

PERSONAL HYGIENE AND HOUSEHOLD FOOD MANAGEMENT PRACTICES ASSOCIATED WITH DIARRHEA AMONG TODDLERS

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Abstract

Introduction: Diarrhea is a public health concern among toddlers in low- and middle-income countries. Environmental factors such as household hygiene practices, drinking water and food management practices are significant potential drivers of diarrhea among toddlers. This research investigated the association between the identified determinants and the occurrence of diarrhea among toddlers living in Surabaya, Indonesia. **Methods:** A community-based cross-sectional study was conducted involving 108 toddlers aged 12–59 months selected through simple random sampling. Chi-square analysis and multivariable logistic regression were performed to examine the data. **Results and Discussion:** Bivariate analysis showed significant associations between diarrhea and toddler age, caregiver education level, personal hygiene, drinking water and food management practices. Based on multivariable logistic regression, male was found to be more prone to diarrhea than female toddlers (OR = 3.18; 95% CI: 1.16–8.73; $p = 0.025$). Diarrhea was more prevalent among toddlers ≤ 24 months compared to those aged > 24 months (OR = 7.54; 95% CI: 2.04–27.86; $p = 0.002$). Poor personal hygiene (OR = 4.47; 95% CI: 2.46–32.33; $p = 0.005$) and inadequate household food management (OR = 8.93; 95% CI: 1.55–12.90; $p = 0.001$) identified as variable linked to diarrhea incidence. **Conclusion:** Diarrhea among toddlers is significantly associated with personal hygiene and food management practices. Younger age and male sex also contribute to higher risk. Strengthening hygiene practices and improving food management in household-level are essential to reduce the burden of diarrhea among toddlers.

INTRODUCTION

A significant global public health issue is diarrhea, which is described as the occurrence of watery stools at least three times per day. As estimated by the World Health Organization (WHO), 1.7 billion toddlers worldwide suffer from diarrheal illnesses each year (1). These cases result in 443,832 toddler deaths (2). Another significant factor contributing to toddler malnutrition is diarrhea.

In Indonesia, diarrhea has been a serious public health issue. It is identified as the second most frequent

cause of mortality in Indonesian toddlers. 14% of post-neonatal deaths in Indonesia are caused by diarrhea (3). Furthermore, it is the primary contributor of death for toddler 12–59 months. Diarrhea is the cause of 10.3% of these deaths. In 2021, the second-highest number of toddler diarrhea cases occurred in the Indonesian province of East Java (4). There were 142,407 toddler cases of diarrhea in the area (5–7).

To address sanitation and hygiene problems, Indonesia has implemented the Community-Based Total Sanitation program, which emphasizes encouraging

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community involvement to change behavior. Promoting safe drinking water and food management, which includes appropriate handling, storage, and processing of food and drinking water, is one of the program's main goals (8–9).

Previous research has shown that proper handwashing lower diarrhea incidence as much as 40–45%, and that poor hygiene and contaminated drinking water account for nearly 60% of diarrheal deaths (10–11). The impact of toddler personal hygiene, caregiver hygiene, drinking water management, and household food management on diarrhea risk in high diarrhea-endemic urban communities, however, is not well documented.

Surabaya City reported the highest number of diarrhea cases in East Java Province, with 63,631 cases in 2025 (12). At the sub-district level, the Gading Community Health Center service area, which includes Gading, Kapas Madya Baru, and Dukuh Setro, has the largest population (90,605 residents) and reported the highest number of diarrhea cases among toddlers (107 cases) in 2024 (13). These findings indicate that the area represents a high-burden setting with substantial population density, which may increase the risk of diarrhea transmission. Therefore, this study aimed to examine the relationship between toddler personal hygiene, caregiver personal hygiene, household drinking water management, and household food management practices with diarrhea incidence among toddlers in this setting.

METHODS

Study Design and Setting

This study employed a cross-sectional design to investigate the relationship between toddler diarrhea incidence and factors such as drinking water management, food management, and personal hygiene. It was conducted using a community-based approach from September 2024 to May 2025 in the service area of the Gading Community Health Center, Surabaya City, East Java, Indonesia.

