



ASSOCIATIONS OF EARLY COMPLEMENTARY FEEDING, MATERNAL HYGIENE, AND HOME SANITATION WITH DIARRHEA AMONG INFANTS 0-6 MONTHS

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Abstract

Background: Diarrhea in infants aged 0-6 months is one of the leading causes of morbidity and mortality in developing countries. **Objective:** This study aims to analyze the relationship between early complementary feeding, personal hygiene habits, sanitation system conditions, availability of waste/trash bins, and household sewage systems on the incidence of diarrhea in infants. **Method:** This analytical observational study used a cross-sectional design conducted at the Borong Health Centre, East Manggarai Regency, NTT. A total of 51 mothers of infants aged 0-6 months were selected using total population sampling. Data were collected through interviews and observations using a questionnaire and then analyzed with bivariate and multivariate tests. **Results:** Bivariate analysis showed significant associations between ECF, availability of proper trash bins, and household wastewater disposal systems with diarrhea ($p < 0.05$). ECF increased the risk of diarrhea by 3.95 times, while poor trash bin availability increased the risk by 4.00 times. Multivariate analysis showed risk trends but no statistical significance after adjusting for confounders. **Conclusion:** Early complementary feeding, availability of waste bins, and household sanitation systems play important roles in increasing the risk of diarrhea among infants aged 0-6 months.

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INTRODUCTION

Diarrhea is a condition in which infants have at least three watery bowel movements or loose stools per day, often leading to dehydration due to fluid loss. It is one of the leading causes of death in infants worldwide, commonly triggered by viruses, bacteria, or parasites.¹ Various factors contribute to infant diarrhea, including poor water quality, inadequate sanitation facilities, limited access to health services, early complementary feeding (ECF), infection, and poor nutritional status.² However, hygiene practices such as hand washing and exclusive breastfeeding can significantly reduce the risk of infection.³

Diarrhea remains a significant public health problem in Indonesia, especially in children under five. Diarrhea is still the leading cause of morbidity and mortality in children under five. The prevalence of diarrhea in children aged 6-23 months was reported to be 19.8% in 2017.⁴ In the 2023 Indonesian Health Survey (IHS), the prevalence of diarrhea in infants under 1 year of age was 6.4%, and in children under 1-4 years of age was 7.4%.⁵ A broader analysis showed the prevalence of diarrhea in children under 5 years of age was 14.22%,⁶ while another study noted an increase in the overall incidence of diarrhea, from 4.5% in 2013 to 6.8% in 2018.⁷

During the first six months of life, nutrition is vital in supporting infants' physical, cognitive, and emotional development. During this period, breastmilk is the primary source of essential nutrients that can optimally meet the nutritional needs of infants.⁸ The WHO and UNICEF recommend exclusive breastfeeding without additional food or fluids for the first six months. This recommendation aims to ensure that infants get the best nutritional intake and provide protection against various diseases.⁹ In addition to being rich in nutrients that support growth and development, breastmilk also contains immunological components that play an essential role in protecting infants from infection.¹⁰

The benefits of exclusive breastfeeding for the first six months of an infant's life are widely recognized. However, once an infant reaches six months, complementary foods are introduced to meet additional nutritional needs that breastmilk can no longer meet alone. Early breastfeeding initiation is important in reducing the risk of diarrhea because breastmilk contains colostrum, which acts as an antibody that helps protect the infant's gut from bacterial and viral infections that cause diarrhea.¹¹ Breastmilk also increases the colonization of good bacteria in the gut, which helps inhibit the growth of pathogens that cause diarrhea. The long-term effect is to reduce the risk of recurrent diarrhea, thereby reducing morbidity from diarrhea in the future.¹² Despite this, many mothers introduce complementary foods before the baby is six months old. Global data shows that 60% of infants are given complementary foods at less than six months.¹³ In Indonesia, only 55.53% of children aged 6-23 months receive complementary foods according to recommendations.¹⁴ This is

reinforced by a study in East Luwu district, Indonesia, that found that no less than 38% of infants have been introduced to early complementary feeding.¹⁵ According to Bailey et al.¹⁶, about 51% of infants have been given complementary foods and drinks before six months. A study by Hutabarat et al.¹⁷ showed that most mothers with limited knowledge about complementary feeding tended to give complementary feeding to infants before six months. Factors such as cultural pressure, misconceptions about infant nutritional needs, and economic conditions are often the main reasons behind complementary feeding. Complementary feeding can pose various health risks to infants, including digestive disorders, allergic reactions to food, and, most commonly, diarrhea.

