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The impact of environmental health facilities and maternal behaviors on the incidence of diarrhea among children under five

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Abstract

The objectives of this study were to determine the prevalence of diarrhea among children under five and assess the relationship between its risk factors related to environmental health facilities and maternal behavior. A prospective case-control community-based study was conducted in the service area of Pasar Ikan Community Health Center, Teluk Segara Subdistrict, Bengkulu City, Indonesia. A total of 140 participants were included, comprising 70 cases and 70 controls. The study found that poor qualification of clean water resources (OR=4.026, p-value=0.000), inadequate utilization of clean water (OR=5.813, p-value=0.000), poor qualification of family latrines (OR=3.574, p-value=0.000), and inadequate utilization of family latrines (OR=3.377, p-value=0.001) were significantly associated with an increased risk of diarrhea prevalence among children under five. Furthermore, unhealthy mothers' behaviors, including frequent feeding of children outside the home (OR=2.728, p-value=0.000) and poor personal hygiene (OR=3.377, p-value=0.001), were also significantly related to a higher prevalence of diarrhea in this age group. Therefore, both substandard environmental health facilities and unhealthy maternal behaviors were identified as significant risk factors for diarrhea prevalence in children under five. These findings emphasize the critical importance of improving environmental health facilities and promoting positive changes in mothers' behavior to reduce the incidence of diarrhea in this vulnerable population.

Introduction

The World Health Organization (WHO) classifies diarrhea in children under five as the passage of three or more loose or watery stools within a 24-hour period.¹ It occurs when the digestive system is unable to properly absorb water or when it produces excessive fluid.² In this age group, diarrhea is particularly concerning due to its potential to cause severe dehydration and malnutrition.³

Diarrhea can be caused by a variety of factors, including viral infections, bacterial infections, parasites, and food poisoning.⁴ Infectious causes are responsible for a significant number of cases of diarrhea in children under five.⁵ Bacterial infections, such as *Escherichia coli* and *Salmonella*, can be contracted through contaminated food or water.⁶ Viral infections, like rotavirus and norovirus, are highly contagious and can spread easily in childcare settings. Parasitic infections, such as *Giardia* and *Cryptosporidium*, often occur due to poor hygiene practices.⁷

Various risk factors increase the susceptibility of children to develop diarrhea. Poor hygiene practices, inadequate sanitation facilities, and contaminated water sources can

significantly contribute to the transmission of infectious agents that cause diarrhea.⁸ Furthermore, overcrowded living conditions and lack of proper handwashing facilities further enhance the risk of diarrhea.⁹

Mother's behavior in hygiene practices plays a crucial role in preventing diarrhea. Mothers must understand and implement practices such as regular handwashing with soap and clean water before feeding the children and after using the toilet.¹⁰ Additionally, ensuring a clean and safe environment for children, including proper disposal of waste, clean utensils, and proper food storage, can greatly minimize the risk of diarrhea.¹¹

This study was conducted in Teluk Segara sub-district, Bengkulu City, Indonesia, selected for its high incidence of diarrhea among children under five. This area has a diverse population with varying access to sanitation and clean water, making it ideal for examining the impact of environmental health factors on childhood diarrhea. Coastal residents, mainly fishermen, often lack proper sanitation, while those inland face groundwater contamination and rely on the public water system. This study explores how these contrasting conditions influence diarrhea prevalence. The aim of this study is to identify the risk factors related to environmental health facilities and mother behavior that might contribute to the prevalence of diarrhea in children under the age of five.

Materials and Methods

This analytical observational study used a prospective case-control design conducted at the Pasar Ikan Community Health Center in the Teluk Segara Subdistrict, Bengkulu Municipality. The study included two groups: a case group of mothers with children under five who experienced diarrhea in the past year and a control group of mothers with children aged 6 months to 5 years without recent diarrhea incidents. Both groups were selected from within the health center's service area, maintaining a 1:1 case-to-control ratio, with a total of 140 participants (70 cases and 70 controls). The sample size calculation followed Lemeshow's guidelines for odds ratio hypothesis testing.¹² Consecutive sampling targeted all eligible mothers visiting the health center.