Population and Sample

All toddlers registered in 2025 ($N = 5,706$) made up the study population. The Lemeshow formula for cross-sectional studies was applied to calculate the necessary sample number:

$$n = Z^2 P(1 - P) / d^2$$

where $Z = 1.96$ (95% confidence level), $d = 0.10$ (precision), and $P = 0.5$ (expected proportion). A

precision level of 0.10 was considered acceptable as this study served as an exploratory investigation intended to provide preliminary evidence for further research.

A total of 108 toddlers between the ages of 12 and 59 months made up the final sample after a 10% non-response rate was taken into consideration. Participants were selected using simple random sampling based on Posyandu (integrated health service post) registration lists.

Eligibility Criteria

Toddlers between 12–59 months who were actively registered at Posyandu, lived in the Gading Community Health Center service area, and had informed consent from their caregivers met the inclusion criteria. Toddlers with a history of allergy, malabsorption disorders, or other infectious diseases causing diarrhea were excluded. Toddler who had moved out of the study area or attended daycare facilities were also excluded.

Variables and Data Collection

Diarrhea incidence, characterized by the passage of unformed stools at least ≥ 3 times within a 24-hour period during the preceding three months, was the dependent variable, according to caregiver reports. Toddler personal hygiene, caregiver personal hygiene, drinking water management, and food management were the independent variables. Toddler personal hygiene consisted of skin cleanliness, hand and foot hygiene, and oral hygiene. Caregiver hygiene included nail cleanliness, handwashing practices at five critical times, and toilet ownership and use. Drinking water management assessed water source, treatment method, storage practices, and container hygiene. Food management covered food selection, storage, preparation, cooking, and serving practices.

Instrument Validity and Reliability

Standardized questionnaires were employed to collect information through in-person interviews with caregivers, supplemented by direct observation of household hygiene practices and environmental conditions (14).

Prior to the main study, the questionnaire was pilot-tested and modified from previously validated instruments. By using Pearson Product Moment correlation, validity testing was carried out with thirty caregivers who shared similar sociodemographic traits but were not part of the study sample. The item-total correlation coefficients were higher than the r -table value of 0.316, ranging from 0.41 to 0.78.

Cronbach's Alpha reliability testing revealed acceptable internal consistency for all variables: drinking water management ($\alpha = 0.661$), food management ($\alpha = 0.895$), toddler personal hygiene ($\alpha = 0.915$), and caregiver personal hygiene ($\alpha = 0.895$).

Scoring and Categorization

Responses were measured using a three-point Likert scale: "No" (0) and "Yes" (1). Total scores were transformed into percentages and subsequently classified into the following categories: good ($\geq 76\%$), moderate (56–75%), and poor ($\leq 55\%$).

Statistical Analysis

The study variables and characteristics of the respondents were summarized using descriptive statistics. The Chi-square test was employed in examining the association between independent variables and diarrhea occurrence. To determine the strength of associations, prevalence rate, together with 95% Confidence Intervals, were employed.

Multivariable logistic regression analysis was performed to obtain adjusted estimates and control for potential confounding variables. All analysis was performed using STATA 18 software with a significance level set at $p < 0.05$.

Ethical Considerations

The approval for the study was given by the Health Research Ethics Committee, Faculty of Dental Medicine, Universitas Airlangga, with the certificate number: 0284/HRECC.FODM/II/2025. Further permission was obtained from the Surabaya City Health Department. The informed consent was obtained from all the caregivers before the study was conducted. The confidentiality of the participants was ensured by replacing the names with codes in all the instruments and data bases used for the study.

RESULTS

Participant Characteristics

The prevalence of diarrhea among toddlers was 65.7%. Table 1 shows that 21.3% of toddlers had low nutritional status, and 18.5% had not completed their immunization schedule. Most toddlers were male (55.6%) and aged 24–35 months (33.3%). Most caregivers were aged 25–44 years (73.1%), had senior high school education (59.3%), and were housewives (91.7%).

