Original

Low Physical Activity May Lead to Obesity Rather than High-Energy Intake in Vietnamese Children

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ABSTRACT *Background:* The prevalence of overweight and obesity in Vietnamese school children has increased rapidly in the past decade. However, factors related to this matter in school children were not well understood. *Purpose:* To identify factors related to child obesity in Vietnamese children. *Methods:* A cross-sectional study was conducted on 134 fifth-grade children at a public primary school in a Hanoi suburb. Height and weight were measured. Dietary intake was assessed by a 24-h dietary recall method for seven days. Children were interviewed about daily activities for seven days by questionnaire to estimate physical activity level. *Results:* The study subjects included 73 boys (54.5%) and 61 girls (45.5%). The prevalence of non-obese and obese of all subjects were 69.4%, and 30.6%, respectively. The average energy intake for seven days in non-obese and obese groups was 1895 ± 298 and 1881 ± 296 kcal/d, respectively ($p>0.05$). Sugar intake was similar among all the 4 groups, being less than 30g/day. Physical activity level in the non-obese group was higher than that of the obese group ($p<0.01$). *Conclusion:* This study showed that a high prevalence of obesity was not based on high energy intake but on low physical activity in Vietnamese children.

Keywords: children, overweight and obesity, energy intake, physical activity level.

INTRODUCTION

Childhood obesity is one of the most serious global public health challenges of the 21st century, affecting every country in the world. In just 40 years the number of school-age children and adolescents with obesity has risen more than 10-fold, from 11 million to 124 million (2016 estimates) (1). In Vietnam, childhood obesity has been on a rapid rise and become a public health concern, especially in big cities. In Hanoi, the capital city of Vietnam, the prevalence of overweight and obesity among 8–11 year-olds in 2003 was 7.5%, increasing to 12.9% in 2009 and 33.3% in 2018 (2). In Ho Chi Minh City, the largest city in Vietnam, the prevalence of overweight and obesity in children aged 7-9 and 10-11 years old were 48.2% (3) and 53.5% (4), respectively.

Previous studies reporting on the prevalence of childhood obesity have shown continued increases in obesity during the past decade, with plateauing of obesity prevalence among some age groups. This is a concern as obese children have a higher risk of developing diseases including asthma and type 2 diabetes mellitus and are reported to have low self-esteem (5). Once established, obesity tracks into adulthood and is associated with an increased risk of cardiovascular disease and certain cancers (5). Studies in Vietnam have suggested that obesity increased the risk of hypertriglyceridemia (6). Addressing overweight and obesity will contribute to reducing deaths and increasing the years of life lived (7).

In simple terms, obesity is the result of an energy imbalance. Diet and physical activity, the risk factors most strongly related to obesity, have changed markedly since the onset of the obesity epidemic (5). Interventions that are successful in the prevention and management of childhood obesity are urgently needed. Understanding the relative importance of overconsumption and physical inactivity to excess weight gain among children can contribute to the development and evaluation of interventions and policies to reduce childhood obesity (8). However, whether energy intake or expenditure is the dominant contributor to childhood obesity is a subject of debate. In the United States, the country with the highest rate of overweight and obese children in the world, there has been no consensus on the main driver of secular trends in weight gain among children (8). In addition, population-level studies on the relationship between lifestyles and childhood obesity typically focus on either physical activity or diet but seldom on both (9). Therefore, this study examined physical activity and dietary intake in relation to overweight and obesity in primary school children in a suburb of Hanoi, Vietnam.

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METHODS

Participants

A total of 134 children (73 boys and 61 girls) in grade 5 (9-10 years old) at a public primary school in suburban Hanoi participated in this study. The school was selected by convenience sampling. All data were collected in October 2020. Informed consent was obtained from the children, their guardians, and teachers according to the Declaration of Helsinki, and the study protocol was approved by the Biomedical Research Ethics Committee of Hanoi Medical University (no. 355/HMUIRB).

Anthropometric characteristics

Height and weight were measured to the nearest 0.1 cm and 0.1 kg using a stadiometer (Seca 213) and a digital scale (OMRON HBF354IT). Children were measured with light clothing without shoes or hair ties. All measurements were conducted three times and the mean was calculated. The nutritional status of the children was determined based on the WHO growth reference for those aged 5-19 years old. BMI-for-age z-score was determined using the software WHO AnthroPlus version 1.0.4 for children above five years of age. Interpretation of cut-offs is >+1SD for overweight, >+2SD for obesity, and <-2SD for thinness.

