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NUTRITIONAL STATUS: THE TRENDS OF PRESCHOOL CHILDREN AGED 10–60 MONTHS IN THE NORTH OF VIETNAM

Nguyen Thi Trung Thu[1], Le Thi Thuy Dung[2,3], Le Thi Tuyet[1]

[1]Hanoi National University of Education, Vietnam
136 Xuan Thuy Str., Cau Giay District, Hanoi, 123106, Viet Nam
[2]M.K. Ammosov North-Eastern Federal University, 58 Belinsky Str., Yakutsk, Republic of Sakha (Yakutia), 677027, Russian Federation
[3]Hanoi Medical University, 1 Ton That Tung Str., DongDa, Hanoi, 116001, Viet Nam

Health is the necessary foundation for the comprehensive development of children. Unhealthy nutritional status of children in all its forms is a global problem. Our research goal was to assess prevailing nutritional status and changes in it among pre-school children in the north of Vietnam. There were several stages in the examination, each performed once a quarter, from September 2017 to March 2018. The results showed that children's height and weight grew. At the initial stage of the examination average age of children was equal to 42 months, average weight and height were 14 kg and 95 cm respectively. At stage 2, average height and weight were equal to 14.2 kg and 97 cm, and at stage 3 they were 15 kg and 99 cm, respectively. All the applied models revealed the correlation between anthropometric indices of children aged 10–60 months and their age ($p < 0.05$), however, only the model $y = 0.2736x + 2.8943$ with $R^2 = 0.8571$ revealed a tight correlation between body mass index and age. We applied the WHO standards (2006) to assess the nutritional status of children. After 6 months of the examination we detected an increase in number of children with good nutritional status and a decrease in number of those with bad one that was the most tightly connected with malnutrition. At stage 3 we revealed 15.7 % children with stunting, 4.3 % children with underweight, and 3.3 % with both disorders, among those who received insufficient nutrition. 1.5 % children suffered from hypotrophy; and 0.1 % children had underweight, stunting, and hypotrophy. Prevalence of overweight and obesity didn't decrease as at stage 1 overweight was detected in 4.5 % cases, and obesity, in 1.2 % cases; and at stage 3, they were detected in 5.5 % and 1.1 % cases respectively. Apart from that, in some cases malnutrition and disorders related to overweight occurred simultaneously: stunting and overweight in 0.6 % cases, stunting and obesity, in 0.1 % cases.

Key words: *development of children, nutritional status, pre-school children, malnutrition, stunting, overweight, obesity.*

1. Introduction

Health is the necessary foundation for the comprehensive development of children. Good health helps children not only to develop intelligence, raise the stature, increase mobility, learn and discover the world, but also to reduce the risk of illness and death. Therefore, regular nutritional assessment plays an important role in child care for family and school.

Nutritional status that doesn't conform to standards and can be determined as "unsatisfactory" or "unhealthy" in all its forms is a global health concern. Not only malnutrition (underweight, stunting, wasting and these disorders combined) but also over-nutrition (overweight and obesity) are reported to be serious problems affecting developing countries. Both of these conditions are hazardous for children as they cause greater risks of poor health and negative consequences for physical, cognitive, and be-

Nguyen Thi Trung Thu – PhD, Faculty of Biology (e-mail: trungthuhnue@gmail.com; tel. (+84) 983-42-09-85).
Le Thi Thuy Dung – Master of Science, Faculty of Pediatrics (e-mail: letono2002@gmail.com; tel: (+84) 987-00-89-14).
Le Thi Tuyet – PhD, Faculty of Biology (e-mail: lttuyet@gmail.com; tuyetlt@hnue.edu.vn; tel: (+84) 968-79 -55-55).

havioral development among them than population in general [1, 2]. Unhealthy nutritional status is a multi-factorial disease that is influenced by environmental and genetic factors, as well as the interaction between them [3, 4]. Malnutrition is one of the leading causes of morbidity and mortality among children under the age of five in developing countries [5].

