Contribution of Environmental Factors and Infectious Diseases Towards Infant Mortality in Rembang District

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Article Info

Abstract

Statistics indicate that the Infant Mortality Rate (IMR) is in the ratio of 17.7/1000 live births in Rembang District, Central Java Province. Therefore, this study sought to determine the contribution of infectious diseases and environmental factors to high infant mortalities recorded in this region. The study implemented an observational analysis with a case-control design with 64 respondents, consisting of equal case and control samples. The sample was selected through purposive sampling, while data collection involved interviews and observations methods. From the results, the variables strongly related to the incidence of infant mortality were ventilate condition with an OR = 5,672 and 95% CI = 1.525 – 21.104 and infectious diseases with an OR = 4.211 and 95% CI = 1.313 – 13.508. Also, the infectious diseases and condition of ventilate variables signified an interaction with a p-value = 0.001.

INTRODUCTION

The quality of national health depends on several indicators, including the Infant Mortality Rate (IMR). IMR is the number of infant deaths (0-11 months) per 1,000 live births in one year (Central Java Province Health Office, 2019), which also functions as an essential indicator for assessing children and women's health and well-being (Sari & Prasetyani, 2021). It measures the quality of human development and describes the issues in public health, health service access and quality, women's health status, and socio-economic conditions of a country (Kiross et al., 2021).

During the last two decades, the global infant mortality rate has decreased. An estimated 6.3 million children died in 2017 from preventable causes, while 1.6 million others died in infancy. According to research conducted in 56 countries, infant mortality still appears as a global health problem that accounts for 144 deaths per 1,000 live births, especially for low and middle income countries (Baraki et al., 2020).

The Indonesian Demographic and Health Survey (IDHS) showed a decreasing IMR from 32/1,000 in 2012 to 24/1,000 in 2017, yet the rate was still higher than the other countries in ASEAN (Indonesian Health Ministry, 2020).

The Central Java Province, in particular, recorded an 8.2/1,000 rate of IMR, in which Rembang District was listed with the highest mortality rate, reaching 17.7/1,000. The IMR in Rembang District has yet to reach Central Java's target of 8.3/1,000 live births (Central Java Province Health Office, 2020).

Infant mortality is affected by various factors, including socio-economy, infancy, maternity, health service, and environmental factors. The high infant mortality rate in Rembang District derived from several health problems, including infectious diseases, low birth weight, asphyxia, congenital abnormalities, encephalitis, and meningitis (Rembang District Health Office, 2020). In another case, Collins et al. (2012) revealed infectious disease as the dominant factor of infant mortality in Nunavut. Respiratory tract disease was commonly found among Nunavut people, which was caused by prematurity, exposure to cigarette smoke, poor housing ventilation, and high population density. A total of 90% of houses in Nunavut were exposed to cigarette smoke. The housings were crowded due to a large number of family members, the small size of the building, and the lack of condition of ventilate for air circulation. Such housing conditions indirectly indicate the quality of the family's health problems since the physical buildings are below the health standards, resulting in higher exposure of disease-causing agents that may infect the family members (Trisiyah & Umbul, 2018).

Ezeh et al. (2014) revealed that around 1.4 million child deaths each year occurred due to diarrheal diseases caused by poor water and sanitation. Babies are more susceptible to health problems associated with poor water sources and sanitation, as their immune systems, respiratory, and digestive systems are still developing. Households with no access to adequate water sources and proper sanitation facilities significantly increase infant mortality levels during the post-neonatal period by 1.38 times compared to infants with access to decent water quality and good sanitation. Babies are very susceptible to disease and infection. Newborns get transplacental immunity from their mothers when they are in the womb. However, when they are exposed to germs from the outside, they do not have a perfect immunity to protect them from potential diseases. Such a condition has caused infant deaths due to improper handling (Rini & Puspitasari, 2014).