Table 1. Characteristics of Respondents

Variable	Frequency (n)	Percentage (%)
Toddler Characteristics		
Sex		
Male	60	55.6
Female	48	44.4
Age in Months		
≤ 24	37	34.3
> 24	71	65.7
Nutritional Status		
Low	23	21.3
Normal	72	66.7
Overweight	13	12.0
Immunization Status		
Complete	88	81.5
Incomplete	20	18.5
Caregiver Characteristics		
Age in Years		
15–24	16	14.8
25–44	79	73.2
45–69	13	12.0
Education Level		
Primary	8	6.5
Junior high	29	23.1
Senior high	60	59.3
Tertiary	11	11.1
Caregiver-child Relationship		
Mother	92	85.2
Non-mother	16	14.8
Occupation		
Housewife	99	91.7
Labor	9	8.3

Factors Associated with Diarrhea Incidence among Toddlers

Bivariate analysis indicated that several variables had a significant relationship with diarrhea occurrence. Sex of the toddler ($p = 0.023$) and age status of the toddler ($p = 0.001$) were significantly associated with diarrhea incidence. In caregiver characteristic, it was seen that level of education demonstrated a significant relationship with diarrhea incidence among toddlers ($p = 0.042$) (Table 2). It was seen that personal hygiene of the toddler ($p = 0.001$) and caregiver ($p = 0.011$) revealed a statistically significant relationship with diarrhea incidence (Table 3). It was seen that environmental sanitation was significantly linked to diarrhea incidence among children. Drinking water ($p = 0.011$) and food ($p = 0.000$) management also significant, (Table 4).

Multivariable logistic regression model was done, and it was seen that sex of the toddler, age status

of the toddler, personal hygiene of the toddler, and food management showed significant link to diarrhea among toddlers. The Hosmer-Lemeshow test was done, and it was seen that it was fit ($p = 0.450$), (Table 5).

Male toddler children had greater odds than females (OR = 3.18; 95% CI: 1.16–8.73; $p = 0.025$). Toddlers aged ≤ 24 months had higher odds of diarrhea

than those older than 24 months (OR = 7.54; 95% CI: 2.04–27.86; $p = 0.002$). Poor personal hygiene among toddler children was linked to higher odds of diarrhea (OR = 4.47; 95% CI: 2.46–32.33; $p = 0.005$). In addition, poor household food management practices significantly enhanced the likelihood of diarrhea (OR = 8.93; 95% CI: 1.55–12.90; $p = 0.001$).

Table 2. Bivariate Analysis of the Relationship between Participant Characteristics and Diarrhea Incidence

Variable	Diarrhea Incidence				Total		<i>p-value</i>
	Diarrhea (people)	Percentage (%)	Non-Diarrhea (people)	Percentage (%)	Total (people)	Percentage (%)	
Toddler Characteristic							
Sex							
Male	15	63.4	45	40.5	60	55.6	0.023*
Female	22	36.6	26	59.5	48	44.4	
Age in Months							
≤ 24	32	86.5	5	13.5	37	34.3	0.001*
> 24	39	54.9	32	45.0	71	65.7	
Nutritional Status							
Low	18	25.3	5	13.5	23	21.3	0.148
Normal	47	66.2	25	67.6	72	66.7	
Overweight	6	8.5	7	18.9	13	12.0	
Immunization Status							
Complete	57	80.3	31	83.8	88	81.5	0.657
Incomplete	14	19.7	6	16.2	20	18.5	
Caregiver Characteristics							
Age in Years							
15–24	14	19.7	2	5.4	16	14.8	0.116
25–44	48	67.6	31	83.8	79	73.2	
45–69	9	12.7	4	10.8	13	12.0	
Education Level							
Primary	7	9.9	1	2.7	8	7.4	0.042*
Junior high	24	33.8	5	13.5	29	26.8	
Senior high	34	47.9	26	70.2	60	55.6	
Tertiary	6	8.4	5	13.5	11	10.2	
Caregiver-child Relationship							
Mother	59	83.1	33	89.2	92	85.2	0.398
Non-mother	12	16.9	4	10.8	16	14.8	
Occupation							
Housewife	63	88.7	36	97.3	99	91.7	0.126
Labor	8	11.3	1	2.7	9	8.3	

