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Path Analysis on Gestational Socio-economic Determinants of Nutritional Status in Children Under Five in Purworejo Regency, Central Java

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ABSTRACT

Background: Undernutrition by height-for-age standard starts during pregnancy and continues to the first two years of life. Linear growth disorders among children under five years are associated with morbidity, mortality, loss of physical growth potential, reduced neurological development, reduced cognitive functions, and increased risks of adulthood chronic diseases. In 2015, the number of undernourished children under five (height-for-age) reached 156 million globally. Purworejo regency was an area with the second highest undernutrition cases in Central Java in 2014. This study aimed to analyze the life-course epidemiology perspectives on the socio-economic factors contributing to the nutritional status of the children aged two to five years in Purworejo regency, Central Java.
Subjects and Method: This was an observational analytical study with case control design. This study was conducted in Purworejo, Kaligesing, and Bruno sub-districts, Purworejo Regency, Central Java in February to March 2017. A total sample 160 children aged two to five years and their mothers were selected by fixed disease sampling. There were 37 children in the case groups, and 113 children in the control groups. The independent variables included family income, maternal age, maternal nutritional status (mid upper arm circumference), birth length, exclusive breastfeeding and the children's history of illness. The dependent variable was the children's nutritional status (height-for-age/HAZ). Data on the children's height were collected using microtoise. Other data were collected by maternal and children health (MCH) books and a set of questionnaires. The data were analyzed using path analysis.
Results: Nutritional status of children under five (height-for-age/HAZ) was affected by family income (x Rp 100,000) (b=0.03; SE=0.24; p<0.001), maternal age (years) (b=0.02; SE=0.02; p=0.160), maternal nutritional status/MUAC (cm) (b=0.08; SE=0.05; p=0.066), birth length (cm) (b=0.22; SE=0.05; p<0.001), exclusive breastfeeding (b= 0.03; SE=0.16; p=0.080), and the absence of illness (b=0.39; SE=0.14; p=0.007).
Conclusion: Nutritional status of the children under five (height-for-age/HAZ) is affected by family income, birth length, exclusive breastfeeding, maternal age, maternal nutritional status, and the absence of illness.

Keywords: nutritional status, children under five, life-course epidemiology, socio-economic

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BACKGROUND

Undernutrition among the children under five years by height-for-age standard is caused by long-term chronic nutrition insufficiency and frequency of the children being exposed to diseases even before they are born (Semba, 2008). Therefore, the nutritional status measurement by height-for-age is able to indicate bad environment or factors which restrict the children's long-term growth. This height-for-age measurement is also able to demonstrate the children's well-being and it is an accurate reflection on social inequalities (de Onis dan Branca, 2016). The nutrition status (height-for-age) commonly occurs among children under two years and its impact is massive and irreversible (UNICEF, 2013; WHO, 2010a).

The nutrition status by height-for-age (HAZ) often does not receive the same attention as weight-for-height (WHZ), or weight-for age (WAZ) from health workers. Moreover, height is not measured regularly as part of a community health program. Family and health workers often fail to recognize short children because short stature is common in communities, so that these children are viewed normal. Family, health workers, and policy makers are not aware of the consequences of the short stature in children and its effects in adulthood; thus it is not considered as a public health issue (Dewey dan Begum, 2011; de Onis et dan Branca, 2016).

WHO (2010b) based on World Health Statistics Data in 2010 showed that 40% of the children under five in Indonesia were stunted. Indonesia's Basic Health Research (*Riset Kesehatan Dasar* /RISKESDAS) in 2013 found that the prevalence of undernutrition by height-for-age (HAZ) among the children under five in Indonesia was 37.2%. Purworejo regency was an area with the second highest prevalence of undernutrition cases among the children under five in Central Java in 2014 (Central Java Health Office, 2014).

The life-course epidemiology perspective provides a strong framework to describe issues related to human nutrition. People's nutritional status goes on over their life-course (Martorell dan Zongrone, 2012).

