

## RESEARCH STUDY

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# Nutritional Status and Motor Development of Toddlers Aged 24-59 Months in Agricultural Area of Semarang District

## Status Gizi dan Perkembangan Motorik Balita Usia 24-59 Bulan di Wilayah Pertanian Kabupaten Semarang

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**ABSTRACT**

**Background:** Poor nutritional status during the growth and development of toddlers is irreversible. It can affect the inadequate functioning of various body systems, including the nervous and muscular systems that play a role in motor development. The trend of food intake in agricultural areas is vegetable consumption, while low animal protein intake will affect the nutritional status and development of toddlers.

**Objectives:** This study aimed to analyze the correlation between nutritional status and motor development in toddlers aged 24-59 months in agricultural areas.

**Methods:** This was a cross-sectional study with a sample size of 65 subjects aged 24-59 months in Sumowono, Semarang Regency, Central Java. The variables studied were nutritional status weight-for-age z-scores (WAZ), weight-for-height z-scores (WHZ), and height-for-age z-scores (HAZ) measured using digital and microtome scales, as well as gross motor and fine motor development measurements with observations and interviews based on the Standard of Child Development Achievement (STPPA) questionnaire. Univariate and bivariate data were then analyzed statistically using the Spearman rank correlation test.

**Results:** Based on anthropometric measurements, 10.8% of toddlers were underweight; 1.5% were overweight; 4.6% were wasting; 9.2% had a possible risk of being overweight; and 40% were stunted. A total of 15.4% of toddlers had severe gross motor delays, and 13.8% had fine motor delays. WAZ (p-value=0.003; r=0.366) and HAZ (p-value<0.001; r=0.633) had relationships with gross motor skills. Both WAZ (p-value=0.019; r=0.291) and HAZ (p-value<0.001; r=0.719) also had relationships with fine motor skills. However, there was no relationship between WHZ with gross motor (p-value=0.935) and fine motor (p-value=0.168).

**Conclusions:** Toddlers with good nutritional status (WAZ and HAZ) will have good gross and fine motor development.

**INTRODUCTION**

Toddlers are children aged one to five years who are in a critical period and are a vulnerable group whose brain cells are undergoing rapid growth and development compared to the previous growth stage. It requires more attention to maximize the child's growth and development which are irreversible once a child is grown-up<sup>1,2,3</sup>. Disturbed or hampered development of toddlers cannot be completely repaired in the future<sup>1</sup>. Toddlers with delayed motor development will have long-term impacts on the child's learning process, independence in doing activities such as eating and dressing, and academic abilities<sup>4</sup>.

Toddlers' motoric development is one dimension that cannot be separated from their growth and development<sup>5</sup>. The brain as the control center and muscles as a tool for movement require a balanced nutritional intake to optimize the motor development of

toddlers<sup>6</sup>. An imbalanced nutritional intake will result in poor nutritional status, thus affecting individual motor development<sup>7</sup>. Child development, gross motor, and fine motor skills are influenced by nutritional status during the growth period<sup>8</sup>. Nutritional status is determined by the quality of nutritional intake and absorption of nutrients in the human body<sup>9,10</sup>. In toddlers, measuring nutritional status has very important benefits for malnutrition prevention in toddlers, early detection of infectious diseases, and optimization of children's physical and motor development<sup>2</sup>.

Delayed motor development and low marks in the nutritional status of toddlers are still problems a lot of toddlers in Indonesia are facing. According to the World Health Organization (WHO), the prevalence of development disorder in children under five in Indonesia was 7.51% in 2016<sup>11</sup>. Apart from that, according to the Basic Health Research (*Riskesdas*) in Indonesia in 2018,

the appropriate development index in children 3-5 years old was 88.3%. Specifically, the development index in children 3-5 years old in rural areas was still lower at 86.7% compared to urban areas<sup>12</sup>. The 2022 Indonesian Toddler Nutrition Status Survey (SSGI) displayed 17.1% of underweight toddlers, 7.7% of wasting toddlers, 21.6% of stunting, and 3.5% of overweight. The SSGI conducted in Central Java in 2022 showed the percentages of underweight, wasting, stunting, and overweight toddlers were 17.6%, 7.9%, 20.8%, and 3.2%, respectively. Based on SSGI conducted in Semarang Regency in 2022, the percentages of underweight, wasting, stunting, and overweight children under five were 12.4%, 3.2%, 18.7%, and 3.7%, respectively<sup>13</sup>. Based on the Indonesian Statistics in Sumowono District in 2020, the percentages of underweight, wasting, and stunting children under five were 8.2%, 2.4%, and 13.8%, respectively<sup>14</sup>.

