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PREVALENCE OF MALNUTRITION AMONG PRESCHOOL CHILDREN: A CROSS-SECTIONAL STUDY AT THUONG LY KINDERGARTEN, HAI PHONG CITY, AND NGUYEN DU KINDERGARTEN, HA TINH CITY

Nguyen Thi Hong Hanh[1,*], Khuc Thi Huyen Trang[2] and Nguyen Thi Thanh Huyen[3]

[1]*Faculty of Biology, Hanoi National University of Education, Hanoi city, Vietnam*
[2]*Vo Thi Sau Secondary School, Hai Phong city, Vietnam*
[3]*Nam Ha Secondary School, Ha Tinh city, Vietnam*
[*]Corresponding author: Nguyen Thi Hong Hanh, e-mail: hanhnth@hnue.edu.vn

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Abstract. This study evaluated the nutritional status of 474 children aged 3-5 years from Thuong Ly Kindergarten in Hai Phong City (n = 274; 132 boys, 142 girls) and Nguyen Du Kindergarten in Ha Tinh City (n = 200; 109 boys, 91 girls) using WHO growth standards and Anthro software. The findings reveal significant disparities in stunting, wasting, underweight, and overnutrition between provinces and genders. Nguyen Du Kindergarten exhibited alarmingly high rates of stunting (24.5%) and underweight (13.0%), with boys more affected (25.7% and 18.3%, respectively). In contrast, Thuong Ly Kindergarten had much lower rates of stunting (4.0%) and underweight (2.9%), though boys had slightly higher rates of wasting (6.0%) compared to girls (2.1%). Overnutrition was prevalent in both regions, particularly among boys. In Thuong Ly Kindergarten, the prevalence of overweight and obesity was 7.6% and 3.8% in boys, compared to 4.2% and 1.4% in girls, respectively. Similarly, in Nguyen Du Kindergarten, boys exhibited higher overweight (7.3%) and obesity rates (4.6%) compared to girls (5.5% and 1.1%, respectively). Overall, Nguyen Du Kindergarten demonstrated a greater burden of overnutrition (9.5%) compared to Thuong Ly Kindergarten (8.2%), with statistical significance ($P = 0.049$). These results highlight the double burden of malnutrition across regions, with Ha Tinh facing higher rates of both undernutrition and overnutrition. Effective, context-specific interventions tailored to local socio-economic and demographic contexts are essential to address these challenges and promote optimal growth and health outcomes in preschool children.

Keywords: Nutritional status, stunting, underweight, undernutrition, overnutrition, double burden of malnutrition.

1. Introduction

Malnutrition remains a significant public health concern, particularly among young children, where it can have profound and lasting effects on growth, development, and overall health. In preschool-aged children, malnutrition, including both undernutrition (stunting, wasting, and underweight) and overnutrition (overweight and obesity), can hinder cognitive development, increase susceptibility to infections, and contribute to the early onset of chronic diseases [1], [2]. Understanding the malnutrition status of preschool children is essential for developing effective interventions to improve health outcomes and prevent future health complications.

In Vietnam, rapid urbanization and socioeconomic changes have led to a double burden of malnutrition, where both undernutrition and overnutrition coexist [3], [4]. This situation presents unique challenges, particularly in urban areas where dietary patterns and lifestyle behaviors are undergoing significant shifts. Preschool children, being at a crucial stage of growth and development, are particularly vulnerable to these changes. A meta-analysis of 72 studies conducted in Vietnam revealed that although the prevalence of undernutrition has declined over time, it remains a significant public health concern. The analysis found that, among children under five, 22.4% were stunted, 5.2% wasted, and 12.2% underweight [5]. Conversely, two cross-sectional studies conducted in 2002 and 2005 among preschool children in urban areas of Ho Chi Minh City using the International Obesity Taskforce cut-off points showed a nearly two-fold increase in the prevalence of overweight and obesity, from 21.4% in 2002 to 36.8% in 2005. This increase was more pronounced in less affluent districts compared to wealthier ones. Additionally, the proportion of boys classified as obese in 2005 (22.5%) was three times higher than in 2002 (6.9%) [6]. A study utilizing the Landscape Analysis Tool developed by the United Nations Children's Fund (UNICEF) and the World Health Organization (WHO) reported an increase in the prevalence of overweight among children under five, from 5.6% in 2010 to 7.4% in 2019 [7]. Therefore, assessing their malnutrition status of preschool children provides valuable insights into the current health landscape and helps identify priority areas for public health interventions.