Unhealthy housings, exposure to chemicals from cigarette smoke, and a low level of clean and healthy living behavior contribute to the increasing infant mortality. Pregnant women who are exposed to cigarette smoke have a higher risk of complications, including the rates of spontaneous abortion, ectopic pregnancy, placental abruption, placenta previa, preterm delivery, and preterm birth (Andriani et al., 2016; Rang et al., 2020). Exposure to cigarette smoke in the fetus causes age-appropriate fetal development, low birth weight (LBW), small head circumference, congenital impairment, and an increased risk of stillbirth. Newborn babies may be suffering from diseases, such as respiratory tract infections, including pneumonia, bronchitis, pulmonary tuberculosis, and otitis media (Gould et al., 2020).

Data from Rembang District Health Office (2020) showed that the coverage of health services for pregnant women to newborn in Rembang is all over 90%. The coverage of healthy houses is 74% while 26% still do not meet the requirements for healthy homes. The public condition when viewed by the largest expenditure on food, drink, and cigarettes are 42% of total household consumption. Cigarettes remain a priority for most people in Rembang District.

A research initiative is substantial to determine the contribution of environmental factors and infectious diseases that contribute to infant mortality in the Rembang District. The study is expected to provide inputs and consideration for relevant agencies in making policies and program plans to reduce the infant mortality rate in the region.

METHOD

The study was organized in Rembang District in 2021. It implemented an observational analysis with a case-control design to examine

the relationship between effects and certain risk factors. It also assessed the measurement of the risk factors for the occurrence of health problems. The independent variables were infectious diseases, exposure to cigarette smoke, condition of lavatory, drinking water sources, and condition of ventilate. Meanwhile, infant mortality was the dependent variable.

The case population consisted of all mothers who experienced infant mortality right after birth to the infant age less than a year. Meanwhile, the control population were all mothers who did not experience infant mortality right after birth to the infant age less than a year. Through a purposive sampling, 32 respondents were selected respectively as the case samples and control samples based on several criteria. The criteria consisted of the requirements that the respondents had been registered for residence and delivery location in Rembang District, obtained complete access for maternal care, obtained delivery assistance from health workers, and had constant physical housing conditions in time between the pregnancy and the organization of the study. A purposive sampling method was utilized for the sample determination.

The data sources included the database of Rembang District Health Office in 2019, field observation, and interviews with respondents. The univariate analysis aimed to produce a general description through the presentation in tables and narratives. The bivariate analysis aimed to determine the relationship and measurement of risks between the independent and dependent variables. Meanwhile, the multivariate analysis assisted in determining the relationship between variables. This research was by the Health Research Ethics Committee, Sports Science Faculty, Universitas Negeri Semarang No 076/KEPK/EC/2021.

RESULTS AND DISCUSSION

The univariate analysis of the case group (table 1) showed the variation of positive frequencies of respective variables. A total of 13 respondents (40.6%) mentioned a low risk of infectious disease, only eight respondents

Table 1. Frequency Distribution of Case Samples

No	Variable	Frequency (n)	%
1	Infectious diseases		
	High risk	19	9.4
	Low risk	13	40.6
2	Exposure to cigarette smoke	24	75.0
	Exposed	8	25.0
	Not exposed		
3	Condition of lavatorie	11	34.4
	Indecent	21	65.6
	Decent		
4	Drinking water source	14	43.8
	Indecent	18	56.2
	Decent		
5	Condition of ventilate	16	50.0
	Inadequate	16	50.0
	Adequate		

(25.0%) responded of not being exposed to the cigarette smoke, 21 respondents (65.6%) stated of having decent condition of lavatorie, and 18 respondents (56.2%) stated of having access to clean drinking water sources. In contrast, condition of ventilate variable shared the same frequencies between those that met the standard and those that did not.