Undernutrition seems to start since the children are in uterus and it affects their nutritional status in childhood, adolescence, and adulthood. Undernutrition does not only affect the individual but it also impacts the future generations. Undernutrition in childhood, adolescence, and pregnant women may bring negative impacts to fetal growth and babies' weight. Fetus with insufficient nutrition intakes will suffer from intra-urine growth retardation/ IUGR), as a result they will be born with low birth weight. If the infants with IUGR or low birth weight survive, they will experience restriction their optimal growth and suffer from various developmental disorders. Stunted female children will grow as stunted women, and they are more likely to give birth stunted children (Martorell dan Zongrone, 2012).

Determinants of the nutritional status of the children under five years (height-for-age) in this study were identified using life-of the socio-economic factors. The life-course epidemiological perspectives have implications to the biological factors and social events that occur in each life stage, even since gestation. The biological factors and social events in each stage of age may bring long-term effects to health condition in the next stages of life. The life-course epidemiological perspectives synchronize paradigms of the eco-social determinants of health, that health is not only affected by biological factors, but also socio-economic and environment.

This study aimed to analyze the life-course epidemiology perspectives of the socio-economic determinants of the nutritional status of the children aged two to five years in Purworejo regency using path analysis.

SUBJECTS AND METHOD

Study Design

This was an observational analysis study with case control design. The study was conducted in Purworejo, Kaligesing, and

Bruno sub-district in Purworejo regency, Central Java in in February to March 2017.

Population and Sample

Population of this study was children aged two to five years old in Purworejo Regency, Central Java. A total of 160 children aged two to five years and their mothers were selected by fixed disease sampling. There were 37 stunted children (height-for-age/ HAZ)) in the case groups and 113 well-nourished children (height-for-age/HAZ) in the control groups.

Variable

The independent variables were family income, maternal age, maternal nutritional status, birth length, exclusive breastfeeding, and children's history of illness. The dependent variable was nutritional status (height for age) of children aged 2 to 5 years old.

Exogenous variables were maternal age, maternal nutritional status, birth length and family income. Endogenous variables were exclusive breastfeeding, history of illness and children's nutritional status (height for age).

Operational Definition

Children nutritional status in this study was the condition of nutritional status (height for age/ HAZ) of children aged two to five years old based on WHO Child Growth Standard Refference.

Current family income was average number of fixed and side income from father, mother and other family members in last a month.

Maternal age was the total number of time units (in years) which measured based on the year of mother was born until she pregnant her children who is currently being the study subject.

Maternal nutritional status was the nutritional status of pregnant women which measured by mid upper arm circumferrence (MUAC) size and recorded in maternal and children health (MCH) books.

Birth length variable was defined as size of children body length that measured at the time of birth and registered on maternal and children health (MCH) books.

Exclusive breastfeeding was defined as the infant only received breast milk, no other liquids or solids are given (not even water) with the exception of oral rehydration solution, drops/syrups of vitamins, minerals or medicines from birth to six years old.

History of child illness was presence or absence children who was suffered from infectious disease (e.g diarrhea, non pneumonia cough, etc) in three months latest.

Instrument Data Collection

The current children's height was measured using microtoise. The data on the children's date of birth, birth length, maternal age, and the maternal nutritional status (MUAC) were collected through MCH books. Information on breastfeeding history and the children's history of illness were collected by a set of questionnaires.

Data Analysis

The data were collected during children health examination in integrated health posts (posyandu), toddler class, and home visits. The categorical data of the study subject's characteristic were described in frequency (n) and percentage (%). Univariat analysis were described in mean, standard deviation (SD), minimum and maximum value. Bivariat analysis were analyzed using Pearson correlation test.

Multivariate analysis were analyzed using path analysis by IBM SPSS AMOS 22 version, following steps:

1. Model specification
2. Model identification
3. Model fit
4. Estimation
5. Model respesification

Ethical Approval

The aim of ethical approval is to protect the study subjects. They are a valuable part of the research process and not merely a means of accessing data.

