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PREVALENCE AND ASSOCIATION OF EATING BEHAVIORS WITH OVERWEIGHT AND OBESITY AMONG STUDENTS AGED 11 - 15 AT NGUYEN TAT THANH MIDDLE AND HIGH SCHOOL, HANOI CITY

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Abstract. This study aimed to assess the prevalence of overweight and obesity among students at Nguyen Tat Thanh Middle and High School in Hanoi and explore the association of these conditions with eating behaviors. The research included a cross-sectional study involving 1,136 students aged 11 to 15 and a case-control study comparing overweight/obese students (n = 109) and normal-weight students (n = 341). Eating patterns were evaluated using the Child Eating Behavior Questionnaire (CEBQ), and nutritional status was determined according to the World Health Organization (WHO) and International Obesity Task Force (IOTF) criteria. The study revealed alarming rates of overweight (28.5%) and obesity (7.8%) among the students, with a higher prevalence among boys. Overweight/obese students scored significantly higher on CEBQ subscales related to Food Responsiveness (FR), Emotional Overeating (EOE), and Desire for Drinks (DD), while scoring lower in Satiety Responsiveness (SR). Linear regression analysis demonstrated that higher scores on FR, EOE, and DD were associated with a 1.59 to 1.69 times higher risk of overweight/obesity, while a higher SR score was associated with a reduced risk (OR = 0.61; β = -0.5; P = 0.009). The study highlights a high prevalence of overweight and obesity among students at Nguyen Tat Thanh Middle and High School and a strong association between eating behaviors and these conditions. These findings offer valuable insights into the intricate interplay between eating behaviors and weight status, emphasizing the promotion of healthy dietary habits among adolescents.

Keywords: eating behaviors, obesity, overweight, Nguyen Tat Thanh Middle and High School.

1. Introduction

In recent decades, the global rise in overweight and obesity among adolescents has emerged as a significant public health concern, transcending geographical boundaries and

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cultural contexts. In Vietnam, a country experiencing rapid socio-economic transitions and cultural changes, the prevalence of overweight and obesity among adolescents has become an issue of increasing significance. Applying the WHO Z-score criteria for classification, the prevalences of overweight and obesity among Vietnamese children aged 11 to 14 are noteworthy. The data reveals that 17.4% of children in this age group are classified as overweight, while 8.6% fall under the category of obesity [1].

The model simulated 7,219,837 Vietnamese children aged 10-14 years and showed that the prevalence of overweight/obesity ranged from 11.6% to 20.8% in boys and 7.5% to 10.5% in girls. The research findings also showed that the decrease in overweight and obesity corresponded to a decrease in mortality, an increase in years lived, and a greater accumulation of quality-adjusted life years [2]. In 2020, an examination of 2,993 secondary school students in Ho Chi Minh City revealed that the prevalence of overweight was 23.5%, while the prevalence of obesity reached 12.1% based on the criteria set forth by the WHO [3].

The prevalence of overweight and obesity in such a relatively young population segment is particularly alarming due to its potential long-term health consequences. Overweight and obesity during adolescence can have enduring effects on physical health, as well as psychological well-being, extending into adulthood. The early onset of these conditions also amplifies the risk of developing chronic diseases such as diabetes, cardiovascular diseases, and musculoskeletal disorders [4]. Addressing these challenges early in life has the potential to not only improve the health and well-being of the younger generation but also to alleviate the burden on the healthcare system and society as a whole.

Adolescence is a stage of life characterized by increased autonomy and independence, leading to shifts in dietary preferences, meal patterns, and eating habits. This pivotal period often sees adolescents making more decisions about what, when, and how they eat, which can significantly impact their nutritional status and overall health. Concurrently, factors such as peer influence, media exposure, and changing family dynamics contribute to the complexity of eating behaviors among adolescents.

Understanding the association between eating behaviors and the risk of overweight and obesity in adolescents is essential for devising effective strategies to curb this health issue. Numerous research studies have consistently highlighted the significant connection between eating behaviors and the occurrence of overweight and obesity among adolescents [5-7]. To investigate this relationship further, a cross-sectional study employing a multistage sampling technique was conducted from January to June 2019 in Bangladesh. The study included 4,609 adolescent students aged 13 to 19 years, representing all eight divisions of the country. Notably, the findings from this study revealed a striking statistic: adolescents who displayed tendencies towards restrained eating behaviors were 1,634 times more likely to experience obesity (95% CI 1,495 -1,786) [8]. Additionally, the research uncovered intriguing insights into the influence of sex and parental country of birth on eating behaviors among adolescents and young adults undergoing specialized obesity treatment. Surprisingly, the study also revealed that cognitive restraint in eating decreased as BMI, waist circumference, and body fat percentage increased. This intriguing observation suggests a potential inverse relationship between one's ability to restrain eating and weight gain, warranting further investigation

