

## Multilevel Analysis: Biopsychosocial Determinants and Environmental Factor on the Incidence of Diarrhea Among Children Under Five in Surakarta

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### ABSTRACT

**Background:** Diarrhea is an endemic disease with a potential to become epidemic in Indonesia. Diarrhea most often occurs in children under five years of age. This study aimed to determine the relationship between biopsychosocial factors, environmental factor, and diarrhea occurrence in Surakarta, Central Java, using multilevel analysis.

**Subjects and Method:** This was an observational analytic study with a cross-sectional approach. This study was conducted on October 2017 - April 2018. A sample of 200 children under five years of age was selected by fixed disease sampling, consisting of 100 children with diarrhea and 100 without diarrhea. The dependent variable was the incidence of diarrhea. The independent variables were the number of family members, maternal knowledge, maternal personal hygiene, and environmental sanitation. The data were collected by questionnaire and analyzed by multilevel logistic regression in Stata 13.

**Results:** The number of family member ( $b = 1.09$ ; 95% CI = 0.02 to 2.15;  $p < 0.046$ ) increased the risk of diarrhea. Good maternal knowledge ( $b = -2.30$ ; 95% CI = -3.46 to -1.14;  $p < 0.001$ ), good maternal personal hygiene ( $b = -2.09$ ; 95% CI = -3.48 to -0.70;  $p < 0.003$ ), and good environmental sanitation ( $b = -1.64$ ; 95% CI = -2.84 to -0.43;  $p = 0.008$ ) decreased the risk of diarrhea in children under five. Village had a substantial contextual effect on the incidence of diarrhea with ICC = 66.14%.

**Conclusion:** The number of family member increases the risk of diarrhea. Good maternal knowledge, good maternal personal hygiene, and good environmental sanitation decrease the risk of diarrhea in children under five. Village has a substantial contextual effect on the incidence of diarrhea

**Keywords:** diarrhea, number of family member, maternal knowledge, maternal personal hygiene, village, contextual effect

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### BACKGROUND

Diarrheal is the second leading cause of death in infants and kills approximately 525,000 toddlers annually worldwide. Globally, there are nearly 1.7 billion cases of diarrhea in toddlers every year. Each episode of diarrhea will result in the loss of nutrients needed by children to grow, so diarrhea is a major cause of malnutrition in children under five (WHO, 2017). Based on

data of Centers for Disease Control and Prevention (2015) there are 2,195 children die every day due to diarrhea. Diarrheal disease causes 1 among 9 toddlers deaths worldwide.

Diarrhea is an endemic disease in Indonesia and is also a potential illness of outbreaks (KLB) that often leads to death. Most diarrhea patients are children under five years (toddlers). In 2015, there were 18

outbreaks of Diarrhea in 11 provinces, 18 districts/cities, with 1,213 people and 30 deaths with Case Fatality Rate (CFR) of 2.47%. Poor sanitation conditions will have negative impacts in many aspects of life, ranging from the decline in the quality of the community's environment, pollution of drinking water sources to the community, the increasing number of diarrhea and the emergence of several diseases (Ministry of health, 2016). According to the data of Indonesia Health Profile 2016, it is estimated that the number of diarrhea patients in health facilities is 6,897,463 people, while the number of diarrhea patients reported which are handled in health facilities are 2,544,084 people or 36.9% (Ministry of Health RI, 2017).

Some factors that trigger the occurrence of diarrhea are the provision of clean water, family latrines, waste processing, waste water management and personal hygiene (Fauziah al., 2016). In addition to environmental sanitation factors, personal factors of maternal hygiene are also very influential on the incidence of diarrhea in infants. Mother's behavior contributes to the increase of diarrhea cases in infants. Mother is the closest person to a toddler who takes care of all the needs such as bathing, preparing and providing food and drink. Unhygienic mothers' behaviors such as not washing hands while feeding children, not cooking and cooking utensils can cause toddlers to be affected by diarrhea (Maharani and Yusiana, 2013).

Biopsychosocial concept is a concept that involves the interaction between biological, psychological and social factors in an effort to understand the process of a sickness and illness of a person and view the mind and body as a whole. The concept of biopsychosocial brings the notion that the condition of pain is not only in terms of physical medicine but also of the psycho-

logical conditions that are influenced by environmental factors (Andri, 2011). The biopsychosocial approach systematically considers the biological, psychological, and social factors and complex interactions in understanding the health problems including diarrhea (Lowe et al., 2016).