Toddlers between 24 and 59 months old have curiosity in trying different activities, such as finicky eating and exploration of their new play environment. When they ignore mealtimes, they will have inadequate food intake<sup>2,15</sup>. Additionally, toddlers' food preferences can be influenced by their surroundings. They learn to be picky eaters from their environment, only eating food that they enjoy although it is harmful<sup>15</sup>. An unbalanced healthy diet contributes to children's delayed motor development and low nutritional status<sup>16</sup>.

Sumowono District, an agricultural area in Semarang Regency, Central Java Province is inhabited by farmers. Based on the results of the literature review, food availability in agricultural areas is in the low category, and the availability of seasonal food might be limited<sup>17</sup>. The largest agricultural products in the Sumowono District are rice, mustard greens, and bananas. Semarang Regency demonstrated that the Sumowono District has lower legume products compared to other regions<sup>18</sup>. Its main sectors are plantations and agriculture, yielding low supplies of fisheries and livestock, as well as making access to animal protein supplies difficult in some remote mountainous areas<sup>19</sup>. Apart from that, Sumowono District is an area prone to drought during the dry season. The supply of vegetables such as mustard greens, cabbage, tomatoes, and spinach tends to be lacking and impacts the low variety of vegetables that mothers provide for toddler food consumption<sup>17,20</sup>.

The availability of food sources influences the adequacy and diversity of food intake, which contributes to the nutritional status and motor development of toddlers. The research was conducted to analyze the relationship between nutritional status based on three anthropometric indices (e.g., weight index for age, weight index for height, and height index for age), motor development, and gross and fine motor skills.

## METHODS

This cross-sectional study was carried out in March 2023 in Sumowono District, Semarang Regency. The sample size was determined using purposive sampling that gathered 65 children who met the respondents' criteria. Participating children should have their mothers willing to be interviewed; the children were aged 24-59 months living in the Sumowono District; and

they were in good health, not born prematurely. To participate in this study, the mothers accepted and signed the informed consent forms. For further approval, the research ethics have been agreed upon by the Health Research Ethics Commission, Faculty of Public Health, Diponegoro University number 188/EA/KEPK-FKM/2023.

A structured questionnaire was used to collect data on the characteristics of toddlers, mothers, and families using interviews. The data required included the toddler's date of birth, gender, history of exclusive breast milk, mother's age, mother's education, and family income. The age of toddlers was calculated based on the date of birth and classified into three groups, namely children aged 24-35 months, 36-47 months, and 48-59 months<sup>21</sup>. Maternal age was classified into three groups, namely mothers aged 17-25 years, 26-35 years, and 36-45 years<sup>22k</sup>. Maternal education was classified into basic education (elementary school to junior high school graduates) and further education (high school and college graduates)<sup>23</sup>. Family income was classified into <IDR 2,480,988.00 and ≥IDR 2,480,988.00<sup>24</sup> based on districts/city minimum wage for Semarang Regency in 2022<sup>24</sup>.

Nutritional status was obtained from height measurements carried out using a Gea medical type SH2A microtome, and body weight measurements were carried out using a Gea brand digital scale type EB-5636. The calculation of z-scores was done using the World Health Organization's (WHO) Anthro application. Nutritional status was assessed based on an anthropometric indicator of WAZ (weight-for-age z-scores), HAZ (length-or height-for-age z-scores), and WHZ (weight-for-height z-scores) and classified based on the toddler's anthropometric status according to the Regulation of the Indonesian Minister of Health Number 2 of 2020 concerning Child Anthropometric Standards<sup>9</sup>.

Motor development was measured from observation using the Standard Child Development Achievement Level (STPPA) questionnaire<sup>21,25</sup>. The value was obtained by calculating the individual score divided by the maximum score according to age and multiplied by 100. The value was analyzed and classified following the 2015 Early Childhood Education (PAUD) Assessment Guidelines. The value categories were not yet developing (score <25), starting to develop (score 26-50), developing as expected (score 51-75), and developing very well (score >76)<sup>26</sup>.

