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Path Analysis on the Effect of Birth Weight, Maternal Education, Stimulation, Exclusive Breastfeeding and Nutritional Status toward Motor Development of Children aged 6-24 Months in Banyumas Regency

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ABSTRACT

Background: The first two years of a child life is a critical period for his growth and development. Motor skill is one of the elements of children development. Having good control of motor skill helps children in exploring their surrounding also helps in improving development. The study aimed to explain the effect of birth weight, maternal education, provision of stimulation, and nutritional status toward the development of children under two years old.
Subjects and Method: The method of the study was analytic observational, with retrospective cohort approach. The study was conducted in 4 sub-districts of Banyumas Regency included: Kembaran, Somagede, Cilongok and Sumpiuh. Cluster sampling was used as subject selection techniques and were classified based on low birth weight and non low birth weight (fixed exposure sampling). There were a total of 120 children whom 40 of them were born with Low Birth Weight and 80 of them with normal birth weight. Exogenous variables among others were birth weight, exclusive breastfeeding, maternal education, stimulation provision. Endogeneous variables were nutritional status, and motor development. Data collection was conducted by using Early Detection Intervention Stimulation for Growth and Development (SDIDTK). Path analysis was used as the analysis technique.
Result: Motor development was affected by nutritional status (b=0.12; SE= 0.04; p=0.006), frequency of stimulation (b=0.04; SE= 0.01; p=0.005), birth weight (b=0.33; SE=0.06; p<0.001), and maternal education (b=0.02; SE=0.07; p=0.719). Nutritional status was affected by exclusive breastfeeding (b =0.10, SE=0.15; p=0.507), maternal education (b=0.23; SE=0.13; p=0.078) and birth weight (b=0.38; SE=0.12; p=0.002).
Conclusion: Motor development was affected by nutritional status, frequency of stimulation, birth weight, and maternal education. Nutritional status was affected by exclusive breastfeeding, maternal education and birth weight.
Key words: birth weight, exclusive breastfeeding, stimulation, maternal education, nutritional status, motor development.

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BACKGROUND

The first five years of children's life is an important period for their growth and development since the basic milestone that occurs during the first five years will determine, the next children's development. As it is discovered that the first two years is a golden period since optimization of growth and development occurs during this stage (Risma, 2009).

Motor development is one element of children developments. Possessing fine and gross motor skills is important for children's growth and independence. Having a good motor control helps children exploring their surrounding also helps improving

cognitive development (Garey H *et al.*, 2016).

Motor formation and development start since the fetal stage within a mother's womb. During the 24 weeks up to 34 weeks of gestational age is neurological maturation of subcorcitospinal system and the enhancement of myelinated fibers in the spine that affect fetal motor development in the future (Ruike *et al.,* 2015).

Infants with low birth weight (LBW) are at risk for numerous complication such as respiratory disorder, sleep apnea, heart problems, lungs problems, jaundice, anemia, chronic lungs problem, infections, and disorders of childhood growth and development (Tiffani *et al.*, 2008).

A study by Tavasoli *et al.,* (2014) found a result that newborn's birth weight affected motor development of children under five years old. A study by Lindawati (2013) shows factors that related to motor development of preschool children in Jakarta namely nutrition, parenting pattern, and child's age. Whereas according to Hasyuti (2011) factors related to gross motor of children aged 6-18 months in Jeneponto Regency are affected by nutrition, health and parenting style.

Motor development of children under five years old is greatly affected by nutrition, health status, and movement practice treatment which are in accordance with development stages. Anatomically, development will occur within individual's body which proportionally changes along with the children's age. Insufficient nutritional status will hamper the growth and development which an individual undergoes, as the result the proportion of body structure does not fit the age and eventually will implicate the development of other aspects (Mahendra dan Saputra, 2006).

Based on the explanation above, it needs to conduct a study about the effect of birth weight, exclusive breastfeeding, maternal education, stimulation provision, nutritional status toward motor development of children under the age of two.

SUBJETCS AND METHOD

The study used analytic correlation as the design of the study, since the study analyzed and revealed the correlation among variables of the study. The approach was conducted by using retrospective cohort. The study was conducted in Banyumas Regency. The study used all children of 6-24 months in Banyumas Regency as the population. Subjects sampling was conducted by means of cluster sampling and fixed disease sampling.