Table 2 details the averagely high frequencies of positive values of respective variables among the control group. A total of 25 respondents (78.1%) highlighted a low risk of infectious diseases, 17 respondents (53.1%) were not exposed to cigarette smoke, 24 respondents (75.0%) had decent condition of lavatorie, 24 respondents (75.0%) obtained access to clean drinking water sources, and 28 respondents (87.5%) had adequate condition of ventilate.

Table 3 showed the bivariate test determined the relationship between the independent and dependent variables and measure the risks. The chi-square test generated a *p-value* = 0.002, reflecting a relationship between infectious diseases and infant mortality in Rembang District in 2019. The Odds Ratio (OR) = 5.220 and 95% CI = 1.745 – 15.611 indicated a risk of 5.220 times greater for infants

with infectious diseases than those with no infectious diseases. This finding is relevant to **Table 2.** Frequency Distribution of Control Samples

No	Variable	Frequency (n)	%
1	Infectious diseases		
	High risk	7	21.9
	Low risk	25	78.1
2	Exposure to cigarette smoke		
	Exposed	15	46.9
	Not exposed	17	53.1
3	Condition of lavatorie		
	Indecent	8	25.0
	Decent	24	75.0
4	Drinking water source		
	Indecent	8	25.0
	Decent	24	75.0
5	Condition of ventilate		
	Inadequate	4	12.5
	Adequate	28	87.5

Rini and Puspitasari (2014) revealing infectious diseases as a risk factor of infant mortality in Sumberasih Health Center.

Infectious diseases are commonly caused by bacteria, viruses, and fungi that spread through water, air, unhealthy living environment, and vector animals. A particular record of maternal pregnancy with complications, prolonged delivery, surgical delivery, birth trauma, and premature birth can also lead to infectious diseases. Infants with infectious diseases are in a critical state due to the still-developing immune system, while the infection may quickly spread to the blood vessels. It is not uncommon for Indonesian mothers to take their babies to health care facilities during an emergency (Kollmann et al., 2017).

The interviews revealed that infectious diseases were found in 19 stillborn infants and 7 live infants. The diseases included ARI (50%), diarrhea (15.38%), heart infection (11.53%), sepsis (7.69%), pneumonia (3.85%), asthma (3, 85%), step (3.85%), and dengue fever (3.85%). The two most common infectious diseases were ARI and diarrhea, which were closely related to environmental factors. This case is related to unsanitary physical housing conditions, inadequate access to clean water, and poor hygiene water (Alemu, 2017).

Table 3. Bivariate Analysis

No	Variable	Case		Control		p-value	OR (95% CI)
		n	%	n	%		
1	Infectious diseases						
	High risk	19	59.4	7	21.9	0.002	5.220
	Low risk	13	40.6	25	78.1		(1.745 – 15.611)
	Total	32	100.0	32	100.0		
2	Exposed to cigarette smoke						
	Exposed	24	75.0	15	46.9	0.021	3.400
	Not exposed	8	25.0	17	53.1		(1.179 – 9.808)
	Total	32	100.0	32	100.0		
	Condition of lavatorie						
3	Indecent	11	34.4	8	25.0	0.412	-
	Decent	21	65.6	24	75.0		
	Total	32	100.0	32	100.0		
	Drinking water source						
4	Indecent	14	43.8	8	25.0	0.114	-
	Decent	18	56.2	24	75.0		
	Total	32	100.0	32	100.0		
5	Condition of ventilate						
	Inadequate	16	50.0	4	12.5	0.001	7.000
	Adequate	16	50.0	28	87.5		(1.993 – 24.581)
	Total	32	100.0	32	100.0		

Infectious diseases in infants can be prevented through breastfeeding. Babies who are not breastfed have a 2.65 times higher risk of death than those who are breastfed. Breastfeeding can protect babies from infections and stillborn syndrome (Lamichhane, Zhao, Paudel, & Adewuyi, 2017). It can also improve their digestive responses to the exposure of microorganisms to the gastrointestinal tract and limit the penetration of bacteria into the bloodstream through the gastrointestinal mucosa. Mothers with an immune digestive tract can produce quality breast milk. An intervention to the households with low socio-economic conditions is considered urgent to provide pregnant mothers with a healthy environment by increasing welfare, improving sanitation facilities, maintaining cleanliness, and managing clean water resources (Ezeh et al., 2014).

