

Exposure to Second-hand Smoke While Breastfeeding Cause a Reducing Its Protective Properties and Higher Diarrhea Prevalence on Infants

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ABSTRACT--- Diarrhea is the second leading cause of mortality among children younger than age 2 years in Indonesia after upper respiratory infections. The scope of mothers who reported exclusive breastfeeding in East Kalimantan is 29% and the prevalence of smoking father is 25%, so there is higher percentage of mothers and children exposed to second-hand smoke. We identify and diagnose 170 children Breastfeeding pattern as the independent variable, occurrence of Diarrhea as the dependent variable, and intermediate variables including children's age and smoking father. The statistical analyses used multiple logistic regression. There are 31.2% children with 1-12 months of age with Diarrhea, 37.6% of them being fed breast milk exclusively, 59.4% partially, and 2.9% predominantly. Among them, 60.1% of fathers are actively smoking. We found association between smoking father and the occurrence of Diarrhea on children with logistic regression analysis *p* value 0.030 and Exp.(B) value of 2.077 (95% CI: 1.072-4.025). Logistic regression analysis presents the evidence of association between breastfeeding pattern and Diarrhea. The association of partial and exclusive breastfeeding and Diarrhea occurrence with *p* value of 0.0018 and 0.005 each. Exp.(B) value of 3.0 (95% CI: 1.4–6.5). Exclusive breastfeeding could help preventing of Diarrhea. Smoking father would affect the protective properties of breast milk with cigarette smoke exposure risk higher prevalence of Diarrhea.

Keywords--- Diarrhea, Second-hand Smoke, Breastfeeding, Infant

I. INTRODUCTION

It is well established by WHO since 2007 that breastfeeding is beneficial to the child and the mother's well-being as well as long term benefits (Horta, Bahl, Martines, & Victora, 2007), and also systematically shown with comprehensive scientific evidence on 2013 (Horta, Victora, & World Health Organization, 2013). Meta-analysis presentation and systematic literature review on this had also reported in Acta Pedriaca (Grummer-Strawn & Rollins, 2015).

Indonesia has been implementing infant and young child feeding programmed following World Health Organization recommendation (2001): early initiation of breastfeeding within 1 hour of birth; exclusive breastfeeding for the first 6 months of life; and introduction of nutritionally-adequate and safe complementary (solid) foods at 6 months together with continued breastfeeding up to 2 years of age or beyond.

East Kalimantan has 29% breastfeeding coverage according to 2018 Indonesia Basic Health Research (Riskesdas); lower than national coverage according to National Institute of Health Research and Development,

Indonesian Ministry of Health: 37.3% for exclusive breastfeeding, 9.3% for partial breastfeeding, 3.3% for predominant breastfeeding, and the rest is formula fed (Balitbangkes Kemenkes RI, 2018). Globally, exclusive breastfeeding coverage was 31% in 2018 according to World Health Assembly (WHA) East Asia and Pacific Regional Office.

In 2017 there are 92,518 cases of Diarrhea occurred on children younger than 2 years of age in East Kalimantan, 56.0% of them (51,776 cases) admitted to health facilities, and the rest goes unreported (Kementerian Kesehatan RI, 2017).

Exclusive breastfeeding helps lower Diarrhea prevalence on children (Gizaw, Woldu, & Bitew, 2017; Hajeebhoy, Nguyen, Mannava, Nguyen, & Mai, 2014a; Li, Dee, Li, Hoffman, & Grummer-Strawn, 2014; Masela, Kawengian, & Mayulu, 2015; Mhrshahi, Oddy, Peat, & Kabir, 2008). Control of nutritional problems that requires systematic actions focused on prevention and appropriate intervention strategies such as specific micronutrient supplementation only contributes 30%, among the most effective interventions for preventing stunting is focusing on the first 1000 days of a child's life, dubbed as "golden period", "critical window", or as the World Bank (2006) called it "window of opportunity". Improving optimal nutrient intake during this period would reduce rates of stunting, infectious disease, and infant mortality.

Infant Mortality Rate (IMR) is still considered as part of the global health issue. The proposed SDG's (Sustainable Development Goals) target for child mortality aims to end, by 2030, preventable deaths children under 5 years of age, aiming to reduce neonatal mortality to at least as low as 25 deaths per 1,000 live births. The main cause of child mortality are infectious disease, neonatal complication, and other causes like wounds and injuries (WHO, 2014)

According to Riskesdas, the smoking prevalence in East Kalimantan was 25% lower than the national number of 29.3% (Balitbangkes Kemenkes RI, 2018). Cigarette used by other family members at home has been associated with breastfeeding mother and children unwillingly suffer from passive smoking that affects healthy family index value on The Healthy Indonesia Program with Family Approach (PIS-PK).