The subjects of the study included four sub districts: Somagede, Kembaran, Sumpiuh, Cilongok. A total of 120 children were selected as the subjects of the study consisted of 40 children with Low Birth Weight and 80 children with Normal Birth Weight.

Inclusion criteria and exclusion criteria of the study. Inclusion criteria: children under two who did not have congenital deviation, children under two who were not suffering from chronic and acute diseases, children under two whose parents were willing to be respondents, children under two who had complete family structures (mother and father). Exclusion criteria: Children under five who had history of congenital deviation, children under five who were suffering from chronic and acute diseases, children under two whose parents were not willing to be respondents, children under two who did not have complete family structures (mother and father). Exogenous variables of the study: birth weight, exclusive breastfeeding, maternal education, stimulation provision. Endogenous variables were nutritional status, motor development. The operational definition of

birth weight was the body weight of an infant during the first hour of birth. The measuring instrument was MCH book. The result of the measurement was in gram

Exclusive breastfeeding is exclusively breastfeed without giving any other food or drinks including plain water, in addition to breast milk (medicines, vitamins, expressed milk are allowed) (WHO, 2014). Measuring instrument used was questionnaires. The measuring result was score 1 if mothers exclusively breastfed and score 0 if mothers did not breastfeed.

Maternal education level was the last formal education level taken by mothers as the subjects of study. The measuring instrument was questionnaires. The measurement result was dichotomy of 1 when maternal education ≥ High School and 0 when maternal education ≤ High School.

The provision of stimulation on motor development was maternal activities that stimulate fine motor of children aged 6-24 months which is any movements that need small muscles also need specific coordination and maternal activities to stimulate gross motor of children aged 6-24 months which is any movements that need children's big muscles. The measuring instrument was questionnaires with Early Detection Intervention Stimulation for Growth and Development (SDIDTK) guidelines. The measurement result was figures/ frequency. Based on book of SDIDTK (Depkes, 2010) the stimulation on motor development is divided based ages such as 6-9 months, 9-12 months, 12-15 months, 15-18 months, 18-24 months. The result is in a form of score figures of stimulation frequency conducted by mothers on children, as the following age 6-9 months, the result was (0-12), 9-12 months, the result was (0-9), 12-15 months, the result was (0-10), 15-18 months, the result was (0-7), 18-24 months, the result was (0-10).

Nutritional status was nutritional condition of children aged 6-24 months that was evaluated based on height for age (H/A) (WHO, 2010). Measuring instrument: the gauge used was microtoice length board available in community health centers, the result was in a form of centimeter. Afterward comparing the result of measurement based on WHO's z score table.

RESULT

A. Characteristics of Subjects of the Study

Mothers who were in healthy reproductive age that was 20-35 year old, there were 93 people (77.50%). Mothers who were in unhealthy reproductive age <20 or ≥35 year old, there were 27 people (22.49%). Majority of subjects were mothers of healthy reproductive age. As many as 66 (55%) subjects of the study were mothers with low education (Primary, Middle) And 54 people (45%) were with higher education (High School, Associate Degree, Bachelor's Degree and Master's Degree).

Table 1. Characteristics of Subjects of the Study

Maternal Characteristics	n	%
Age		
< 20 years	4	3.33
20-35 years	93	77.50
≥ 35 years	23	19.16
Education		
Low Education <SMA	66	55
High Education ≥SMA	54	45

Table 2. Characteristics of Exclusive Breastfeeding

Breastfeeding	n	%
Exclusive Breastfeeding	74	61.7
Non Exclusive Breastfeeding	46	38.3
Total	120	100

Table 2 showed that most of the subjects exclusively breastfeed their children during 0-6 month, as many as 74 people

(61.7%). They gave only breast milk without formula milk and other foods in addition to breast milk during 0-6 month. Meanwhile there were 46 orang (38.3%) who did not exclusively breastfeed. The characteristics of specific data of study subjects on the frequency of motor stimulation provision in accordance to children development was presented as follow.

Table 3. The frequency of motor stimulation provision by parents to children in accordance with growth and development

Motor Stimulation Provision	n	%
2	1	0.8
3	2	1.7
4	24	20
5	27	22.5
6	7	5.8
7	7	5.8
8	22	18.3
9	5	4.2
10	19	15.8
11	1	0.8
12	4	4.1
Total	120	100

Based on the table above, most of the subjects, which was 27 people (22.5%), gave motor stimulation to their children with frequency 5 times within a week. The frequencies which were performed at the least were 2 times, 11 times, and 5 times within one week, respectively by one person (2.4%).