Dietary assessments

Dietary intake was assessed by a 24-hour dietary recall questionnaire for seven days using standard food measures and a food photobook published by the Vietnamese National Institute of Nutrition during interviews to estimate portion size. When children couldn't remember exactly what they had eaten, we contacted the caregiver to reconfirm. The nutritional value of food was calculated based on the Vietnam Food Composition Table published by the Ministry of Health and Vietnam National Nutrition Institute (10). Sugar intake was estimated from reports of various food sugar concentrations (11).

Physical activity assessments

The 7-day minute-by-minute activity record was used to assess the physical activity level. The activity record form is designed based on the template developed by Koebnick et.al (12). Children were instructed to name the activity and the intensity of the activity with 3 levels of light, moderate and vigorous, and mark the start and end times for each activity. The recording method was explained to teachers, children, and their guardians with an example of a completed physical activity form. We asked teachers and guardians to help the children to complete the activity record. When collecting the activity record form, we interviewed children to improve the accuracy of the activity record by adding and correcting the content regarding omissions and unclear points.

Statistical analysis

The physical activity level (PAL) was calculated based on the following formula:

PAL = ∑24h {MET value of physical activity x time (min)} /1440

In which the MET value of physical activity was referenced from the compendium of physical activities of Ainsworth et al. (13).

The time spent in each physical activity intensity in each day was calculated using METs for each participant: average minutes spent in sedentary and light physical activity (METs< 3), moderate to vigorous physical activity (METs ≥3.0).

All statistical analyses were performed using SPSS software (version 26; IBM Corporation, Armonk, New York). The data were expressed as mean±SD or n (%). The study analyses involved comparisons between the non-obese and obese groups. Differences between groups were assessed using independent *t*-tests for continuous data and chi-squared tests for categorical data. *P* values less than 0.05 were defined as a statistical difference.

RESULTS

Figure 1 shows the weight status of all the children. The prevalence of overweight and obesity in children aged 10 years old was very high, at about 30.6%. The prevalence of thinness in children was low at 6% and their average BMI for age z-score was -2.12 SD near the cut-off point of the normal level. Therefore, the following results were presented in the non-obese group consisting of thin and normal children, and the obese group including overweight and obese children.

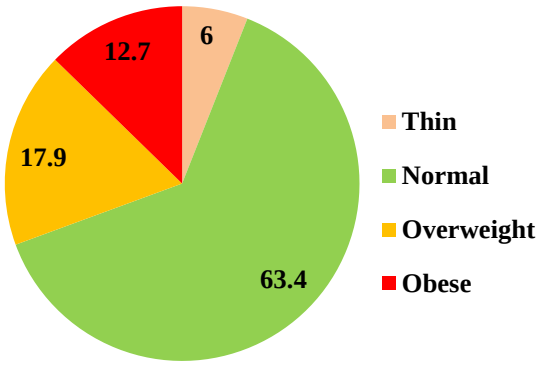

Figure 1. Weight status of children assessed by BMI-for-age z-score (n=134)

Table 1. Characteristics of child subjects (n=134)

	Girls (n=61)	Boys (n=73)	*p*-value†
Age (months)	123.3±3.5	123.0±3.1	0.723
Height (cm)	138.0±5.3	137.9±6.9	0.895
Weight (kg)	32.4±5.7	36.0±8.3	**0.006**
BMI (kg/m^2)	17.0±2.5	18.8±3.4	**0.000**
BMI-for-age z-score	-0.1±1.2	0.7±1.3	**0.000**
Weight status (%)			
Non-obese	78.7	61.6	**0.008**
Obese	21.3	38.4	

Abbreviation: BMI, body mass index.
Values are mean±SD and %. †Independent *t*-test except Chi-squared test for weight status (%). Significant difference: $p<0.05$.

Characteristics of children are summarized in table 1. No statistically significant differences were observed between the boys and girls with regard to age and height. However, the prevalence of overweight and obesity in boys was significantly higher than in girls at 38.4% and 21.3%, respectively ($p=0.008$).

Average energy and nutrient intakes in the 7-day nutritional survey are shown in table 2**.** There were no significant differences between non-obese and obese children in the intakes of energy, protein, lipid intake, fiber, and sugar in both genders. However, the carbohydrate intake of boys was significantly higher in the non-obese group than in the obese group ($p<0.05$).