Women exposed to environmental tobacco smoking while pregnant present serious threat to their own health and their children's health. These health threats continue after birth when the nicotine and other harmful substances is transferred into breast milk, more than double that transferred to maternal serum. Exposure to second-hand smoke reduces the protective properties of breast milk (Mennella, Yourshaw, & Morgan, 2007).

Higher rate of Diarrhea on infants with smoking fathers and lower rate of breastfeeding exclusivity prompted this study to evaluate the interaction between exposure to second-hand smoke and breastfeeding behavior on infant Diarrheal infection.

II. METHODOLOGY

An observational, analytic, cross-sectional retrospective design was used to estimate the association between breastfeeding patterns--with exclusive breastfeeding, predominant breastfeeding, and partial breastfeeding as independent variable; Diarrhea diagnoses as dependent variable; children age, smoking father, the usage of baby bottles, sanitation, and family income as intermediate variable. Subject of the study are children 1-12 months of age that were admitted to Dirgahayu Hospital Samarinda in 2018. Data collection were conducted for 2 months,

between September and October 2018 total samples with numbers of respondents as many as 170 children from three pediatric wards.

The statistical analyses used in this study were univariate frequency distribution, bivariate with simple logistic regression, and multivariate with logistic regression.

This study has met the ethical requirements by taking into account the national health research guidelines and ethical standards referring to WHO 2011 and CIOMS 2016. Ethical approval for the study was provided by the Institutional Review Board (IRB) of the ethical committee of health research, Poltekkes Kemenkes Kalimantan Timur, clearance number No.LB.02.01/7.1/5622/2018.

III. RESULTS

The characteristics of the respondents can be seen on following table 1:

Table 1: Frequency distribution of Respondents based on Children, Mother, and Family Characteristics at Dirgahayu Hospital

Variables	Frequency (n = 170)	Percentage (100%)
Children's age:		
<6 months	104	61.2
≥6 months	66	28.8
Father's smoking status		
Smoking	103	60.1
Non-smoking	67	39.4
Water source		
Non clean water company	21	12.4
Clean water company	149	87.6
Baby bottle usage		
Using baby bottle	98	57.6
Does not use baby bottle	72	42.4
Family income		
Under the RMW	51	30
Over the RMW	119	70

A list of the distribution of participant characteristics and the main variables is presented in Table 1. From 170 respondents, most children (61.2%) were younger than 7 months of age. More than half of the subject's father are smokers (61.2%). Regarding the household economic status, the majority (70%) family income were over the regional minimum wage. The participants also primarily got their water from PDAM (Indonesian regional water utility company) (87.6%), and were mostly used baby bottle for both breast milk and formula milk (57.6%).

Table 2 shows the frequency distribution of respondents' breastfeeding pattern.

Table 2: Frequency Distribution of Respondents based on Breastfeeding Pattern Dirgahayu Hospital

Breastfeeding Pattern	Frequency (n = 170)	Percentage (100%)
Partial	101	59.4
Predominant	5	2.9
Exclusive	64	37.6

Frequency distribution of independent variables presented on Table 2, only 37.6% of subjects exclusively breastfed until 6 month of age, while more than half of the subjects(59.4%)partially breastfed with some formula milk. 2.9% of the subjects predominantly breastfed, being fed with liquid like honey, water, or sweet tea and then exclusively breastfed once the mother could produce breast milk with stability.

Table 3: Frequency Distribution of Respondents based on Diarrheal Diseases suffered by Infants Admitted in Dirgahayu Hospital

Diarrhea Diagnosis	Frequency (n = 170)	Percentage (100%)
Diarrhea		
Yes	53	31.2
No	117	68.8

Table 3 shows that the prevalence of Diarrhea is 31.2%.

Table 4: Bivariate analysis of smoking father associated with Diarrhea in infants.

Variables	Diarrhea Diagnosis		Total	<i>p</i> value	crude OR (95% CI)
	Yes	No			
Breastfeeding pattern					
Partial	39 (38.6%)	62 (61.4%)	101 (100%)	0.044*	Baseline
Predominant	1 (20%)	4 (80%)	5 (100%)	0.417*	2.516 (0.3 – 23.3)
Exclusive	13 (20.3%)	51 (79.7%)	64 (100%)	0.015*	2.468 (1.2 – 5.1)
Father's smoking status					
Yes	39 (37.9%)	64 (62.1%)	103 (100%)	0.030**	2.307 (1.133 – 4.697)
No	14 (20.9%)	53 (79.1%)	67 (100%)		

Age (months)					
<6 months	27 (40.9%)	39 (59.1%)	66 (100%)	0.044**	2.077 (1.072 – 4.025)
≥6 months	26 (25%)	78 (75%)	104 (100%)		

*Simple Logistic Regression

**Chi-square

The bivariate analysis between the breastfeeding pattern and Diarrhea diagnoses revealed that for 101 infants that were partially breastfed, 39 (38.6%) positively diagnosed with Diarrhea. The number are lower (20%) among predominantly and exclusively breastfed infants. The association of breastfeeding pattern and Diarrheal diseases, where p value for partial and exclusive breastfeeding's 0.044 and 0.015 respectively. There were no association found on predominant breastfeeding where the p value is 0.417. Exp (B) value found is 2.586 (95% CI: 1.2 – 5.1), which means that partial breastfeeding have 2.468 more risk of Diarrhea compared to exclusive breastfeeding.