Univariate analysis aimed to classify data on respondents' characteristics, nutritional status, and motoric development of toddlers. In bivariate data analysis, the Spearman Rank correlation test was used to determine the correlation between nutritional status variables and motor ability variables in toddlers.

## RESULTS AND DISCUSSION

The largest group of toddlers was aged 24-35 months; more than half of the toddlers were female; and most of the toddlers had a history of exclusive breastfeeding. The maternal age group of 26 - 35 years was more than half of the respondents. The most recent education of the toddlers' mothers was primary education. More than half of families with children under

five years old had family income above the Semarang Regency's minimum wage in 2022 (Table 1).

**Table 1.** Distribution of general characteristics and breastfeeding history of toddlers

General Characteristics and Toddler's Breast Milk History		n	%	Min.	Maks.	$\bar{x}$ (SD)
Toddler's Age	24-35 m.o	25	38.5			
	36-47 m.o	18	27.7	24 months	59 months	41.45 (9.90)
	48-59 m.o	22	33.8			
Gender	Male	29	44.6			
	Female	36	55.4			
Breast Milk History Exclusive	Do not accept	6	9.2			
	Accept	59	90.8			
Mother's Age	17-25 y.o	16	24.6			
	26-35 y.o	37	56.9	20 years	44 years	30.81 (5.40)
	36-45 y.o	12	18.5			
Mother's Education	Basic	34	52.3			
	Further	31	47.7			
Family Income	<Rp2,480,988.00	28	43.1	Rp 500,000	Rp 5,000,00	2,313,846.154
	≥Rp2,480,988.00	37	56.9			(1,036,803.520)

n: Number of respondents; SD: Standard deviation; Rp. 2,480,988.00: Semarang Regency's minimum wage

**Table 2.** Distribution of nutritional status index WAZ, HAZ, and WHZ

Nutritional Status of Toddlers		n	%	Min.	Max.	$\bar{x}$ (SD)
WAZ Index	Underweight (<- 2 SD)	7	10.8			
	Normal weight (-2 sd. +1 SD)	57	87.7	-2.96 SD	1.68 SD	-0.96 (0.92)
	Overweight (>+1 SD)	1	1.5			
WHZ Index	Wasting (<- 2 SD)	3	4.6			
	Good Nutrition (-2 sd. +1 SD)	56	86.2	-4.26 SD	2.85 SD	-0.16 (1.12)
	Risk of overweight (>+1 SD)	6	9.2			
HAZ Index	Stunting (<- 2 SD)	26	40.0	-3.44 SD	1.99 SD	-1.57 (1.14)
	Normal (-2 sd. +3 SD)	39	60.0			

SD: Standard deviation

Most toddlers had normal WAZ and HAZ nutritional status, and more than half had normal HAZ nutritional status. There were more cases of underweight toddlers (10.8%) than overweight toddlers (1.5%). The data showed that the children experienced wasting (4.6%) and the risk of overweight (9.2%). Data on the HAZ index showed high cases of stunting (40.0%) (Table 2). Toddlers were mostly in the starting development of gross motor skills (15.4%) and fine motor skills (13.8%). The average motor development score for toddlers was included in the development category that is in line with expectations (Table 3).

In terms of the most delayed gross motor development, 84% of the toddlers aged 24-35 months

experienced some trouble in the indicator of jumping forward and backward with two legs; 72.2% of toddlers aged 36-47 months had some challenges in climbing on a wide board; and 63.3% of the toddlers aged 48-59 months had difficulties in making hanging movements. Furthermore, the observation results indicated that 76% of toddlers aged 24-35 months had the most delayed fine motor development in terms of cutting paper without a pattern; 83.3% of toddlers aged 36-47 months experienced a delay in cutting paper following a straight line; and 77.2% of toddlers aged 48-59 months had delayed eye and hand coordination to carry out complex movements.

