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Environmental risk factors of diarrhea in children under five years of age: A cross-sectional study in Indonesia

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ABSTRACT

Background and purpose: Diarrhea is an environmental-based disease that causes mortality and morbidity in children under five around the world. This study investigated the association between environmental factors with diarrhea in children under five in Indonesia.

Methods: A cross-sectional study was conducted with data derived from the 2017 Indonesia Demographic Health Survey (IDHS). Families with children under five who had complete data were included in this study. The diarrhea variable in children was self-reported by their mothers. The relationship of each predictor with diarrhea was analyzed using a logistic regression modeling and odds ratios (ORs) with 95% confidence intervals (CI).

Results: A total of 17,155 households with children under five were included. The prevalence of reported diarrhea among children under five was 14.22%. Families living in rural areas (OR: 0.87; 95%CI: 0.78-0.97) and mothers of 25-34 years of age (OR: 1.42; 95%CI: 1.24-1.64) and >35 years of age (OR: 1.56; 95%CI: 1.29-1.89) had significant associations with diarrhea.

Conclusion: The discerned outcomes underscore the amplified likelihood of diarrhea incidents among children under five originating from rural residential settings in contrast to their urban counterparts. Additionally, the investigation underscored a correlative link between maternal age and occurrences of diarrhea in the children of this specific age group mothers.

Keywords: Children under five years, diarrhea, IDHS, rural area

INTRODUCTION

Diarrhea is characterized by loose stools, decreased stool consistency, and passing three stools in 24 hours.[1,2] Children with diarrhea may suffer from dehydration and electrolyte disturbances, and children with diarrhea are at risk to experience stunting, malnutrition, and cognitive impairment.[3] Globally, diarrheal disease ranks as the second cause of morbidity and mortality in children under five years old. World Health Organization (WHO) reports that 1.7 billion cases of diarrhea among children are reported annually, resulting in 525,000 child deaths.[1] According to the Global Burden of Diseases, diarrheal disease is the leading cause of mortality among children under five years old (499,900 deaths; 95%CI: 447,000–558,000).[4] The 2016 WHO report showed that under-five mortality rate in low-income countries was 73.1 deaths per 1000 live births, almost 14 times the average rate in high-income countries (5.3 deaths).[5]

Based on the national health survey data, the prevalence of diarrhea in Indonesia was estimated to be 9.0% (4.2%-18.9%).[6] In 2013, it was reported at least 162,000 cases of diarrhea treated in Indonesia, which resulted in 460 deaths among children. Additionally, in 2012, the morbidity rate of diarrhea was 214 per 1000 people, resulting in 2,843,801 cases of diarrhea in Indonesia.[7] Moreover, there is an increasing trend in the number of provinces reporting higher incidence and crude fatality rates of diarrhea. It is estimated that there are around 40 million cases of infant diarrhea annually, resulting in 200,000 to 400,000 deaths per year.[7]

The prevalence of diarrhea is influenced by various factors, including environmental factors such as poor household environments, unsafe drinking water, and poor sanitation.[6] Studies have shown that children living in areas with inadequate access to safe drinking water and sanitation are at a higher risk of developing diarrhea.[4] In addition, low-income or marginalized populations are disproportionately affected by diarrheal diseases. Socioeconomic status is also an essential factor in diarrhea prevalence among young children, with those living in impoverished conditions being more susceptible to the disease.[8] Additionally, maternal-related factors, including maternal education levels and breastfeeding, have also been linked to diarrhea prevalence in young children. Studies have found that children who are breastfed exclusively for the first six months of life are less likely to develop diarrhea.[9]

Addressing the environmental factors, such as improving access to safe drinking water and sanitation and addressing food insecurity, is critical in reducing the burden of diarrhea in children under five, particularly in low-income or marginalized populations. This study investigates the association between environmental factors and diarrhea in children under five using data from the Indonesia Demographic Health Survey (IDHS).

METHODS

Study design and population

A cross-sectional study was conducted with data derived from the 2017 IDHS. Families with children under five who had complete information were included in this study. Children who were born prematurely were excluded from this study. Eligible families included in the analysis was 17,115 families with children under five years.

