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Analysis of Physical Growth and Motor Development in Early Childhood

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Abstract

Physical growth and motor development in early childhood are critical for shaping long-term health and cognitive abilities. Research has extensively examined Body Mass Index (BMI), arm span, leg length, and motor skills as key indicators of a child physical growth and competence. However, discrepancies between physical growth and BMI, particularly in underweight children, remain poorly understood. This study aimed to assess the physical growth and motor development of kindergarten children, focusing on BMI, arm span, leg length, gross motor skills, and fine motor skills. A quantitative descriptive approach was employed, utilizing measurements of BMI, arm span, and leg length. The assessments of gross and fine motor skills using standardized tests were also administered. Data were analyzed to determine the minimum, maximum, and mean values for each variable. Frequency distributions were used to categorize BMI and motor skill levels. The results showed that 75% of the children were underweight, despite average arm span and leg length measurements falling within normal ranges. In motor skills, 83.3% of the children exhibited very good fine motor skills. Meanwhile, the gross motor skills of the students were primarily in the average to above-average category. In conclusion, the study revealed a significant prevalence of underweight children, despite normal physical growth indicators, suggesting potential nutritional concerns. The findings highlight the need for further investigation into the socio-economic and dietary factors affecting a child development and for targeted interventions to support the enhancement of both physical growth and motor skills.

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INTRODUCTION

The development of motor skills in kindergarten children faces several challenges, including limited opportunities for physical activity, socioeconomic factors, and insufficient teacher training. Many children lack access to appropriate play environments and tools, leading to delays in fine motor skill development (Ohl et al., 2013; Alesi et al., 2020). A significant proportion of kindergarten students, 37.92%, struggle with essential locomotor and manipulative skills (Wick et al., 2017; Specht et al., 2022). Socioeconomic constraints also affect motor skills, as families with limited resources may not provide adequate play opportunities or proper nutrition, both crucial for motor development (Specht et al., 2022). Moreover, the increasing prevalence of sedentary activities, like screen time, exacerbates motor skill deficits (Bhatia, Davis and Shamas-Brandt, 2015; Yudanto, 2019). Teachers also face challenges, reporting difficulties in implementing effective motor skill activities due to insufficient training and resources (Wick et al., 2017; Yudanto, 2019).

Children experience problems with hand-eye coordination or have difficulty coordinating their body movements, such as holding small objects (fine motor skills) or running and jumping (gross motor skills). Motor problems in early childhood refer to impairments or delays in a child's ability to control and coordinate body movements, both gross motor (movements involving large muscles) and fine motor (movements involving small muscles). These problems can affect a child's ability to perform everyday physical tasks, such as walking, holding objects, or playing. While these studies highlight the importance of addressing motor developmental problems, they also underscore the need for a comprehensive approach that considers the interaction between motor skills and other developmental domains.

Recent studies have focused on the physical and motor development of young children, recognizing early childhood as a critical period for health and cognitive growth. Research has highlighted the relationship between body mass index (BMI), anthropometric measures such as arm span and leg length, and the development of gross and fine motor skills (Stewart, Rule and Giordano, 2007; Astikasari et al., 2021). These physical indicators are essential markers of overall health, growth patterns, and motor competence (Cameron et al., 2012; Rochma et al., 2023). However, existing studies primarily focus on elementary school children, leaving a research gap in understanding the motor and physical profiles of kindergarten students.

This study aims to address the research gap by analyzing the physical and motor development of kindergarten children, focusing on BMI, arm span, leg length, and motor skills. This research introduces the novel element of BMI in young children, which has not been extensively explored. The findings are expected to provide new insights into the relationship between BMI and motor skills, contributing to a deeper understanding of childhood development and identifying potential areas for intervention.

A key issue that remains unexplored is the disparity between normal growth patterns in physical measurements, such as arm span and leg length, and lower BMI categories, particularly in underweight children (Cameron et al., 2012). While these children may exhibit normal physical growth, nutritional deficiencies can impact their long-term development. Further investigation is needed to understand the role of socioeconomic factors and dietary intake in these discrepancies (Johor et al., 2020). This study aims to fill this gap by providing a comprehensive profile of physical and motor development in kindergarten children and offering practical recommendations for improving both growth and motor skills.