The chi-square test on the cigarette smoke exposure variable generated a *p-value* = 0.021, reflecting a relationship between the exposure to cigarette smoke and infant mortality in Rembang District in 2019. The Odds Ratio (OR) = 3.400 and 95% CI = 1.179 – 9.808 indicated a 3.4 times greater risk of infant mortality among the respondents who were exposed to cigarette smoke compared to those who were not. This finding is relevant to the previous research conducted in Ambon City that revealed the risk of infant mortality by 3.36 times due to exposure to cigarette smoke (Paunno et al., 2015).

The interviews revealed that the respondents' family members commonly consumed two up to 12 cigarettes daily with an average exposure time of less than one hour per day. The respondents of case group mentioned more family members smoking inside the house compared to the respondents of control group. Smoking inside the house can increase the exposure of cigarette smoke to other family members, especially pregnant women and babies who are vulnerable to the chemical substances contained in cigarettes.

Cigarette smoke may harm mothers during the pregnancy period, as it can reduce blood flow to the placenta and result in impaired growth of the fetus. Cigarette smoke inhaled by pregnant women can cause bleeding, miscarriage, and infant lower weight from 20% to 30% (Widayani, 2011). At the epigenetic level, exposure to cigarette smoke during pregnancy can cause genetic changes and affect health development due to the mutation of DNA methylation and mRNA expression in placental tissue (Gould et al., 2020). Cigarette smoke produced from a certain number of cigarette consumption can also cause growth disorders and preterm birth (Cahyaningrum & Nency, 2019). Mothers exposed to the smoke of ten cigarettes per day during pregnancy are twice as likely to give birth to premature babies (Collins et al., 2012). Family members should be aware of several preventive measures by reducing cigarette consumption at home, keeping a safe distance from children and pregnant women while smoking, increasing the ventilatory system at home, and conducting socialization on the dangers of cigarette smoke exposure. Counseling about smoking cessation is urgent among parents to reduce the impact of exposure in the early life of babies and anticipate long-term health effects (Vanker et al., 2017).

The chi-square test generated a *p*-value = 0.412, reflecting no relationship between condition of condition of lavatory and infant mortality in Rembang District in 2019. One of the reasons could be that babies have not defecated in condition of lavatory. The percentage of households with decent condition of lavatory shared the same number between the case and control respondents. A total of 11 respondents of case group and eight respondents of control group did not have decent condition of lavatory. During the observation, there were found vector animals and slippery floors in several lavatories. The conditions might be risky for mothers to bring their babies to defecate in lavatories. The existence of vector animals, especially cockroaches was due to the open wastewater flow with no filter (Sutikno et al., 2021).

The chi-square test on the drinking water source variable generated a *p-value* = 0.114, reflecting no relationship between the drinking water source and infant mortality in Rembang

District in 2019. There was no significant difference between the drinking water consumed by respondents who experienced stillborn birth and those who did not. A total of 18 respondents of case group and 24 respondents of control group used proper drinking water from the local water company, water terminals, rainwater reservoirs, and protected wells. Meanwhile, a total of 14 respondents of case group and eight respondents of control group used improper drinking water sources from mobile water vendors and refilled gallons with unknown quality and refinery methods. Respondents that consumed water from street vendors used to boil the water before consumption to prevent pathogenic microorganisms, such as bacteria, viruses, protozoa, spores, and fungi (Purhadi et al., 2017). To sum up, drinking water sources were not related to infant mortality, as the respondents commonly consumed decent water despite different sources.