Early complementary feeding (ECF) can disrupt the digestive function of infants who have not yet fully developed. The digestive system of infants under six months is still very sensitive and lacks the capacity to digest solid food effectively. As a result, ECF can cause various digestive problems, such as constipation, bloating, or even diarrhea. Diarrhea in infants is a serious health concern as it can lead to rapid dehydration and lack of essential nutrients. In many developing countries, diarrhea is still the leading cause of death in infants.¹⁸ This issue should be seriously prioritized, given its significant impact on infant health and survival.

Research has shown that BMS can reduce the effectiveness of breastmilk in providing nutrition and immunological protection for infants.¹⁹ This is because breastmilk can adjust its nutritional composition according to the specific needs of infants at each stage of growth, an ability that BMS cannot replicate. By introducing complementary foods too early, an infant's breastmilk consumption may be reduced, directly reducing the intake of calories and other essential nutrients found only in breastmilk. This reduction can have a negative impact on meeting the infant's optimal nutritional needs and reduce the immune protection benefits provided by breastmilk.

In addition to nutritional factors, maternal hygiene, and the living environment play an important role in maintaining infant health and preventing infections.²⁰ Inadequate hygiene practices can lead to pathogen contamination of food and drink, which in turn can trigger severe infections in infants. Therefore, the adoption of good hygiene practices is essential. This includes washing hands thoroughly before feeding or preparing food, cleaning utensils carefully, and keeping the living environment free of contaminants. These measures are essential to minimize the risk of exposure to pathogens and protect the baby's overall health. Poor hygiene can significantly affect the quality of the breastmilk itself, especially during the milking and storage process. Inadequate hygiene can lead to contamination by harmful bacteria, which can jeopardize the baby's health. This becomes even more important when the breastmilk has to be stored in a bottle or used for breastfeeding later. Ensuring optimal hygiene at all these stages is important to minimize the risk of contamination and maintain the nutritional integrity and safety of breastmilk for the baby.

On the other hand, the condition of household waste management is often overlooked in infant health, even though it is an important factor in preventing infectious diseases.²¹ Poor household waste management can create a favorable environment for breeding insects such as flies, which are vectors of various pathogens that cause diarrhea.²² Poorly managed organic waste can pollute the surrounding environment and become a source of pathogenic bacteria that can potentially infect infants, especially when they start crawling and exploring the home environment. Therefore, the cleanliness of the home environment, including good waste management, is very important for creating a safe environment for infants. Bins that are not covered or not emptied regularly can be a potential source of infection. Proper household waste management should be an integral part of an infant diarrhea prevention strategy. This includes ensuring bins are tightly closed and emptied regularly to prevent the spread of pathogens around the infant area.

Although several studies have examined factors contributing to diarrhea in infants and young children, most studies have focused on children aged six months and above, particularly in the context of complementary feeding practices. For example, Sani and Achadi⁴ analyzed feeding practices, sanitary hygiene, and other factors associated with diarrhea in children aged 6-23 months in Indonesia. Similarly, Birhanu *et al.*²³ and Teshome *et al.*²⁴ conducted a study in Northwest Ethiopia. They explored maternal hygiene practices during complementary feeding in children aged 6-24 months. Nabila *et al.*²⁵ also investigated the relationship between complementary feeding and the incidence of diarrhea. However, there needs to be more research on infants under six months, especially regarding the influence of complementary feeding, maternal hygiene, and home sanitation on the risk of diarrhea. This study addresses this gap by focusing on infants aged 0-6 months, a critical period largely ignored in previous studies. The findings are expected to provide new insights into preventing diarrhea in younger infants by examining these important factors.