to elucidate the direction of this association [9]. In a broader context, a comprehensive analysis encompassing 282,213 samples collected in the "latest Global School-based Student Health Survey" spanning from 2003 to 2015 across six World Health Organization (WHO) regions was conducted among school children aged 11 to 17 years. The results of this extensive survey illuminated the correlation between overweight and obesity and unhealthy dietary patterns and lifestyles [10].

Nevertheless, there is a scarcity of research examining the connection between eating behaviors and overweight and obesity among Vietnamese adolescents. Particularly during the middle school years (11-15 years old), a period characterized by substantial physical - physiological changes and the emergence of heightened awareness concerning eating habits among students. Specifically, within the contemporary landscape of economic and lifestyle transformations in Hanoi, there exists a substantial influence on the eating behaviors of students, subsequently impacting the prevalence of overweight and obesity among them. It delves into the various dimensions of eating behaviors, including dietary choices, portion sizes, meal frequency, and emotional eating, to provide a comprehensive understanding of how these factors influence weight status during this critical life stage. By shedding light on these associations, we hope to inform public health initiatives, healthcare professionals, parents, and educators about effective interventions to promote healthier eating behaviors and ultimately reduce the burden of overweight and obesity among adolescents. This study aims to investigate the prevalence and intricate relationship between eating behaviors and overweight and obesity in students at Nguyen Tat Thanh Middle and High School, Hanoi.

By unraveling the complexities of this issue, we can lay the groundwork for interventions, educational initiatives, and policy frameworks aimed at fostering healthier lifestyles and attitudes in this pivotal demographic. In doing so, we aspire to not only enhance the immediate health of Vietnamese adolescents but also to shape the future of a resilient, thriving generation.

2. Content

2.1. Subjects and methods

2.1.1. Study design and participants

The study was conducted at Nguyen Tat Thanh Middle and High School (grades 6 - 9) in Hanoi City from 2022 to 2023. Students with a prior history of psychological or physical issues were intentionally omitted from the research. The study consisted of two phases:

- Phase 1: This research comprised a cross-sectional investigation involving a convenience sample of 1,136 students aged between 11 and 15 years, consisting of 521 girls and 615 boys. Convenience sampling methodology was employed to assemble the study's sample.

- Phase 2: To investigate the association between eating behaviors and overweight, and obesity, a case-control study design was employed. The control group comprised students classified as having normal weight (n = 341); while the disease group encompassed students categorized as overweight and obese (n = 109). Students who had not completed questionnaires about eating behaviors were excluded from the study.

The research protocol received approval from the Hanoi National University of Education (Grant No. SPHN22-12). Data collection and storage adhered strictly to ethical standards, safeguarding the confidentiality of individuals. Throughout the study, children retained the prerogative to decline to answer any inquiries or to terminate their participation in the investigation at any juncture.

2.1.2. Eating behavior measures

The Child Eating Behavior Questionnaire (CEBQ) is a questionnaire consisting of thirty-five items, specifically designed to assess children's eating patterns [11]. It employs a five-point Likert frequency scale, ranging from 1 (never) to 5 (always). These items are categorized into eight subscales, each serving to measure different aspects of eating behavior: (1) Food Responsiveness (FR; 5 items); (2) Enjoyment of Food (EF; 4 items); (3) Emotional Overeating (EOE; 4 items); (4) Desire for Drinks (DD; 3 items); (5) Slowness in Eating (SE; 4 items); (6) Satiety Responsiveness (SR; 5 items); (7) Food Fussiness (FF; 6 items); (8) Emotional Under-eating (EUE; 4 items). The subscales "food approach" (FR, EF, EOE, and DD) focus on behaviors associated with a positive inclination or pro-intake dimension, reflecting habits that promote food consumption. Conversely, the subscales "food avoidance" (SE, SR, FF, and EUE) pertain to anti-intake behaviors, encompassing habits that lead to the avoidance of food consumption. It's worth noting that the Vietnamese version of the CEBQ has undergone validation and has been previously employed in research [12].

