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Fine motor, gross motor, and social independence skills among stunted and non-stunted children

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ABSTRACT

Child growth and development are important aspects of the quality of human capital in future. This study aimed to examine the association between stunting and fine motor, gross motor, and social independence development among children under the age of five years old. We included a total of 525 children from district level survey in Sedayu Subdistrict, Yogyakarta, Indonesia, for further analysis. Stunting was associated with fine motor (OR = 3.45; 95% CI: 1.22–9.76) and social independence (OR = 7.09; 95% CI: 2.01–25.01), but not gross motor skill (OR = 2.43; 95% CI: 0.67–8.81). Performance ratios of fine motor (p = 0.02) and social independence (p = 0.01) skills were also higher among non-stunted children compared to stunted children.

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Fine motor; gross motor; social independence; stunting; child development

Introduction

Early childhood development is crucial in human capital investment (Belli, Bustreo, & Preker, 2005; Nandi, Bhalotra, Deolalikar, & Laxminarayan, 2017). Conversely, children with developmental impairments are at risk of having poor school performance, low productivity, more children with inadequate parenting, therefore, lead to poverty transmission across generations (Grantham-McGregor et al., 2007). Investments in later life productivity were therefore considered to be effective at any phase of childhood (Francesconi & Heckman, 2016).

Developmental impairments, especially in the gross motor aspect, could start in the first year of life (Valla, Wentzel-Larsen, Hofoss, & Slinning, 2015). Developmental delay in at least two domains of fine or gross motor, language, cognitive, social, and daily activities affect up to 3% of children under the age of five globally (Mithyantha, Kneen, McCann, & Gladstone, 2017). In low- and middle-income countries, more than 200 million under-five children were reported not to meet their developmental capacity in which Asia held the highest number of these disadvantaged children (Grantham-McGregor et al., 2007).

Childhood stunting has been used as an indicator of impaired development (Grantham-McGregor et al., 2007). There is varying evidence as to whether stunting contributes to motor and psychosocial impairments. A meta-analysis study revealed that children with higher height-for-age Z-score were more likely to have better cognitive and motoric scores (Sudfeld et al., 2015). However, a review study in low- and middle-income countries highlighted that the relationship between stunting and motor or psychosocial development was weak and unclear (Miller, Murray, Thomson, & Arbour, 2016; Perkins et al., 2017). Results of those studies were varied due to different study

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designs and measurement methods being used making it hard to relate between studies (Perkins et al., 2017). An earlier study in India showed that factors correlated with motor development included length-for-age Z-score, psychosocial stimulation, and diversified dietary consumption (Larson et al., 2017). In addition, a systematic review study resulted in the contribution of physical activity on motor skills (Zeng et al., 2017). A study in Ethiopia found that stunting status, younger child's age, maternal mental disorder, and household socio-economic status were associated with overall childhood development (Hadley, Tegegn, Tessema, Asefa, & Galea, 2008).

In Indonesia, to our knowledge, there were only limited studies examining the association between stunting and child development. Most of these studies had smaller sample size (Hanani & Syauqy, 2016; Pantaleon, Hadi, & Gamayanti, 2015; Susanty & Margawati, 2012), restricted in child's age (Hanani & Syauqy, 2016; Pantaleon et al., 2015; Probosiwi, Huriyati, & Ismail, 2017; Susanty & Margawati, 2012), and used different developmental assessment tools (Hizni, Julia, & Gamayanti, 2010; Pantaleon et al., 2015; Susanty & Margawati, 2012), whereas only one study by Probosiwi et al. (2017) assessing social development, however, the developmental measurement was not specified. Therefore, this study aimed to analyze the relationship between stunting and motoric and social developments among children under the age of five years in Sedayu Subdistrict, Yogyakarta, Indonesia.