Table 4. Nutritional Status of Children under two

Z Score	n	%
< -3	1	0.8
-3 up to -2	43	35.8
-2 up to 2	64	53.4
≥2	12	10

B. Result of Path Analysis

The result of data analysis by using IBM SPSS AMOS 22 was as the following:

1) Model specification

In model specification, the relation of studied variables would be described. There were six observed variables within the study namely birth weight, exclusive breast-feeding, maternal education, the provision of stimulation on development of children under two, nutritional status, motor development.

2) Model Identification

In this stage it conducted a calculation on degree of freedom (df) that showed whether path analysis was possible to be conducted or not.

Degree of freedom = (number of observed variables x (number of observed variables+ 1))/2 – (endogenous variables + exogenous variables + parameter)

= (6x(6+1)/2-(2+4+13)

= 21-19 = 2

The result of calculation df= 2 showed that it was over identified, therefore it was possible to conduct path analysis.

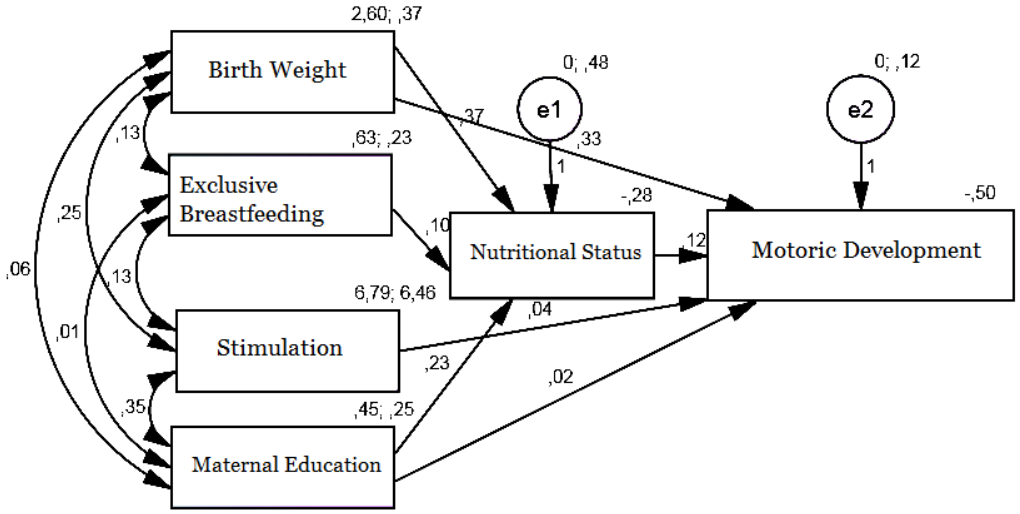
3) Model Appropriateness

Path analysis model made by the researchers based on the theory underwent appropriateness test with the best model of variables correlation according to computer (SPSS) called saturation model, that was made based on researchers' sample data.

Picture 1 showed structural model after conducting estimation by using IBM SPSS AMOS 22, hence it obtained values as it was illustrated in the figure. Indicator that showed the appropriateness of path analysis model as in table 5 also showed goodness of fit measure that obtained fit index of CMIN as much as 0.19 with p = 0.91 >0.05; NFI = 0.99 >0.90; CFI= 1.00 >0.90; RMSEA = 0.00 <0.05 which meant the empirical model met the established criteria and considered in accordance with empirical data.

4) Parameter estimation

Parameter estimation showed variable of cause-effect relationship showed by unstandardized path coefficient (b).