Based on Central Java Provincial Health Profile (2016) data, the proportion of cases of diarrhea in 2016 was 68.9%, it increased compared to the proportion of 2015 which was at 67.7%. In Central Java Province, the achievement of population with access to proper sanitation in 2016 was 77.60%, it was lower than the achievement in 2015 which was 78.70%. The percentage of total community based sanitation village (STBM) in 2016 was 62.7%, it slightly increased compared to that in 2015 which was 61.4%. Data on the study of clean and healthy living behavior (PHBS) in the household order reported by District Health Office in Central Java in 2016 percentage of households were 44.03%, it has decreased compared to that in 2015 which was 46.45%.

The number of diarrhea patients in Surakarta City which was handled in 2016 was 11,183 people, most cases occurred in banjarsari sub district for about 4,211 people, followed by laweyan sub district for about 2,136 people and jebres district for about 1892 people. Surakarta is the lowest percentage of the implementation of STBM which was 3.9% in 2016. The percentage of population with decent sanitation access is 61.7% and the coverage of clean and healthy living (PHBS) is 74.2% (Surakarta City Health Office 2017).

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## SUBJECTS AND METHOD

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### 1. Study design

This was an analytic observational study with a cross sectional design. The study was

conducted in Surakarta, Central Java, Indonesia, in October 2017 - april 2018.

## 2. Population dan sample

The population source in this study was toddlers in Banjarnegara regency. A sample of 200 children comprising 8 children from each village by fixed disease sampling.

## 3. Study variables

The dependent variable was diarrhea. The independent variables were family size, maternal knowledge, maternal healthy behavior, and environmental sanitation.

## 4. Operational definition of variables

The incidence of diarrhea is described as a condition of bowel discharge 3 times or more per day in infants with consistency of soft or liquid stool.

The number of family members was defined as how many people in a family. The measurement scale was continuous.

Maternal knowledge was defined as things that the mother knows about diarrhea in children under five including the definition, causes, symptoms, prevention and treatment. The measurement scale was continuous.

Maternal healthy behavior was defined as a mother's behavior that can cause diarrhea in infants. The measurement scale was continuous.

Environmental sanitation was defined as the condition of the maternal residence which includes the availability of sanitation facilities such as toilet, clean water source, dustbin, and sewerage channel. The measurement scale was continuous.

## 5. Study Instruments

The data about the number of family members, mother's knowledge and behavior were obtained using questionnaires. The environmental sanitation data were obtained using an observation sheet. The data of urban village standby stratum was obtained based on the annual report of City Health Office.

## 6. Data analysis

Univariate analysis was done to see the frequency distribution and percentage characteristics of research subjects. Bivariate analysis was done to study the relationship between diarrhea occurrence and independent variables using chi-square test and odds ratio calculation (OR) with confidence level (CI) of 95%. Furthermore multivariate analysis was done using logistic regression through multilevel approach.

## 7. Research ethics

The research ethics included informed consent, anonymity, confidentiality and ethical clearance. Ethical clearance in this study was conducted at Dr. Moewardi hospital, Surakarta.

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## RESULTS

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### 1. The Characteristics of Subjects

Distribution frequency characteristic of children was described in table 1.

Table 1 shows that the proportion of children under five who experienced the highest incidence of diarrhea in the age group <24 months was 42 children (66.7%), the age proportion of children who did not experience the highest incidence of diarrhea in the age group ≥24 months was 79 people (57.7% ). Most of the educational level of mothers whose children did not experience diarrhea were senior high school graduate for about 61 people (57%), while mothers whose children suffer diarrhea mostly had education level <Senior high school for about 54 people (58.1%). Most of the income of the family which the children did not suffer from diarrhea belongs to the group whose outcome is ≥Rp. 1,668,700 for about 55 people (56.1%), whereas toddlers experiencing diarrhea incidence mostly reside in group whose income of family <Rp. 1,668,700 for about 57 people (55.9%). Most of the children under five suffered from low social capital (39.9%),

while those without diarrhea were the highest in the high social capital group (77.8%).