Methods

Study location and participants

This study was a cross-sectional survey conducted in Sedayu Subdistrict, Bantul District, Yogyakarta Special Region, Indonesia. By using secondary data from the Stimulation, Detection, and Early Intervention of Child Growth Development (SDIDTK) survey conducted by Sedayu II Primary Health Center. Population in this study was all children under the age of five years who were enrolled in the survey in February 2017. A total of 525 children was included in this study as a total sampling after we excluded two children with missing data on either height-for-age or developmental aspect data. This study was ethically approved by Alma Ata University Institutional Review Board number: KE/AA/II/816/EC/2019.

Variables

Our dependent variables were fine motor, gross motor, and social independence developments, whereas the independent variable was stunting. Fine motor, gross motor, and social-independence developments were calculated based on the Pre-Screening Development Questionnaire (KPSP) criteria for each age group. The questionnaire was developed by Indonesian Ministry of Health and is currently used nationally for early detection of child development at every level of primary health care (e.g. primary health centers, integrated health posts, clinics) and pre-schools in Indonesia. The developmental aspects covered in the questionnaire included fine motor, gross motor, language, and social-independence (Ministry of Health of Indonesia, 2016).

Gross motor skill was defined as the developmental aspect which was associated with the child ability to move by involving large muscles such as sitting, standing, running, and jumping. Fine motor skill referred to the aspect that related to the movement which required certain body parts with smooth muscle and precise coordination such as grasping, pinching, and writing. Social independence was the child's ability to develop independence (e.g. eating, cleaning-up their toys) and social skills (e.g. being separated with their mothers/caregivers, interact with their friends and environment) (Ministry of Health of Indonesia, 2016).

We scored one for each age-specific criterion met by the child. Sum of this score reflects developmental performance made by the child (Ministry of Health of Indonesia, 2016). We calculated the developmental performance ratio as the observed score divided by an expected score based on age-specific recommendation. A performance ratio of 1 indicated that the child followed the developmental standard for his/her age, whereas a ratio which fell far from 1 meant that the child had a reduced developmental aspect (Worku et al., 2018). We categorized the developmental score into two groups: delayed if the sum of age specific-developmental score below 50% and normal if the sum of age-specific developmental score equal to or above 50%.

Child length or height was measured by a nutritionist and trained community health workers during survey data collection by using portable length board. Meanwhile, child development information was obtained by a face-to-face interview between mothers and midwives. Subsequently, researchers estimated height-for-age Z-score by using WHO Anthro 2005 software as well as calculated developmental score. Stunting was defined as a nutritional status based on low height-for-age Z-score which fell below −2 SD compared to growth reference (WHO, 2006).

Data analyses

Descriptive statistics were used for describing child characteristics. Independent t-test was performed to estimate the difference of mean in the fine motor, gross motor, and social-independence developments across stunting status. Chi-square test was performed to analyze the relationship between each variable. We adjusted the child's age and child's sex in the multiple logistic regression for the association between stunting and fine motor, gross motor, and social independence developments. A significance level of 5% was set. We used Stata 14.2 for all these analyses.

Results

Our study covered 525 children under the age of five years old whose characteristics are presented in Table 1. Children were distributed equally across age. There was a higher proportion of male children (52.38%) compared to female children (47.62%). The prevalence of stunting was around 21%. A small portion of children had delayed fine motor (2.86%), gross motor (1.90%), and social independence skills (2.10%).

In chi-square test results (Table 2), stunting was the only significant variable associated with a delayed fine motor skill (OR = 3.38; 95% CI: 1.20–9.52) and social independence skill (OR = 6.82;

Table 1. Characteristics of children under five years of age.

Characteristics	n	%
Child's age		
0–11 months	75	14.29
12–23 months	101	19.24
24–35 months	113	21.52
36–47 months	118	22.48
48–59 months	118	22.48
Sex		
Male	275	52.38
Female	250	47.62
Stunting		
Yes	112	21.33
No	413	78.67
Fine motor skill		
Delayed	15	2.86
Normal	510	97.14
Gross motor skill		
Delayed	10	1.90
Normal	515	98.10
Social independence skill		
Delayed	11	2.10
Normal	514	97.90

Table 2. Bivariate and multivariate results of determinants of delayed fine motor, gross motor, and social independence skills.

