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The Relationship Between Milk Bottle Hygiene and the Incidence of Diarrhea in Infants Aged 0-6 Months: A Study in Gajahan Health Center, Surakarta

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Abstract: Diarrheal disease remains a significant cause of infant morbidity and mortality worldwide, particularly in developing countries like Indonesia. This study examines the relationship between milk bottle hygiene and the incidence of diarrhea in infants aged 0-6 months in Surakarta, Indonesia, with the goal of highlighting the importance of proper bottle sanitation in reducing diarrhea risk. **Objective:** The objective of this study is to analyze the relationship between milk bottle hygiene and the incidence of diarrhea in infants aged 0-6 months. The study aims to provide insights into the role of bottle sanitation in preventing gastrointestinal infections in infants. **Methodology:** This research employed a quantitative, analytic observational approach using a cross-sectional study design. The population consisted of 50 infants who met specific inclusion and exclusion criteria. Data were collected through structured questionnaires, and chi-square tests were used for statistical analysis to assess the relationship between milk bottle hygiene and diarrhea incidence. **Findings:** The study found a significant relationship between poor milk bottle hygiene and an increased incidence of diarrhea in infants (p-value < 0.05). The findings indicate that inadequate bottle cleaning practices contribute to gastrointestinal infections in infants, reinforcing the importance of proper hygiene in preventing diarrhea. **Implications:** The findings highlight the need for targeted public health interventions to educate mothers and caregivers on proper milk bottle sanitation. Implementing simple hygiene practices could significantly reduce the risk of diarrhea and other preventable gastrointestinal diseases in infants, particularly in resource-limited settings. **Originality:** This study offers original contributions by focusing on milk bottle hygiene as a key factor influencing diarrhea incidence in infants, an area that has been largely underexplored in previous research. The study provides valuable insights that could inform policies and interventions aimed at improving infant health and preventing diarrheal diseases.

Keywords: Diarrhea Incidence, Milk Bottle Hygiene, Babies Aged 0-6 Months

INTRODUCTION

Diarrheal disease remains one of the leading causes of death among children, especially in developing countries like Indonesia. According to the Ministry of Health of the Republic of Indonesia, approximately 443,832 children under the age of five die each year due to diarrhea, despite being preventable through proper sanitation and hygiene. In

Central Java, the total number of diarrhea cases reached 374,844 in 2023, with young children accounting for a significant portion of these cases. This issue is exacerbated by poor hygiene practices, particularly the improper handling and cleaning of infant feeding bottles. Dr. Hasto Wardoyo, the Head of the National Family Planning Coordinating Board (BKKBN), emphasized that many cases of diarrhea are not caused by formula milk itself, but by contaminated feeding bottles that are not properly sterilized. Residual milk left in bottles serves as a breeding ground for bacteria such as E. coli and Salmonella, increasing the risk of gastrointestinal infections and, consequently, diarrhea in infants (BKKBN, 2024). Addressing these sanitation issues is crucial for reducing diarrhea-related morbidity and mortality, especially in regions with limited access to clean water and sanitation facilities.

The role of proper sanitation in preventing diarrhea cannot be overstated. UNICEF reports that diarrheal diseases are a significant contributor to malnutrition in children under five, further increasing their vulnerability to infections (UNICEF, 2023). In Indonesia, nearly 780 million people lack access to improved drinking water, and 2.5 billion people lack access to improved sanitation. These deficiencies significantly contribute to the high incidence of diarrhea in low-income communities. Efforts to prevent diarrhea, such as promoting exclusive breastfeeding, improving sanitation practices, and encouraging handwashing with soap, have proven effective in reducing the disease burden. Dr. Hasto Wardoyo also emphasized that improving the sterilization of infant feeding bottles and enhancing maternal knowledge about hygiene are essential steps in reducing the risk of diarrhea in young children (BKKBN, 2024).

Previous research has consistently highlighted the link between poor hygiene practices, including the sanitization of milk bottles, and the increased incidence of diarrhea in infants. Durduran and Luby stress the importance of hand hygiene in preventing diarrhea, which indirectly affects milk bottle cleanliness (Durduran et al., 2019; Luby et al., 2011). However, the specific relationship between the cleanliness of feeding bottles and infant diarrhea remains underexplored. Ehlayel found that sterilizing feeding bottles significantly reduces diarrhea incidence, but such studies are sparse in developing countries, such as Indonesia, where access to clean water and sanitation is often limited (Ehlayel et al., 2009). Most research has focused on food and water hygiene, leaving the cleanliness of infant feeding bottles as a less explored factor in gastrointestinal infections.