Thuong Ly Kindergarten is located in a typical urban district of Hai Phong, where demographic characteristics, socioeconomic status, and access to healthcare and education services closely reflect those of the broader city population. Similarly, Nguyen Du Kindergarten is situated in the central part of Ha Tinh City, serving a diverse group of children from both urban and peri-urban areas. Both schools operate under the national early childhood education framework. Therefore, the nutritional status of children in these two kindergartens can be reasonably considered indicative of broader patterns in their respective cities. The two kindergartens were selected to represent urban areas with distinct regional, economic, and geographical profiles. Hai Phong, a developed northern port city, features higher average income levels, better infrastructure, and greater access to health services. In contrast, Ha Tinh, located in the north-central region, faces economic limitations, lower living standards, and frequent natural disasters, which may negatively affect child nutrition. These contextual differences are expected to influence nutritional outcomes.

By examining the prevalence of malnutrition among preschool children in these two kindergartens, this cross-sectional study aims to provide a comprehensive understanding of the nutritional challenges faced by this age group in different regions of the country. The results of this study will be instrumental in identifying the specific forms of malnutrition prevalent in each area and will contribute to the development of targeted interventions to improve child nutrition and health outcomes in Vietnam.

2. Content

2.1. Research methodology

2.1.1. Research subjects

This study included a total of 474 children, comprising 274 children (132 boys and 142 girls) from Thuong Ly Kindergarten in Hai Phong City and 200 children (109 boys and 91 girls) from Nguyen Du Kindergarten in Ha Tinh City. The participants were between 3 and 5 years of age. Only children whose parents or guardians provided informed consent were included in the study. Those diagnosed with chronic diseases, such as asthma, diabetes, congenital heart disease, or other long-term medical conditions, were excluded. Children with known developmental disorders or significant cognitive impairments were also not included.

2.1.2. Standing height measurement

A portable stadiometer was used to measure standing height. The child removed shoes and headwear, then stood barefoot on a flat surface, back against the stadiometer, with heels together and toes slightly outward. The head, shoulder blades, buttocks, and heels touched the vertical board. The child's head was alighed in the horizontal plane, ensuring that the lower border of the orbit and the upper border of the ear canal were level. The stadiometer's sliding headpiece was gently lowered until it touched the crown of the child's head. The height was measured to the nearest 0.1 cm. Each child's height was measured twice, and the average of the two measurements was recorded as the final height.

2.1.3. Weight measurement

A digital weighing scale with a precision of 0.1 kg was used to measure the child's weight. The child removed shoes, and heavy clothing, then stood still at the center of the scale with arms relaxed and eyes facing forward. The weight was recorded to the nearest 0.1 kg once the scale reading stabilized. As with height measurement, each child was weighed twice, and the average of the two measurements was taken as the final weight.

2.1.4. Nutritional status assessment

The nutritional status of children was assessed following WHO growth standards using the WHO Anthro software version 1.0.4. Anthropometric measurements, including weight and height, were used to calculate Z-scores for Weight-for-Age (WAZ), Height-for-Age (HAZ), Weight-for-Height (WHZ), and Body Mass Index-for-Age (BAZ), which represent the number of standard deviations (SD), a measurement deviatesfrom the WHO reference population median. Z-scores between -2 SD and +2 SD are considered normal. Moderate undernutrition is defined by Z-scores between -3 SD and -2 SD, and severe undernutrition by Z-scores below -3 SD, with specific thresholds identifying moderate and severe stunting (HAZ), wasting (WHZ), or underweight (WAZ). Overnutrition is

classified as overweight with Z-scores between +2 SD and +3 SD and obesity with Z-scores above +3 SD, based on BAZ or WHZ. The automated calculations provided by the WHO Anthro software facilitate accurate and efficient classification of nutritional status, covering the full spectrum from undernutrition to overnutrition [8], [9].