METHODS

This study is an analytical observational study with a cross-sectional research design. This research was conducted in the working area of the Borong Health Center, East Manggarai Regency, NTT, in July 2021. This study used total population sampling based on inclusion and exclusion criteria. Inclusion criteria are 1) All mothers with babies aged 0-6 months who live in the working area of the Borong Health Center; 2) Mothers willing to become respondents. Exclusion criteria included mothers who could not complete the questionnaire, especially related to IYCF, personal hygiene habits, and household sanitation conditions. The subjects in this study were 51 mothers who had infants aged 0-6 months.

The variables in this study consisted of early complementary feeding (ECF), personal hygiene habits, sanitation system conditions, availability of trash bins, and household sewage systems. At the

same time, the dependent variable is diarrhea. Early complementary feeding is defined as introducing foods and liquids other than breast milk before the infant reaches six months.²⁶ Personal hygiene refers to the mother's habit of washing hands with soap regularly before preparing food and after using the toilet.²⁷ Home sanitation is an effort to maintain the health of the house and its environment by preventing direct contact with waste. This is seen from the condition of the sanitation system, household waste, and household sewage system.²⁸ Diarrhea is characterized by reduced stool consistency, increased water content, and frequent bowel movements, which are quantitatively defined as three or more watery or watery bowel movements within 24 hours.

Data on infant diarrhea was obtained through interviews. However, it is recognized that confounders in this study were not measured, such as family handwashing practices or environmental contamination. This study used complementary feeding and personal hygiene questionnaires that were conducted by previous researchers with reliability values ≥ 0.90 and ≥ 0.74 . This study obtained Ethical Clearance from the Ahmad Dahlan University Ethics Commission, 012309205. Published on September 15, 2023. Univariate analysis was performed to describe the characteristics of each research variable, bivariate analysis using Chi-Square with a confidence level of 95% ($\alpha = 0.05$), and multivariate analysis using a logistic regression test.

RESULTS

Characteristics of Respondents

The characteristics of respondents in this study include age, education level, and occupation, as shown in Table 1. The age distribution of respondents ranged from 25-35 years (58.8%), most respondents (43.1%) were high school graduates, and the majority worked as housewives (66.7%).

Table 1. Characteristics of the respondents

Characteristics	Distribution	
	n	%
Age		
< 25 years	9	17.6
25-35 years	30	58.8
> 35 years	12	23.6
Level of education		
Elementary School	12	23.5
Junior High School	6	11.8
Senior High School	22	43.1
College	11	21.6
Occupation		
Farmer	7	13.7
Government employee	4	7.8
Private employee	6	11.8
Housewife	34	66.7
Total	51	100

There were six variables taken in this study, and the frequency distribution of each variable is shown in Table 2. The data illustrate that most infants (54.9%) were given ECF at 0-6 months. Most respondents (82.4%) had good personal hygiene habits by washing their hands regularly. Respondents' sanitation system buildings were eligible at 74.5%, and those with trash bins were ineligible at 58.8%. Respondents with unqualified sewerage conditions were 56.9%, and most infants aged 0-6 months had experienced diarrhea at 52.9%.

Table 2. Frequency distribution of ECF, Personal hygiene habits, condition of the sanitation system, Household sewage system, and Diarrhea incidents in infants

Characteristics	Distribution	
	n	%
Early complementary feeding		
Given	28	54.9
Not given	23	45.1
Personal hygiene habits		
Not washing hands regularly	9	17.6
Wash hands regularly	42	82.4
The condition of the sanitation system		
Not eligible	13	25.5
Eligible	38	74.5
The availability of a waste/trash bin		
Not eligible	30	58.8
Eligible	21	41.2
Household sewage system		
Not eligible	29	56.9
Eligible	22	43.1
Diarrhea incidents in infants		
Yes	27	52.9
No	24	47.1
Total	51	100

Early complementary feeding, personal hygiene practice, and diarrhea incidents

Table 3 shows the bivariate analysis of each variable on diarrhea. Based on Table 3, the bivariate analysis shows that only the variables ECF, the availability of waste/trash bin, and Household sewage system have a statistically significant relationship with diarrhea because they have a p-value <0.05. At the same time, other variables are not statistically significant.