Under-nutrition is the underlying cause of death in estimated 45% of all deaths among children aged under 5 years [5]. As per data provided by the WHO, the number of children affected by stunting, underweight, and wasting globally was 37%, 15% and 8% respectively [6]. Under-nutrition is reported to be higher in Asia and Africa than in Europe; in Africa the prevalence of stunting and underweight has increased over the past 23 years [6].

According to the National Institute for Nutrition, in 2010 nutritional status among children under 5 years improved in Vietnam, but still unhealthy nutritional status prevalence remains at a high level. Vietnam has been one of these countries where malnutrition is an important public healthcare problem. The prevalence of underweight, stunting and wasting among preschool children were 17.5%, 29.3% and 7.1% at national level. The prevalence of over-nutrition among children under 5 years old is 5.6%, of which the obesity prevalence is 2.8%. In the urban areas the prevalence of over-nutrition is 6.5% [7].

Although, Vietnam has many programs to improve nutritional status at children, under-nutrition is still a challenge for the public healthcare in the country.

The study therefore aimed to assess the prevalence of nutritional status among preschool children in the North of Vietnam, special attention being paid to occurrence of more than one nutritional status disorder. In addition, the aim was to evaluate the changes in nutritional status among children each 3 months.

2. Data and methods

2.1. Data collection

A longitudinal study was conducted in 8 preschools in Hanoi city, Nam Dinh province, Thanh Hoa province. 2,035 children aged 10–60 months were selected randomly excluding children who had any medical causes for malnutrition, overweight or obesity such as disorders (hypothyroidism and Cushing syndrome) or drugs (steroids, antidepressants, antipsychotics, and seizure medications). The study was conducted during 6 months from September 2017 to March 2018.

Sample size for cross-sectional study was calculated as per the following formula [8]:

$$N = \frac{Z^2_{1-\alpha/2} \times p \times (1-p)}{d^2} \times DE$$

where p (risk factor ratio in the study population) was estimated at 10%, d (maximum error of estimation) was 0.02 with reliability of 98%, DE (design factor) was 2, $Z_{(1-\alpha)/2}$ (coefficient of confidence) was 1.96 with $\alpha = 0.05$. With an additional 10% non-response in the formula, the sample size needed for the study was 1,989 children.

In fact, the study was to be conducted on 2,287 preschool children. We excluded children with lacking information (birth date, weight, height, sex), children aged over 60 months, and children who were absent on the day of measurement; thus, the total sample size dropped to 2,035 children, and it was slightly larger than expected sample size. Our study was approved by The Ethics Committee of the Vietnam National Institute for Nutrition.

2.2. Measurements

Data about name, date of birth, sex of the children were taken from the school databases. Anthropometric indices, including weight and height, were measured twice for each individual, and the means of weight and height were used for the purpose of analysis. Weight and height were measured for children wearing light clothing, without shoes or other things that can affect results of weight and height measuring. The measurements were repeated at 0, 3, and 6 months in the time study. Body mass index (BMI) was calculated as the weight per square of the height (kg/m^2).

The nutritional status of the children was classified using criteria of sex-specific weight-for-age (W/A), height-for-age (H/A), weight-for-height (W/H) z-score for children aged under 5 proposed by the World Health Organization in 2006 [9]. Z-score is the deviation of an individual's value from the median value of a reference population, divided by the standard deviation of the reference population (such as National Center for Health Statistics, NCHS) [9].

Children nutritional status was determined and assigned into one of the following categories: malnutrition (underweight, stunting, wasting and coordination), normal nutritional status, over-nutrition (overweight, obesity); weight/height ratios were also identified for a specific age.

Children with below -2 standard deviations (−2 SD) of the WHO median for W/A z-score, H/A z-score, and W/L z-score were considered to suffer from underweight, stunting or wasting respectively. And children with deviations from +2 SD to +3 SD and over +3 SD of the WHO median for W/H z-score were considered to suffer from overweight and obesity.

2.3. Statistical analysis

Data were imported and statistically processed with EpiData software, Microsoft Excel, and SPSS 16.0 software. The qualitative variables were represented by quantity (n) and percentage (%), and compared by the $\chi 2$ test. Quantitative variables were checked for standard distribution. If variables were standard distribution, they were expressed as a mean ± SD and compared by Student T test. If variables were non-standard distribution, they were expressed as a median (25th – 75th percentile) and compared by Mann-Whitney-U test. Determining the correlation of anthropometric indices and age was based on the function $f(x) = ax + b$ with R^2 value. *P* values of < 0.05 for both sides were considered significant.

