EFFECT OF STUNTING ON GROSS MOTOR AND FINE MOTOR DEVELOPMENT IN CHILDREN AGED 6-24 MONTHS

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Abstract. Lack of nutritional intake during the golden period results in malnutrition; one of which is stunting. In stunted children, motor development disorders are associated with inhibition of the process of muscle maturity, so that the ability to move muscles is impaired. With early detection, deviations in child development can be noticed early; as a result, efforts to improve motor skills in these children can be given in a timely manner. This study aimed to determine the effect of stunting on motor development. The study used a cross-sectional design applied to a sample of children aged 6-24 months living in Pasuruan. Purposive sampling method was utilized to recruit 120 children with the following inclusion criteria: aged 6-24 months, lived in Pasuruan and there was a parent or guardian who was willing to participate in the study. Those with special needs, acute respiratory infection, hearing loss and visual disturbances were excluded. Stunting was measured using height for age while motor development was assessed using Denver Development Screening Test II (DDST II) screening sheet. Subjects obtained as many as 120 children with 35.8% of children aged under one year (6-12 months). There more boys than girls (50.8%). The prevalence of stunting is 28.3%. A total of 21.7% of children had impaired gross motor development and 14.2% had impaired fine motor development. The results of chi-square test, showed that the incidence of stunting is a variable that has a significant effect on gross motor development (OR = 2.805; 95% CI: 1.133-6.947; p=0.023) and fine motor development (OR = 4.702; 95% CI: 1.615-13.688; p=0.007). Gender and age variables had no significant influence on either gross motor development or on fine motor development.

Keywords: stunting, gross motor, fine motor, development, children

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INTRODUCTION

The first thousand days of birth are an important period for the growth and development of the child because all organs and systems of the body develop rapidly. This period is counted from conception until the child is two years old. Malnutrition that occurs during this period can cause stunting and have an impact on less than optimal motor development in children (Kartika *et al*, 2020). Stunting is a condition of failure to grow in children under five due to chronic malnutrition, especially in the first 1000 days of life (WHO, 2015). Stunting is indicated by z-score of less than-2SD for the short category and less than-3SD for the very short category based on height to age (WHO, 2017). Causes of stunting are such as parenting, food intake, health services and environmental sanitation (Adriani *et al*, 2022). According to nutritional status survey, the incidence of stunting in Indonesia has decreased from 24.4% in 2021 to 21.6% in 2022 (Ministry of Health Republic of Indonesia, 2022). East Java province has 19.2% of stunting incidence and the prevalence of stunting incidence in Pasuruan Regency exceeds the percentage of East Java province which is 20.5% (Ministry of Health Republic of Indonesia, 2022). This indicates that stunting incidences in Pasuruan Regency are still high. Exclusive breastfeeding for 6 months followed by complementary foods for breastfeeding is one of the malnutrition prevention methods (Calista *et al*, 2021). Stunting can affect a child's development in using muscles, both large muscles

and small muscles to perform gross motor and fine motor movements (Rohayati *et al*, 2021).

Development is process of maturation of function and body structure which is qualitative (Alni *et al*, 2023). Some aspects of child development include gross motor development, fine motor development, language development, and social personal development. Motor development is a change in the ability to perform movements through the interaction between maturity and experience factors during life through coordination of central nervous system, nerves and muscles (Fitriani and Adawiyah, 2018). Motor development can also be used as a reference to find out growth and development of children, because it is easy to see. Things that can affect motor development are nutritional status, health conditions, and stimulation by the environment. Poor nutritional status inhibits the rate of children's motor development which will have an impact on the other aspects (Fitriani and Adawiyah, 2018).

Inadequate nutrient intake during brain development results in a reduced number of nerve axons, apical dendrites become short, and the myelination process becomes inhibited so that the speed to conduct nerve impulses between neurons is disrupted (Kartika *et al*, 2020). The development of the child's brain is not optimal, so the cognitive ability to think becomes low (Fitriani and Adawiyah, 2018). Disorders in motor development of stunted children are associated with inhibition of the process of muscle maturity, so that the ability to move muscles is impaired (Kartika *et al*, 2020).