Table 2. Energy and nutrient intakes by genders and groups (n=134)

	Girls			Boys		
	Non-obese (n=48)	Obese (n=13)	*p*-value	Non-obese (n=45)	Obese (n=28)	*p*-value
Energy intake (kcal/d)	1798±241	1850±209	0.482	1998±321	1896±331	0.197
Protein intake (g/d)	74±23	73±14	0.876	82±24	81±28	0.886
Protein intake (% EI)	16.6±6.0	15.6±1.5	0.596	16.4±3.6	17.2±6.0	0.472
Lipid (g/d)	59±13	62±15	0.544	64±17	64±14	0.996
Lipid intake (% EI)	29.7±4.8	30.1±5.6	0.801	28.6±4.9	30.3±3.9	0.137
Carbohydrate (g/d)	252±38	260±34	0.459	280±45	253±50	**0.021**
Carbohydrate intake (% EI)	56.0±4.6	56.4±5.5	0.794	56.3±5.0	53.5±5.0	**0.023**
Fiber intake (g/d)	3.9±1.4	3.6±1.0	0.583	4.3±1.7	4.2±2.0	0.736
Sugar intake (g/d)	28±16	29±8	0.945	29±17	26±12	0.398

Abbreviation: EI, energy intake
Values are mean±SD and %. *P*-values were computed using an Independent *t*-test with significant difference at $p<0.05$.

Table 3. Physical activity of children with non-obese and obese girls and boys

	Girls			Boys		
	Non-obese (n=48)	Obese (n=13)	*p*-value†	Obese (n=13)	Non-obese (n=48)	*p*-value†
Physical activity level (PAL)	1.44±0.11	1.34±0.12	**0.002**	1.48±0.12	1.41±0.13	**0.018**
Sleeping time (min/d)	622±38	616±40	0.684	618±49	599±46	0.111
Sedentary to light physical activity (min/d)	730±49	763±55	**0.038**	717±67	765±62	**0.003**
Moderate to vigorous physical activity (min/d)	90±38	66±28	**0.044**	108±45	80±31	**0.005**
Percentage of children walking or biking to school (%)	47.9	61.5	0.093	46.7	60.7	0.046
Minutes spent walking or biking to school a day	7±9	9±9	0.513	7±9	6±7	0.743

Values are mean±SD and %.
†Independent *t*-test except Chi-squared test for walking or biking to school (%). Significant difference: $p<0.05$.
PAL was calculated by ∑24h {MET value of physical activity x time (min) } /1440 min. It is the same as the average METs.

Table 3 shows the physical activity of children. The physical activity level in the obese group was significantly lower than in the non-obese group. Obesity children spent more time in sedentary to light activities than non-obese children. Time spent on moderate to vigorous physical activity in obese children was less than in non-obese children. There were no significant differences in sleeping time, the number of children walking or cycling to school, or the time spent walking or cycling between obese children and non-obese children.

Multiple linear regression was used to predict BMI-for-age z-score based on gender, PAL, and energy intake (Table 4). The regression was statistically significant and the three predictors explained 11% of the variance ($R^2 = 0.13$, $F(3, 120) = 6.33$, $p < 0.001$). Participants' predicted BMI-for-age z-score is equal to 1.7688 + 0.8885(GENDER) – 1.8491(PHYSICAL ACTIVITY LEVEL) + 0.0001(ENERGY INTAKE), where gender is coded as 1=girl and 2=boy, physical activity level is measured in PAL and energy intake is measured in kcal. Children's BMI-for-age z-score increased by 0.0001 for each kcal of energy intake and decreased by 1.85 for each PAL of physical activity and BMI-for-age z-score in boys was higher than in girls at 0.89. Gender and physical activity level were significant predictors of BMI-for-age z-score at $p=0.0001$ and $p<0.05$, respectively. It was found that energy intake did not significantly predict BMI-for-age z-score ($p= 0.8513$).

Table 4: Multiple linear regression predicting BMI-for-age z-score of children.

Predictor	Estimate	Standard Error	*t*-statistic	*p*-value
Constant	1.7688	1.2906	1.3705	0.1729
Gender	0.8885	0.2225	3.9935	0.0001
Physical activity level (PAL)	-1.8491	0.8943	-2.0676	0.0407
Energy intake	-0.0001	0.0004	-0.1878	0.8513

$R^2 = 0.13$, $F(3, 120) = 6.33$, $p < 0.001$

Abbreviation: PAL, physical activity level
PAL was calculated by ∑24h {MET value of physical activity x time (min)} /1440 min. It is the same as the average METs.

DISCUSSION

The purpose of the present study was to find related factors of overweight and obesity in children aged 10 years old in Hanoi, Vietnam. We found that in Vietnamese children, the high prevalence of obesity was based not on high energy intake but on low physical activity. Most of the previous trials to control obesity were focused mainly on energy intake such as prevention by reducing/limiting junk foods and sweet foods and beverages (14-15). However, the results of this study suggest that this strategy of obesity control would not be effective in Vietnamese children.