3. Results and discussion

3.1. Characteristics of the research objects

The characteristics of 2,035 children from 11 preschools in Hanoi, Nam Dinh and, Thanh Hoa are presented in Table 1.

The most part of the data were collected in Hanoi with 904 chidlren (44.42%), followed by Nam Dinh with 609 children (29.93%) and minimum in Thanh Hoa with 522 children (25.65%). Among them, there were 1,113 boys (54.7%) and 922 girls (45.3%). The sex ratio in this study is 120.7 boys/100 girls. This ratio is higher than the sex ratio at birth in Vietnam in 2009 (110,6 boys/100 girls) according to the General Statistics Bureau [10].

Results in Table 1 showed that anthropometric indices in this study such as weight, height, BMI z-score, W/H z-score changed according to an age and mean values for the population (with $P < 0.0001$).

The study had three stages, and there was a three months break between them. Children's weight and height were increment. In detail, at stage 1, children's age was 42 months, mean weight and height were 14 kg and 95 cm, respectively. At stage 2, mean weight and height were 14.2 kg and 97 cm and at stage 3, they were 15 kg and 99 cm. After 6 months, children's weight increased by 1 kg, but the increase was not uniform, weight increased

Table 1

Participants' sampling as per age groups, divided by sex and totally

Age group	Boys		Girls		Total	
	n	%	*n*	%	*n*	%
10 – 24 months	76	6.83	53	5.75	129	6.34
25 – 36 months	296	26.59	240	26.03	536	26.34
37 – 48 months	489	43.94	399	43.28	888	43.64
49 – 60 months	252	22.64	230	24.94	482	23.68
10 – 60 months	1113	100	922	100	2035	100

Table 2

Anthropometric characteristics in children aged 10–60 months

Characteristic	Stage 1	Stage 2	Stage 3	P_{1-2}	P_{2-3}	P_{1-3}
Age	42,68 (35.22 – 48.62)	45 (38 – 51)	48,0 (40.97 – 54.0)	<0.0001	<0.0001	<0.0001
Height	95,0 (89.5 – 101)	97 (92 – 103)	99 (93 – 105)	<0.0001	<0.0001	<0.0001
H/A z-score	-0.89 (-1.74 – -0.02)	-0.51 (-1.25 – 0)	-0.71 (-1.43 – 0)	<0.0001	0.101	<0.0001
Weight	14,0 (12.5 – 15.6)	14,2 (13.0 – 16.0)	15,0 (13.5–17)	<0.0001	<0.0001	<0.0001
W/A z-score	-0.62 (-1.3 – 0.12)	0 (-1 – 0)	-0,06 (-1.0 – 0.04)	<0.0001	0.259	<0.0001
BMI	15.39 (14.49 – 16.51)	15 (14 – 16,18)	15,42 (14.51 – 16.54)	0,006	<0.0001	0.301
BMI z-score	-0.04 (-0.78 – 0.77)	0 (0 – 0.67)	0 (-0.14 – 0.9)	<0.0001	0.001	<0.0001
W/H z-score	-0.14 (-0.84 – 0.61)	0 (-0.11 – 0.46)	0 (-0.12 – 0.58)	<0.0001	<0.0001	<0.0001

Scale comparison between 2 groups was performed with χ^2 test. Variables were presented by median (25^{th} – 75^{th} percentile), P was received from Mann-Whitney U test.

0.2 kg at stage 2 and 0.8 kg at stage 3 (with $P < 0.0001$). In addition, children's height increased by 4 cm after 6 months, approximately by 0.67 cm per 1 month. This showed that height increased stably. These results were comparable with the results obtained by Phuong H.V. et al in 2015 in the Red river delta in research performed on children aged 36–59 months (mean weight and height were 14.7 kg and 98.5 cm, respectively) [11]. The values of anthropometric indices were within the range from -2 SD to +2 SD, so children's weight and height could be considered normal for their age. BMI z-score at stage 2 and 3 was 0 SD (standard deviation) and was higher than that at stage 1 (with $P < 0.05$), because weight was gained faster than height grew.