In addition, the bivariate analysis as detailed in table 4, revealed that father's smoking status was positively associated with Diarrhea occurrence where infants with smoking father has 2.3 (95% CI: 1.13-4.7) higher risk of Diarrhea compared to infants with non-smoking father. Children who less than 6 months of age also has 2.077 higher risk to be diagnosed with Diarrhea compared to 6 months or more.

Table 5: Final model of multivariate association between breastfeeding patterns with the occurrence of Diarrhea

Variables	p value	Exp (B)(95% CI)
Breastfeeding pattern		
Partial	0.018	Baseline
Predominant	0.410	2.701(0.3 – 28.7)
Exclusive	0.005	3.000(1.4 – 6.5)
Father's smoking status	0.043	
Children's age	0.012	

Table 5 outlines the final model after stepwise backward elimination was used in multiple logistic regression, revealed that statistically there are significant correlation between partial and exclusive breastfeeding and the occurrence of Diarrhea with p value 0.018 and 0.005 each. Exp (B) value obtained is 3.0 (95% CI: 1.4 – 6.5), which means that on partially breastfed children has 3 times risk of Diarrhea compared to exclusively breastfed children (after controlled variables of smoking father and children's age).

Model equation:

$$\text{Logit(Diarrhea)} = 0.507 + 0.994(\text{predominant}) + 1.135(\text{exclusive}) + 0.758(\text{smoking status}) - 0.918(\text{children's age})$$

IV. DISCUSSIONS

Breast milk's unique composition is considered the ideal food the nutritional needs of all children and promoting optimal growth in neuro-psychomotor development, protective action against infection and microbes (Martin, Gunnell, Owen, & Smith, 2005), reduction of the incidence of autoimmune diseases (Kwan, Buffler, Abrams, & Kiley, 2004), and allergic manifestations (Oddy et al., 1999).

Leukocytes found in breast milk forms specific antibodies that offers anti-microbial property (Martin et al., 2005). B and T lymphocytes plays significant part in protection against infection passed to infants through breast milk in the form of adaptive immune system. Antigen are any substance that stimulates the establishment of specific immune response. When an antigen enters the body, it stimulates the immune system to produce antibodies (Radji, 2010).

Breastfeeding provides passive natural immunity. Mother passes antibodies to the fetus through placenta, or to her infant while breast-feeding, especially during colostrum stage. The antibodies required from maternal transfer usually does not last long, only in a few month until the children could reproduce the immune system. Breastfeeding offers protection protective against wide spectrum of illnesses (Rollins et al., 2016), especially non communicable diseases (NCD) (Kramer, McGill, & Matush, n.d.), and promoting optimal growth and development on all children (Delgado & Matijasevich, 2013; Poton, Soares, de Oliveira, & Gonçalves, 2018).

Breastfeeding, especially exclusive breastfeeding, is beneficial for the child as it could reduce infant mortality (Sankar et al., 2015) in line with the result of this study that partially breastfed children (pumping and formula feeding) has 3 times higher risk of Diarrhea. Diarrhea remains the second leading cause of death after respiratory infections among infants in Indonesia.

There are different ways to provide nutrition intake for children. Children feeding patterns according to Indonesia Ministry of Health (2014),: exclusive breastfeeding; predominant breastfeeding, partial breastfeeding, bottle (formula) feeding, and solid food feeding.

Diarrhea is an endemic disease in Indonesia that might constitute an extraordinary event followed by death. Among 6,897,463 people reported with Diarrhea in 2016, 3,198,411 of them (or 46.4% from the target) were admitted in health facilities (Kementerian Kesehatan RI, 2017).

Among 170 respondents of this study, 53 (31.18%) of them contracted Diarrhea. Our study provides evidence that breastfeeding exclusivity is related with Diarrhea occurrence on infants, with 0.417 p value. Exp.(B) value obtained is 2.568 (95% CI: 1.2 – 5.1), which means that partial breastfeeding present 2.468 times more risk to contract Diarrhea compared to exclusive breastfeeding. This result is consistent with that of a previous study conducted in Bangladesh, which demonstrated that exclusive and predominant breastfeeding significantly limits infant morbidity through the reduction of Diarrhea and respiratory infections (Mihirshahi et al., 2008).