	Crude OR	95%CI	*p*	Adjusted OR	95%CI	*p*
Fine motor skill						
Child's age (months)						
<24 (ref)						
≥24	2.05	0.57–7.37	0.27	2.15	0.59–7.80	0.24
Sex						
Male (ref)						
Female	0.96	0.34–2.69	0.94	0.94	0.33–2.66	0.91
Stunting						
No (ref)						
Yes	3.38	1.20–9.52	0.02	3.45	1.22–9.76	0.02
Gross motor skill						
Child's age (months)						
<24 (ref)						
≥24	0.33	0.92–1.18	0.09	0.34	0.09–1.23	0.10
Sex						
Male (ref)						
Female	0.73	0.20–2.61	0.63	0.81	0.22–2.92	0.74
Stunting						
No (ref)						
Yes	2.51	0.70–9.06	0.16	2.43	0.67–8.81	0.18
Social independence skill						
Child's age (months)						
No (ref)						
Yes	2.30	0.49–10.77	0.29	2.83	0.59–13.62	0.20
Sex						
Male (ref)						
Female	0.24	0.05–1.11	0.07	0.22	0.05–1.06	0.06
Stunting						
No (ref)						
Yes	6.82	1.96–23.72	0.00	7.09	2.01–25.01	0.00

Crude OR = crude odd ratios. Adjusted OR = adjusted odd ratios after adjusting age and sex.

95% CI: 1.96–23.72). However, stunting was not related to gross motor skill (OR = 2.51; 95% CI: 0.70–9.06). We did not find a significant relationship between child's age and sex and each of the three developmental aspects.

The distribution of performance ratio of fine motor, gross motor, and social independence skills is presented in Figure 1. By performing the two-sample t-test, we found that there was a

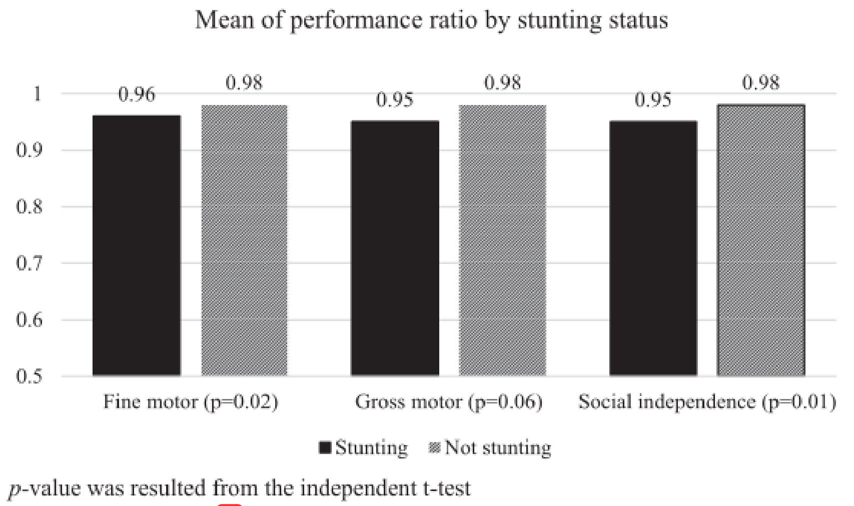

Figure 1. Mean of performance ratio of fine motor, gross motor, and social independence skills among stunted and non-stunted children.

significant difference in the fine motor performance ratio between stunted and non-stunted children (p=0.02) in which non-stunted children (0.98) had higher performance ratio compared to stunted children (0.96). A similar finding was shown in social independence skill performance ratio where children who were not stunted (0.98) had higher performance ratio compared to stunted children (0.95) with a p-value of 0.01. Although gross motor performance ratio was larger among non-stunted children compared to stunted children, however, the result was not significant (p=0.06).