METHODS

This study employed a survey method with a quantitative comparative approach, focusing on the anthropometric measurements and motor skill development of children. A descriptive quantitative method was applied to provide a comprehensive overview of the sample's characteristics, as well as the developmental outcomes observed. The study subjects consisted of 24 students, aged 6–7 years, from Class B at Al Hidayah Kindergarten, Pakisaji, Malang Regency. Data collection was conducted on March 4, 2023, after obtaining prior consent from parents and teachers.

Sample Characteristics and Selection

The sample used in this study includes all 24 students from Class B, aged 6–7 years. These students were selected using a total sampling technique, meaning all students from the target group were included,

ensuring that the data was representative of the entire class population. This approach was chosen to capture a complete picture of the developmental characteristics of the children within this specific kindergarten group.

Instruments and Procedures

Data collection involved anthropometric measurements and motor skill tests, which were conducted directly with the students. The instruments used for data collection are outlined as follows:

Anthropometric Measurements.

Body Mass Index (BMI): BMI was calculated using the formula: weight (kg) divided by height (m^2). The weight of each child was measured using a calibrated digital scale, and height was measured using a stadiometer. These measurements provide insights into the nutritional and growth status of the children.

Arm Span and Leg Length: Arm span and leg length were measured using a standard measuring tape for precise anthropometric measurements. Arm span was recorded by measuring the distance from fingertip to fingertip with arms extended horizontally, while leg length was measured from the top of the hip to the bottom of the foot.

Motor Skill Development Tests.

Gross Motor Skills: These were assessed using the Test of Gross Motor Development, Second Edition (TGMD-2) (Ulrich, 2000). The TGMD-2 evaluates fundamental movement skills such as running, hopping, and jumping, as well as object control skills like throwing and catching. Each movement was repeated twice, and the results were recorded for analysis. The gross motor skills tested included running, galloping, hopping, leaping, horizontal jumping, sliding, two-hand striking, stationary bouncing, catching, kicking, overhand throwing, and underhand rolling.

Fine Motor Skills: These were assessed through activities such as cutting and coloring. Children were asked to cut and color two different objects, and their performance was evaluated using a rubric. However, it is important to note that the rubric had not been standardized or validated, and it followed the guidelines from the 2013 Curriculum, which had not yet been updated to the Independent Curriculum (Burhaein et al., 2024).

Data Collection Process

The data was collected in a systematic and controlled environment. Anthropometric measurements were taken in a designated area where students were individually measured for height, weight, arm span, and leg length. The motor skill assessments were conducted in a separate area to avoid distractions, with each child performing the tasks in front of a trained observer who recorded the results. The tests were repeated twice to ensure accuracy and consistency.

Data Analysis

The data analysis involved several steps to ensure accurate interpretation of the results. First, the BMI values were calculated manually, and then the results were categorized according to standard BMI-for-age growth charts, classifying children as underweight, normal, overweight, or obese. Gross motor skills and fine motor skills were also manually scored based on performance curves associated with each test.

Once the manual calculations were complete, the data was entered into Microsoft Excel and analyzed using SPSS (Statistical Package for the Social Sciences). Descriptive statistics such as minimum, maximum, and average values were used to summarize the data. Additionally, frequency distributions were calculated to provide insights into the proportion of children falling into various performance categories for BMI, gross motor skills, and fine motor skills. The statistical analysis provided a detailed view of the children's physical and motor skill development.

RESULT

This section presents the results of the data analysis, which includes Body Mass Index (BMI), arm span, leg length, gross motor skills, and fine motor skills of children in Class B at Al Hidayah Kindergarten. The analysis aims to describe the distribution of these variables, providing insights into the physical and motor development of the children.

The results are systematically presented in tables, illustrating the minimum, maximum, and average values for each variable. Additionally, the frequency distribution of the children across various categories, such as BMI levels (underweight, normal, overweight, obesity), gross motor skills (very high to very low), and fine mo-

tor skills (very good to poor), is explored.