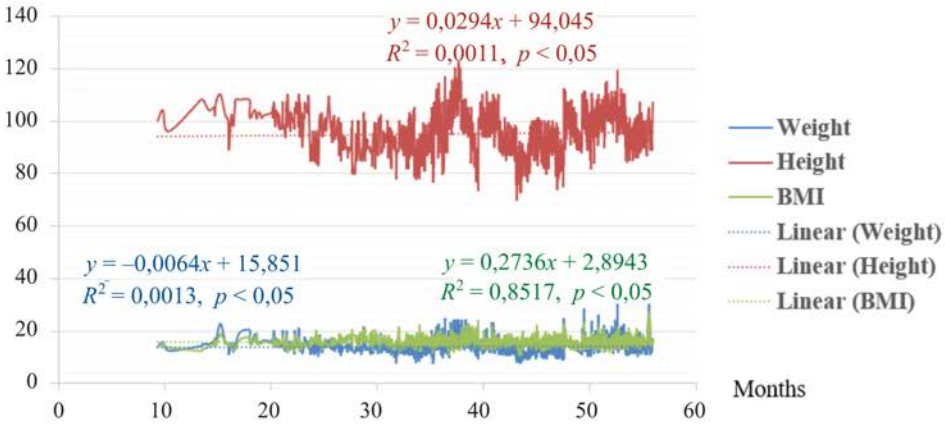
According to data obtained in general nutrition survey performed in 2009–2010 on children under 5 years old, W/A z-score, H/A z-score, W/H z-score were -0.82, -0.86, -0.47, respectively [7]. So, since 2010, nutritional status among Vietnamese children under 5 years has improved. According to data obtained in research that included 145,078 children aged 3–6 years in Tianjin, China and was performed from 2006 to 2014, mean values of height z-scores increased significantly (from 0.34 to 0.54), mean values of weight z-scores were constant, and mean values of BMI z-scores decreased significantly (from 0.40 to 0.23) [12].

3.3. The correlation between anthropometric indices and age

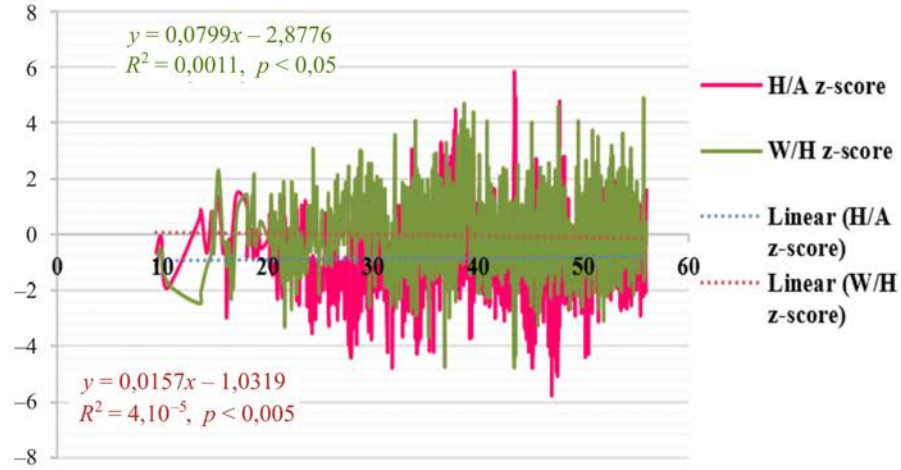
All models show the correlation between anthropometric indices and age among children aged 10–60 months ($P < 0.05$). However, only model $y = 0.2736x + 2.8943$ with $R^2 = 0.8571$ showed the tight correlation between BMI and age. This can explain 85% of the difference in BMI among children aged 10–60 month in this study. Presumably, BMI determined as per the WHO criteria can be used to classify the nutritional status among Vietnamese children aged 10–60 months.