2.1.5. Statistical analysis

Statistical analysis of the data was conducted using SPSS version 22.0 to evaluate the nutritional status of children under 5 years of age. Continuous variables were first assessed for normality using the Shapiro-Wilk test. Normally distributed variables were expressed as mean ± standard deviation (SD) and analyzed using Student's *t*-test for two-groups comparisons or One-way ANOVA for multiple group comparisons. Non-normally distributed variables were presented as median with interquartile ranges (25^{th} - 75^{th} percentiles) and analyzed using the Mann-Whitney *U* test for two-group comparisons. Categorical variables, including nutritional status classifications, were analyzed using the Chi-square test. The Correlation Matrix of Anthropometric Indicators and Age Among Children was constructed using the R software version 4.3.2, specifically employing the heatmap_plot function.

2.2. Results and discussion

2.2.1. Characteristics of the study subjects

Table 1 presents the characteristics of study subjects from two different kindergartens.

Table 1. Characteristics of the study subjects

Parameter	Thuong Ly Kindergarten, Hai Phong (n = 274)	Nguyen Du Kindergarten, Ha Tinh (n = 200)	*p*
Male (n, %)	132, 48.2%	109, 54.5%	0.295
Age (years)[a]	4.27 ± 0.72	4.18 ± 0.82	0.158
Weight (kg)[b]	17.0 (15.0 - 19.5)	15.1 (12.2 - 18.2)	**<0.0001**
Height (cm)[b]	105.0 (100.0 - 110.0)	100.2 (89.4 - 106.6)	**<0.0001**
BMI (kg/m^2)[b]	15.3 (14.3 -16.5)	15.5 (14.6 - 16.6)	0.064
Height-for-age Z-score[b]	0.01 (-0.86 - 0.99)	-0.79 (-1.98 - 0.22)	**<0.0001**
Weight-for-age Z-score[b]	0.07 (-0.73 - 0.75)	-0.50 (-1.48 - 0.26)	**<0.0001**
Weight-for-height Z-score[b]	-0.08 (-0.78 - 0.80)	-0.02 (-0.61- 0.73)	0.094
BMI-for-age Z-score[b]	0.03 (-0.72 - 0.91)	0.14 (-0.53 - 0.90)	0.174

BMI, body mass index; [a]Data are mean±SD; [b]Data are median (25^{th} - 75^{th} percentiles); p obtained by Student t-test or Mann-Whitney U test, or Chi-square test. Bold values indicate a significant difference.

The gender distribution and age of subjects were consistent across the two locations, indicating a balanced sampling in terms of basic demographic parameters. Significant differences in weight and height suggested variations in growth patterns among children from different locations. Children from Thuong Ly Kindergarten were generally taller and heavier, potentially reflecting better nutrition or more favorable socio-economic

conditions. Children from Nguyen Du Kindergarten showed significant lower HAZ and WAZ. Despite the differences in weight and height, BMI values, WHZ, and BAZ were relatively consistent between the two groups, suggesting similar body proportions across locations.

2.2.2. Correlation matrix of anthropometric indicators and age

The correlation matrix (Figure 1) shows strong positive relationships among weight, height, and WAZ, with the highest correlation observed between weight and WAZ (r = 0.90). Similarly, BAZ and WHZ exhibit near-perfect correlations (r = 0.99), indicating consistent patterns in nutritional status measures. However, age shows weaker correlations with BMI, suggesting that these indicators are less influenced by age compared to weight and height in children aged 3 to 5 years.