These results offer a comprehensive overview of the children's developmental status, enabling a deeper understanding of their physical and motor abilities, which are crucial for identifying areas of strength and those needing improvement.

Data Description of BMI, Arm Span, Leg Length, Gross Motor Skills, and Fine Motor Skills.

The data includes the minimum value, maximum value, and average for each variable: Body Mass Index (BMI), arm span, leg length, gross motor skills, and fine motor skills. The detailed distribution is presented in Table 1.

Table 1. Descriptive Statistics of BMI, Arm Span, Leg Length, Gross Motor Skills, and Fine Motor Skills

Variable	Minimum Value	Maximum Value	Average Value
Body Mass Index (BMI)	11.7	25.5	17.4
Arm Span (RL)[cm]	102	129	112
Leg Length (PT)[cm]	54	71	58
Gross Motor Skills (MK)	88	130	95
Fine Motor Skills (MH)	12	16	13.8

From Table 1, it is evident that the Body Mass Index (BMI) of children in the group has a minimum of 11.7, a maximum of 25.5, and an average of 17.4. Similarly, arm span ranges from 102 cm to 129 cm, with an average of 112 cm, while Leg Length varies from 54 cm to 71 cm, with an average of 58 cm. Gross motor akills scores range from 88 to 130, with an average of 95, and fine motor akills range between 12 and 16, with an average of 13.8.

Description of Body Mass Index.

The Body Mass Index (BMI) measurements are classified into four categories: underweight, normal, overweight, and obesity. The frequency distribution of children based on these categories is shown in Table 2.

Table 2. Frequency Distribution of Children Based on BMI Categories

BMI Category	Frequency (n)	Percentage (%)
Underweight	18	75%
Normal	5	20%
Overweight	1	5%
Obesity	0	0%
Total	24	100%

As shown in Table 2, 75% (18 children) are in the underweight category, 20% (5 children) fall in the normal category, and 5% (1 child) is in the overweight category. No children fall under the obesity category.

Description of Gross Motor Skills

Gross motor skills were assessed using the Gross Motor Development Test (TGMD), and the results were categorized into seven levels: very high, high, above average, average, below average, low, and very low. The frequency distribution of the results is shown in Table 3.

Table 3. Frequency Distribution of Children Based on Gross Motor Skills

Gross Motor Skills Category	Frequency (n)	Percentage (%)
Very High	0	0%
High	5	20.8%
Above Average	8	33.3%
Average	10	41.7%
Below Average	1	4.2%
Low	0	0%
Very Low	0	0%
Total	24	100%

As seen in Table 3, 41.7% (10 children) scored in the average category, 33.3% (8 children) are above average, 20.8% (5 children) scored high, and 4.2% (1 child) scored below average. There were no children in the very high, low, or very low categories.

Description of Fine Motor Skills.

The Fine Motor Skills were measured using a cutting and pasting test, and the results were classified into four categories: very good, good, sufficient, and poor. The frequency distribution is presented in Table 4:

Table 4. Frequency Distribution of Children Based on Fine Motor Skills

Fine Motor Skills Category	Frequency (n)	Percentage (%)
Very Good	20	83.3%
Good	4	16.7%
Sufficient	0	0%
Poor	0	0%
Total	24	100%

According to Table 4, 83.3% (20 children) scored in the very good category, and 16.7% (4 children) scored in the good category. No children scored in the sufficient or poor categories.

DISCUSSION

The results of this study provide valuable insights into the physical and motor development of children in Class B at Al Hidayah Kindergarten, particularly in relation to Body Mass Index (BMI), arm span, leg length, gross motor skills, and fine motor skills. With the majority of children falling into the underweight category for BMI, the findings raise concerns about potential nutritional or health challenges. In contrast, the motor skills assessments reveal generally positive development, especially in fine motor skills, where most children scored in the 'very good' category. These outcomes highlight both strengths and areas for improvement, particularly in supporting children's physical growth and enhancing specific motor skills through targeted interventions.