Table 3. Bivariate Analysis of the Relationship between Toddlers and Caregiver Personal Hygiene with Diarrhea Incidence

Variable	Diarrhea Incidence				<i>p-value</i>
	Diarrhea (people)	Percentage (%)	Non-Diarrhea (people)	Percentage (%)	
Toddler Personal Hygiene					
Poor	56	76.7	17	23.3	0.001*
Good	15	42.9	20	57.1	
Caregiver Personal Hygiene					
Poor	66	70.2	28	29.8	0.011*
Good	5	35.7	9	64.3	

Table 4. Bivariate Analysis of the Relationship between Drinking Water and Food Management Practices and Diarrhea Incidence

Variable	Diarrhea Incidence				<i>p-value</i>
	Diarrhea (people)	Percentage (%)	Non-Diarrhea (people)	Percentage (%)	
Drinking Water Management					
Poor	52	74.3	18	25.7	0.011*
Good	19	50.0	19	50.00	
Food Management					
Poor	62	74.7	21	25.3	0.000*
Good	9	36.0	16	64.00	

Table 5. Multivariate Logistic Regression of Factors Associated with Diarrhea among Toddler

Variable	Category	OR	95% CI	<i>p-value</i>
Toddler's Sex	Male	3.18	1.16–8.73	0.025
	Female	Ref	–	–
Toddler's Age (Months)	≤ 24	7.54	2.04–27.86	0.002
	> 24	Ref	–	–
Toddler's Personal Hygiene	Poor	4.47	2.46–32.33	0.005
	Good	Ref	–	–
Food Management	Poor	8.93	1.55–12.90	0.001
	Good	Ref	–	–

DISCUSSION

Interpretation of Key Findings

In this study, the following factors related to diarrhea among toddlers in a high-burden urban setting. The findings indicate that younger age groups, caregiver education, toddler hygiene, and household food management practices play important roles in influencing diarrhea risk. Younger toddlers, particularly those ≤ 2 years were more likely to experience diarrhea. These findings align with earlier research showing that toddler in early life are more susceptible to enteric infections because of an immature immune system and because of hand-to-mouth activities (5,15). At this point, exposure to environmental pathogens is also more likely due to increased mobility and poor self-hygiene skills (3,16). The aforementioned findings emphasize once more how susceptible young toddlers are to diarrheal illnesses.

Caregiver education was identified as a factor associated with a lower risk of diarrhea incidence, where higher educational attainment may facilitate better access to health-related information and resources (17–18). However, it is important to note that caregiver knowledge and practical understanding of hygiene and sanitation play a more direct role in preventing diarrhea, independent of formal educational level. Previous studies have shown that caregivers with adequate knowledge are more likely to adopt recommended practices such as proper handwashing, safe food handling, and appropriate child feeding, which contribute to reducing diarrhea incidence (5,14). Therefore, while education may support the acquisition of knowledge, it is the application of that knowledge in daily practices that is crucial in diarrhea prevention.

From a behavioral aspect, toddler personal hygiene has been associated with diarrhea, particularly in toddler whose personal hygiene is not optimal. This result aligns with various research that have shown that poor personal hygiene is a conduit for fecal-oral transmission of pathogens, particularly in toddler due to their high exposure rate to surfaces (19–20). However, the lack of consistency in significance across personal hygiene domains may indicate a variability in daily practices.

The incidence of diarrhea was also substantially correlated with household food management practices. Because inadequate food management can raise the risk of microbial contamination during food preparation, storage, and feeding, food management are crucial in preventing diarrhea (14,21). As contaminated food, improperly stored and reheated food, and unsafe feeding practices are critical in the occurrence of diarrhea in toddler, food management have been found in prior studies to be significant contributors to diarrhea in toddler (22–23). However, food hygiene is often not considered, yet it plays an important part in the causation of diarrhea.