Another study conducted in the city of Padang shown that there is association between exclusive breastfeeding and acute Diarrhea cases on children 0-1 year of age in local health center of Kuranji, Padang, Indonesia (Rahmadhani, Lubis, & Edison, 2013).

There is high prevalence of Diarrhea on children younger than 2 years of age, and to avoid it mothers need to start providing timely initiation of breastfeeding and practice exclusive breastfeeding (Gizaw et al., 2017).

Actively smoking father causing children to be easily contracted diseases. Harmful substances found in cigarette smoke could cause the cilia in the air passages to stop functioning properly, causing pathogens to easily

enter the respiratory system resulting in infections. Cilia is microscopic hairs along the respiratory system that move in sweeping motion to keep it clean (Candra, 2014).

Smoke exposure decrease protein and fat components of milk, as well as parity and body mass index which affects protein and fat concentration in breast milk (Bachour, Yafawi, Jaber, Choueiri, & Abdel-Razzak, 2012).

Nicotine and other harmful components of cigarettes is passed onto children via breast milk and environmental tobacco smoking exposure, risking higher rate of respiratory allergy and Sudden Infant Death Syndrome (SIDS) (Reece-Stremtan & Marinelli, 2015).

Smoking during pregnancy and breastfeeding affected the lactation process adversely by decreasing milk production and altering milk composition and taste, which may suppress the infant's appetite to breastfeed (Napierala, Mazela, Merritt, & Florek, 2016). Passive smokers are people who exposed to environmental tobacco smoke. Exposure to secondhand smoke harms infants since the effect last days and even weeks after the exposure (Smith, 2009). Simultaneous maternal smoking and breastfeeding lowers the prevalence of breastfeeding initiation and continuation since tobacco smoke and (or) nicotine change maternal hormones levels, which associated with decreased volume of milk production and disturbed milk release from the breast (Bachour et al., 2012).

Many smoking cessation programs are designed to encourage mothers and their partners to quit smoking during pregnancy (Reece-Stremtan & Marinelli, 2015), but considering the serious health consequences for infants, it is imperative to promote smoking cessation before, during and after pregnancy for mothers and other adults within the household. Passive exposure to smoke for children risking increased frequency of Diarrheal diseases.

One previous study determined that exclusive breastfeeding significantly lower the morbidity of Diarrheal disease and chronic respiratory illnesses (Mihirshahi et al., 2008). The study conducted in Bangladesh where the majority (70%) of children were not colostrum fed because the tradition of pre lacteal feeding and supplementary feeds of water, mustard, herbal tea, or honey were to be given with breast milk.

Researchers also found that timely initiation of exclusive breastfeeding decreases considerably the neonatal mortality in Ghana (Edmond, Kirkwood, Amenga-etego, Owusu-agyei, & Hurt, 2007). According to Mihirshahi et al. (Mihirshahi et al., 2008), when it comes to lower the risk of Diarrhea and respiratory infection, the different between exclusively and predominantly breastfed children was not significant, but the rate was significantly lower in partially breastfed children.

Another study by Hajeighbhoy et al (Hajeighbhoy et al., 2014a), states that within 5 months the prevalence of respiratory illnesses were 3 times higher and the prevalence of Diarrhea were 4 times higher on partially breastfed children when compared with exclusively and predominantly breastfed children at the same time.

When investigating practices of breastfeeding of infants 0-6 months in Ethiopia, Haile & Biadgilign (Haile & Biadgilign, 2015) observed that more than 80% of the subjects did not breastfed optimally following Breastfeeding Performance Index (BPI). BPI is significantly associated with Diarrhea, fevers, and respiratory infections that start up to 2 weeks after delivery.

Children's sex, vaccination history, parent's education, and exclusive breastfeeding history were not significantly related to infection risk; this is consistent with one previous study that also found no significant association between these variables (Candra, 2014). In our multivariate analysis, exclusive breastfeeding history status with p value $0.33 > 0.05$, OR: 0.75 (95% CI: 0.32-1.77) means that exclusive breastfeeding history was

rendered no significantly associated with children's infection. Nutritional status, complimentary food, and father's smoking status evidently associated with children infections.

When investigating breastfeeding and risk of infection at 6 years, (Li et al., 2014) found no significant association between breastfeeding with upper airway and urinary infections in infants, though breast milk could protect infants from otitis, pharyngitis, and sinusitis. Other than the exclusive breastfeeding history, complementary food is a significant contributing factor on the immune system quality of children older than 6 months of age.

V. CONCLUSION

Children who receive exclusive breastfeeding are less likely to contract Diarrhea. Second-hand smoke exposure impairs the protective properties of human milk. Children, especially younger than 6 months of age, who have smoking father have a higher likelihood of contracting Diarrhea.

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