Redmond examined microbial contamination in feeding bottles and highlighted that even bottles considered clean could still harbor harmful bacteria, such as Enterobacteriaceae and Staphylococcus aureus, which can lead to infections (Redmond et al., 2009). Despite these findings, few studies have explored the methods of sterilization and cleaning that prevent such contamination. Additionally, maternal education and socioeconomic status play a crucial role in determining hygiene practices at home. Haris showed that mothers with higher education levels tend to recognize dehydration signs and use oral rehydration therapy correctly, which likely correlates with better hygiene practices, including bottle sanitation (Haris et al., 2021). However, there remains a significant gap in research connecting socioeconomic status to specific bottle sanitation practices, which could impact the prevalence of diarrhea.

Furthermore, while WASH (Water, Sanitation, and Hygiene) interventions have been shown to reduce parasitic infections, their effectiveness in preventing gastrointestinal diseases, including diarrhea, remains insufficient unless combined with proper hygiene practices, such as cleaning feeding bottles. McQuade demonstrated that WASH interventions alone did not significantly reduce enteric infections, but combining them with proper hygiene practices, including bottle sanitation, could provide a more comprehensive approach to reducing gastrointestinal diseases (McQuade et al., 2020). This highlights the need for research that integrates proper feeding bottle hygiene into broader sanitation and hygiene interventions to effectively reduce diarrhea in infants.

The objective of this study is to identify the relationship between milk bottle hygiene and the incidence of diarrhea in infants aged 0-6 months in the working area of the Gajahan Surakarta Health Center. The study aims to address gaps identified in previous literature regarding the impact of milk bottle hygiene on infant health. Specifically, it seeks to investigate how proper milk bottle hygiene practices, such as using soap, special brushes, correct storage, and sterilization, can reduce the incidence of diarrhea in infants. This research will contribute new insights into the relationship between bottle hygiene and infant diarrhea and provide empirical data on how hygiene practices can mitigate health risks. The study also aims to offer recommendations for effective educational interventions that can help mothers maintain proper bottle hygiene as a preventive measure.

It is hypothesized that improper hygiene of milk bottles significantly contributes to the incidence of diarrhea in infants aged 0-6 months. Specifically, infants whose feeding bottles are not adequately cleaned, sanitized, or stored are more likely to develop

gastrointestinal infections, which can lead to diarrhea. The hypothesis is based on the assumption that contaminated milk bottles introduce harmful pathogens, such as E. coli and Salmonella, into the infants' digestive systems, increasing the risk of infection. Studies by Redmond and Ehlayel support the idea that improper bottle cleaning contributes to pathogen transmission (Ehlayel et al., 2009; Redmond et al., 2009). Therefore, this study predicts that infants whose mothers adhere to proper milk bottle hygiene practices will show a significantly lower incidence of diarrhea compared to those whose bottles are inadequately sanitized. This hypothesis will be tested through statistical analysis of data collected from the study area, with the goal of validating or refuting the correlation between bottle hygiene and infant diarrhea.

RESEARCH METHOD

This research employs a quantitative approach with an analytic observational design, using a cross-sectional study to examine the relationship between milk bottle hygiene and the incidence of diarrhea in infants aged 0-6 months in the working area of the Gajahan Health Center Surakarta. The focus of this study is on infants who use milk bottles for feeding, whether they are breastfed or formula-fed. The cross-sectional design is chosen because it allows the study of the relationship between variables such as the hygiene of milk bottles and the occurrence of diarrhea at a single point in time. This method is appropriate for identifying patterns and making observations without requiring longitudinal tracking.

The data for this study is collected from infants and their parents in the Gajahan Health Center's service area. The parents or guardians of these infants are the primary respondents, providing information on milk bottle hygiene practices and the incidence of diarrhea in their infants. Purposive sampling is used to select participants who meet the inclusion criteria of infants aged 0-6 months who use feeding bottles. The inclusion criteria specify that the infants must be fed formula or breast milk using bottles, and the parents must provide informed consent. The exclusion criteria eliminate infants with immune system disorders or other conditions like HIV or Primary Inflammatory Disease (PID). To determine the appropriate sample size, the Slovin formula is used, calculated as follows:

$$n = \frac{N}{(1+Ne^2)}$$

Where:

- n= sample size
- N= population size
- e= tolerable error limit (10%)

For a population of 100, this calculation gives a sample size of $n = 50$, ensuring a statistically valid representation of the group.