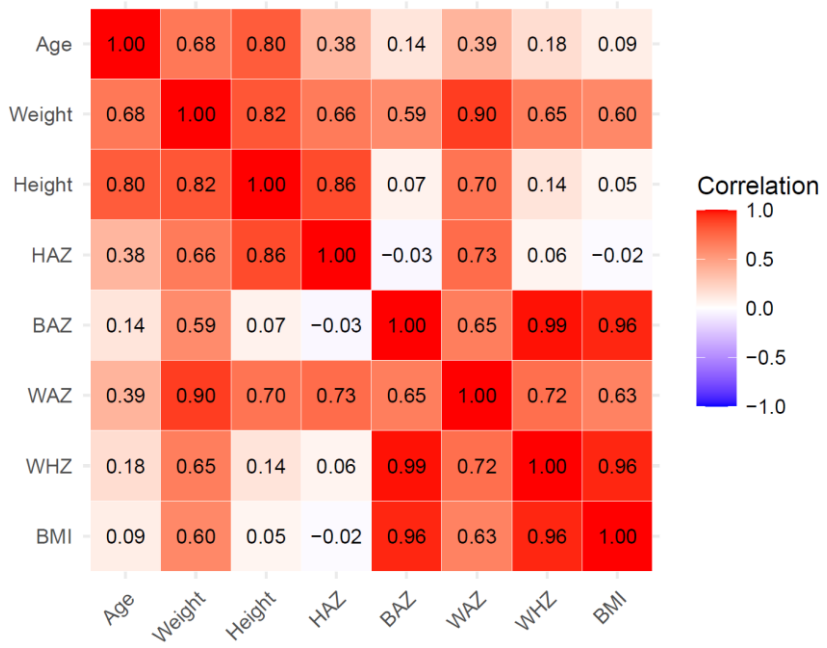

Figure 1. Correlation matrix of anthropometric indicators and age among children aged 3 -5 years in Thuong Ly Kindergarten (Hai Phong) and Nguyen Du Kindergarten (Ha Tinh)

HAZ: Height-for-Age Z-score; BAZ: BMI-for-Age Z-score;
WAZ: Weight-for-Age Z-score; WHZ: Weight-for-Height Z-score

2.2.3. Distribution of undernutrition status by kindergarten and gender

The data in Table 2 revealed significant disparities in the prevalence of stunting, wasting, and underweight among children aged 3-5 years across different kindergartens and between genders. Nguyen Du Kindergarten exhibited the highest rates of stunting and underweight, particularly among boys. Statistical analysis confirmed that these differences were most significant (P < 0.01). In Thuong Ly Kindergarten, the overall stunting rate was 4.0%, with boys slightly less affected (3.8%) compared to girls (4.2%). Wasting was more prevalent among boys (6.0%) than girls (2.1%), leading to a combined

rate of 4.0%. The underweight rate was relatively low but still notable, with boys at 3.8% and girls at 2.1%, resulting in an overall rate of 2.9%. Nguyen Du Kindergarten showed alarmingly high stunting rates, with an overall prevalence of 24.5%. Boys were slightly more affected (25.7%) than girls (23.1%). Underweight was also extremely high in Nguyen Du Kindergarten, particularly among boys (18.3%) compared to girls (6.6%), resulting in a combined rate of 13.0%.

Table 2. Undernutrition status of children by kindergarten and gender

Under-nutrition		Stunting			Wasting			Underweight		
		Boys	***Girls***	***Total***	***Boys***	***Girls***	***Total***	***Boys***	***Girls***	***Total***
Thuong Ly Kinder-garten	n	5	6	11	8	3	11	5	3	8
	%	3.8	4.2	4.0	6.0	2.1	4.0	3.8	2.1	2.9
Nguyen Du Kinder-garten	n	28	21	49	3	0	3	20	6	26
	%	25.7	23.1	24.5	2.7	0	1.5	18.3	6.6	13.0
P		<0.01	<0.01	<0.01	0.055	0.332	0.071	<0.01	0.163	<0.01

P was obtained from the Chi-square test.