Variables

The diarrhea variable in children was self-reported by their mothers. Diarrhea variables were measured by asking all mothers whether their children had diarrhea in two weeks before the survey. Those who answered “yes” were coded 1, and “no” were coded 0. Other variables retrieved from the IDHS data were environmental

factors including residence types (urban, rural), wealth index (poorest or poor, middle, and rich), type of toilet (flush or poor flush toilet, pit latrine, composting toilet, and other), and types of drinking water (improved and not improved). The demographic factors were including: mother's age at child's birth in years (15-24, 25-34, 35 or more), mother's level of education (no education, primary, secondary, or higher), father's age at child's birth in years (15-24, 25-34, 35 or more), father's education (no education, primary, secondary, or higher).

Statistical Analysis

An analysis of the data was conducted using the statistical package SAS (v.9.4, SAS Institute, Cary, NC, USA). A descriptive statistical analysis was used to summarize the essential characteristics of the participants in the study. We used Chi-square test to evaluate the relationships of the variables with diarrhea.

In the multivariate analysis, each predictor's relationship with diarrhea was analyzed using a logistic regression modeling and odds ratios (ORs). We assessed the significance using 95% confidence intervals (CI) and *p*-values of <0.05. We included candidate factors with a p-value of 0.2 in the bivariate analysis to the multivariate modelling.

Our first step was to have household characteristics in the multivariate analyses. Next, the final model consists of all attributes of the participants, including parental characteristics. The variance inflation factor (VIF) test indicated no multicollinearity problems in the final regression model.

RESULT

The study included a total of 17,115 families with children under five years old, which were almost proportionally distributed based on their residential area and more than two third had a middle wealth index (77.95%). Most families reported using flush or poor flush toilets (82.82%) and obtaining drinking water from an unimproved source (59.11%). The educational level of parents varied, with 55.77% and 57.00% of mothers and fathers completing junior high school, respectively. More than half (52.25%) of mothers were aged between 25 and 34 years, while 45% of fathers were 35 years or over. The study found a prevalence of diarrhea of 14.22% among children under five. Additional details on the characteristics of study participants are presented in Table 1.

Table 2 presents the results of the bivariate analysis between various socio-demographic characteristics and diarrhea in children under five. Diarrhea was significantly related to residential types, wealth index, and type of toilet. Children whose parents with low education levels are more likely to have diarrhea. Moreover, mothers between the ages of 25 and 34 were more likely to have diarrhea in their children. While fathers over 35 were more likely to report diarrhea in their children.

Table 3 summarizes the findings from the multivariate analyses. In the final model, we found that families living in rural areas were less likely to have diarrhea than those living in urban areas. Furthermore, the older age of the mother was also associated with a higher risk of experiencing diarrhea in their children, with mothers aged 25-34 and >35 years showed higher risk compared to the youngest age group.

DISCUSSION

The primary objective of this study was to investigate the relationship between environmental factors and the prevalence of diarrhea among children under five in Indonesia. Using data from the IDHS, we aimed to shed light on this complex relationship. Our research yielded remarkable findings, highlighting a significant link between the geographical location of residence and the prevalence of diarrhea in this particular age group.

Specifically, families living in rural areas were less likely to have diarrhea in their under-five children than their urban counterparts. However, it's important to compare this with a previous study. The previous research in India underscored a contrasting narrative by indicating a higher incidence of diarrhea in rural areas.[10] This difference in findings prompts a deeper exploration of the underlying causes. In particular, the higher prevalence of diarrhea in rural areas could potentially be attributed to a confluence of environmental factors, most notably poor sanitation, inadequate access to improved drinking water sources and limited availability of health facilities. These determinants play a central role in increasing the vulnerability of children under five to diarrhea.[10,11]

Table 1. Characteristics of families and the prevalence of diarrhea in children under five in Indonesia

Characteristics (N=17,115)	f (%)
Environmental factors:	
Residence types	
Urban	8,433 (49.16)
Rural	8,722 (50.84)
Wealth index	
Poorest or poor	445 (3.06)
Middle	11,348 (77.95)
Rich	2,765 (18.99)
Type of toilet	
Flush or poor flush toilet	14,207 (82.82)
Pit latrine	595 (3.47)
Composing toilet	17,46 (10.18)
Other	606 (3.53)
Type of Drinking water	
Not improved	10,139 (59.11)
Improved	7,015 (40.89)
Demographic factors:	
Mother's education	
Preschool	236 (1.38)
Primary	4,253 (24.79)
Secondary	9,567 (55.77)
Higher	3,099 (18.06)
Mother's age (Years)	
15-24	3,122 (18.20)
25-34	8,964 (52.25)
≥35	5,069 (29.55)
Father's education	
Preschool	225 (1.35)
Primary	4,335 (26.08)
Secondary	9,474 (57.00)
Higher	2,586 (15.56)
Father's age (Years)	
15-24	1,512 (9.27)
25-34	7,366 (45.14)
≥35	7,441 (45.60)
Diarrhea:	
No	14,715 (85.78)
Yes	2,440 (14.22)