Data collection is done using questionnaires and observational techniques, gathering insights from parents about their infants' bottle hygiene practices and any incidence of diarrhea. The collected data is then analyzed statistically to determine any significant relationship between hygiene practices and the occurrence of diarrhea. Statistical tests, such as chi-square analysis, will be employed to validate or reject the hypothesis that poor bottle hygiene contributes to higher rates of diarrhea in infants.

By following this structured approach, the research aims to provide empirical evidence on the link between bottle hygiene and diarrhea in infants, contributing to public health recommendations and interventions aimed at reducing the incidence of diarrheal diseases in young children.

RESULT AND DISCUSSION

This study was conducted from August to September 2024 in the working area of the Gajahan Health Center, Surakarta City. The method used was analytic observational research with a cross-sectional study approach. Primary data collection was carried out through distributing questionnaires to respondents in the Gajahan Health Center working area.

Research subjects were selected based on predetermined inclusion and exclusion criteria. The number of samples used was 50 people, obtained through purposive sampling technique. After the data collection process was completed, the following research results were obtained:

Table 1. Characteristics of Research Subjects

Variable	Diarrhea	No Diarrhea	Total	Chi-square	P-value
Mother's Age					
20–23 years	1 (33.3%)	2 (66.7%)	3 (100%)	1.714	0.634
24–27 years	5 (27.8%)	13 (72.2%)	18 (100%)	5.535	0.137
28–31 years	3 (13.6%)	19 (86.4%)	22 (100%)		
>31 years	1 (14.3%)	6 (85.7%)	7 (100%)		
Mother's Education					
Primary School (SD)	1 (100%)	0 (0%)	1 (100%)	5.535	0.137
Junior High School (SMP)	0 (0%)	6 (100%)	6 (100%)		

Variable	Diarrhea	No Diarrhea	Total	Chi-square	P-value
Senior High School (SMA)	7 (20.6%)	27 (79.4%)	34 (100%)		
Higher Education	2 (22.2%)	7 (77.8%)	9 (100%)		
Mother's Occupation					
Housewife	9 (28.1%)	23 (71.9%)	32 (100%)	4.102	0.392
Trader	0 (0%)	2 (100%)	2 (100%)		
Civil Servant	0 (0%)	2 (100%)	2 (100%)		
Private Sector	0 (0%)	1 (100%)	1 (100%)		
Entrepreneur	1 (12.5%)	7 (87.5%)	8 (100%)		
Number of Children					
1	4 (28.6%)	10 (71.4%)	14 (100%)	1.804	0.614
2	5 (35.8%)	9 (64.2%)	14 (100%)		
3	1 (15.4%)	11 (84.6%)	13 (100%)		
4	0 (0%)	10 (100%)	10 (100%)		
Total	10 (20%)	40 (80%)	50 (100%)		

Based on the data in the table, it can be seen that the incidence of diarrhea in infants aged 0-6 months is most prevalent among mothers aged 20-23 years, which is 33.3%. Meanwhile, mothers aged 24-27 years recorded 27.8%, those aged 28-31 years 13.6%, and mothers aged over 31 years showed a percentage of 14.3%. Statistical analysis showed a p-value of 0.634 ($p > 0.05$), which means there is no significant relationship between maternal age and the incidence of diarrhea in infants aged 0-6 months.

Furthermore, in terms of mother's education level, it was found that all mothers with primary school education experienced diarrhea in their infants (100%), while there were no cases of diarrhea in infants from mothers with junior high school education (0%). Data for mothers with high school education had a percentage of diarrhea incidence in infants aged 0-6 months of 20.6%, and mothers with tertiary education had a percentage of diarrhea incidence in infants aged 0-6 months of 22.2%. From the results of statistical analysis, the p- value = 0.137 (p-value> 0.05) indicates an insignificant relationship between maternal education and the incidence of diarrhea in infants aged 0-6 months.

Based on the data in the table, it is known that housewives have a prevalence of diarrhea in infants aged 0-6 months of 28.1%. Meanwhile, there were no cases of diarrhea in infants from mothers who worked as traders, civil servants, or private employees, with a percentage of 0% each. Mothers who are self-employed showed a percentage of diarrhea incidence of 12.5%. The statistical analysis showed a p-value of 0.392 ($p > 0.05$), indicating that there was no significant association between the type of maternal employment and the incidence of diarrhea in infants aged 0-6 months.

Furthermore, it was reported that mothers with one child in the family had a 28.6% incidence of diarrhea in infants aged 0-6 months. Mothers with two children showed a rate of 13.3%, while mothers with three children had a rate of 15.4%. There was no incidence of diarrhea in infants of mothers with four children (0%). The statistical test results obtained a p- value of 0.614 (p>0.05), which indicates that there is no significant relationship between the number of children in the family and the incidence of diarrhea in infants aged 0-6 months.