The results of the bivariate analysis in Table 3 show several factors associated with the incidence of diarrhea in infants aged 0-6 months in the working area of the Borong Health Center. One of the significant factors is the provision of ECF. Diarrhea occurred more in infants who were given ECF, which was 37.3%. There was a statistically significant relationship between ECF and the incidence of diarrhea, with a p-value = 0.019 ($p < 0.05$). The odds ratio (OR) value of 3.95 indicates that infants who were given ECF had a 3.95 times greater chance of experiencing diarrhea compared to infants who were not given ECF, with a confidence interval (CI) of 1.23-12.73.

Table 3. Correlation of each variable and diarrhea incidents

Variable	Diarrhea				Total		p-value	COR*	CI 95%
	Yes		No		n	%			
	n	%	n	%					
Early complementary feeding									
Given	19	37.3	9	17.6	28	54.9	0.019	3.95	1.23-12.73
Not given	8	15.7	15	29.4	23	45.1			
Personal hygiene habits									
Not washing hands regularly	6	11.7	3	5.9	9	17.6	0.473	2.00	0.44-9.07
Wash hands regularly	21	41.2	21	41.2	42	82.4			
The condition of the sanitation system									
Not eligible	6	11.8	7	13.7	13	25.5	0.570	0.69	0.19-2.45
Eligible	21	41.2	17	33.3	38	74.5			
The availability of a waste/trash bin									
Not eligible	20	39.2	10	19.6	30	58.8	0.019	4.00	1.22-13.05
Eligible	7	13.7	14	27.5	21	41.2			
Household sewage system									
Not eligible	19	37.3	10	19.6	29	56.9	0.039	3.32	1.04-10.58
Eligible	8	15.7	14	27.4	22	43.1			

Another factor that showed a significant association was the condition of the trash bins at home. Infants living in homes with inadequate trash bins had a diarrhea prevalence of 39.2%. There was a significant association between the availability of trash bins and the incidence of diarrhea, with a p-value = 0.019 ($p < 0.05$). The OR value of 4.00 indicates that infants with unqualified trash cans are 4 times more likely to experience diarrhea than infants with qualified trash cans.

In addition, household sewage systems were also significantly associated with the incidence of diarrhea. Infants living in homes with unqualified waste disposal systems had a diarrhea incidence rate of 37.3%. This relationship was statistically significant with a p-value = 0.039 ($p < 0.05$). The OR value of 3.32 indicates that infants in homes with inadequate sewage systems had a 3.32 times chance of experiencing diarrhea compared to infants living in homes with proper sewage systems (CI = 1.23-12.73).

Meanwhile, several other factors did not show statistically significant associations. Maternal handwashing habits, for example, had the same percentage of infants with and without diarrhea at 41.2% each. The p-value = 0.473 ($p > 0.05$) indicates no significant association between personal hygiene habits and the incidence of diarrhea. Similarly, the condition of the home sanitation system. Although 41.2% of infants living in a home with an adequate sanitation system still experienced diarrhea, no statistically significant association was found, with p-value = 0.570 ($p > 0.05$). The OR value of 0.69 indicates that infants in homes with unqualified sanitation systems had a slightly lower chance of experiencing diarrhea, although this result was not significant.

Multivariate analysis

Multivariate statistical analysis is shown in Table 4.

Table 4. Results of multivariate analysis after controlling for confounding variables

Characteristics	COR (95% CI)	AOR (95%CI)	P Value
Early complementary feeding			
Given			
Not given	3.95 (1.23-12.73)*	3.52 (0.93-13.27)	0.06
Personal hygiene habits			
Not washing hands regularly			
Wash hands regularly	2.00 (0.44-9.07)	2.78 (0.44-17.46)	0.27
The condition of the sanitation system			
Not eligible			
Eligible	0.69 (0.19-2.45)	0.33 (0.06-1.68)	0.18
The availability of a waste/trash bin			
Not eligible			
Eligible	4.00 (1.22-13.05)*	4.23 (1.03-17.27)*	0.04
Household sewage system			
Not eligible			
Eligible	3.32 (1.04-10.58)*	3.44 (0.82-14.5)	0.12

The results of multivariate analysis showed an increased risk of diarrhea in infants aged 0-6 months who were given ECF. Infants who received ECF had an adjusted odds ratio (AOR) of 3.52 (95% CI: 0.93-13.27), indicating that infants who were given ECF were 3.52 times more likely to experience diarrhea than infants who were not given ECF. Although the odds ratio showed a high increase in risk, this association was not statistically significant as the p-value = 0.06 ($p > 0.05$). Previously, the results of bivariate analysis showed a significant association with a crude odds ratio (COR) value of 3.95 (95% CI: 1.23-12.73; $p < 0.05$), but the significance decreased after controlling for confounding variables.