Table 2. Crude odds ratios of diarrhea based on environmental and demographic factors

Variables	Children's Diarrhea Status		
	Yes	No	COR (95%CI)
Environmental factors:			
Residence types			
Urban	1,096 (15.9)	7,337 (84.1)	Ref
Rural	1,344 (15.4)	7,378 (85.6)	0.81 (0.74-0.89)***
Wealthy index			
Poorest or poor	51	394	Ref
Middle	1,654	9,694	0.90 (0.68-0.99)**
Rich	306	2,459	1.26 (1.12-1.70)**
Type of toilet			
Flush or poor flush toilet	1,965	12,245	Ref
Pit latrine	83	512	0.859 (0.67-1.09)
Composing toilet	315	1,431	0.729 (0.63-0.83)**
Other	77	529	1.026 (0.78-1.34)
Type of Drinking water			
Un-improved source	1,500	8,639	Ref
Improved source	940	6,075	1.071 (0.97-1.17)
Demographic factors:			
Mother's education			
Preschool	39	197	Ref
Primary	675	3,578	0.832 (0.53-0.98)**
Secondary	1,385	8,182	0.958 (0.61-1.48)
Higher	341	2,758	1.384 (1.18-2.17)***
Mother's age (Years)			
15-24	589	2,533	Ref
25-34	1,216	7,748	1.505 (1.34-1.67)***
≥35	635	4,434	1.653 (1.46-1.87)***
Father's education			
Preschool	28	197	Ref
Primary	698	3,637	0.695 (0.42-0.83)***
Secondary	1,345	8,129	0.785 (0.48-0.98)*
Higher	277	2,309	1.216 (1.13-2.01)***
Father's age (Years)			
15-24	284	1,228	Ref
25-34	1,099	6,267	1.234 (1.05-1.44)
≥35	933	6,508	1.467 (1.26-1.72)***

COR=crude odds ratio; CI=confidence interval; *p<0.05, **p<0.01, ***p<0.001

Furthermore, an examination of the available literature concerning childhood diarrhea underscores the substantive influence exerted by both environmental conditions and personal hygiene practices on the propagation of acute diarrhea within rural regions.[12,13] Counter to this pattern, an investigative study conducted in the locale of Mbour presents a divergent trend, unveiling a higher incidence of diarrheal cases within urban settings as compared to their rural counterparts. This variance in outcomes necessitates a nuanced analysis, wherein potential factors contributed to the elevated urban cases including overcrowding as well as deficiencies in accessing high-quality healthcare resources.[14]

Table 3. Multivariate regression model of children's diarrhea

	1st Model aOR (95%CI)	2nd Model aOR (95%CI)
Environmental factors:		
Residence types		
Urban	Ref	Ref
Rural	**0.82 (0.74-0.91)*** **	**0.87 (0.78-0.97)***
Wealthy index		
Poorest or poor	Ref	Ref
Middle	**0.88 (0.67-0.99)** **	0.85 (0.62-1.15)
Rich	**1.25 (1.12-1.71)** **	1.02 (0.72-1.43)
Type of toilet		
Flush or poor flush toilet	Ref	Ref
Pit latrine	0.93 (0.70-1.24)	1.03 (0.76-1.40)
Composing toilet	0.79 (0.67-0.93)	0.83 (0.69-0.99)
Other	0.79 (0.58-1.07)	1.02 (0.74-1.42)
Type of Drinking water		
Un-improved source	Ref	Ref
Improved source	0.94 (0.85-1.04)	0.90 (0.80-1.00)
Demographic factors:		
Mother's education	-	
Preschool		Ref
Primary		0.90 (0.44-1.81)
Secondary		1.01 (0.50-2.04)
Higher		1.15 (0.56-2.37)
Mother's age (Years)	-	
15-24		Ref
25-34		1.42 (1.24-1.64)*
≥35		1.56 (1.29-1.89)***
Father's education	-	
Preschool		Ref
Primary		0.58 (0.28-1.15)
Secondary		0.57 (0.28-1.17)
Higher		0.69 (0.33-1.45)
Father's age (Years)	-	
15-24		Ref
25-34		1.06 (0.86-1.30)
≥35		1.13 (0.89-1.43)