Table 2. Relationship between milk bottle hygiene and diarrhea incidence

Hygiene	Diarrhea	No Diarrhea	Total	Chi-square	P-value
Good	6 (14%)	37 (86%)	43 (100%)	7.018	8
Poor	4 (57.1%)	3 (42.9%)	7 (100%)		

Based on the questionnaire data regarding the level of hygiene of milk bottles shown in the table above, 43 respondents (86%) indicated that the hygiene of milk bottles was classified as good, while 7 respondents (14%) were classified as less hygienic. It is also known that most infants, namely 40 people (80%), did not experience diarrhea, while 10 other infants (20%) experienced diarrhea.

The results of the analysis using the chi- square test showed a p value <0.05, indicating a significant relationship between the level of hygiene of milk bottles and the incidence of diarrhea in infants aged 0-6 months.

DISCUSSION

Incidence of Diarrhea in Infants Aged 0-6 Months

Diarrheal disease remains one of the primary causes of morbidity and mortality in infants worldwide, particularly in low- and middle-income countries such as Indonesia. According to the Riskesdas 2018 survey, the prevalence of diarrhea in infants aged 0-11 months in Indonesia reached 15%. Central Java experiences a high incidence, with approximately 40% of toddlers affected annually, translating to 291,203 cases (Java Health, 2018). This is compounded by environmental and sanitation-related factors that increase the vulnerability of infants to gastrointestinal infections. In Surakarta, several sub-districts, including the Gajahan Health Center working area, report high diarrhea prevalence in infants, as noted by the Surakarta City Health Office (Surakarta, 2016). These findings point to a significant public health concern, highlighting the importance of identifying and addressing risk factors that contribute to diarrhea in this vulnerable population.

Various factors can contribute to the occurrence of diarrhea in infants. Common causes include the contamination of food and water, the presence of infectious agents such as viruses, bacteria, and parasites, and poor hygiene and sanitation practices. In the case of infants, the use of contaminated milk bottles is a notable risk factor. Pathogens such as E. coli, Salmonella, and Clostridium difficile are common culprits, and improper hygiene practices specifically in the cleaning and storage of milk bottles can exacerbate the risk of diarrhea. This research emphasizes the importance of maintaining proper milk bottle hygiene as a preventive strategy to reduce the incidence of diarrhea in infants.

Relationship Between Milk Bottle Hygiene and the Incidence of Diarrhea in Infants Aged 0-6 Months

The data analysis in this study shows a significant relationship between milk bottle hygiene and the incidence of diarrhea in infants. Out of the 7 respondents with poor hygiene practices, 42.9% of the infants did not experience diarrhea. However, among the 43 respondents with good hygiene practices, 14% still experienced diarrhea. The statistical test using the chi-square method returned a p-value of <0.05, indicating a significant association between milk bottle hygiene and the incidence of diarrhea. This suggests that while good milk bottle hygiene can reduce the risk of diarrhea, it may not entirely eliminate the possibility, as other factors like household hygiene, maternal practices, and environmental influences also contribute to the risk of infection. For instance, studies by Hartati S. pointed out that poor hand hygiene, insufficient maternal knowledge, and unsanitary living conditions are often linked with higher diarrhea rates, particularly among infants (Haris et al., 2021).

Despite the positive correlation between proper milk bottle hygiene and a reduction in diarrhea incidence, some challenges persist. These include the complexities of achieving widespread behavioral change in hygiene practices, particularly among mothers with limited education or resources. The prevalence of diarrhea among infants whose mothers practiced proper hygiene underscores the multifaceted nature of the disease. While milk bottle hygiene is an essential preventive measure, it must be integrated into broader public health efforts that address other sanitation and hygiene-related factors.

Socioeconomic and Demographic Factors

The study also explored the influence of maternal age, education, occupation, and number of children on the incidence of diarrhea in infants. The results indicated that most mothers in the study were aged 28-31, which also identified this age group as being most prevalent. Maternal education emerged as a crucial factor, with a higher percentage of mothers with high school education showing a lower incidence of diarrhea in their infants. However, statistical analysis revealed that maternal education was not significantly associated with the incidence of diarrhea, with a p-value of 0.137, suggesting that other factors, such as maternal practices and the broader living environment, might have a greater impact.