## 2. Bivariate analysis determinant of diarrhea occurrence

Bivariate analysis was used to observe independent variables (family size, maternal

knowledge, maternal healthy behavior, and environmental sanitation) with the dependent variable (diarrhea occurrence). The result of bivariate analysis can be seen in Table 2.

**Table 1. Sample Characteristics**

Subject Characteristics	Diarrhea Case				Total	
	no diarrhea		diarrhea		n=200	%
	n=100	%	n=100	%		
<b>Children age</b>						
< 24 months	21	33.3	42	66.7	63	100
≥24 months	79	57.7	58	42.3	137	100
<b>Mmaternal education</b>						
< Senior high school	39	41.9	54	58.1	93	100
≥ Senior high school	61	57	46	43	107	100
<b>Family Income</b>						
< Rp 1,668,700	45	44.1	57	55.9	102	100
≥ Rp 1,668,700	55	56.1	43	43.9	98	100
<b>Social Capital</b>						
Low	23	37.1	39	62.9	62	100
High	77	55.8	61	44.2	138	100

**Table 2. Bivariate Analysis of Determinants of Diarrhea Occurrence**

Variable	Diarrhea Case				Total		OR	95% CI	p
	no diarrhea		diarrhea		N	%			
	n	%	N	%					
<b>Family size</b>									
≤ 4	54	59.3	37	40.7	91	100	1.9	1.1 – 3.5	0.016
> 4	46	42.2	63	57.8	109	100			
<b>Maternal knowledge</b>									
Poor	21	22.6	72	77.4	93	100	0.1	0.1 – 0.2	<0.001
Good	79	73.8	28	26.2	107	100			
<b>Maternal healthy behavior</b>									
Poor	11	16.9	54	83.1	65	100	0.1	0.1 – 0.2	<0.001
Good	89	65.9	46	34.1	135	100			
<b>Environment sanitation</b>									
High	16	22.2	56	77.8	72	100	0.2	0.1 – 0.2	<0.001
Low	84	65.6	44	34.4	128	100			

## 3. Multivariate analysis with multi-level approach

Multivariate analysis describes the effect of more than one independent variable to one dependent variable. The method used is multilevel logistic regression was STATA 13 program.

Table 3 shows that the number of family members >4 people (b= 1.09; 95% CI= 0.02 to 2.15; p= 0.046) increased the risk of diarrhea. Good maternal knowledge (b= -2.30; 95% CI= -3.46 to -0.70; p= 0.003), good maternal behaviour (b= -2.09; 95% CI= -3.47 to -0.70; p= 0.003)

and good environmental sanitation ( $b = -1.64$ ; 95% CI =  $-2.83$  to  $-0.43$ ;  $p = 0.003$ ) reduced the risk of diarrhea in infants.

In the data analysis, the ICC results were 66.14%. It shows that the variation of diarrhea incidence which was about 66.14% is determined by the variable at the village level. This figure is bigger than the standard

role of thumb size of 8-10% then the contextual influence shown from the multi-level analysis is very important to be taken into account. In the table, it is also shown that  $p < 0.001$ . This means that multilevel models differ statistically significant from ordinary logistic regression models.

**Table 3. Results of multilevel logistic regression determinant of diarrhea in infants in Surakarta**

Diarrhea Case/Incidents	b	95% CI		p
		Lower limit	Upper limit	
<b>Fixed Effect</b>				
The number of family member >4	1.09	0.02	2.15	0.046
Good maternal knowledge	-2.30	-3.46	-1.14	<0.001
Good behavior	-2.09	-3.47	-0.70	0.003
Good environmental sanitation	-1.64	-2.83	-0.43	0.003
<b>Random Effect</b>				
Village	6.42	1.99	20.81	
n observasi = 250				
Log likelihood = - 70.77				
LR test vs. logistic regression, $p < 0.001$				
ICC = 66.14%				

## DISCUSSION

### 1. The effect of family size on the occurrence of diarrhea

The results of this study showed that family size  $\geq 4$  increased the risk of diarrhea. This study is consistent with Okour et al. (2012), which stated that family size is one of the determinants of risk factors for diarrhea.

Based on a study conducted by Mohammed and Tamiru (2014), it showed that households that have family members greater than 5 people are at high risk of diarrhea. Susanti et al. (2016) found that occupancy density >4 persons in the household greatly affected the susceptibility of children under five suffering from diarrhea because diarrhea is a contagious disease that not only occurs in infants but also occurs in adults. If an adult in a household has diarrhea, a toddler living in the same household is at risk for diarrhea.