**Table 3.** Distribution of toddler motoric development

Toddler Motor Development		n	%	Min.	Max.	$\bar{x}$ (SD)
Gross Motor	Starting to develop (SD)	10	15.4			
	Developing according to expectations (DE)	41	63.1	45.00	87.50	66.5 (11.8)
	Developing very well (DW)	14	21.5			
Fine Motor	Starting to develop (SD)	9	13.8			
	Developing according to expectations (DE)	38	58.5	45.83	93.75	69.00 (12.06)
	Developing very well (DW)	18	27.7			

**Table 4.** Relationship between nutritional status and gross motor development of toddlers

Variable	Gross Motor						Total	p-value	r		
	SD		DE		DW						
	n	%	n	%	n	%					
WAZ Index	Underweight (<- 2 SD)	5	71.4	2	28.6	0	0.0	7	100.0	0.003*	0.366
	Normal weight (-2 sd. +1 SD)	4	7.0	39	68.4	14	24.6	57	100.0		
	Overweight (>+1 SD)	1	100.0	0	0.0	0	0.0	1	100.0		
WHZ Index	Wasting (<- 2 SD)	1	33.3	2	66.7	0	0.0	3	100.0	0.935	
	Good nutrition (-2 sd. +1 SD)	7	12.5	35	62.5	14	25.0	56	100.0		
	Risk of overweight (>+1 SD)	2	33.3	4	66.7	0	0.0	6	100.0		
HAZ Index	Stunting (<- 2 SD)	8	30.8	18	69.2	0	0.0	26	100.0	<0.001*	0.633
	Normal (-2 sd. +3 SD)	2	5.1	23	59.0	14	35.9	39	100.0		

WAZ: weight-for-age z-scores; WHZ: weight-for-height z-scores; HAZ: Height-for-age z-scores; SD: starting to develop; DE: developing according to expectations; DW: developing well; p-value: probability value; r: correlation coefficient; correlation test using Rank Spearman; \*significant if a p-value of <0.05.

The statistical analysis showed a relationship between the nutritional status of the WAZ index (p-value=0.003; r=0.366) and HAZ index (p-value<0.001; r=0.633) with gross motor skills. However, there was no correlation between the nutritional status of the WHZ index and gross motor skills (p-value=0.935; r=0.010) with a very weak positive correlation coefficient. If the nutritional status of the WHZ index is better, gross motor development will be higher. The results of the cross-tabulation showed a tendency for toddlers with the WAZ, HAZ, and WHZ indexes and normal nutritional status to have gross motor development in the category of developing according to expectations and developing very well (Table 4).

Statistical analysis showed a relationship between the nutritional status of the WAZ index (p-value=0.019; r=0.291) and HAZ index (p-value<0.001; r=0.719) with fine motor skills. The correlation coefficient has a positive direction between the nutritional status of the WAZ index with a sufficient correlation and HAZ with

a strong correlation. It means that if the nutritional status of the WAZ and HAZ indices is better, the fine motor development will be higher. Nevertheless, there was no correlation between the nutritional status of the WHZ index (p-value=0.168; r=-0.173) with fine motor skills. The correlation coefficient was negative with a very weak correlation, meaning that if the nutritional status of the WHZ index is higher, the progress in fine motor skills will be lower. The cross-tabulation results showed a tendency for toddlers with the WAZ, HAZ, and WHZ indexes and normal nutritional status to have developing and well-developing fine motor development according to expectations (Table 5).

Balanced nutritional intake will influence nutritional status and optimal brain development, especially in toddlers. Optimal physical development, brain, workability, and health are influenced by good nutritional status. Otherwise, a toddler with poor nutritional status lacks the energy to do activities in his/her environment<sup>27,28</sup>.

**Table 5.** Relationship between nutritional status and fine motor development of toddlers

Variable	Fine Motor						Total	p-value	r		
	SD		DE		DVW						
	n	%	n	%	n	%					
WAZ Index	Underweight (<- 2 SD)	1	14.3	6	85.7	0	0.0	7	100.0	0.019*	0.291
	Normal weight (-2 sd. +1 SD)	8	14.0	31	54.5	18	31.6	57	100.0		
	Overweight (>+1 SD)	0	0.0	1	100.0	0	0.0	1	100.0		
WHZ Index	Wasting (<- 2 SD)	0	0.0	3	100.0	0	0.0	3	100.0	0.168	
	Good Nutrition (-2 sd. +1 SD)	5	8.9	33	58.9	18	32.1	56	100.0		
	Risk of overweight (>+1 SD)	4	66.7	2	33.3	0	0.0	6	100.0		

Variable	Fine Motor						Total		p-value	r	
	SD		DE		DVW		n	%			
	n	%	n	%	n	%					
HAZ Index	Stunting (<- 2 SD)	7	26.9	19	73.1	0	0.0	26	100.0	<0.001*	0.719
	Normal (-2 sd. +3 SD)	2	5.1	19	48.7	18	46.2	39	100.0		