The occupation of mothers also seemed to play a role in the incidence of diarrhea, with housewives exhibiting a higher prevalence of diarrhea in their infants (28.1%) compared to mothers in other occupations. This finding aligns with the research who found that housewives tend to spend more time at home, thus having more opportunities to manage their children's environment. However, this also means that any lapses in hygiene or improper use of milk bottles in these settings can significantly increase the risk of infections like diarrhea. Moreover, it is essential to recognize that while education and occupation influence hygiene practices, they do not guarantee optimal hygiene behaviors without proper guidance and education.

The findings of this study align with previous research on the relationship between milk bottle hygiene and diarrhea incidence.

Studies (Durduran et al., 2019; Majumder et al., 2017) confirmed that improper cleaning of milk bottles could lead to an increased risk of gastrointestinal infections in infants. Similarly, (Anggraini et al., 2024; Matsungo et al., 2023) showed that poor milk bottle hygiene significantly increases the likelihood of diarrhea in infants. Research by (Anggraini et al., 2024; Currier & Widness, 2018; Liu et al., 2024) also supported the idea that unsanitary milk bottles can harbor pathogenic bacteria, which, when ingested by infants, can lead to infections that cause diarrhea. However, the findings of this study differ from those of (Avilés-Polanco et al., 2024), who found no significant relationship between milk bottle hygiene and diarrhea. These discrepancies may be attributed to differences in environmental factors, such as water quality, sanitation, and maternal hygiene practices, which play a more significant role in some regions.

Implications for Public Health and Policy

The findings of this study underscore the importance of proper milk bottle hygiene as a crucial factor in reducing the incidence of diarrhea in infants. The study emphasizes the need for targeted public health interventions aimed at educating mothers on proper bottle cleaning and sterilization techniques. Such interventions could involve community-based education programs, collaboration with local health centers, and broader public health campaigns that encourage better hygiene practices. Moreover, integrating these efforts with initiatives to improve overall sanitation and water quality can have a more significant impact on reducing the burden of diarrheal diseases. Efforts to promote breastfeeding, which has been shown to reduce the risk of diarrhea, should also be encouraged, as breast milk provides essential nutrients and immunity that formula feeding cannot replicate.

In addition, policies should focus on ensuring that mothers, particularly in low-income communities, have access to the necessary tools and information to maintain proper hygiene. Public health campaigns should be designed to target both mothers' knowledge and practices, as well as the environmental factors that contribute to the spread of pathogens. The findings from this study also highlight the need for further research on the role of maternal knowledge, socioeconomic status, and home hygiene in preventing diarrhea, particularly in areas with limited access to sanitation and health resources. By addressing these factors comprehensively, the incidence of diarrhea in infants can be significantly reduced, improving overall child health and reducing mortality rates associated with diarrheal diseases.

CONCLUSION

The findings of this study highlight a significant relationship between milk bottle hygiene and the incidence of diarrhea in infants aged 0-6 months. Proper milk bottle hygiene, including thorough cleaning, sterilization, and proper storage, was shown to reduce the incidence of diarrhea, with statistical tests confirming this relationship (p-value <0.05). Despite these findings, the study also showed that other factors, such as environmental hygiene, maternal practices, and infectious agents, contribute to the risk of diarrhea in infants. The research reinforces the importance of educating mothers on the proper sanitation of feeding bottles and integrating these practices into broader hygiene and health strategies. The results align with previous studies that emphasize the role of hygiene in preventing gastrointestinal infections in infants, but they also provide additional insights into the specific impact of milk bottle hygiene.

This research contributes to the body of knowledge by highlighting the direct link between milk bottle hygiene and the incidence of diarrhea in infants, particularly in a developing region such as Surakarta, Indonesia. It expands on previous studies by specifically focusing on the role of milk bottle cleanliness, a factor that has not been sufficiently explored in the literature, especially in low-resource settings. By providing empirical evidence that supports the relationship between bottle hygiene and reduced diarrhea rates, this study offers a new perspective on preventive measures that can be taken at the household level. Additionally, the research underscores the importance of maternal education, particularly in areas where access to sanitation and healthcare may be limited, and suggests practical interventions for public health programs aimed at improving hygiene practices.

Despite its contributions, this study acknowledges several limitations. First, the research was conducted in a specific area Gajahan Health Center in Surakarta and may not be directly generalizable to other regions with different socioeconomic or environmental conditions. Second, while the study focused on the impact of milk bottle hygiene, other factors, such as maternal health, nutrition, and overall household sanitation, were not fully explored. Additionally, the reliance on self-reported data may introduce bias, as respondents may not always accurately report their hygiene practices. Future research could address these limitations by expanding the study to different regions and incorporating more comprehensive variables, such as household sanitation, nutrition, and the broader healthcare environment. Longitudinal studies could also provide more insights into the long-term impact of milk bottle hygiene on infant health.

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