This study has received ethics approval from the Ethics Health Research Commission of Dr. Moewardi Hospital/ School of Medicine, Sebelas Maret University, Surakarta, No: 79/II/HREC/2017, dated on February 16, 2017.

RESULTS

1. Characteristics of the study subjects

The characteristics of the study subjects were presented in Table 1. Table 1 showed that the number of female children under five was higher (53.1%). Most mothers were graduated ≥senior high schools (34.4%), yet seven mothers did not complete primary school. Most of the mothers were housewives (71.9%).

Table 1. Characteristics of the study subjects

Characteristics	Criteria	n	%
Children's sex	Male	75	46.9
	Female	85	53.1
Mothers' education	Did not complete primary school	7	4.4
	Primary school	45	28.1
	Junior high school	48	30.0
	Senior high school	55	34.4
	Diploma	3	1.9
	Bachelor	2	1.3
Mothers' occupation	Housewife	113	70.6
	Labor	1	0.6
	Farmer	21	13.1
	Trader	16	10.0
	Teacher	1	0.6
	Government officer	3	1.9
	Private employee	2	1.3
	Business owner	3	1.9

2. Univariate Analysis

a. Frequency Distribution

The univariate analysis was conducted to identify the frequency distribution and percentage of the variables on the nutritional status (height-for-age) of the children aged two to five years old, current family income, maternal age, birth length, exclusive breastfeeding, and children's history of illness.

Table 2 showed the frequency distribution of the study variables on family income, maternal age, and birth length. The majority of the children (60%) were from low-income family (<Rp 1,300,000). Most of the mothers (80.6%) belonged to healthy reproductive age (20-35 years). As many as 74.4% of the mothers had good nutritional status at pregnancy (MUAC ≥23.5 cm). Percentage of the children under five with normal birth length (≥48 cm) was 85%, respectively.

The categorical data of the study subject's characteristic were described in frequency (n) and percentage (%). This was presented on Table 3. Table 3 showed frequency distribution of the variables on breastfeeding and history of illness. Most of the study subjects (66.3%) received exclusive breastfeeding. Most of the children (67.5%) were not sick in the last three months.

Table 2. Frequency distribution of the study variables

Variables	n	%	Mean	SD	Min.	Max.
1. Age of the children (months)			40.94	10.32	23	60
24-40 months	75	46.9				
41-60 months	85	53.1				
2. Children current height (Cm)			93.52	6.84	78.3	115.1
<94 Cm	86	53.8				
≥94 Cm	74	46.3				
3. Height for Age (HAZ)			-1.20	1.21	-3.77	1.90
Severe stunted (<-3 SD)	15	9.4				
Stunted (<-2 to-3 SD)	32	20.0				
Normal height (≥2 SD)	113	70.6				
4. Family income per month (x Rp 100,000)			1,282,500	9.13	300,000	4,000,000
<Rp 1,300,000.00	96	60				
≥ Rp 1,300,000.00	64	40				
5. Maternal age (years)			25.19	4.49	17	35
<20 years old	31	19.4				
20-35 years old	129	80.6				
6. Maternal nutrition status/ MUAC (Cm)			24.66	2.01	20.0	30.0
MUAC <23.5 cm	41	25.6				
MUAC ≥23.5 cm	119	74.4				
7. Birth length (cm)			48.39	1.81	45.0	52.0
<48 Cm	24	15.0				
≥48 Cm	136	85.0				

Table 3. Frequency distribution of the study variables using categorical data

Variables	n	%
1. Breastfeeding		
Not exclusive breastfeeding	54	33.8
Exclusive breastfeeding	106	66.3
2. History of illness		
Diarrhea	7	4.4
Upper respiratory tract infection (non pneumonia cough)	45	28.1
No history of illness	108	67.5

3. Bivariate Analysis

Bivariate analysis explained the effect of the independent variables towards the dependent ones using Pearson product moment test. The result of bivariate analysis test presented in Tabel 5.