In addition, multivariate analysis showed an increased risk of diarrhea among infants aged 0-6 months who were cared for by mothers who did not wash their hands regularly. Infants with mothers who did not wash their hands regularly had an AOR of 2.78 (95% CI: 0.44-17.46). Although this odds ratio showed higher odds than the mothers who had regular handwashing habits, this association was not statistically significant, with $p = 0.27$ ($p > 0.05$) and a wide confidence interval covering 1.0, indicating high uncertainty. The results of the previous bivariate analysis also showed a non-significant association with a COR of 2.00 (95% CI: 0.44-9.07).

Multivariate analysis of the home sanitation system condition showed no significant association between unqualified sanitation conditions and the incidence of diarrhea. Infants living in homes with unqualified sanitation had an AOR of 0.33 (95% CI: 0.06-1.68), indicating lower odds of having diarrhea compared to infants living in homes with qualified sanitation. However, this result was not statistically significant, with $p = 0.18$ ($p > 0.05$) and a wide confidence interval covering 1.0.

The previous bivariate analysis showed similar results with a COR of 0.69 (95% CI: 0.19-2.45), which was also not significant.

Multivariate analysis showed a significant association between the availability of inadequate bins and the incidence of diarrhea in infants aged 0-6 months. Infants living in homes with inadequate bins had an AOR of 4.23 (95% CI: 1.03-17.27; $p = 0.04$), indicating that infants living in homes with inadequate bins had a 4.23 times higher risk of diarrhea compared to infants living in homes with adequate bins. This result is statistically significant, with a p -value <0.05 and a confidence interval not including the number 1. The results of the previous bivariate analysis also showed a significant association with a COR of 4.00 (95% CI: 1.22-13.05).

Finally, the multivariate analysis showed a trend toward an increased risk of diarrhea among infants living in homes with unqualified sewage systems. Infants living in homes with unqualified sewage systems had an AOR of 3.44 (95% CI: 0.82-14.5). Although the AOR value indicated a higher chance of experiencing diarrhea, this association was not statistically significant, with $p = 0.12$ ($p > 0.05$) and a confidence interval that included 1.0. Previously, bivariate analysis showed a significant association with a COR of 3.32 (95% CI: 1.04-10.58), but once controlled for, this association became insignificant.

DISCUSSION

Early complementary feeding and diarrhea incidents

The results of this study indicate that early complementary feeding (ECF) tends to increase the risk of diarrhea in infants aged 0-6 months. This finding is in line with several previous studies stating that feeding before the age of 6 months can increase the susceptibility of infants to gastrointestinal infections.²⁹ At this age, infants' immune systems and digestive tracts are not yet optimally developed to receive foods other than breastmilk. As a result, unhygienic or substandard supplementary foods can be a medium for pathogens that cause diarrhea.

However, multivariate analysis in this study showed that the association between ECF and diarrhea incidence was not statistically significant ($p = 0.06$). After controlling for confounding variables such as environmental sanitation, maternal hygiene, and household sewage systems, the strength of the association decreased. The wide confidence interval (0.93-13.27) indicates uncertainty in the effect estimate, possibly due to the limited sample size or high variation among study subjects.

However, the adjusted odds ratio (AOR) value remained high, indicating the potential risk should be cautioned. This finding aligns with the World Health Organization (WHO) recommendations, which recommend that infants be exclusively breastfed for the first six months of

life.³⁰ Breastmilk contains sufficient immunity and nutrients to support growth while protecting infants from infections, including diarrhea.³¹ Early complementary feeding, in addition to being physiologically inappropriate, also carries a high risk of contamination due to unhygienic cutlery or foodstuffs.³²

Therefore, health workers and policymakers need to continue educating mothers and families on the importance of exclusive breastfeeding and the appropriate timing of complementary feeding. Health promotion programs at the primary care level should emphasize evidence-based education on the dangers of early complementary feeding, especially in the context of households with inadequate sanitation and hygiene.