The results of this study show that 75% of children in Class B at Al Hidayah Kindergarten are classified as underweight, constrasting with the growing global trend of childhood obesity, as noted in the WHO's global report on child malnutrition (2021). This discrepancy may be influenced by regional nutritional practices or socio-economic factors, emphasizing the need for localized interventions (Fiori et al., 2020). Previous research by Putri, Stephani and Sumarno (2020a) also noted that underweight prevalence in children is often linked to dietary insufficiencies, which aligns with the findings of this study (Sandhu et al., 2006; Isong et al., 2018; Rundle et al., 2019; Neumeyer, Merker and Hagenäs, 2020; Leão et al., 2023). While some studies suggest that malnutrition is primarily a result of inadequate food access, others, such as Putri, Stephani and Sumarno (2020b), argue that cultural practices and education play a critical role in nutritional outcomes. Although the absence of obesity in the sample is positive, the high percentage of underweight children highlights the need for specific nutritional and health programs. This raises a debate on whether the priority should be addressing underweight issues or maintaining current strategies to prevent obesity, which remains a concern globally (Graf et al., 2004).

The motor skills development observed in this study aligns with prior research emphasizing the importance of early motor skills for childhood development. The results reveal that 41.7% of children scored within the average range for gross motor skills, with 33.3% scoring above average, reflecting generally positive outcomes similar to findings by Goodway and Robinson (2015). They noted that structured physical activities during early childhood significantly enhance gross motor skills. However, the 4.2% of children who scored below average may indicate that not all children benefit equally from such programs, possibly due to environmental or genetic factors (Spessato et al., 2012). In terms of fine motor skills, the overwhelming majority (83.3%) scored in the 'very good' category, supporting previous studies that highlight the impact of targeted activities like cutting and pasting on fine motor development (Lopes et al., 2012). While the overall results are positive, the absence of children in the 'sufficient' or 'poor' fine motor skills categories raises questions about the assessment tools used and whether they fully capture variations in skill levels. Critics argue that these tools may lack sensitivity in detecting subtle deficits, potentially leading to an overestimation of motor proficiency in certain cases (Fiori et al., 2020).

The results on physical development, particularly arm span and leg length, indicate that the children in Class B at Al Hidayah Kindergarten exhibit typical physical growth patterns, with minimal variance in averages suggesting homogeneity in development. Previous studies, such as those by Lorentzon, Norjavaara and Kindblom (2011; Johnston et al., 2013) and Johnston et al. (2013), have similarly found that arm span and leg length often align with age-related growth expectations in early childhood. This supports the idea that these measurements are reliable indicators of normal physical development. However, the contrast between these measurements and the high percentage of underweight children (75% with low BMI) raises concerns, as prior research has established that low BMI may signal potential nutritional deficiencies despite normal skeletal growth (Gauld et al., 2004; Bann et al., 2018; Geserick et al., 2018). On the positive side, the arm span and leg length data suggest that growth is progressing appropriately, but on the negative side, the BMI data indicate a potential gap in nutritional adequacy, necessitating further investigation into dietary habits and socio-economic factors affecting this population. This disparity underscores the importance of addressing nutritional status while monitoring physical growth.

CONCLUSION

The results of this study provide a clear depiction of the physical and motor development of children in Class B at Al Hidayah Kindergarten, showing typical growth in arm span and leg length but a concerning prevalence of underweight children based on BMI data. While motor skills, particularly fine motor skills, are well-developed in most children, the high number of underweight children suggests potential nutritional deficiencies that require attention. The findings emphasize the need for targeted interventions aimed at improving nutritional intake to support both physical growth and overall health. For future research, it is recommended to expand the sample size for broader generalizability and to investigate the socio-economic and dietary factors that may contribute to the underweight classification. Additionally, incorporating more comprehensive assessments of motor skills and physical development, including genetic and environmental influences, could provide deeper insights into the developmental challenges faced by children in this age group.

CONFLICT OF INTEREST

The authors declared no conflict of interest.

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