.

3. Results

3.1 Characteristic of respondents

Table 5 Socio-demographic, child feces disposal and household WASH

Variables	n (%)	Variables	n (%)
Settlements		**Child's feces disposal**	
Native settlers	141 (77)	Safe	101 (55)
Immigrant settlers	42 (23)	Unsafe	82 (45)
Mother's educational level		**Sanitation service level**	
Middle/lower	87 (48)	Limited	19 (10)
Secondary/higher	96 (52)	Basic	136 (74)
Mother's age		Safely manage	28 (15)
< 25 years old	37 (20)	**Sanitation chain**	
25-35 years old	87 (48)	Safe sanitation chain	119 (64)
> 35 years old	59 (32)	Unsafe sanitation chain	64 (35)
Father's educational level		**Drinking water**	
Middle/lower	66 (36)	Tank water	139 (76)
Secondary/higher	117 (64)	Tap water	11 (6)
Father's age		Jerrycan water/other	33 (18)
< 30 years old	45 (25)	**Mother's handwashing site**	
30-40 years old	96 (52)	Sink	54 (30)
> 40 years old	42 (23)	Other than sink	129 (70)
Household monthly income		**Child common defecation site (≤ 2 years)**	
Low: < 2,000,000	51 (28)	Disposable diaper	47 (26)
Middle: 2,000,000–4,000,000	90 (49)	Pants/cloth diaper	23 (13)
High: > 4,000,000	42 (23)	Bath floor toilet	4 (2)
Home status		Basic toilet	10 (5)
Rental	60 (33)	Safely manage toilet	0
Parents house	85 (46)	**Child common defecation site (> 2 years)**	
Private house	38 (21)	Disposable diaper	13 (7)
Number of household members		Pants/cloth diaper	6 (3)
4 or less	80 (44)	Bath floor toilet	5 (3)
> 4	103 (58)	Limited toilet	8 (4)
Number of children		Basic toilet	53 (29)
2 or less	131 (72)	Safely manage toilet	14 (8)
> 2	52 (28)		

*Native settlers are Sundanese, the original ethnics of West Java Province.

The study population mostly consisted of native settlers (Table 5). Mothers, as the main caregivers of the children under five years old, were less likely to obtain a secondary school or higher education compared to fathers. More than 50% of participants came from low or middle-income families making <2,000,000 IDR (137.1 United Stated Dollar; USD) or 2,000,000–4,000,000 IDR (137.1–274.2 USD) per month, respectively. Roughly one half the mothers lived in a parent's house, one third lived in a rental house, and 21% lived in a private house.

Table 6 Child characteristics

Variables	n (%)
Age of child	
≤ 2 years	84 (46)
> 2–5 years	99 (54)
Gender of child	
Boys	102 (56)
Girls	81 (44)
Birth weight	
< 2.5 kg	15 (8)
≥ 2.5 kg	168 (92)
Breastfeeding duration	
< 2 years	56 (31)
2-3 years	123 (67)
> 3 years	4 (2)
Height for age z-score (HAZ)	
< -2 SD (Stunted)	42 (23)
≥-2 SD (Normal)	141 (77)
Diarrhea symptoms in past two weeks	
Yes	10 (5)
No	173 (95)

3.2 Prevalence of child stunting

Child stunting was found to have moderate prevalence, even though more than half the children received breastfeeding until two years and only 8% children were born with a birth weight of less than 2.5 kg (Table 6). The prevalence of child stunting among children ≤ 2 years of age and those

> 2 – 5 years of age were 8.74% and 14.21%, respectively. We did not find a significant association between children's age and L/HAZ in this study. As shown in Table 7, the mean L/HAZ value for boys was lower than that of girls, especially among children older than 2 years of age. The same tendencies were found for the prevalence of stunting, with boys having a significantly higher risk of stunting when compared to girls (COR: 2.39; 95% confidence interval [CI]: 1.13-5.05) (data not shown).