Picture 1. Structural model of unstandardized solution

Table 5. Path analysis on factors that affected the motor development of children under two

Dependent Variables		Independent Variables	b*	SE	p	β*
Direct Effect						
Motor Development	←	Nutritional status: good (PB/U) ≥-2	0.12	0.04	0.006	0.21
Motor Development	←	Maternal education ≥High School	0.02	0.07	0.719	0.03
Motor Development	←	Stimulation frequency	0.04	0.01	0.005	0.21
Motor Development	←	Birth weight ≥ 2500 g	0.33	0.06	<0.001	0.45
Indirect effect						
Nutritional status	←	Exclusive breastfeeding	0.10	0.15	0.507	0.06
Nutritional status	←	Maternal education ≥High School	0.23	0.13	0.078	0.15
Nutritional status	←	Birth weight ≥ 2500 g	0.38	0.12	0.002	0.30
Model Fit						
CMIN= 0.19						
p=0.91		>0.05				
CFI=1		>0.09				
NFI= 0.99		>0.09				
RMSEA =0.00		<0.08				
b*= unstandardized path coefficient						
β**=standardized coefficient						

The result of the study showed that motor development was affected by nutritional status, stimulation frequency, birth weight and maternal education. Nutritional status was affected by exclusive breastfeeding, maternal education, and birth weight.

1. Every one unit increase in nutritional status (PB/U) would increase the motor development of children under two by 0.12 unit (b=0.12; SE=0.04; p=0.006).
2. Every one unit increase in maternal education would increase the motor development by 0.02 unit (b= 0.02, SE = 0.07, p = 0.719).
3. Every one unit increase in stimulation frequency would increase motor develop-

ment by 0.04 unit (b=0.04; SE=0.01; p= 0.005).

4. Every one unit increase in normal birth weight ≥2,500 g would increase motor development by 0.33 unit (b=0.33; SE= 0.06; p<0.001).

Nutritional status was affected by exclusive breastfeeding, maternal education ≥High school and birth weight ≥2,500 g.

1. Every one unit increase in exclusive breastfeeding would increase nutritional status of children under two by 0.10 unit (b=0.10; SE=0.15; p=0.507).
2. Every one unit increase in maternal education ≥High school would increase nutritional status of children under two by 0.23 unit (b=0.23; SE=0.13; p=0.078).
3. Every one unit increase in birth weight ≥2,500 g would increase nutritional status of children under two by 0.38 unit (b=0.38; SE= 0.12; p=0.002).

5) Model Re-specification

The model in the study already fit with sample data as it was showed by saturation model and also path coefficient that valued more than zero and was statistically significant, therefore it did not need to re build path analysis model since it had obtained model that was in accordance with sample data.

DISCUSSION

A. Exclusive Breastfeeding affected nutritional status of children under two

The result of analysis showed that there was a direct positive effect between exclusive breastfeeding with nutritional status of children under two. Exclusive breastfeeding is giving only breast milk to infants 0-6 months without any additional food (Kligman *et al.*, 2006).

Exclusive breastfeeding for children at age 0-6 months will affect the fulfillment of nutrition for infants since breast milk is the most complete and fits the needs of babies 0-6 months. It is in accordance with the study by Fisher *et al.*, (2008) which elaborates that mothers who breastfeed their babies from 0-12 months will give positive effect on the diet pattern of children during their childhood (under five) and is related to higher energy intake of children under five so that it is easier for them to eat and drink (better diet pattern). Exclusive breastfeeding for 6 months without any additional food and drink is highly recommended for optimizing baby's growth in the future, as well as the preventive effort for obesity during childhood (reduce the risk for obesity by 4%) (Sinigaglia *et al.,* 2016). In addition, factors that affect malnutrition of children under two in Uganda, among others is exclusive breastfeeding which is not yet optimum during 0-6 months because the mothers work (Habaasa G, 2015).

A study by Giri et al., (2013) shows the similar thing that is the existence of relationship between exclusive breastfeeding with nutritional status of children 6-24 months, in which babies who are exclusively breastfed will have increasingly better nutritional status than babies 6-24 months who are not exclusively breastfed.

Breast milk possesses all elements that meet baby's needs of nutrition during 6 months period, except if mother is having severe mal nutrition or health problem. For children of 6-24 months, breast milk consumption along with complementary food can give natural antibody for children therefore children will not easily get sick. Exclusively breastfeeding also will give positive effect to nutritional status of children under five (Sahanggamu *et al.*, 2017)

B. Maternal education affected nutritional status of children under two

The result of hypothesis test showed the positive relationship between maternal edu-

cation and nutritional status of children under two.

Education is an important matter for individual's mindset and character building. In accordance with the mandate of the 1945 Constitution every citizen has the right to get adequate education. Higher parental education makes it easier to comprehend information on health. High parental, especially maternal education is expected to be more open to receive information about health problem, thus health status will get increasingly better.