3.4. The prevalence of nutritional status among children aged 10–60 months

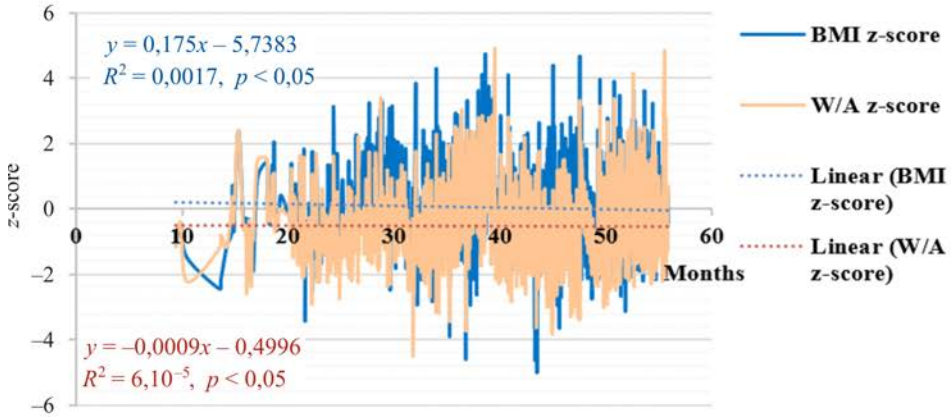
We used the WHO 2006 standard to assess the nutritional status of children; the result was presented in Table 3. At stage 3, children had all nutritional status types: malnutrition, normal status, overweight, obesity,



a. weight, height, BMI



b. Z-score H/A and Z-score W/H



c. Z-score W/A and Z-score BMI

Figure 1. Shows the correlation between anthropometric indices:
a) weight, height, BMI; b) H/A z-score and W/A z-score;
c) W/H z-score and BMI z-score with age from 10–60 months

Table 3

The correlation between anthropometric indices and age among children aged 10–60 months in Hanoi, Nam Dinh and Thanh Hoa

Nutritional status	Stage 1			Stage 2			Stage 3		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
Normal	72.9	74.0*	73.4	76.4	76.7	76.5	77.3	77.8*	77.5
Underweight	7.9	8.0	7.9	5.2	5.9	5.6	3.9	4.7	4.3
Stunting	18.1	19.8	18.8	16.2	17.0	16.6	15.0	16.6	15.7
Wasting	3.6	3.8	3.7	1.9	2.4	2.1	1.4	1.7	1.5
Overweight	6.0	2.8*	4.5	6.3	3.7*	5.1	7.0	3.7*	5.5
Obesity	1.7	0.5*	1.2	1.8	0.8*	1.3	1.7	0.4*	1.1
Underweight and stunting	5.3	5.4	5.4	4.0	4.4	4.2	2.8	4.0	3.3
Underweight and wasting	1.2	1.5	1.3	0.5	0.5	0.5	0.4	0.1	0.2
Underweight, stunting and wasting	0.5	0.4	0.5	0.4	0.1	0.2	0.2	0	0.1
Stunting and overweight	0.7	0.4*	0.6	0.6	0.4*	0.5	0.9	0.3*	0.6
Stunting and obesity	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Data were presented in %, *means the difference between boys and girls is statistically significant.

and two disorders together (underweight and stunting, underweight and wasting…). After 6 months, good nutritional status increased incrementally, and bad nutritional status decreased, especially malnutrition. This highlights the significance of regular assessment of nutritional status in children under 5 years. Children develop actively and fast at this age, so it is very important to detect bad nutritional status timely to help families, schools and the community to react quickly and provide children with good nutrition necessary for their comprehensive development.

At stage 3, among malnutrition, the prevalence of stunting was the highest (15.7%), next to underweight (4.3%), underweight and stunting (3.3%), wasting (1.5%), underweight and wasting (0.2%), underweight, stunting and wasting (0.1%). The prevalence of overweight and obesity did not decrease with 4.5% overweight and 1.2% obesity at stage 1, and 5.5% overweight and 1.1% obesity at stage 3, respectively. In addition, sometimes malnutrition and overweight occurred together: stunting and overweight (0.6%), stunting and obesity (0.1%).