Table 7 Child's height for age z-score (HAZ) by gender and age of child

	Boys		**Girls**	
	≤ 2 years (n=48)	**> 2–5 years (n=54)**	**≤ 2 years (n=36)**	**> 2–5 years (n=45)**
Height for age age-score (mean± **SD)**	-1.19 ± 1.19	-1.57 ± 0.93	-0.99 ± 0.97	-1.45 ± 0.83
Stunting n (%)	12 (25.0)	18 (33.3)	4 (11.1)	8 (17.8)

3.3 The risk factors of child stunting

Table 8 shows the results of a multivariate logistic regression model that included household sociodemographic characteristics, child characteristics, child faeces disposal practices, and WASH practices as contributing factors to child stunting. The adjusted analysis revealed that unsafe child faeces disposal was a significant risk factor of child stunting (AOR: 2.56; 95% CI: 1.10-5.96) (Table 8). In addition, the odds of stunting also increased when mothers did not use the sink as a handwashing site (AOR: 3.69; 95% CI: 1.25-10.97) and the children used tap water as their drinking water (AOR: 5.04; 95% CI: 1.15-22.07). Other factors increasing the odds of stunting were low child birth weight (AOR: 12.37; 95% CI: 3.10-49.37) and being native settlers (AOR: 3.46; 95% CI: 1.08-10.96).

Table 8 Factors associated with under-five children's stunting in an urban slum of Indonesia

Variables	Multivariable logistic regression model	
	AOR (95% CI)	p-value
Settlements		
Immigrant settlers	1	-
Native settlers	3.46 (1.08–10.96)	0.0368
Household monthly income		
Low: < 2,000,000	1	-
Middle: 2,000,000–4,000,000	3.05 (0.98–9.46)	0.0539
High: > 4,000,000	1.59 (0.46–5.55)	0.4604
Child's faeces disposal		
Safe	1	-
Unsafe	2.56 (1.10–5.96)	0.0290
Drinking water source		
Tank water	1	-
Tap water	5.04 (1.15-22.07)	0.0318
Jerrycan water/other	1.94 (0.66-5.72)	0.2295
Mother's handwashing site		
Sink	1	-
Other than sink	3.69 (1.25–10.97)	0.0184
Child gender		
Boys	2.79 (1.17-6.70)	0.0208
Girls	1	-
Age of child		
≤ 2 years	1	-
> 2–5 years	1.83 (0.76–4.41)	0.1784
Birth weight		
< 2.5 kg	12.37 (3.10-49.37)	0.0004
≥ 2.5 kg	1	-
Breastfeeding duration		
< 2 years	1	-
2-3 years	0.79 (0.32-1.98)	0.6300
> 3 years	5.75 (0.42-78.30)	0.1891

3.4 The risk factors of mothers on performing unsafe child faeces disposal

One third of mothers chose disposable diapers as their most common defecation site where mostly used for children younger than 2 years old, while another third used improved toilets for those older than 2 years old (Table 5). Forty-five mothers disposed of their child's faeces unsafely via disposable diaper in an open waste disposal/ditch, directly to open ditch, or an improved toilet with an unsafe sanitation chain (12.6%, 10.9%, or 21.5% respectively). The multivariate logistic regression analysis revealed that mothers who had access to a shared toilet (AOR: 14.74; 95% CI: 2.49-87.17) had higher odds of engaging in unsafe child faeces disposal (Table 9). Other factors that increased the odds of mothers' unsafe child faeces disposal included having children younger than 2 years of age (AOR: 2.51; 95% CI: 1.25-4.99) and a lower than secondary school education level (AOR: 2.85; 95% CI: 1.38-5.89).

Table 9 Factors affected mother's unsafe child faeces disposal in an urban slum of Indonesia

Variables	**Multivariate logistic regression model**	
	AOR (95% CI)	**p-value**
Mother's educational level		
Middle/lower	2.85 (1.38-5.89)	0.0046
Secondary/higher	1	
Age of child		
≤ 2 years	2.51 (1.25-4.99)	0.0090
> 2–5 years	1	
Sanitation service level		
Limited	14.74 (2.49-87.17)	0.0030
Basic	5.59 (1.53-20.43)	0.0092
Safely manage	1	
Home status		
Rental	1.54 (0.59-3.98)	0.3753
Parents house	1.33 (0.55-3.19)	0.5282
Private house	1	
Household monthly income		
Low: < 2,000,000	1	
Middle: 2,000,000–4,000,000	0.94 (0.41-2.19)	0.8939
High: > 4,000,000	1.26 (0.48-3.34)	0.6356

4. Discussions

We examined the prevalence of unsafe child faeces disposal and child stunting in urban slums in Indonesia, as well as their contributing factors. We found that the prevalence of unsafe child faeces disposal was lower than that in other Asian countries such as India and Bangladesh, and Cambodia (79%, 84%, and 64% respectively) (15,17,24). The prevalence (45%) was also lower than that in other regions, such as Sub-Saharan Africa (71.4%) and Asian and North Africa (62.2%) (18). Thus, although we focused on urban slums, mothers in this study area had safer child faeces disposal practices when compared to other low-to-middle income countries. Unfortunately, this is of little consequence in light of the strong and significant association between unsafe child faeces disposal and child stunting (Table 4). Indeed, this latter finding accords with recent studies on multiple countries, where unsafe child faeces disposal was associated with a higher risk of child stunting, particularly in Asia and Africa (18).