Table 5. The results of Pearson product moment test on the effect of gestational socioeconomics determinants of nutritional status (height-for-age/HAZ) in children aged two to five years old

Independent Variables	r	p
Family income per month (x Rp 100,000.00)	0.56	<0.001
Maternal age (years)	0.42	<0.001
Maternal nutritional status/MUAC (cm)	0.57	<0.001
Birth length (cm)	0.66	<0.001
Exclusive breastfeeding	0.42	<0.001
History of illness	0.36	<0.001

Tabel 5 showed that current family income, maternal aged, maternal nutritional status, exclusive breastfeeding and absence of illness had positive and statistically significant effect to nutritional status of children aged two to five years old.

4. Path Analysis

a. Model specification

The model specification described relationship among the variables under the study. Observed variables of this study included maternal age, maternal nutritional status/ MUAC, birth length, exclusive breastfeeding, appropriate complementary feeding, history of illness and nutritional status of children under five (height-for-age/ HAZ).

b. Model Identification

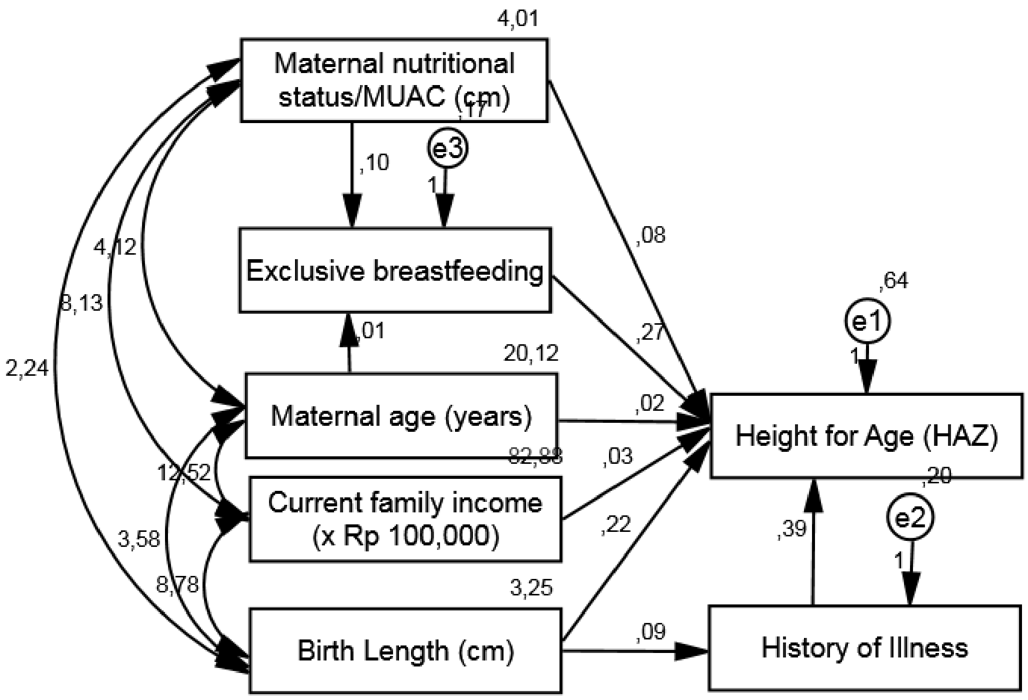
Observed variables of nutritional status (height for age/ HAZ):

1) Number of observed variables = 7
2) Endogenous variables = 3
3) Exogenous variables = 4
4) Number of parameter = 15

Formula of degree of freedom was:

df = (number of observed variables x (number of observed variables + 1))/2 – (endogenous variables + exogenous variables + number of parameter)
= (7 x (7+1))/2 – (3 + 4 + 15)
= 28-22= 6

The df score resulted from the identification of Picture 1 was 6. The result indicated that the path analysis model was over identified, so that the path analysis against the model could be conducted.