The total share of stunting was 19.8%, and the total share of underweight was 7.9%, the share of wasting amounted to 1.8%. These figures are lower than those obtained by the National Institute of Nutrition in research performed among children under 5 years in Vietnam in 2010 with 29.3% of stunting, 17.5% of underweight, and 7.1% of wasting [7]. This showed that the prevalence of malnutrition among children under 5 years decreased significantly. A study among children aged 6–59 months from Northern Ethiopia showed high prevalence of malnutrition (47.3% of stunting, 25.6% of underweight, and 8.9% of wasting) [13]. The study in six districts of Kilimanjaro showed high prevalence of underweight (46.0%), stunting (41.9%) and wasting (24.7%). In further analysis, 21.1% children turned out to suffer from both underweight and wasting, 12.1% had wasting and stunting, and 32.5% had underweight and stunting; and 12% of children had all three nutritional status disorders [14]. So, if we fail to reduce the stunting condition, children will be exposed to the long term effects of stunting and may not reach their full growth potential [15].

The prevalence of over-nutrition among children under 5 years in this study amounted to 7.3%. there was an increase in the figure in comparison with previous data obtained by the National Institute for Nutrition in 2009–2010 (5.6%), of which the obesity prevalence was 2.8%, and as for urban areas, the prevalence of

over-nutrition was 6.5% there [7]. However, the prevalence of over-nutrition in this study is lower than that in Turkey (with 8.6% for overweight and 6.6% for obesity) among children under 5 years [16] and in Lebanon (with 6.5% for overweight and 2.7% for obesity) [17], and higher than that in Sub-Saharan Africa (with 6.8% overweight/obesity) [18]. A community based cross-sectional study conducted in Gondar City showed the combined prevalence of overweight/obesity was 13.8% with overweight accounting for 9.6% and obesity for 4.2% of the total figure [19]. According to a longitudinal study performed on 2,677 Vietnamese children aged 3–6 years in 2013, 2014 and 2016, the overall estimated prevalence of overweight increased from 9.1% to 16.7% and the overall prevalence off obesity decreased from 6.4% to 4.5% [20]. However, between 2006 and 2014 in China, there were no significant changes in prevalence of overweight and obesity among 3–4 years children. Nevertheless, prevalence of obesity increased from 8.8% in 2006 to 10.1% in 2010, and then remained stable until 2014 among 5–6 year old children [12].

According to the national nutrition strategy accepted for 2011–2020, the prevalence of stunting and underweight in this study has achieved the target level fixed by the government [21]. In comparison with the study of Phuong H.V. performed on 39–59 month children in Thanh Liem, a Red River Delta district, the prevalence of stunting, underweight and wasting was 18.1%, 11.3% and 3.1%; overweight and obesity was low at 1.9% [11]. So stunting and overweight in Hanoi, Nam Dinh and Thanh Hoa are still a public healthcare problem; to solve it, we need to improve nutritional status among preschool children.

In addition, normal nutrition status in girls was higher than in boys (74.0% against 72.9%, at stage 1, and 77.8% against 77.3% at stage 3) with $P < 0.05$. On the contrary, the total prevalence of overweight and obesity in boys was higher than in girls (7.9%, 1.8% against 4.0%, 0.5% respectively at stage 3). Similar results were obtained in the study performed in Northwest Ethiopia with prevalence of obesity equal to 7.4% among boys and 1.2% among girls [19]; in China, boys also had higher prevalence of obesity than girls [12]. This might be explained by the differences in gender-dependent behaviors of children and family childcare. Although, no significant differences between genders were observed in a national cross-sectional survey among 2–5 year old children in Lebanon [17]. So this discrepancy needs to be evaluated in details to provide appropriate strategy to control nutritional status for each gender of children.

4. Conclusions

The research results revealed a tight correlation between BMI and the children's age among preschool children, and roved that using BMI according to the WHO data to assess the nutritional status of children at this age was appropriate. Substantial number of children aged from 10 to 60 months in the Northern Vietnam suffer from both overweight and obesity, as well as underweight, wasting, and stunting. The regular assessment of anthropometric indicies has a positive effect, helping families and communities to evaluate nutritional status, thus ensuring a child has all th possibilities for further harmonious development.

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