According to previous studies, child faeces are considered more harmful than adult faeces (20,21). Regardless of whether individuals have access to improved sanitation facilities, the safe disposal of child faeces can function as a key barrier to pathogen transmission (25). Our results revealed two potential contamination sources of faecal bacteria when mothers performed unsafe child faeces disposal. First, even if a child used an improved toilet for defecation or a mother rinsed the faeces into an improved toilet, the sewer system might be inadequate. The same consequences for mother who disposed child faeces directly into open ditch. Sewer systems with open channels and open ditch that located next to living spaces often do not flow during the dry season, while flooding during the rainy season can lead to potential contamination. Thus, it is important to dispose of child faeces into toilets connected to a safe sanitation chain (which is the safest method of child faeces disposal overall) (22). The second potential contamination source stemmed from mothers' disposal of child faeces via disposable diapers without concealment in an open space/ditch, where the possibility of faecal leaking is high.

When a living environment is contaminated by faecal matter, the faecal bacteria can be transmitted to the children's play area, toys, or meals through a variety of indirect routes, such as flies, rats, or person-to-person contact (26). One study noted that child behaviours such as 'mouthing' and 'geophagy' where children purposively or accidentally consumed dirt from the soil are the potential contamination routes (27). In the Indonesian population, previous studies have shown that unsafe child faeces disposal is the strongest contributing factor of child diarrhoea (AOR: 1.46; 95% CI: 1.18–1.82), even when compared to a lack of access to improved sanitation and drinking water (28). This was parallel to our findings, in which 9.5% of stunted children were found to have diarrhoea in the past two weeks (COR: 2.37; 95% CI: 0.64-8.82); however, this association was nonsignificant (data not shown). Thus, experiencing diarrhoea for prolonged periods, especially among children younger than 24 months, led to declines in growth (29). Additionally, there is evidence showing that a living environment contaminated with faecal bacteria after performing unsafe child faeces disposal can also lead to asymptomatic environmental enteropathy, resulting in impaired growth (17,30).

Further analysis was conducted to explore the factors associated with mothers' unsafe child faeces disposal. We found that mothers with a lower than secondary school education had significantly increased odds of unsafe child faeces disposal (Table 5). A similar result was found in other studies on mothers who had obtained a middle school or lower education (31). In contrast, mothers with higher education level tend to be more exposed to information sources such as mass media, which decreases the likelihood of them engaging in unsafe child faeces disposal (15). Children's age (lower than 2 years) was another factor associated with unsafe child faeces disposal (AOR: 2.51; 95% CI: 1.25-4.99) (Table 5). In support of our findings, one study showed that mothers with children aged less than 18 months had three times higher risk of performing unsafe child faeces disposal than older children (15), whilst this was less likely for mothers with children older than 25 months (24). Refers to our finding, mother's tendency on choosing disposable diaper for infant and younger age children were higher than older child. Furthermore, the latest study also emphasized mother's false belief that infant and young child faeces is tiny and odourless so that harmless than adult faeces, might affect mothers on engaging unsafe child faeces disposal (32).

According to our study results, mothers were the only caregivers at home, meaning that they could not leave their children unattended for long periods. In fact, we found that mothers who used shared toilets had higher risk of performing unsafe child faeces disposal (Table 5). Thus, safe child faeces disposal might put a heavier burden on mothers with young children, especially mothers who used shared toilets located outside the house. Furthermore, older children who already used toilet as common defecation site, using shared or basic toilet with open channel system considered unsafe disposal. In other words, living in a community with full improved sanitation facilities does not guarantee that mothers will perform safe child faeces disposal (33) and having safe sanitation chain is necessary to prevent the contamination. Owning basic private toilets was preferable for each household, but the high cost and lack of space to install adequate sanitation facilities necessitated the acceptance of less convenient systems (34,35).