To strengthen the evidence and clarify the association between early complementary feeding and the incidence of diarrhea, further research with a larger sample size, more thorough control of confounding variables, and a longitudinal approach that can observe long-term effects are recommended. Thus, strategies to prevent diarrhea in infants can be designed more effectively and based on strong scientific evidence.

Personal hygiene practice and diarrhea incidents

This study showed that mothers who did not wash their hands regularly tended to have infants more at risk of diarrhea. However, this association was not statistically significant ($p = 0.27$), with a wide confidence interval and adjusted odds ratio (AOR) of 2.78. This insignificance could be due to the limited sample size, high variation in data, or the possibility of other variables that have not been optimally controlled for in the analysis.

Although these results do not show a statistically significant association, it is important to examine the role of personal hygiene in the context of infant health further. Theory and scientific evidence suggest that handwashing, particularly before feeding or after defecation, is one of the most effective preventive practices against diarrheal disease. The World Health Organization states that handwashing with soap can significantly reduce the risk of infections transmitted through the fecal-oral route.³³ In fact, some studies report that handwashing practices in the household environment can reduce the incidence of diarrhea.³⁴

Therefore, although no statistically significant association was found in this study, it is important not to ignore the importance of handwashing habits in public health practices. Education on proper handwashing techniques, appropriate timing, and consistency of implementation should remain part of health promotion strategies, especially for mothers or caregivers of vulnerable infants.

In addition, it should be considered that the non-significance of this result could also be due to interactions with other factors that are more dominant in influencing diarrhea incidence, such as

access to clean water, environmental sanitation quality, or maternal education level. Combining these protective factors may mask the direct effect of personal hygiene practices. To gain a more comprehensive understanding, further research with a more robust design, a larger sample size, and more detailed and standardized instruments to measure personal hygiene habits is recommended.

The condition of the sanitation system

This study showed that the condition of the household sanitation system did not have a statistically significant association with the incidence of diarrhea in infants aged 0-6 months ($p = 0.18$). The adjusted odds ratio (AOR) value below 1 indicates that infants living in homes with inadequate sanitation have a slightly lower chance of experiencing diarrhea. However, this result cannot be considered meaningful as it is likely influenced by the limited sample size or confounding variables that have not been fully controlled.

Theoretically, a proper sanitation system plays a crucial role in preventing the transmission of diarrheal diseases, especially those spread through the fecal-oral route.³⁵ Poor sanitation increases the risk of environmental contamination, whether through water, food, or household surfaces, thus becoming one of the main factors in the transmission of gastrointestinal infections. Improved sanitation facilities, such as latrines, have been shown to reduce the incidence of diarrheal disease.³⁶ In line with this, a meta-analysis showed that sanitation interventions can reduce diarrheal morbidity by 25%, with greater reductions observed when high sanitation coverage is achieved.³⁷

The discrepancy between the results of this study and global theoretical evidence may be explained by the possible presence of other protective factors that were more dominant in the study population, such as access to clean drinking water, good handwashing practices, or exclusive breastfeeding. These factors may mask the adverse effects of inadequate sanitation. Therefore, further research is needed to understand this relationship more comprehensively with a more robust design, larger sample size, and more thorough and standardized variable control. A multivariate approach that considers the interaction between behavioral and environmental factors will provide a more accurate picture of the role of sanitation in preventing infant diarrhea.

The availability of a waste/trash bin

This study's results showed a statistically significant association between the condition of household waste bins and the incidence of diarrhea in infants aged 0-6 months. Infants living in homes with inadequate bins had a 4.23 times greater risk of developing diarrhea than infants living in homes with proper bins (AOR = 4.23; 95% CI: 1.03-17.27; $p = 0.04$). This result is consistent with the bivariate findings and reinforces the notion that poor household solid waste management is a significant risk factor in diarrheal disease transmission.

Theoretically, inadequate waste management can increase the population of disease vectors such as flies and cockroaches. These disease vectors play a role in spreading diarrhea, causing pathogens to food, cutlery, and household surfaces. Poor household waste management can be a major pathway for the spread of enteric infections in rural and urban areas.³⁸ In addition, Prüss-Ustün *et al.*³⁹ study confirmed that households without proper waste management systems are at higher risk of diarrheal disease, especially in vulnerable groups such as infants and toddlers.