Interestingly, personal hygiene of caregivers and care provisions in terms of drinking water were statistically insignificant in contributing to diarrhea, unlike in most other studies where these two factors were identified as key contributing factors to diarrhea-related illness (4,24–25). This discrepancy may be explained not only by caregiver educational background but also by contextual and behavioral factors. In urban settings, where access to improved water sources may be relatively uniform, variability in these factors can be

limited, reducing their observable impact in statistical models. In addition, previous studies suggest that caregiver knowledge and awareness play a more direct role in influencing hygiene-related behaviors than formal educational level alone, as knowledge has been shown to significantly affect practices such as handwashing and food handling, which are directly associated with diarrhea prevention (26). From a methodological perspective, the lack of variability in responses may also indicate a ceiling effect, where similar reported practices limit the ability of statistical analysis to detect significant associations.

Although there are many sanitation and hygiene projects, the high level of diarrhea in this study indicates that it can be assumed that the projects have not solved the problem of diarrhea completely. Many differences exist between rural and urban areas still remain to be discussed, which affect the risk. As can be seen from the literature, the relationship between three factors, environmental exposure (for example, water and waste), caregiver behavior (for example, food and food preparation), and child susceptibility (for example, malnutrition), plays a role in the causation of diarrheal diseases (27–28).

Comparison with Previous Studies

The association with previous research is in agreement with previous research that suggests enteric pathogens can infect toddlers under 2 years old. Toddlers will frequently place hands into their mouths while exploring surroundings and may not yet have acquired sufficient immune protection from enteric pathogens (5,29). The association with early childhood and increased mobility compared to hygiene practices which are based upon caregiver activity are consistent findings from other parts of Indonesia and other developing countries (16,30).

In addition, education level of the caregivers significantly correlated to prevalence of diarrhea. Toddler cared for by less-educated caregivers experienced a greater frequency of diarrhea than those being cared for by more-educated caregivers. Findings from this study support other studies which demonstrate how the education level of caregivers influences their health literacy, hygiene practice, and ability to obtain accurate health information regarding disease prevention, especially as it relates to diarrhea (17,18). Caregivers with advanced education were more inclined to employ more recommended practices (e.g., handwashing, proper food management, or child feeding) that help decrease the incidence of diarrhea (31).

Hygiene-related factors were also significant in this study. In the bivariate analysis, it is evident that

both toddler personal hygiene and caregiver personal hygiene were significantly associated with diarrhea. This means that poor hygiene among the caregivers and the toddlers increases the risk of diarrhea. This is supported by the evidence that hygiene contributes significantly to the diarrhea transmission. It is well known that inadequate hygiene represents a key determinant to the transmission of diarrhea through the fecal-oral route, especially among toddler because they come into contact with the environment and rely on caregivers for daily activities (30,32).

However, in the multivariable analysis, only toddler personal hygiene remained significant for diarrhea, whereas caregiver hygiene did not. This may indicate an indirect effect of caregiver hygiene on diarrhea risk, which is mediated by other variables. Another possible explanation is that the effect of hygiene among caregivers may not have been significant due to homogeneity of the data. Therefore, these results highlight the need for maintaining good hygiene practices among toddler and for preventing diarrheal diseases (26,33).

The significance of household water management, as seen in this study, is similar to what has been seen in other studies which revealed that water contamination is common in collection, transportation, and storage, despite the availability of improved water sources (23,28). Re-contamination in households is a significant challenge in numerous low- and middle-income countries, which emphasizes the significance of water management in households (31,34).

In addition, food management was a critical risk of diarrhea incidence in this study. From other studies, there is evidence that contamination in food preparation, storage, and feeding can contribute significantly to diarrhea incidence in toddler (32). Feeding bottles, utensils, and cooked food can become significant risk factors in diarrhea incidence, especially in situations where there are inconsistencies in hygiene practice (35).

From a broader perspective, these findings support the global evidence that water, sanitation, and hygiene interventions form a crucial part of diarrheal disease prevention strategies (23,32). However, more recent studies and systematic reviews also emphasized that such infrastructure-based interventions alone might not be enough to prevent diarrheal diseases, as behavioral change and community engagement also form a critical part of diarrheal disease prevention strategies (21,31,34).