2.2.3. Distribution of overnutrition status by kindergarten and gender

Figure 2 indicates a consistent trend in which boys have higher rates of overweight and obesity compared to girls in both kindergartens, with Nguyen Du Kindergarten demonstrating a greater burden overall.

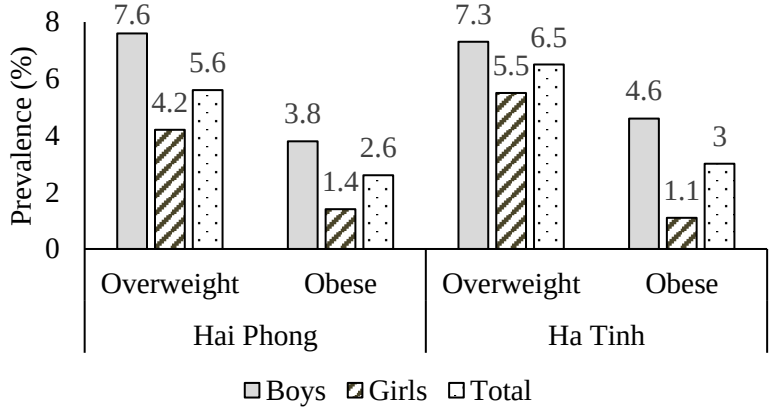

Figure 2. Prevalence of overweight and obesity among children based on Weight-for-Height Z-score in Thuong Ly Kindergarten (Hai Phong) and Nguyen Du Kindergarten (Ha Tinh)

In Thuong Ly Kindergarten, the prevalence of overweight was higher among boys (7.6%) compared to girls (4.2%). Similarly, obesity rates were also higher in boys (3.8%) than in girls (1.4%). In Nguyen Du Kindergarten, similar pattern was observed with the overweight prevalence in boys (7.3%) exceeding that of girls (5.5%), and obesity rates again higher with boys (4.6%) than girls (1.1%). When comparing the two locations, the

combined prevalence of overweight and obesity in total was higher in Nguyen Du Kindergarten (9.5% = 6.5% overweight + 3.0% obesity) than in Hai Phong (8.2% = 5.6% overweight + 2.6% obesity). This difference was statistical significant (P = 0.049), indicating a higher overall burden of overnutrition among children in Ha Tinh Kindergarten compared to Hai Phong.

The findings of this study revealed a significant double burden of malnutrition in Nguyen Du Kindergarten (Ha Tinh), where both the prevalence of undernutrition (wasting and stunting) and overnutrition (overweight and obesity) were higher compared to Thuong Ly Kindergarten (Hai Phong). This complex nutritional profile highlighted the interplay of socio-economic, environmental, and lifestyle factors specific to Ha Tinh, which need careful examination. The double burden of malnutrition in Nguyen Du Kindergarten (Ha Tinh) could be attributed to its ongoing nutritional and economic transition. While economic growth has improved overall food assessibility, the quality and balance of diets may not have advanced accordingly. Ha Tinh, as a developing province, continue to face persistent poverty in some rural areas, leading to chronic undernutrition manifested through high rates of stunting and wasting. Concurrently, urbanization and exposure to modern food environments have led to the consumption of energy-dense, nutrient-poor diets high in fats and sugars. Research from Vietnam suggested that provinces undergoing rapid economic development frequently face such nutritional disparities [10]. Besides, healthcare infrastructure and public health programs in Ha Tinh may be less robust than those in Hai Phong, a more developed urban centre. Environmental challenges, such as periodic flooding in Ha Tinh, can disrupt food supplies and healthcare services, thereby exacerbating undernutrition in vulnerable populations. Such environmental shocks may also contribute to reliance on cheap, calorie-dense processed foods in urban areas, promoting overnutrition. Studies have shown that areas prone to environmental instability often experience heightened nutritional challenges [2].