Therefore, in order to prevent child stunting, we suggest promoting full community coverage against unsafe child faeces disposal. As mentioned in a recent study, safe child faeces disposal should be increased to 75–100% to prevent stunting (18). Our study goes a step further, emphasizing that mothers' education is essential for their child faeces disposal practices. In addition, the engagement of families, whole communities, and the government is required for the provision of adequate sanitation systems for each household. The government should better implement and regulate existing policies related to (1) the installation of sewer systems leading to open access ditches or rivers, and (2) the disposal of child faeces together with kitchen waste. The use of washable cloth diapers and child potty training at an early age might also be a means of limiting potential contaminating sources of faecal bacteria that lead to child stunting in the urban slums of Indonesia.

5. Study Limitations

This study has some limitations. First, the sample size was too small, thus preventing us from generalizing the results to all urban slums in Indonesia or other low-to-middle countries. Nevertheless, due to the lack of research on unsafe child faeces disposal in Indonesia (28), our study may still be useful in reducing unsafe child faeces disposal practices, and thereby child stunting, in Indonesia, particularly in urban slums.

Second, the study design was cross-sectional, so we cannot claim that any of the observed associations were causal. However, we obtained primary data through in-depth interviews and direct observation of unsafe child faeces disposal among mothers, as well as the current condition of sanitation facilities and living conditions, could establish a clear image of the contamination routes from exposure to health outcomes. This study may enhance the evidence from the past literature that used secondary data from the National Demographic Health Survey or systematic reviews conducted in other middle-income countries (9,18,31,36). Therefore, the findings can still increase attention and awareness of mothers, communities, and the government in Indonesia on child faeces disposal.

Third, we did not measure actual contamination of faecal bacteria in children's living environments, which would have provided stronger evidence. Thus, analysing every possible route from exposure to disposal and child morbidity using longitudinal studies should be conducted in future studies.

6. Conclusions

Our study revealed that the prevalence of unsafe child faeces disposal is lower in an urban slum of Indonesia than in other low-to-middle income countries. However, it was still insufficient to prevent child stunting. Unsafe child faeces disposal was also found to be a crucial factor contributing to child stunting. Mothers with an educational level of lower than secondary school, who lived in households with access to shared toilets, and who had a child of younger than 2 years had significantly greater odds of unsafe child faeces disposal.

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Appendix 1

Approaching WASH (Water, Sanitation and Hygiene), faeces management, and health of under-five children in an Urban Slum of Indonesia

A) Socio - Economic Status (SES)

1. Name of caregiver (**mother**):______________birthday/Age:_______________
2. Religion: a. Islam b. Christianity c. Buddhist d. Hindi
3. Ethnicity: a. Sundanese b. Javanese c. Others (specify)__________
4. Educational Background:

a. None	b. elementary School	c. Junior High School
d. High school (SMA, SMK)	e. University (S1, Diploma)	f. Other

5. How much is your monthly income?

a. No exact salary/zero	e. 3,000,000 – less than 4,000,000 rupiah/month
b. Less than 1,000,000 rupiah/month	f. 4,000,000 – less than 5,000,000 rupiah/month
c. 1,000,000 – 2,000,000 rupiah/month	g. 5,000,000 – less than 6,000,000 rupiah/month
d. 2,000,000 – 3,000,000 rupiah/month	h. 6,000,000 rupiah/month and more

Father

6. Age: __________________________
7. Education Background:

a. None	b. elementary School	c. Junior High School
d. High school (SMA, SMK)	e. University (S1, Diploma)	f. Other

8. How much is your monthly income?

a. No exact salary/zero	e. 3,000,000 – less than 4,000,000 rupiah/month
b. Less than 1,000,000 rupiah/month	f. 4,000,000 – less than 5,000,000 rupiah/month
c. 1,000,000 – 2,000,000 rupiah/month	g. 5,000,000 – less than 6,000,000 rupiah/month
d. 2,000,000 – 3,000,000 rupiah/month	h. 6,000,000 rupiah/month and more

9. Who own this house? a. my own house b. rental house c. parents house
10. Number of households/ number of household members: _____/_____ Number of children:___________
11. How many Under 5 children do you have?____ Your youngest child birthday :____;____;____;M/F

B) Water, Sanitation and Hygiene

1. What is your toilet type?

   a. Sitting b. Squatting

   ---If you choose Squatting type, which one?

   a. ceramic type b. cement type

2. How many toilet you have at home? _______
3. Location of the toilet? a. Within the house. b. Ouside the house c. Inside the room
4. Please choose your drainage system.
   1. Toilet: a. closed ditch to river b. open ditch to river c. septic tank d. Other____
   2. For other works (e.g. cooking, washing, bathing): a. closed ditch to river b. open ditch to river c. septic tank d. Other____