This study aimed to determine the effect of stunting on gross motor and fine motor development in children. With early detection, deviations that occur in child development can be noticed early, so that efforts to improve motor skills in those children can be given in a timely manner.

MATERIALS AND METHODS

This study used a cross-sectional design with a sample of children aged 6-24 months living in Pasuruan, East Java. The number of children aged 6-24 months was as much as 27,665 children. Sample size calculation using Yamane's formula (Yamane, 1973).

$$n = N / (1+Ne^2)$$

where n = sample size

N = population

e = margin of error

With the population of 27,665 and 10% margin of error, such calculation resulted in a minimum sample size of 100 children. Assuming 20% loss to follow-up, the target number of samples needed was as many as 120 children.

Purposive sampling technique was used with the following inclusion criteria: 1) child aged 6-24 months, 2) living in Pasuruan, 3) with parent/guardian's consent to participate in the study. Exclusion criteria were: 1) having acute respiratory infection, 2) child with special needs, 3) having hearing loss and visual disturbances.

Children aged 6-24 months and accompanied by a guardian who came to the 'Integrated Healthcare Center for Toddlers' under the auspices of public health centers of Lekok, Puspo and Wonorejo, in Pasuruan Regency, East Java Province in March 2023 were recruited according to inclusion and exclusion criteria. Then, the guardian who accompanied the children were explained about the procedure to be carried out and, if agreed, signed in the informed consent forms.

Stunting was measured using height for age following the criteria set out by World Health Organization (WHO, 2017). After knowing the age and measuring the height of the child, the results obtained will be converted into z-scores for the assessment of stunting. Based on WHO (2017), children are said to be normal if the z-score values of height for age is greater than -2SD, and stunted if the z-score value is lesser than or equal to -2SD.

Motor development was assessed using a Denver Development Screening Test II (DDST II) sheet developed by Frankenburg and Dodds (1967) - and is recommended by the American Academy of Pediatrics for use in detecting developmental delays in children aged 0 months to 6 years. If it happened that a child was in an abnormal condition or potentially had a delay in motor development, recommendations would be given to the guardians.

Statistical Package for the Social Sciences (SPSS) version 16.0 (IBM Corporation, Armonk, NY) was used for data analyses. Descriptive analysis was used to determine the percentage and amount of each characteristic of the subject using the frequency test. Bivariate analysis was used to assess the relationship of the independent variable on the dependent variable. Bivariate analysis employed in this study was Chi-square test with a confidence level of 95% (p-value = 0.05). Multivariate analysis in this study utilized multiple logistic regression test.

This study obtained an ethical clearance from the Ethics Committee, Faculty of Medicine, Universitas Sebelas Maret Surakarta (FK UNS) with letter number 25/UN27.06.11/KEP/EC/2023.

RESULTS

Table 1 shows that as many as 120 children were recruited; 35.8%

Table 1

Subject characteristics (N = 120)

Characteristic	Frequency *n* (%)
Sex	
Boy	61 (50.8)
Girl	59 (49.2)
Age	
6-12 month	43 (35.8)
13-24 month	77 (64.2)
Stunting incidence*	
Stunting	34 (28.3)
Normal	86 (71.7)
Gross motor development†	
Abnormal	26 (21.7)
Normal	94 (78.3)
Fine motor development†	
Abnormal	17 (14.2)
Normal	103 (85.8)

*Stunting is defined as having the z-score of height-for-age of less than -2SD (-2 standard deviation) for the short category and less than -3SD (-3 standard deviation) for the very short category (WHO, 2017).