The double burden of malnutrition observed in Nguyen Du Kindergarten (Ha Tinh) is consistent with trends seen in other developing regions of Vietnam and globally. According to the National Institute of Nutrition (NIN, 2020), stunting and wasting remained significant in rural and economically transitioning provinces, while overweight and obesity were on the rise due to urbanization and dietary changes. The stunting rate among children under 5 years old was 19.6%. However, this rate was markedly higher in certain regions, such as the Northern Midlands and Mountainous areas (28.4%) and the Central Highlands (32.7%) [11].

The prevalence of overweight and obesity in our study aligned with findings from a cohort of 1,993 preschool children aged 24 - 59 months in Dong Anh and Hoan Kiem districts, Hanoi, where overweight and obesity rates were 8.03% and 4.16%, respectively [12]. In contrast, these rates were significantly lower compared to those reported in a cross-sectional survey conducted during the 2014 - 2015 academic year across 20 kindergartens in Vung Tau City, where the combined prevalence of overweight and obesity reached 36.4%, including an obesity rate of 18.2% [13]. Consistent with our findings, a 2018 study conducted among 1,593 preschool children aged 24 - 60 months in Nam Hong commune, Dong Anh district, Hanoi, also demonstrated a dual nutritional burden. The prevalence of undernutrition was 4.2%, while overnutrition affected 9.0% of the children, with a higher

prevalence in boys (10.9%) than in girls (6.7%) [14]. Internationally, countries undergoing similar transitions, such as Indonesia and India, have reported comparable patterns of malnutrition [15].

Our observation that undernutrition tended to affect boys more than girls ($P = 0.085$) revealed that boys exhibited higher rates of underweight, stunting, and wasting across the provinces. This suggests that boys might have been more vulnerable to severe forms of malnutrition. These findings were consistent with a meta-analysis on gender differences in undernutrition [16].

These findings underscore the complexity of tackling the coexistence of undernutrition and overnutrition within the same regions, presenting significant public health challenges. Addressing this double burden requires tailored interventions that account for the unique socio-economic, cultural, and environmental factors influencing dietary habits and health outcomes in each region. Developing and implementing comprehensive, region-specific strategies is essential to effectively mitigating these challenges and promoting optimal health outcomes nationwide.

The study's strengths included a robust sample size of 474 children across two provinces, allowing for meaningful comparisons between regions and genders. The use of WHO growth standards and validated software ensured a reliable and standardized assessment of nutritional status. Additionally, the focus on both undernutrition and overnutrition provided a comprehensive perspective on the double burden of malnutrition. However, the study had several limitations, including its cross-sectional design, which limited the ability to draw causal inferences, and the lack of detailed socio-economic or dietary data restricted deeper analysis of observed disparities. Furthermore, the findings were based on data from specific kindergartens, which may limit their generalizability to all preschool children in the studied provinces.

3. Conclusions

This study hightlights the double burden of malnutrition among preschool children in Thuong Ly Kindergarten (Hai Phong) and Nguyen Du Kindergarten (Ha Tinh), with significant regional and gender disparities. Nguyen Du Kindergarten recorded alarmingly high rates of stunting (24.5%) and underweight (13.0%). In contrast, Thuong Ly Kindergarten showed lower rates of stunting (4.0%) and underweight (2.9%), though boys exhibited higher wasting (6.0%) compared to girls (2.1%). Overnutrition was prevalent in both regions, with Nguyen Du Kindergarten demonstrating a higher overall prevalence of overweight and obesity (9.5%) compared to Thuong Ly Kindergarten (8.2%). In both regions, boys consistently showing higher rates than girls.

These findings emphasize the pressing need for targeted interventions tailored to the specific socio-economic, cultural, and environmental contexts of each region. Strategies should focus to reduce undernutrition in high-burden areas like Ha Tinh while simultaneously addressing the rising prevalence of overnutrition in both provinces. The development and implementation of comprehensive, region-specific policies and programs are essential to improving nutritional outcomes and supporting the healthy growth and development of children nationwide.

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