The “Community-Based Total Sanitation” (STBM) has been initiated to address the issue of diarrheal disease. The five pillars include the elimination of open

defecation, promotion of handwashing practices, and improvement in drinking water and food practice (9,20). Although STBM has led to some improvements in terms of sanitation coverage, evaluations have also shown that such interventions have not been uniform, particularly in urban areas where diarrheal disease risk factors still exist (14,36). Such issues have also been seen in other countries, where WASH interventions have also not been uniform, particularly in urban areas (2,18).

Limitations and Cautions

However, some limitations of the results of this particular study should be considered. Firstly, since the study design was cross-sectional, no causality can be established, and thus the results can be considered associations and not causal effects (23,29–30). It is not possible to determine if the exposures occurred before the onset of diarrhea. Secondly, hygiene practices were assessed depending on caregiver responses, which might be prone to social approval bias. Thus, caregivers might report higher hygiene practices than those actually practiced in real life, leading to misclassifying exposure (5,17).

Thirdly, the outcome variable was measured based on diarrhea that occurred within the last three months, and thus some bias might be present since caregivers might not accurately report illness events. Fourth, there is a possibility of reverse causality, where some of the caregivers may have already enhanced their hygiene practices after their child developed diarrhea. In this case, their hygiene practices at the time of the survey may not reflect those before their child developed diarrhea.

Lastly, this study was conducted in a single health center's catchment area in Surabaya, and its results may not reflect those in other areas, both in rural and other urban areas, which may have different environments and socio-economic conditions (3,20).

Recommendations for Future Research

Despite the above limitations, this study has significant implications in understanding factors related to childhood diarrhea in urban communities. The results indicate that enhancing caregiver education and hygiene practices remains an important strategy in the prevention of diarrheal disease in toddlers.

Further research should consider using longitudinal or cohort study designs to better elucidate the association between hygiene practices and childhood diarrhea. This will help to clarify whether hygiene practices precede the occurrence of diarrheal disease and can provide more support for causal inferences (14).

Further studies can also include direct observation of hygiene practices and/or the microbiological analysis of water and food samples, which may yield more objective measurements of the level of environmental contamination and reduce the reliance on self-reported data (21,33). In addition, conducting multi-site studies in different areas in Indonesia can help establish if the results obtained in this study can be replicated in different rural and urban settings with different sanitation conditions (15,19). These results can be useful in the effective implementation of WASH and STBM interventions to address childhood diarrheal diseases worldwide (34).

It is important to enhance the execution of the Community-Based Total Sanitation (STBM) program in densely populated urban areas where contamination pathways may persist. Hygiene promotion messages should also be integrated into routine maternal and child health services, such as Posyandu, to reinforce consistent handwashing, safe food preparation, and hygienic child-care practices. In addition, health promotion strategies should place greater emphasis on caregivers with lower educational attainment, who may require more targeted and accessible health education to improve household hygiene behaviors, as these factors are strongly associated with diarrheal disease among children under five (37).

CONCLUSION

This study highlights that diarrheal disease among toddlers in a high-burden urban setting arises from the combined effects of child vulnerability, caregiver capacity, and household practices. Younger age (≤ 2 years), poor toddler hygiene, and unsafe food management were identified as key risk factors. While higher caregiver education may support access to health information, the findings underscore that caregiver knowledge and the application of appropriate hygiene, feeding, and food management practices play a more direct role in reducing diarrhea risk. Thus, it can be concluded that better hygiene practices for toddlers and caregivers, better domestic drinking water management, and better food practices can reduce the prevalence of diarrhea among toddlers. These results highlight the continued importance of household-level hygiene behaviors and caregiver capacity in preventing diarrheal disease among toddler in urban settings.

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AUTHORS' CONTRIBUTION

AT: Conceptualization, Methodology, Data collection, Data curation, Formal analysis, Investigation, and Writing – original draft preparation. RA: Conceptualization, Methodology, Supervision, and Writing – review & editing. SA: Formal analysis, Validation, Data analysis supervision, and Writing – review & editing. SM: Overseas supervision, and Writing – review & editing.

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