†Gross and fine motor development is defined as normal when there is no delay and/or at most there is 1 caution; abnormal when there are 2 or more caution and/or 1 or more delays in each category (Frakenburg and Dodds, 1967).

aged 6-12 months. There are more boys (50.8%) than girls. The prevalence of stunting is 28.3%. A total of 21.7% of children had impaired gross motor development and 14.2% had impaired fine motor development.

The results of Chi-square test in Table 2 show that stunting significantly affects the development of gross motor (OR = 2.805; 95% CI: 1.133-6.947; *p*=0.023) and the development of fine motor (OR = 4.702; 95% CI: 1.615-13.688; *p*=0.007). Gender and age had no significant influence on both gross motor development and on fine motor development.

Table 2 also shows that stunting children under two years old are 3 times more likely to have delayed gross motor development when compared to non-stunted children (OR = 3.148; 95% CI: 1.207-8.212; *p*=0.019). The risk of delayed fine motor development in stunting children under two years old is 5 times higher when compared to normal children (OR = 5.115; 95% CI: 1.661-15.747; *p*=0.004). There was no significant effect on gender and age of children under two years on motor development (*p*=0.191 and *p*=1.000, respectively) and fine motor (*p*=0.435 and *p*=0.962, respectively).

DISCUSSION

The percentage of stunting in this study was 28.3%. Based on the results of Indonesia's nutritional status survey (Ministry of Health Republic of Indonesia, 2022), this proportion exceeds the prevalence of stunting in Pasuruan Regency, even at the Indonesian level. The results showed that some children experienced gross and fine motor development disorders with a prevalence of 21.7% and 14.2%, respectively. Based on the results of this present study, stunting has a significant influence on the development of gross motor and fine motor. A study in Zimbabwe

Table 2

Bivariate and multivariate analysis test results

Variable	Gross motor development					
	Normal	Abnormal	OR (95% CI)	*p*-value*	aOR (95% CI)	*p*-value†
Sex, *n* (%)			1.550 (0.645-3.725)	0.326	1.869 (0.731-4.778)	0.191
Boy (N = 61)	50 (82.0)	11 (18.0)				
Girl (N = 59)	44 (74.6)	15 (25.4)				
Age, *n* (%)			1.335 (0.526-3.389)	0.543	1.000 (0.373-2.683)	1.000
6-12 months (N = 43)	35 (81.4)	8 (18.6)				
13-24 months (N = 77)	59 (76.6)	18 (23.4)				
Stunting, *n* (%)			2.805 (1.133-6.947)	0.023	3.148 (1.207-8.212)	0.019
Stunted (N=34)	22 (64.7)	12 (35.3)				
Normal (N=86)	72 (83.7)	14 (16.3)				

Table 2 (cont)

Variable	Fine motor development					
	Normal	Abnormal	OR (95% CI)	*p*-value*	aOR (95% CI)	*p*-value†
Sex, *n* (%)			1.192 (0.427-3.333)	0.737	1.562 (0.510-4.788)	0.435
Boy (N = 61)	53 (86.9)	8 (13.1)				
Girl (N = 59)	50 (84.7)	9 (15.3)				
Age, *n* (%)			1.403 (0.459-4.289)	0.551	0.971 (0.291-3.245)	0.962
6-12 months (N = 43)	38 (88.4)	5 (11.6)				
13-24 months (N = 77)	65 (84.4)	12 (15.6)				
Stunting, *n* (%)			4.702(1.615-13.688)	0.007	5.115 (1.661-15.747)	0.004
Stunted (N=34)	24 (70.6)	10 (29.4)				
Norma (N=86)	79 (91.9)	7 (8.1)				

*Chi-square test; †Multiple logistic regression test

aOR: adjusted odds ratio; CI: confidence interval; OR: odds ratio

showed that stunting affected the development of children by causing a delay or disorder, especially on eye and hand coordination, gross motor and general development (Mutapi *et al*, 2021). In line with research by Rohayati *et al* (2021), there is a relationship between stunting incident and gross motor development, fine motor and language development in children aged 0-24 months. Mustakim *et al* (2022) stated that stunted children have a 2.9 times risk of have developmental delays compared to those who are not stunted. They also found that stunting is significantly related to the development of children aged 1-3 years. Research conducted by Nahar and co-workers in Bangladesh shows that stunted children have less developmental ability compared to normal children in all aspects, both cognitive, language, motor and social-emotional (Nahar *et al*, 2020). In contrast to the research conducted by Setianingsih *et al* (2020), they found no effect of stunting on fine motor development (p=0.082), but there was a significant effect of gross motor development (p=0.001) in stunted children.