Picture 1. Structural model of the observed variables on the nutritional status of the children under five using unstandardized solution

c. Model fit and estimation

Picture 1 showed a structural model which had been estimated using SPSS Amos. The indicators that were fit with the model in picture 1 included the results of fit CMIN (Norm Chi Square) index as many as 5.014 with p=0.542 (>0.05); GFI (*Goodness of Fit Index*)=0.991 (≥0.90); NFI (*Normed Fit Index*)= 0.987 (≥0.90); CFI (*Comparative Fit Index*)=1.000 (≥0.90); RSMEA (*Root*

Mean Square Error of Approximation) <0.001 (<0.08). These values showed that the model met criteria and they were in line with the empirical data.

Table 6. Path analysis on the life-course epidemiology perspectives on the socio-economic factors contributing to the nutritional status (height-for-age/HAZ) of the children under five

Dependent variables		Independent variables	b*	SE	p	β**
Direct impact						
Height for Age	←	Family income (x Rp 100,000)	0.03	0.01	<0.001	0.24
Height for Age	←	Maternal age (years)	0.02	0.02	0.160	0.09
Height for Age	←	Maternal nutritional status/MUAC (cm)	0.08	0.05	0.066	0.14
Height for Age	←	Birth length (cm)	0.22	0.05	<0.001	0.33
Height for Age	←	Exclusive breastfeeding	0.27	0.16	0.080	0.11
Height for Age	←	History of illness	0.39	0.14	0.007	0.15
Indirect impact						
Exclusive breastfeeding	←	Maternal nutritional status/MUAC (cm)	0.10	0.02	<0.001	0.43
Exclusive breastfeeding	←	Maternal age (years)	0.01	0.01	0.078	0.14
History of illness	←	Birth length (cm)	0.09	0.02	<0.001	0.33
N observation	=	160				
Fit model						
CMIN	=	5.01	NFI		= 0.98	
P	=	0.542	CFI		= 1.00	
GFI	=	0.99	RMSEA		<0.001	

*=unstandardized coefficient path
**= standardized coefficient path

The results of Table 6 were presented below:

1) Nutritional status of the children under five was affected by family income, maternal age, birth length, exclusive breastfeeding, and the history of infectious disease.
a) A leverage to one unit of family income (x Rp 100,000) increased the nutritional status (height-for-age/HAZ) of the children under five years by 0.03 unit (b=0.03; SE= 0.01; p<0.001).
b) An increase to one unit of the maternal age (years) elevated the nutritional status (height-for-age/HAZ) of the children under five years by 0.02 unit (b=0.02; SE=0.02; p=0.160).
c) An increase to one unit of maternal nutritional status/MUAC (cm) elevated the children's nutritional status (height-for-age) by 0.08 unit (b=0.08; SE=0.05; p=0.066).
d) An increase to one unit of birth length (cm) elevated the children's nutritional status (height-for-age/HAZ) by 0.22 unit (b=0.22; SE=0.05; p<0.001).
e) An increase to one unit of exclusive breastfeeding leveraged the children's nutritional status (height-for-age/HAZ) by 0.03 unit (b=0.03; SE=0.01; p= 0.080).
f) A leverage to one unit of the children's history of infectious disease increased the children's nutritional status (height-for-age/HAZ) by 0.39 unit (b=0.39; SE=0.14; p= 0.007).
2) Exclusive breastfeeding was affected by the maternal nutritional status/MUAC (cm) and their age at pregnancy (years).
a) An increase to one unit of the maternal nutritional status/MUAC (cm) elevated

the exclusive breastfeeding by 0.10 unit (b=0.10; SE=0.02; p<0.001).

b) An increase to one unit of maternal age elevated exclusive breastfeeding by 0.01 unit (b=0.01; SE= 0.01; p=0.078).

3) The children's history of infectious disease was affected by birth length. An increase to one unit the birth length (≥48 cm) elevated the children's being healthy by 0.09 unit (b= 0.09; SE=0.02; p<0.001).

DISCUSSION

1. Effects of family income towards children's under five nutritional status (HAZ)

The study indicated that monthly family income had a positive, direct, and statistically significant relationship towards the nutritional status of the children under five years (height-for-age and weight-for-age). Family income of the subjects under the study is generated from salary/ wages (salary as an employee, business profit, and labor wages), plantation/ farming products trading (such as coconut and clove).