   ----If you have septic tank, when was the last time you emptied your septic tank? ________

5. What is your water source?

- For Bathing, Toilet and Washing:

  a. Ground water b. Jerry can seller c. PDAM d. Galloon new e. Galloon refill

- For cooking and drinking:

  a. Ground water b. Jerry can seller c. PDAM d. Galloon new e. Galloon refill

6. How often is the toilet cleaned?

   a. Every day b. Once in a week c. Twice in a week d. Once in a month e. Never

7. Do you have handwashing station? a. yes b. no
8. Where you usually do handwashing?

C) Under-five Faeces Disposal

1. Who routinely care for the under 5 child on defecation ? a. Mother b. Father c.Grandmother d. Adolescent girl d. Baby sitter e. Anybody in the house f. Others________
2. What is the usual place for the child to pass stool? a. Paper diaper b. Cloth diaper c. Their cloth/pants d. in potty e. On soil f. in toilet g. others _________
3. How do you dispose the child's faeces? a. Left open in the defecation site b. Toilet c. Paper diaper garbage dump without cover d. Paper diaper garbage dump with cover e. Disposed in nearby bush f. Open drainage ditch/river g. Buried

D) Infant and Young Children Feeding Practices + Child health

1. Your child birth weight/length:___ kg/___cm Currently : ____kg/____cm
2. How many weeks was your gestational age before you have delivery?
3. Did your child get initiation of breastfeeding? A. yes b. No
4. Has your child ever breastfed? A. yes b. No
5. How long your child been breastfed?________ Is he/she still breastfeeding? a. Yes b. No
6. Have your child suffer from disease for the past 2 weeks? a. Yes b. No
7. What kind of symptom your child have? A. fever b. Cough/runny nose c. diarrhoea d. Others

This questionnaire are modification from Aluko et al., (2017), Blum et al.,(2003) and WHO, (2008).

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Appendix 2

Documentations

Figure 5 In-depth interview

Figure 6 On-site observation (improved toilet with open channel)

Figure 7 On-site observation of child faeces disposal

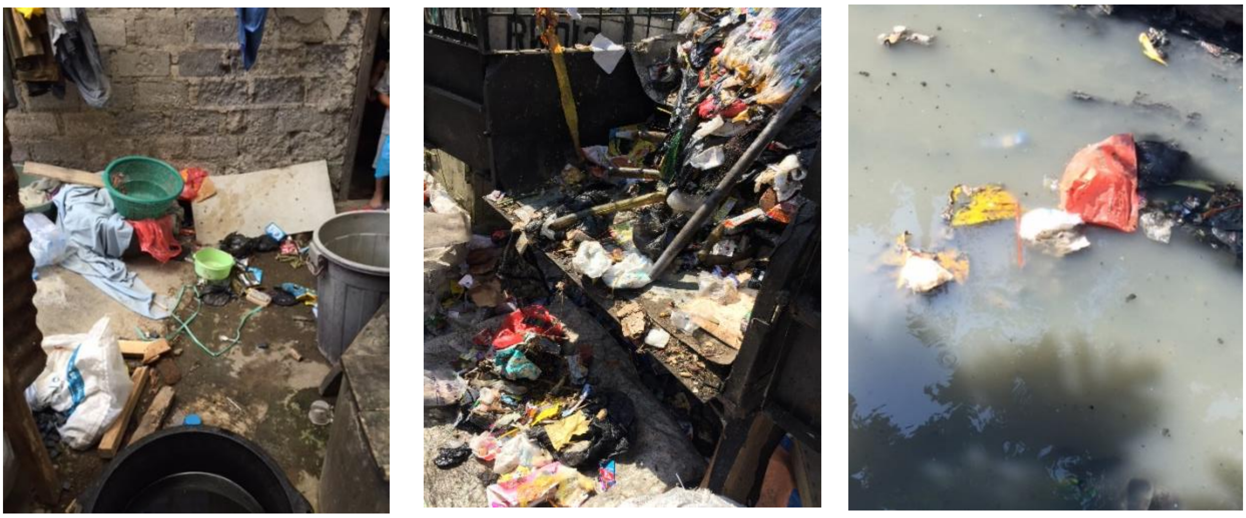

Figure 8 Disposal of disposable diaper

Jerrycan water 20 liter

Ground water

Tank water 19 liter

Figure 9 Drinking water

Figure 10 Handwashing site other than sink