Based on the result of a study by Latorre *et al.,* (2016) parents with high level of education (finish bachelor's degree) have children with better nutritional status than parents with lower level of education. A study by Ahsan *et al.,* (2017) find that nutritional status of children in Bangladesh is greatly affected by a lot of factors from characteristics of people/ community, house holds, also individual characteristics. Individual characteristics among others are maternal education, maternal occupational status (employed or unemployed), mothers' age. Therefore, the effort to improve nutritional status of children under two should be conducted by means of collaboration of various parties. The implemented program should also be cross sector.

The program among others are providing education on nutrition for mothers, improvement effort on environmental sanitation, improvement of healthcare service capacity, improvement of parental especially maternal education since mother is the first family educator. Maternal education is one of individual characteristics that causes stunting and wasting in Uganda which is in accordance with UNICEF framework that the reason of malnutrition on children under five is the low parental education level (Grace *et al.,* 2016)

C. Birth weight affected nutritional status of children under two

The result of hypothesis test showed positive effect between birth weight with nutritional status of children under two. Birth weight is a description of children under two's nutritional status in his early life. Infant who were born with less than 2,500 g or also called as low birth weight, has undergone nutrition deficiency during his intrauterine period. A study by Kensara *et al*., (2016) in Saudi Arabia inds that infants who were born with low birth weight are related to the worsening nutritional status that is measured by means of anthropometry. It is found that the result is low and the result of blood biochemistry test represents poor nutritional status. Based on regression model as the study result of Roifah (2010) it shows that infant mortality rate will increase on infants with low birth weight history and infant mortality rate will increase on malnutrition with a condition that other predictor variables are constant.

It is different from the study made by Patandianan et al., (2015) on children of 2-3 years old in RSUP Prof. Dr. RD Kandou Manado with history of Small Gestasional Age (SAG) showed that there is no effect between nutritional status of children under five with birth weight. However, there is a positive or one way correlation betwen birth weight and nutritional status. It means, the bigger birth weight the bigger nutritional status will be. Children of 2-3 years old with history of low birth weight and small gestational age will experience catch up growth

D. Nutritional status affected motor development of children under two

Nutritional status is the outcome of daily consumption pattern of children under two. Motor development of children under two consists of gross motor and fine motor. Gross motor development is development

from the element of maturity and control of body movement and the development is closely related to the development of motor center within the brain. Gross motor development occurs when the acted movement involves most parts of the body and usually needs power since it is performed by big muscles.

Nutritional status that has significant correlation with gross motor development also elaborated by a study by Solihin et al., (2013) physical development, especially gross motor skill will get increasing perfectly within active, free, and unstructured play. It is different from Wulandari (2010) that elaborates the absence of correlation between nutritional status of children under five and gross motor development of children under five.

Based on a study by Sani (2014) protein intake of children under five will affect gross motor development of children under five. Good nutritional status will make children have enough energy for activities that involve gross motor. The same result also shows by Ati et al., (2013) that conveys the existence of positive correlation and statistically significant between nutritional status and gross motor development of children under two.

Fine motor development is movements that use small muscles or some particular body parts that are affected by the opportunity to learn and practice. For example the ability to move objects from hands, scribbling, arranging blocks, cutting, writing, and others. Subasinge *et al.,* (2010) elaborates that children under five who suffer from chronic energy deficiency are at risk for enduring fine motor delay compared to healthy children under fie with good nutritional status. Chronic energy deficiency leads to children do not get adequate intake especially the need for brain nutrition so that it is potential to endure delay in fine motor development and other development (Park *et al.,* 2011). Adequate nutritional status is important as the means of optimization on children growth and development

E. Maternal education affected motor development

The result of hypothesis showed the positive effect between maternal education and motor development of children under two.

Children of mothers who are less educated commonly have higher mortality rate than those who are born from mothers who are more educated. Parental education level affects children development. Parental low education level leads to the risk of developmental delay on children

Based on a study by Hastuti (2009) a result is found that parents with higher level of education give motor stimulation more often than parents with low level of education. It gives positive impact to gross motor development of children under two. Family environment plays a very important role in the children's establishment, from personality, as well as motor development of children under five, since family is the closest external factor that affects children's growth and development.