To assess the impact of environmental health facilities and maternal behaviors on the incidence of diarrhea, several questionnaire items were used. These items were grouped into two main constructs: environmental health facilities and maternal behaviors. The construct of environmental health facilities was measured using 10 items encompassing several aspects: qualification of clean water resource (2 items); availability of clean water (1 item); utilization of clean water (3 items); qualification of family latrine (3 items); and utilization of family latrine

(1 item). The construct of mother behaviors was measured using 6 items related to: the habit of feeding children outside the house (2 items) and personal hygiene (4 items). Data collection was conducted using a structured questionnaire, which was pre-tested at other community health centers. The validity of all items was assessed by calculating the correlation between each item and the total score using the product-moment correlation test. All items were found to be valid. Reliability was assessed using the split-half technique, resulting in a reliability coefficient of 0.8066 for environmental health facilities and 0.8245 for mother behaviors. These coefficients indicated that both instruments met the required standards for reliability.

A consecutive sampling technique was employed to recruit participants until the desired sample size was achieved. The case group consisted of mothers with children aged 6 months to 5 years who presented with diarrhea at the Pasar Ikan Community Health Center for treatment and resided within the health center's catchment area. The control group comprised mothers with children aged 6 months to 5 years who did not have diarrhea but visited the Pasar Ikan Community Health Center for other health concerns.

Multivariate analysis used logistic regression with the Backward Method, systematically excluding non-significant variables to identify significant predictors of childhood diarrhea. Ethical approval for this study was obtained from the Medical and Health Research Ethics Committee of Universitas Gadjah Mada (approval number: KE/FK/32/EC).

Results

The characteristics of research subjects

Respondents were 140 mothers divided into two groups: 70 respondents from the case group and 70 respondents from the control group. Table 1 shows that the majority of the 70 respondents in each group (case and control) were between the ages of 30 and 39 (54.2% in the case group and 51.4% in the control group); the majority of respondents in both the case group (51.4%) and the control group (54.2%) had a senior high school education background; and a significant proportion of mothers in both groups were identified as primary caregivers within the household (case group: 78.6%; control group: 81.4%). Table 2 indicates that the majority of children in both the case and control groups were aged 13-24 months (38.6% and 44.3%, respectively). Furthermore, both groups had a larger proportion of male children (case: 55.7%; control: 60.0%).

The environmental health facilities

This study found that when examining environmental health risks among 140 participants, 35.4% of those in the case group and 64.6% in the control group had access to

qualified water sources. About 48.8% of the case group and 51.2% of the control group were provided with clean water. Furthermore, 38.6% of the case group and 61.4% of the control group had family latrines that adhered to hygiene standards, and 37.8% of the case group vs 62.2% of the control group had family latrines available for use.

The study revealed a significant association between clean water sources and diarrhea incidence in under-five children, with those exposed to unhygienic water sources being 4.026 times more likely to suffer from diarrhea. In contrast, the availability of clean water showed no significant impact on diarrhea incidence among under-fives due to a *p-value* of 0.412. However, the utilization of clean water significantly affected diarrhea incidence, where children under five in households not utilizing their facilities had a 5,813 times higher chance of contracting diarrhea. The availability and utilization of family latrines were significantly related to the occurrence of diarrhea. The children were 3.574 times more likely to get diarrhea if their family latrine did not meet hygiene standards and 3.377 times more likely if the latrine was not used properly (Table 3).

Mothers' health behavior

It was found that fewer mothers in the control group practiced feeding their children outside the house (34.6%) compared to the case group (65.4%). Similarly, a smaller percentage of mothers in the case group (37.8%) maintained good personal hygiene than those in the control group (62.2%). Mothers who fed their children outside were found to have a 2.728-fold increased risk of their children experiencing diarrhea compared to those who did not ($p=0.000$). Additionally, mothers with poor personal hygiene exhibited a 3.377-fold higher likelihood of their children developing diarrhea ($p=0.001$). These results underscore the critical role of safe feeding practices and proper personal hygiene in mitigating diarrhea risks among children under five (Table 4).

Multivariate analysis

Based on the Wald coefficients presented in Table 5, inadequate personal hygiene habits emerged as the most significant predictor of diarrhea prevalence among children under five. This was closely followed by the use of not-qualified clean water sources, non-standard family latrines, and the practice of mothers feeding their young children during outdoor play.