### 2. The effect of maternal knowledge on the occurrence of diarrhea

The results of this study indicate that good maternal knowledge reduced the risk of diarrhea in children under five.

Maternal knowledge remains as a strong predictor of diarrhea morbidity. Lack of knowledge of mothers about healthy life is a risk factor that causes diarrhea in infants (Merga and Alemayehu, 2015).

According to a study conducted by Mukhtar et al. (2011), it was concluded that poor maternal knowledge about the dangers of diarrhea and its treatment caused the child severe dehydration during diarrhea. This is supported by the results of a study by Mumtaz et al. (2014) which indicates that the lack of knowledge of mothers about the dangers of diarrhea leads to a lack of attitudes and practices in prevention and appropriate treatment in case of diarrhea. Therefore, there is a need for maternal

health education about diarrhea to prevent immediate prevention if exposed to diarrhea.

This result is consistent with a study conducted by Desta et al. (2017), which stated that maternal knowledge is significantly associated with diarrheal cases. Maternal knowledge of diarrhea is directly related to the level of education, employment and information.

### **3. The effect of maternal healthy behavior on the occurrence of diarrhea**

The results of this study indicate that there is an effect of diarrhea prevention behavior on the occurrence of diarrhea. Mothers who have a toddler with good behavior have an effect on reducing the incidence of diarrhea, while the mother of underfives with bad behavior have an effect to increase the risk of diarrhea in the children.

Behavioral factors that can cause and increase the risk of diarrhea in infants include defecating, using contaminated drinking water, not washing hands after defecating and disposing of feces properly, not exclusively breastfeeding (milk) does not provide measles immunization for children under five, as well as waste disposal behavior (Mengistie et al., 2013; George et al., 2014; Thiam et al., 2017). Hand washing habits have a significant relationship with the incidence of diarrhea. Washing hands with soap, especially after defecation, after disposing of feces, before preparing food, before feeding the child and before meals has an impact in reducing the incidence of diarrhea (Rohmah and Syahrul, 2017).

### **4. The effect of environmental sanitation on the diarrhea occurrence**

This study also resulted in the finding that there is an effect of environmental sanitation on the incidence of diarrhea in children under five. Children with good

environmental sanitation have a lower risk of having diarrhea from those with less environmental sanitation.

Study conducted by Imada et al. (2016), analyzed the relationship of environmental sanitation with the occurrence of diarrhea in the Amazon. The result shows that there was a decrease in the prevalence of diarrhea from 45.1% to 35.4% with the improvement of sanitation.

This finding is in line with the study of Roman et al. (2017) which stated that diarrhea risk factors include poor sanitation, unsafe water supply and improper environmental hygiene. Mukti et al. (2016) showed that there were still households using latrines without septic tanks. In latrines that do not have septic tanks, feces can seep into the soil around the toilet and contaminate the water source. Fecal exhausted feces around the house cause unpleasant odor and are infested with flies, thus becoming a source of diarrhea transmission.

Consuming unhygienic drinking water increases the risk of diarrhea in children (Hasan and Richardson, 2017). The study of Samwel et al. (2014) suggests that household characteristics that have a statistically significant effect on the incidence of diarrhea in children include the source of drinking water. This is in line with a study of Bitew et al. (2017) indicating that the use of unprotected unprotected water sources and inadequate drinking water services increase the risk of diarrhea in toddlers.

Zelege and Alemu (2014) showed that household waste management is one of diarrhea risk factors. Handling methods and types of waste collection in households that are not sanitary is an environmental exposure to the incidence of diarrhea in infants. This is in line with the results of Thiam et al. (2017) study stating that the use of open pockets for storing household

waste and disposing of household waste has a significant relationship to the incidence of diarrhea.

### 5. The effect of village level on the diarrhea occurrence

The results showed that the variation of diarrhea incidence which was 66.14% is determined by the variables at the village level, so it is important to be taken into account.

The low quality of the environment is a potential condition for the transmission of diarrheal diseases (Patil et al., 2014). Slum environmental conditions are at high risk of diarrheal cases due to poor housing and facility sanitation (Adane et al., 2017).

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