Child's age, sex, and stunting were entered into multivariate analysis (Table 2). Results showed that stunted children were more likely to have fine motor impairment 3.5 times higher compared to non-stunted children (95% CI: 1.22–9.76). Childhood stunting also increased the risk of having delayed social independence skills 7 times higher compared to those who were not experienced stunting (95% CI: 2.01–25.01). There was no relationship between stunting and gross motor skills (adjusted OR = 2.43; 95% CI: 0.67–8.81). Similar to bivariate findings, no significant relationship found on the child's age and sex regarding developmental impairments.

Discussion

The prevalence of stunting in this study was 21.3%. Based on the Indonesia Basic Health Research (Riskesdas) survey, this proportion was similar to stunting prevalence in Yogyakarta Special Region (21.4%) (NIHRD, 2019). While there was no nationally nor regionally representative data, our study revealed that the prevalences of children having delayed fine motor, gross motor, and social independence developments were 2.9%, 1.9%, and 2.1%, respectively, which was only slightly below the global estimation of childhood developmental delays (3%) (Mithyantha et al., 2017).

This study reported the significant relationship between stunting and delayed fine motor skill in children under five years of age. Mean of fine motor performance ratio between stunted and non-stunted was also significantly different. However, there was no significant association between stunting and gross motor skill. A longitudinal study conducted in Jamaica suggested that as a chronic form of malnutrition, stunting was linked to the changes in a certain area of the brain which was responsible for fine motor functions (Chang, Walker, Grantham-McGregor, & Powell, 2010). The timing of brain development may occur during prenatal and postnatal period which could determine a child's motoric problems (Golding, Emmett, Iles-Caven, Steer, & Lingam, 2014). A study among twin subjects found that thyroid hormone deficiency which took place in the first few weeks of pregnancy resulted in the delayed gross motor skill, but when it occurred in later weeks of pregnancy, the risk of fine motor delays would become higher (Williams & Gross, 1980).

Motoric development and stunting may share the same underlying factor, such as socioeconomic status. While stunting has long been recognized to be related to socioeconomic factors (Black et al., 2008), a previous study in North-Eastern Germany confirmed our result that fine motor development was more affected compared to gross motor development. This study reported that children from lower socioeconomic status were more likely to have delayed fine motor skill, but not gross motor skill (Gottschling-Lang, Franze, & Hoffmann, 2013). Nevertheless, we did not obtain any factor regarding socioeconomic aspects in our study samples.

This study found that stunting and social independence impairment were linked. An earlier study also showed stunted children had a lower social-emotional score (Nahar, Hossain, Mahfuz, Islam, Hossain, Murray-Kolb, et al., 2020). This could be explained by anxiety, depressive symptoms, and poor self-esteem which were commonly found among stunted children compared to non-stunted children, thus causing poor psychosocial functioning (Walker, Chang, Powell, Simonoff, & Grantham-McGregor, 2007). Short-statured children may have psychological problems such as their own satisfaction regarding the height, and the proneness of being treated as if they were younger than their age, bullied, or teased (Erling, 2004). Furthermore, the adverse psychosocial outcome may also continue until the adolescent period where height could affect self-efficacy and peer interactions (Himaz, 2018).

Limitation and future research

This study was based on the cross-sectional survey at the district level, therefore, cannot be used to address causal links between variables. Two improvements should be made when designing the future studies in this topic: 1) a follow-up design for the survey at the certain stage of child development would allow the better quality of causal-effect evidence and 2) including broader determinants of child development, such as socioeconomic factors and early child stimulation for further insights to factors associated with child development.

Conclusion and implications

Childhood stunting is associated with delayed fine motor and social independence skills, but not gross motor skills. Although there is only a slight difference in the developmental performance ratio between stunted and non-stunted children, we could not ignore that child growth and development are the keys of the quality of the human capital. Thus, it is important to identify influences that will enable the prevention of poor growth and development, especially during the first 1000 days of life.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Kiki Nur Meylia was an undergraduate student at Department of Nutrition, Universitas Alma Ata, Indonesia. This publication was part of her thesis research. Currently, Kiki works as a nutritionist at Yogyakarta Teladan School, Indonesia.

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