According to the Head of Bruno Health Center, Purworejo that Bruno subdistrict is an area with low educational level, low health level, and low socio-economic level. The low income makes the people's purchasing power for food is low. Food consumption often prioritizes carbohydrate food sources. The children under five years do not receive sufficient animal protein, which is important for their growth.

This finding is supported by Omondi and Kiraba (2016) showing that family income is significantly associated with the children under five years' nutritional status (height-for-age). In this context, income refers to family's purchasing power for food, and the use of money to obtain and to process the food.

High income leverages life quality, improves sanitation, promotes access to health services, provides food sufficiency for family, provides optimal nutrition intake (Kavosi et al., 2014; Ruwali, 2011; Alom et al., 2012).

2. Effects of Maternal Nutritional Status Towards children under five nutritional status (HAZ)

Information on the mothers' nutritional status at pregnancy under the study was collected through MUAC. The study finding showed a positive, direct, and nearly statistically significant relationship between the mothers' nutrition at pregnancy (MUAC ≥23.5 cm) and the nutritional status (height-for-age) of the children under five years.

MUAC is commonly used as an indicator of energy and protein malnutrition among pregnant women. MUAC values during pregnancy among pregnant women in developing countries are relatively stable. MUAC helps to screen for fat and body tissue reserves in pregnant women. Teenage pregnant mothers (<20 years) are likely to have low MUAC, which reflects decreased body mass. MUAC among pregnant women aged ≥25 years does not change during pregnancy and it is a good indicator to assess mothers' and fetus' health risks (Tang et al., 2016; Katz et al., 2010).

Long-term undernutrition among pregnant mothers is associated with uterus volume and it is a predictor for fetus growth and birth size (low birth weight and length) (Christian et al., 2013).

3. Effects of birth length towards children under five nutritional status (HAZ)

The study findings showed a positive, direct, and significant relationship between birth length (≥48 cm) and the children under five years' nutritional status based on the height-for-age standard. Children with normal birth length seem to have better nutritional status based on the height-for-age standard. This study observes that people and health workers overlook height measurement in the children under five years.

Parents bring their children to integrated health posts to measure their weight but not their height. The height measurement, which is not conducted every month, makes the children's height growth not well monitored. Height is not measured following the right procedure. In some integrated health posts (posyandu), the height of children who are able to stand up and who are cooperative are measured using med-line. Meanwhile, height should be measured using microtoise tools. Height is not measured regularly because tools are limitedly available, devices are not ready for use, and children refuse to be measured.

According to Dewey and Begum (2011); de Onis dan Branca (2016), the nutritional status of the children under five with short stature does not receive the same attention as low weight from health workers, especially if height is not measured regularly as part of community health programs. Family and health workers often fail to recognize children with short stature since they are considered normal in communities. Family, health workers, and policy makers are unaware of the consequences of short stature in the children under five years in their adulthood, so it is not considered as a public health issue.

Martins et al., (2011) describes mechanism of short stature etiology among the children under five years. Human height can be modified by genetic and environmental factors. A number of studies show that undernutrition in children changes function of the insulin growth factor (IGF). Growth hormone concentration increases, but the number of IGF-1 plasms decreases. This condition is caused by resistance of the induced growth hormone resulted from nutrition deficiency in liver, which reduces IGF-1 synthesis that leads to increasing growth hormone plasma. The presence of IGF-1 in the central nervous system controls growth hormone synthesis through negative feedback.

Factors that control growth hormone resistance in the undernourished children include increased cortisol concentration, reduced insulin concentration, and decreased essential amino acid in blood. The reduced IGF-1 concentration is the prominent factor contributing to delayed growth among the undernourished children. Nutrition from food intake is the main regulator for IGF-1, it marks sensitivity of the IGF-1 concentration determination in blood, which works as an indicator on the nutritional status of children with delayed growth (Martins et al., 2011).