Parents with high education give positive influence on the psychomotor development of children under five (Nurdin, 2015). Parental education is positively related to psychomotor development of children under five. Parents with high education have children with better motor development than children whose parents have low eduaction (Hastuti, 2009). Parents with high education are expected to gibe bigger intellectual stimulation and create home environment that promotes and facilitates children development.

The result of a study in Malawi on parental perception toward children physical activity affects the development particularly children's motor. Children who

actively move are considered as healthier than children with less movement. Parents play as the facilitator of children's fine motor therefore attempting to provide the supporting facilities (Pullaka, 2015). Maternal education also affects children's health condition. Mothers who possess high education level will give positive interaction to the process of stimulation on fine motor development of children under five. Maternal education becomes social factor related to the well-being of children's healt (Quansah *et al*., 2016)

F. Frequency of stimulation affected motor development

The result of hypothesis showed the existence of positive effect between stimulition frequency with motor development of children under two.

Motor development is highly affected by brain, through playing stimulation on muscle growth occurs, when children jump, throw, or run. In addition, children play by using their entire emotion, feeling and mind. Rismayanti (2012) states that providing stimulation can optimize motor development on children in accordance with their development stage, by perceiving something in their surrounding to keep on moving. The most stimulation is obtained from children's closest environment. Family and parents, especially mother, is the first and the main environment for a child under five.

Stimulation given in the first three years (golden age) will give quite significant effect for their brain development and becomes the foundation of future life. The earlier stimulation is given, the better development will occur.

A study by Wulandari TW (2015) gives an illustration that the more often stimulation is given to an infant, it will give positive effect on motor development. Meanwhile a study by Yanti et al., (2011) shows that children who obtain motor stimulation have higher score of motor development than children who obtain less stimulation.

Providing stimulation on fine motor by using high technology does not give negative impact as long as it is not given too much. Stimulation in a form of games that need fine motor movement *(touch screen)* for children under three does not give positive implication on to fine motor development. (Bedford *et al.,* 2016). The intensity of stimulation from family and environment greatly affects toward motor development (Giagazoglou *et al.,* 2007).

G. Birth weight affected toward motor development

The result of hypothesis showed the existence of positive effect between birth weight and motor development of children under two.

During gestational age between 28 up to 34 weeks is neurological maturation of subcorcitospinal system and the enhancement of myelinated fiber in the spine that affects motor development of fetus in the future (Ruike *et al.,* 2015). Infants who were born with low birth weight for premature birth will be at risk for enduring motor development disorder during their childhood.

A study by Tavasoli *et al.,* (2014) states that in Turkey children under five with history of low birth weight have lower motor development than children under five who were born with normal birth weight especially for fine motor. It is different to the result of a study by Eickmann *et al*., (2012) that in Brazil premature birth does not affect motor development of infants 6-12 months since motor development is influenced by a lot of factor.

The result of the study showed that there was a positive effect between low birth weight with gross motor development of

children under two. In accordance with Barker theory on lifetime epidemiology that the condition inside intrauterine will affect the condition of extra uterine, the condition of birth will affect toward childhood and adolescence. It is different from a study by Fitriana (2016) that states there is no correlation between infants' birth weight with gross motor development of children under two.

Based on a study by Nazi *et al*., (2012) in Iran on infants 8-12 months, it elaborates the children under five with a history of low birth weight are more vulnerable to endure fine motor development disorder than children under five with normal birth weight. In a different study Nazi *et al*., (2015) compares motor development of infants with low birth weight who are supported with ventilator, without ventilator and infants with normal birth weight. It find a result that infants with very low birth weight endure poor fine motor development, and are vulnerable to motor development disorder in the next stage.

Tavazoli *et al*., (2014) also elaborates that infants who were born with moderate low birth weight often experience motor development disorder and fine motor in particular. The same result is also showed by systematic review study by Moreira *et al*., (2013) that states that premature babies are more vulnerable to experiencing motor development disorder compared to mature infants and in long term they will face problems in their academic. It can be prevented by early guidance for parents and special assistance by health workers.

Based on the study it can be concluded that motor development is affected by nutritional status, stimulation frequency, birth weight, and maternal education. Nutritional status is affected by exclusive breastfeeding, maternal education and birth weight.

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