Nutritional status has an impact on the growth and development of children. Malnutrition in children can affect the development of muscle tissue impacting the children' daily movement. Malnutrition begins to occur during pregnancy and after birth but this condition will be seen when the baby is 2 years old (Afrida and Aryani, 2022). Developmental delays in stunted children are caused by nutritional deficiencies in early life, which at that time is a critical period for the development of children (Mustakim *et al*, 2022). This may be due to the fact that a deficient nutrient index is related to a deficiency of essential nutrients needed for brain development such as folic acid, iron and iodine (Wondemagegn and Mulu, 2022). Iodine deficiency is related to the impact of brain development at the beginning of a child's life (Wondemagegn and Mulu, 2022). Children who received little iron significantly had developmental

disorders compared to children who received enough iron (Bahtiar *et al*, 2021).

The more severe of child's stunting condition, the slower of motor development and cognitive development abilities (Arini *et al*, 2019). One of the adverse effects of stunting is disruption of the brain due to changes in structure and function (Calista *et al*, 2021). Inhibition of motor development results from a delay in the maturity of nerve cells found in the cerebellum. The maturity of inhibited nerve cells is influenced by the number of cortical dendrites, myelin in the spinal cord, and the reduction of neurotransmitter synapses (Afrida and Aryani, 2022).

Motoric development in children goes through the process by which children acquire movement patterns and skills. Motoric ability is based by several factors such as physical and muscular nerve maturity, repetitive exercise and environment (Afrida and Aryani, 2022). Fine motor activity includes the ability for precise, efficient and adaptive movements using the small muscles of the hands, feet, lips and tongue and hand-eye coordination simultaneously. Gross motor skills involve movements that use large muscles in the arms, legs, and body (Nahar *et al*, 2020). In humans, skeletal muscles are located in the arms, limbs and along the legs as a determinant of muscle mass. In stunted children, a decrease in muscle mass was found due to a reduction in limb length, which is less noticeable than in wasting children (Nahar *et al*, 2020). Over time, if left unchecked, the ability to move muscles also decreases due to weak muscle strength (Afrida and Aryani, 2022).

Children who lack nutritional intake are at risk of severe acute malnutrition and death. From birth, children use motor skills to play and interact with the surrounding environment. As children grow older, impaired motor development may have an impact on communication

and social skills (Nahar *et al*, 2020). Motor skills in children who have delayed motor development can still be improved to have the skills being in accordance with their age. This is possible because children are very quick to learn and follow the things that happen around them, especially the experiences that can be from their parents. Stunting conditions can be minimized by providing balanced nutrition because height growth can still increase until the child is over 18 years old (Setianingsih *et al*, 2020).

In conclusion, the prevalence of stunting is still high in Pasuruan Regency. Stunting has an impact on the motor development of children under two years, both in gross and fine motor skills. Inhibition of motor development is caused by a delay in the maturity of nerve cells contained in the cerebellum. Efforts have been made by the government to deal with stunting, one of which is the improvement of nutrition with supplementary feeding given to children who are malnourished. With the stimulation of child development, which is accompanied by supplementary feeding, it is expected that the ability of children's motor development would be improved and thus, reduce the incidence of stunting periodically. Such government programs eventually produce a good impact on society.

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CONFLICT OF INTEREST DISCLOSURE

The authors declare no conflict of interest.

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