Obesity rate: The mixed obesity rate for girls and boys was about d 31%. These results were similar to data from the National Nutrition Survey in Hanoi in 2018 (2), which showed an obesity rate of 33.3% for 8-10 years old, indicating that our subjects were generally representative of children in Hanoi. The obesity rate is quite high but it is similar to that of most East Asian countries and other parts of the world (26%) (16), with the exception of Japan (17). For Japanese children of a similar age group, the obesity rate was 11% in 2020 (18), which was perhaps the lowest in developed countries for this age.

Accuracy of the results: Results of 24-h dietary recall nutrition surveys are often underestimated because subjects forget some foods that they have eaten, especially with children. Such underestimate problems can be improved with the help of parents (19). Surveys for a full week show more accurate results than surveys for 3 days, which are often used. In this study, the survey was 7 days and children's parents cooperated. Through these efforts, we believe that the reliability of this nutrition survey was greatly improved.

Concerning the accuracy of estimations of physical activity, there may be some limitations. Most of the previous studies in Vietnam were measurements of steps or described activity levels such as low, moderate, and high (4), (20). However such methods do not indicate the PAL. To define PAL more accurately, we used a time/study method. Subjects and their parents wrote down the time in minutes spent in various activities for 7 days. PAL was calculated using the measured time of various activities and metabolic equivalents (METs) (13).

Energy, nutrient, and sugar intakes: The average energy intakes for seven days in the non-obese and obese groups were 1895 ± 298 and 1881 ± 296 kcal/d, respectively ($p>0.05$). Major energy source (carbohydrate, lipid, and protein) intakes were similar in all the groups. The energy ratio for these nutrients (percentages from protein, lipid, and carbohydrate) was 16:30:54, which was similar to that of the Japanese (21). This ratio is consistent with WHO recommendations (22).

In many countries, a high intake of sugar is an important factor for obesity. Some countries put a fine on products with high sugar concentrations (23). In North and South American and European countries, the sugar intake is nearly 100g a day (24-25). WHO recommends energy from sugar at less than 10% and further suggests 5%, which is about 50g or 25g of sugar a day (22). Nowadays, sugar includes not only sucrose but isomerized sugars (fructose and glucose) made from starch is common because it is cheap and tasty at lower temperatures. Luckily, in Vietnam, there is a sugar composition table that includes sucrose, fructose, glucose, and lactose (11). In this study, we used the composition table and calculated sugar intake. It was similar in all groups, being less than 30g/day, which meets the WHO recommendation.

Physical activity: In the present study, the clearest differences between obese and non-obese children were physical activity level (PAL). The multiple linear regression showed the most relevant factor for body weight was PAL with a p-value less than 0.05 (Table 4).

Differences in average PAL per day between the non-obese and obese groups were 0.1 in girls and 0.07 in boys. Since the average basic metabolic rates per day for 10-year girls and boys are 1200 kcal and 1330 kcal, respectively (26), a difference in energy expenditure was 120 kcal/day (1200 kcal x 0.1) in girls and about 90 kcal/day (1330 kcal x 0.07) in boys. Since they are daily differences, it is not small. Such differences were caused by the different amounts of time spent on activities.

Time spent in sedentary to light activities in obese children was about 30 minutes and 50 minutes longer than in non-obese girls and boys, respectively. On the contrary, time spent in moderate to vigorous activity was 25 minutes longer for non-obese girls and boys than for obese ones (Table 3). In Vietnam, parents take children to school by car or motorcycle because traffic makes walking unsafe. It is easy to think that such a lifestyle is one of the major factors in obesity; however, between non-obese and obese children in both genders the time spent commuting to school on foot or bicycle was short and not different (Table 3), indicating that the travel method to and from school is not a major factor in obesity.

Many previous studies have shown that sleep duration is negatively correlated with BMI (27-28). However, in the present study, there was no difference in sleep duration between non-obese and obese children.

Gender difference: Consistent with findings from several previous studies assessing the weight status of Vietnamese children, the prevalence of overweight and obesity in boys was significantly higher than in girls (4), (29-31). The higher prevalence of overweight and obesity in boys could be explained by the different social expectations about weight and body shape for boys and girls (30), (32). In Vietnam, society typically places more importance on males compared to females, resulting in boys being fed and taken care of very well (30).

In conclusion, the high prevalence of child obesity in Hanoi was mainly caused by lower physical activity rather than higher energy intake. Based on our present findings we need to consider strategies for obesity control in Vietnam once again.

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CONFLICTS OF INTEREST (COI)

The authors have no conflicts of interest to disclose.

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