Discussion

The results of our study indicated that poor personal hygiene of mothers was the strongest predictor of childhood diarrhea ($\text{Exp}(B)=4.916$), suggesting that children of mothers with poor hygiene are nearly five times more likely to experience diarrhea compared to those whose

mothers practice good hygiene. This finding aligned with recent studies that underscore the critical role of maternal hygiene in preventing childhood diarrhea.¹³ A meta-analysis study in Ethiopia reported that inadequate handwashing practices among mothers were significantly associated with an increased risk of childhood diarrhea (OR:2.5, 95% CI: 1.3,2.1). A cluster-randomized control trial study by Lin *et al.* (2018) in rural Bangladesh examined the impact of individual and combined chlorinated drinking water, hygienic sanitation, handwashing (WSH), and nutritional interventions on protozoan infections in children.¹⁴ The study found that individual handwashing and hygienic sanitation interventions significantly reduced the prevalence of Giardia infections. However, chlorinated drinking water and nutrition improvements did not demonstrate a significant effect on protozoan infection rates. Furthermore, combined WSH interventions did not offer additional benefits beyond the individual interventions. These findings suggest that, in similar rural, low-income settings, targeted individual WSH interventions may be a more feasible and cost-effective approach to reducing Giardia infections compared to complex combined interventions. These study findings emphasized the urgent need for interventions that focus on improving maternal hygiene practices, particularly handwashing with soap at critical times, to effectively combat childhood diarrhea.

Access to clean water is a critical factor in preventing childhood diarrhea. This study found that children without adequate access to clean water were over four times more likely to experience diarrhea (Exp(B)=4.485). This finding aligns with existing research demonstrating the importance of clean water in reducing the risk of diarrhea in children. For example, a meta-analysis by Wolf *et al.* (2018) showed that interventions focused on improving drinking water quality and availability, such as point-of-use filters and piped water, significantly decreased the incidence of diarrhea compared to unimproved water sources.¹⁵ The study also highlighted the impact of other hygiene interventions, such as sanitation improvements and handwashing with soap, in reducing diarrhea prevalence.

The family latrine availability, which did not meet hygiene conditions, had a significant role in diarrhea incidence ($p < 0.05$ and OR=4.388). The results of this research were in line with research conducted by Ramadhani (2019), who stated that there was a relationship between the use of healthy latrines and the incidence of diarrhea in toddlers, but the strength of the relationship in this category was low.¹⁶ Studies have shown that factors such as the lack of household latrines, insufficient access to clean water, and poor latrine maintenance contribute to an increased risk of diarrhea. Additionally, inadequate sanitation facilities and improper waste management were associated with higher incidences of diarrheal diseases among children

under five. Ensuring the availability of clean and sanitary latrines in households was crucial in reducing the incidence of diarrhea among children, emphasizing the importance of proper sanitation practices and facilities.

Conclusions

The study found that poor personal hygiene practices, contaminated water sources, and unhygienic family latrines were significant risk factors for diarrhea among children under five. It is evident that increasing promotion programs on personal hygiene, particularly among mothers, is crucial for reducing diarrhea incidence.

Recommendations

This study identified poor environmental health facilities (water and sanitation) and detrimental maternal behaviors (feeding practices and hygiene) as significant risk factors for diarrhea among children under five. Therefore, interventions should prioritize improving access to clean water, developing standard family latrine use, encouraging safe food handling practices, and promoting good personal hygiene. These include infrastructure improvements, household water treatment, educating mothers on proper food preparation and storage, breastfeeding, and handwashing.

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Table 1. Characteristics of mothers.

| Variable | Category | Case | | Control | |
|-------------|---------------------|------|-------|---------|-------|
| | | N | % | N | % |
| Age (years) | 20-29 | 24 | 34,3 | 27 | 36,4 |
| | 30-39 | 38 | 54,2 | 36 | 51,4 |
| | ≥40 | 8 | 11,4 | 7 | 10,7 |
| Education | Elementary | 6 | 8,6 | 7 | 9,3 |
| | Junior high school | 28 | 40,0 | 25 | 37,9 |
| | Senior high school | 36 | 51,4 | 38 | 54,2 |
| Occupation | Housewife | 55 | 78,6 | 57 | 81,4 |
| | Self-employed | 13 | 18,6 | 10 | 16,4 |
| | Government-employed | 2 | 2,9 | 3 | 3,6 |
| | Total | 70 | 100,0 | 70 | 100,0 |