The chi-square test on the condition of ventilate variable generated a p-value = 0.001, indicating a relationship between condition of ventilate and infant mortality in Rembang District in 2019. The Odds Ratio (OR) = 7.000 and 95% CI = 1.993 – 24.581 reflected that the respondents with inadequate condition of ventilate signified a risk of 7 times greater in experiencing infant mortality than those with adequate condition of ventilate. This finding is relevant to previous studies stating that home condition of ventilate one of the factors that might increase the risk of fatal diseases. Inadequate condition of ventilate increase humidity and provide viability for pathogenic viruses, bacteria, and fungi (Apriningrum, 2017; Geoghegan et al., 2016). A total of 20 respondents lived with inadequate condition of ventilate, consisting of 16 respondents of case group and four respondents of control group. There were 12 respondents who highlighted the availability condition of ventilate in their houses, yet the adequacy was less than 10% of the floor area. Meanwhile, the other eight respondents mentioned unavailable condition of ventilate in their houses.

Improper condition of ventilate may block the air circulation, cause a lack of oxygen exchange, and lead to the risk of respiratory diseases, such as ARI and tuberculosis (Dewanti et al., 2010). There was a respondent whose child

Table 4. Logistic Regression Multivariate Test Results between Infectious Diseases and Condition of ventilate on Infant Mortality

Variable	B	P Wald	OR	95% CI
Infectious diseases	1.438	5.845	4.211	1.313-13.508
Condition of ventilate	1.736	6.703	5.672	1.525-21.104
Constant	-5.284	11.846		

had congenital abnormalities due to the mother's activities or work during pregnancy. The fetus was poisoned by the candle smokes used for producing *batik*, as there was no ventilation in the *batik* house that made the air polluted. As a result of the incident, the fetus was born with congenital abnormalities and died after a few days.

Following the multivariate test (table 4) of the four candidate variables, namely infectious diseases, exposure to cigarette smoke, drinking water sources, and condition of ventilate, a significant relationship between infectious disease and condition of ventilate variables was related to infant mortality. The analysis generated the OR of infectious diseases = 4.211 and 95% CI = 1.313 – 13.508, reflecting a death risk of 4.211 times higher for infants with infectious diseases. Meanwhile, the analysis condition of ventilate variable generated the OR = 5.672 with 95% CI = 1.525 – 21.104, reflecting a death risk of 5.672 times higher for infants living in housing with inadequate ventilation. Between the two variables, condition of ventilate was considered the most dominant variable associated with infant mortality.

Table 5 showed interaction test signified an interaction between infectious diseases and condition of ventilate with a p-value = 0.001. The relationship between infectious diseases and infant mortality had different effects for infants

that lived in housing with adequate condition of ventilate and those that did not. If a baby suffers from an infectious disease and at the same time lives in a house with poor condition of ventilate, the risk of infant mortality is likely to increase.

Table 5. Interaction Test between Infectious Diseases and Condition of ventilate on Infant Mortality

Interaction	-2 Log Likelihood	G	p-value
Infectious diseases* condition of ventilate	71.557	17.166	0.001

The research data also confirmed ARI as the infectious disease that led to infant mortality by 50%. ARI is a respiratory disease related to poor condition of ventilate. The finding is relevant to Safrizal (2017) that highlighted a relationship between condition of ventilate and the incidence of ARI infection in children under five years old (p-value = 0.032).

CONCLUSION

The variables which were strongly related to the IMR consisted of condition of ventilate with OR = 5.672 and 95% CI = 1.525 – 21.104 and infectious diseases with OR = 4.211 and 95% CI = 1.313 – 13.508.

Multivariate test results that show a significant relationship with infant mortality are variable infectious disease and condition of ventilate. Interaction test signified an interaction between infectious diseases and condition of ventilate with a p-value = 0.001. It means if a baby suffers from an infectious disease and at the same time lives in a house with poor condition of ventilate, the risk of infant mortality is likely to increase

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