*p<0.05, **p<0.01, ***p<0.001; aOR=adjusted odds ratio; CI=confidence interval

We observed that households with a medium income level were significantly associated with an increased likelihood of reported diarrhea among children under five.[15] Our results were consistent with a previous study conducted in Manado that also reported a link between family income and diarrhea in young children. However, our findings were inconsistent with other studies that found an association between diarrhea and poor sanitation. Wealthier families tend to have better access to hygiene and sanitation facilities, such as soap for handwashing, aqua-guard to protect their homes against bacterial contamination in water, and constructed toilets. In contrast, low-income families often face financial constraints and lack access to these resources, which puts them at a higher risk for diarrhea.[16] Furthermore, previous study identified several social determinants of health, such as poverty, limited access to healthcare, social networks, lack of education, stigma, racism, and gender bias, as key factors contributing to health inequalities.[15]

Mothers aged 25-34 and those aged ≥35 were more likely to report cases of diarrhea in their under-five children. This association between mother's age and the prevalence of diarrhea is consistent with previous research.[17] Specifically, young children born to older mothers are at increased risk of experiencing diarrhea, a

correlation underscored by the previous study.[18,19] Notably, several studies accentuate how age can shape an individual's health knowledge and behaviors. In the context of this study, mothers aged ≥35 years emerge as particularly susceptible to providing inadequate treatment for their toddlers' diarrhea. This phenomenon could potentially be attributed to the interplay of factors such as access to education and generational shifts. The inference drawn is that younger mothers tend to have improved access to education and health information due to evolving societal trends, while formal education might be comparatively less accessible for older mothers.[20]

Education level is also essential in diarrhea symptoms amongst children aged under five. This study indicated that children whose parents had low education levels are more likely to experience diarrhea. This is in line with several studies which mention that maternal educational status was statistically associated with childhood diarrhea. In comparison to children whose mothers did not have any formal education, children whose mothers attended primary and higher education had a lower risk of diarrhea. This may be because education is expected to enhance household health and sanitation practices. Education can increase awareness about diarrhea transmission and prevention methods.[9,16]

This study exhibits several strengths. Firstly, the response rates of the IDHS were notably high,[21] thereby reflecting a commendable level of participant engagement that enhances the data's robustness. Additionally, the study harnessed a standardized questionnaire, validated through previous research,[21] further bolstering the methodological integrity of the investigation. However, inherent limitations exist within this study. The reliance on maternal self-reported data collection introduces the potential for recall bias. Moreover, the study's cross-sectional design (first phase) constrains the ability to infer causal relationships between environmental factors and diarrhea, as cross-sectional studies predominantly offer static snapshots of data rather than longitudinal insights. To address these limitations and amplify our understanding of the intricate interplay between environmental factors and diarrhea in children under five, it is imperative that forthcoming research undertakings adopt more objective data collection methods. Integration of laboratory testing can yield quantifiable indicators of environmental influences, thereby mitigating potential biases linked to self-reporting. Equally vital is the incorporation of longitudinal research designs, facilitating nuanced investigations into the temporal dynamics between environmental factors and diarrhea onset. Moreover, it's important to note the absence of data pertaining to sanitation and hygiene behaviors, despite their evident association with diarrhea. This information gap impedes a holistic understanding of the multifaceted influences contributing to diarrhea prevalence. Therefore, future studies are strongly recommended to encompass a comprehensive assessment of sanitation and hygiene practices, facilitating an exhaustive analysis of their role in shaping diarrhea's occurrence among children under five.

CONCLUSION

The research findings reveal a noteworthy link between residing in rural areas and the elevated prevalence of diarrhea among children under five in Indonesia. Furthermore, maternal age has surfaced as another influencing factor in diarrhea occurrence within this age group. To comprehensively address the issue of diarrhea, it is imperative to delve deeper into these relationships. This necessitates the pursuit of further studies, specifically employing longitudinal research designs that track data over extended periods and intervention studies that explore potential strategies for mitigating the impact of environmental factors. Through these endeavors, a clearer understanding of the causal connections between environmental factors and diarrhea among children under five can be established, guiding the development of more effective prevention and intervention efforts.

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AUTHOR CONTRIBUTION

Conceptualized and designed the study: I.N.S and Y.W. Performed the analysis: I.N.S. Curated the data: I.N.S and Y.W. Wrote the original draft: I.N.S. Interpreted the data: I.N.S. and Y.W. Revised the manuscript: I.N.S and Y.W. All authors have read and agreed to the published version of the manuscript.

CONFLICT OF INTEREST

There are no conflicts of interest.

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