Table 2. Characteristics of children under five.

| Variable | Category | Case | | Control | |
|--------------|----------|------|-------|---------|-------|
| | | n | % | n | % |
| Age (months) | ≤12 | 9 | 12,9 | 4 | 5,7 |
| | 13-24 | 27 | 38,6 | 31 | 44,3 |
| | 25-36 | 15 | 21,4 | 17 | 24,3 |
| | >36 | 19 | 27,1 | 18 | 25,7 |
| Sex | Male | 39 | 55,7 | 42 | 60,0 |
| | Female | 31 | 44,3 | 28 | 40,0 |
| | Total | 70 | 100,0 | 70 | 100,0 |

Table 3. The influence of environmental health facilities on diarrhea incidence in children under five.

| Variable | Case | | Control | | OR (CL 95%) | <i>p-Value</i> |
|--------------------------------------|------|------|---------|------|----------------|----------------|
| | n | % | n | % | | |
| Qualification of clean water sources | | | | | | |
| Not qualified | 42 | 68,9 | 19 | 31,1 | 4,026 | 0,000 |
| Qualified | 28 | 35,4 | 51 | 64,6 | 1,977<OR<8,20 | |
| | | | | | 1 | |
| Availability of clean water | | | | | | |
| Not available | 9 | 60,0 | 6 | 40,0 | 1,574 | 0,412 |
| Available | 61 | 48,8 | 64 | 51,2 | 0,529<OR<4,68 | |
| | | | | | 5 | |
| Utilization of clean water | | | | | | |
| Not utilized | 30 | 78,9 | 8 | 21,1 | 5,813 | 0,000 |
| Utilized | 40 | 39,2 | 62 | 60,8 | 2,422<OR<13,9 | |
| | | | | | 48 | |
| Qualification of family latrines | | | | | | |
| Not qualified | 36 | 69,2 | 16 | 30,8 | 3,574 | 0,000 |
| Qualified | 34 | 38,6 | 54 | 61,4 | 1,724<OR<7,40 | |
| | | | | | 5 | |
| Utilization of family latrines | | | | | | |
| Not utilized | 39 | 67,2 | 19 | 32,8 | 3,377 | 0,001 |
| Utilized | 31 | 37,8 | 51 | 62,2 | 1,665<OR<6,84 | |
| | | | | | 8 | |

Table 4. The influence of mothers' health behavior as a risk factor on diarrhea incidence in children under five.

| Variable | Case | | Control | | OR (CL 95%) | <i>p-Value</i> |
|--|------|------|---------|------|----------------|----------------|
| | n | % | n | % | | |
| Feeding children while playing outside the house | | | | | | |
| Yes | 34 | 65,4 | 18 | 34,6 | 2,728 | |
| No | 36 | 40,9 | 52 | 59,1 | 1,339<OR<5,5 | 0,000 |
| 61 | | | | | | |
| Personal hygiene | | | | | | |
| Poor | 39 | 67,2 | 19 | 32,8 | 3,377 | |
| Good | 31 | 37,8 | 51 | 62,2 | 1,665<OR<6,8 | 0,001 |
| 48 | | | | | | |

Table 5. Logistic regression analysis: risk factors associated with diarrhea.

| Variable | B | SE | Wald | df | Sig. (p-value) | Exp (B) (OR) | β | Rank of contribution |
|--|--------|-------|--------|----|-------------------|-----------------|---------|----------------------|
| Poor personal hygiene of mothers | 1,592 | 0,440 | 13,081 | 1 | 0,000 | 4,916 | 1,592 | 1 |
| Qualification of clean water source | 1,501 | 0,425 | 12,481 | 1 | 0,000 | 4,485 | 1,501 | 2 |
| Qualification of family latrines | 1,479 | 0,446 | 10,994 | 1 | 0,001 | 4,388 | 1,479 | 3 |
| Feeding children while playing outside the house | 1,099 | 0,439 | 6,260 | 1 | 0,012 | 3,002 | 1,099 | 4 |
| Constant | -9,104 | 1,647 | -- | - | -- | -- | | |

-2 likelihood = 145,451

overall percentage correct =75,0

cox & snell R square =0,293