4. Effects on breastfeeding towards children under five nutritional status (HAZ)

The study found a positive, direct, and nearly statistically significant effect towards the children under five years' nutritional status based on height-for-age standard.

Exclusive breastfeeding is important for the children's fast growth, including weight and height increase in the first six months of life. The study by Suri and kumar (2015) and Alom et al., (2012) shows that the prevalence of undernutrition among children who receive exclusive breastfeeding for six months is low. Six month breastfeeding with good quality of milk is expected to prevent growth disorders in the children under five years (Steyn et al., 2006).

Breastmilk contains nutrition which consists of fat, carbohydrate, protein, vitamin, and mineral. Body fat plays key roles in regulation of bone mass and linear growth (Dewey et al., 2005). Fat tissue secretes several hormones, including leptin which determines bone density and growth performance. In addition, leptin affects immunity system (Karsenty, 2006; Gat-Yablonski et al., 2004).

The study found that mothers did not breastfeed exclusively because the babies were cranky, mothers thought the babies were hungry, mothers said they did not produce enough milk, mothers worked, the babies were fed using formula milk at hospital and it continued at home. Therefore, babies were introduced to food other than breastmilk before reaching six months.

The study also found that exclusive breastfeeding was affected by mothers' age at pregnancy and their nutritional status during pregnancy (MUACH measurement). The older a woman gets, she is psychologically better prepared for pregnancy. Mothers belong to adult age group (≥20 years) are considered more experienced in caring children, especially if they have had children. Psychological preparedness and experiences affect the mothers in providing their children with nutrition, through exclusive breastfeeding and appropriate complementary feedings.

Nutritional status of the lactating mothers reflects their breastmilk quality and quantity. Breastmilk can reach 100% quality depending on the mothers' nutrition starting from pregnancy and daily food intake. Women who do not have sufficient nutritional reserves or those who do not receive optimal nutrition intake use most of their nutrition to produce breastmilk (Rah et al., 2008).

Pregnant mothers with low MUAC are susceptible to infections that compromise their nutritional status and overall health status. It detriments the mothers' ability to take care of their children and pregnancy well. Low MUAC in pregnant mothers also reflects food scarcity in the family, and it affects breastfeeding and supplementary feedings for the children (Lartey, 2008; Villamor et al., 2002).

5. Effects on the history of illness towards children under five nutritional status (HAZ)

The study found a positive, direct, and statistically significant relation between the children's history of not contracting a disease and their nutritional status based on height-for-age and weight-for-age standards. The study by Suri and Kumar (2015) shows a relationship between exposure to infectious diseases, such as diarrhea and upper respiratory infection, and undernutrition among the children under five years. The children who were suffering from diarrhea in the last two weeks were 2.5 times more likely to be undernourished compared to the healthy ones (Asfaw et al., 2015).

During the data collection, the study found that most of the children under five years had upper respiratory infection and diarrhea at least once in the last three months. Infectious diseases have detrimental effects, they can reduce amount of food intake, and lead to undernutrition. Children who suffer from an infectious disease have higher metabolism level and they need bigger food intake. Meanwhile, the children's appetite is decreasing and they loss nutrition because of diarrhea and vomiting (Simondon et al., 2001; Rytter et al., 2014).

The study found that the children's history of illness was affected by their birth length. Children under five years with normal birth length (≥48 cm) seemed to have better health status; they were not sick in the last three months. According to Martin et al., (2011), growth hormone and IGF-1 of the children with normal birth length play important roles in their immunity development, reproduction, and cardiovascular systems. Therefore, children with normal birth length seem to have better immune system so that they are not easily exposed to infections.

The study concludes that the nutritional status of the children under five years is affected by family income, maternal age, maternal nutrition, birth length, exclusive breastfeeding, and the children's history of illness. Exclusive breastfeeding is affected by maternal nutrition (MUAC ≥23.5 cm) and maternal age at pregnancy. The children's history of illness is affected by birth length.

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