This finding is also relevant in the local context of the study area, where some households were found not to have closed bins or to dump waste directly into the open environment. This increases the likelihood of cross-contamination between waste and infant feeding or play areas. Thus, interventions that target the improvement of basic sanitation facilities, including the provision of closed bins and education on household waste management, are important in diarrhea prevention efforts.

Therefore, health promotion programs at the Health Center level and community health cadres should pay special attention to solid waste management. Education on proper waste storage and disposal should be integral to diarrhea prevention strategies, especially in households with infants. In addition, local policies that support the provision of proper trash facilities in every home are also needed to reduce the risk of spreading environment-based diseases.

The household sewage system

The results showed that unqualified household sewage systems tended to increase the risk of diarrhea in infants aged 0-6 months. However, this association was not statistically significant after controlling for confounding variables ($p = 0.12$; AOR = 3.44; 95% CI: 0.82-14.5). The wide confidence interval that includes 1 indicates uncertainty in the effect estimate. This may be due to the limited sample size, variation in household characteristics, or suboptimal measurement of sewage system conditions in this study.

Nonetheless, inadequate sewage systems have been shown to contribute to an increased risk of diarrheal disease.⁴⁰ Household wastewater disposed of carelessly can contaminate groundwater and open channels, becoming a medium for spreading diarrhea-causing pathogens through the fecal-oral mechanism. Poor waste management is one of the main causes of the spread of infectious diseases in communities.

The non-significance of the results in this study does not necessarily negate the importance of improving household sewage systems. Rather, it points to the need for further research with a more robust design and larger sample size. In addition, future studies are advised to consider interactions with other factors such as clean water quality, the habit of disposing of domestic waste into open

drains, and family hygiene behavior. This approach will provide a more complete and contextual understanding of the contribution of sewage systems to the incidence of diarrhea in infants.

Limitation of the study

This study has several limitations that need to be considered. First, the limited sample size may affect the statistical power of the analysis, especially for variables that did not show a significant association, such as maternal handwashing habits and the condition of the home sanitation system. Second, the study's cross-sectional nature limits the ability to draw direct causal inferences between the variables studied and the incidence of infant diarrhea. In addition, the reliance on self-reported data from respondents may lead to biased information, especially regarding personal hygiene habits and household waste management. Third, although multivariate analysis has been conducted to control for confounding variables, several other external factors that could potentially affect the incidence of diarrhea, such as access to clean water and a wider diet, have not been fully controlled in this study. Therefore, further studies with more robust designs, larger samples, and more thorough control of variables are needed to strengthen these findings.

CONCLUSION

This study found that of the five independent variables studied, only the condition of household waste bins showed a statistically significant association with the incidence of diarrhea in infants aged 0-6 months after multivariate analysis (AOR = 4.23; 95% CI: 1.03-17.27; $p = 0.04$). Infants living in homes with inadequate trash bins had a higher risk of diarrhea than in homes with proper trash bin facilities. Meanwhile, the variables of early complementary feeding (ECF) and household sewage systems tended to increase the risk of diarrhea, but the association was not statistically significant after controlling for confounding variables. Personal hygiene habits and the condition of the household sanitation system did not show a statistically significant association with the incidence of diarrhea, either in bivariate or multivariate analysis.

RECOMMENDATION

Based on the findings of this study, it is recommended that education on the dangers of early complementary feeding, the importance of exclusive breastfeeding, and household waste management be included in health service programs such as pregnant women's classes and Posyandu. Health cadres must also be actively involved in monitoring and delivering promotional messages on household environmental hygiene, particularly regarding closed bins and proper waste disposal systems. To support this, it is necessary to develop educational media that is simple and easy for the community to understand. At the policy level, the results of this study can be used as a basis for advocacy to local governments to strengthen baby-friendly household sanitation regulations and

programs. Finally, further research with a broader scope and evaluative approach is highly recommended to test the effectiveness of this findings-based intervention in preventing diarrhea in infants aged 0-6 months.

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Declarations

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