WAZ: weight-for-age z-scores; WHZ: weight-for-height z-scores; HAZ: Height-for-age z-scores; SD: starting to develop; DE: developing according to expectations; DW: developing well; p-value: Probability value; r: correlation coefficient; correlation test using Rank Spearman; \*significant if a p-value is <0.05

This study found that delayed gross and fine motor development was mostly found in underweight and stunted toddlers. Stunting is the biggest case compared to the prevalence of underweight and wasting (Table 2). In the realm of motor development, most toddlers exhibited delays in their gross motor skills than fine motor skills. Underweight or stunted toddlers tend to show delayed progress in their physical movements, indicating that poor nutritional status can hinder both gross and fine motor skill performance. Consequently, insufficient diverse food intake leading to inadequate nutrition indirectly results in developmental setbacks of both health status and motion functionality<sup>29</sup>. In addition to macronutrient essentials, micronutrient aids brain function along with emotional responses which have an enormous impact on a toddler's overall support mechanism<sup>30</sup>.

This study showed that gross motor development was determined by nutritional status according to the WAZ and HAZ indices. This is in line with research by Davidson et al. showing a relationship between the nutritional status of WAZ (p-value=0.002; r=0.284) and HAZ (p-value<0.001; r=0.353) with the gross motor skills of toddlers in rural areas<sup>1</sup>. Additionally, according to research conducted in Bantul, stunted toddlers were 2.43 times more likely to have delayed gross motor development<sup>31</sup>. Poor nutritional intake and nutritional status that are not treated quickly will negatively affect the growth and development of the brain, resulting in delayed motor skills in toddlers according to their age<sup>32</sup>kal. Motor development is influenced by nerves and muscles which will be mature with age. Therefore, motor development and nutritional status have similarities in which growth and development will go along with age and affect the physical condition<sup>33</sup>.

This study also showed that fine motor development was influenced by the nutritional status of the WAZ and HAZ indices. Previous research stated that there was a relationship between stunting and fine motor development (p-value=0.02). In addition, the study mentioned that stunted toddlers had a 3.45 times higher risk of experiencing delays in fine motor development. Stunting is a condition of chronic malnutrition that may adversely change certain parts of the brain responsible for motor function<sup>31</sup>.

Growth and development will continue to increase with age, and so will motor development<sup>34</sup>. Even though there are growth and development differences among children, the differences will not be too much except for children with genetic disorders<sup>35</sup>. Apart from that, the nutritional status of WAZ and HAZ is determined by age as a reference for whether weight and height are

appropriate for a toddler's age<sup>36</sup>. Therefore, the analysis results concluded that the nutritional status of the WAZ and HAZ indices as well as motor development will continue to increase with age. However, this study found no significant relationship between the nutritional status of the WHZ index and motor skills because the index was only used to measure body weight relative to the toddlers' weight and height.

Other research states that mothers who have good knowledge and provide motor stimulation to their children tend to produce children with good motor development according to their age<sup>37</sup>. Other research states that good nutritional status will not necessarily affect motor development<sup>38</sup>. Genetics, parental knowledge, and provision of motor stimulation by a mother or caregiver are other variables that can also influence motor development<sup>39,40</sup>. Apart from the influence of nutritional status, providing stimulation by parents or caregivers is a recommended treatment for improving toddlers' motor development and thus warrants further research.

Health workers and policymakers need to pay attention to poor nutritional status in toddlers which could affect their motor development. Indirectly, the area of residence is also an environmental factor that will influence the nutritional status of toddlers. Several villages in Sumowono District are still difficult to reach locations, and thus it is hoped that the local government will make efforts to provide all communities equal access to protein food resources which have good benefits for the growth and development of toddlers.

## CONCLUSIONS

The nutritional status of the WAZ and HAZ indices can influence the development of toddlers' gross and fine motor skills. Good nutritional status will help increase the chances of toddlers having good motor development. Mothers of toddlers can search for and understand information that influences the perception of nutritional status, stimulation of motor development, as well as application of parenting styles. This current study emphasizes that mothers need to pay attention to weight and height growth as well as motor development of children according to their age.

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### Author Contributions

SEFI: data curation, formal analysis, investigation, project administration, resources, software, writing-original draft; DRP, AFA, NL: conceptualization, funding acquisition, methodology, resources, supervision, validation, writing-review & editing.

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