2.1.3. Anthropometric Study

The anthropometric evaluation was conducted in accordance with the standardized method developed by Lohman et al. [13]. Height (in centimeters) was determined using a vertical height ruler with a precision of 1 millimeter, while weight (in kilograms) was assessed using an electronic scale. Each measurement was taken twice, and the results were averaged. Prior to these measurements, students were permitted to remove their shoes, hats, and coats.

In this study, the evaluation of children's nutritional status was conducted by merging the 2007 World Health Organization (WHO) standards with those of the International Obesity Task Force (IOTF). According to the IOTF, nutritional status was determined based on specific BMI values for age and gender that corresponded to BMI values at 18 years old. These categories included thinness (BMI < 18.5 kg/m^2), overweight (25 kg/m^2 ≤ BMI < 30 kg/m^2), and obesity (BMI ≥ 30 kg/m^2) [14]. On the other hand, the WHO defined nutritional status for children aged 5-19 years using BMI-for-age Z-scores. Thinness was identified as a BMI-for-age Z-score < -2SD, overweight as BMI-for-age +1SD < Z-score ≤ +2SD, and obesity as BMI-for-age Z-score > +2SD. A child was classified as overweight or obese only when both sets of criteria were satisfied.

2.1.4. Statistical analysis

Data management was performed using Epidata 3.1 software. The statistical analyses were done with the SPSS 16.0 software, applying statistical tests commonly used in the field of biomedicine. Quantitative variables were expressed either as the mean ± standard deviation ($\bar{X}$ ± SD) or as the median (25^{th} to 75^{th} percentiles). To compare quantitative variables, the following statistical tests were employed: For normally distributed variables: Student's t-test; for non-normally distributed variables: Mann-Whitney U-test

or Kruskal-Wallis test. In the case of qualitative variables, the comparison was conducted using either the Chi-square test or the Fisher Exact test. To explore the relationship between eating behavior and overweight or obesity, univariate and multivariate logistic regression methods were employed as part of the analysis. Pearson correlations were calculated to assess the associations among the eight subscales of the CEBQ. Correlations exceeding 0.5 were categorized as large, those falling between 0.3 and 0.5 were regarded as medium, and correlations ranging from 0.1 to 0.3 were considered small [15]. *P*-values < 0.05 were considered as significant.

2.2. Results and discussion

2.2.1. Prevalence of overweight and obesity among students at Nguyen Tat Thanh Middle and High School

Figure 1 illustrates the prevalence of overweight and obesity among students at Nguyen Tat Thanh Middle and High School. Within the study population, 28.5% of students were categorized as overweight, while 7.8% were classified as obese. Notably, the data indicates a higher prevalence of both overweight and obesity among boys when compared to girls ($P < 0.001$).

The percentage of overweight and obesity among students at Nguyen Tat Thanh Middle and High School was notably higher than the corresponding percentages observed among students 6 - 14 years old in Thai Nguyen City in 2023 (where 20.4% were overweight and 8.2% were obese) [16].

Childhood rates of overweight, encompassing pre-obesity and obesity, have been on the rise worldwide in recent decades. On average across 27 OECD countries, the prevalence of youth overweight increased from 16.6% to 18.3% between 2009 - 2010 and 2017-2018 [17, 18]. This trend exhibited variations across countries. Notably, 23 OECD countries saw an increase in this rate. Among them, Lithuania, Belgium, Estonia, and Russia experienced substantial growth, with rates increasing by 40 - 60%. Within the United States, NHANES data for 2017-18 indicated that 41.5% of children and adolescents aged 2-19 were either overweight or obese, compared to 37.4% in 2009-10 [19].

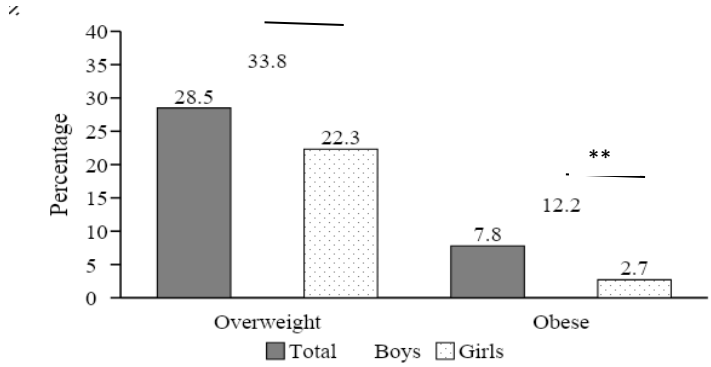

Figure 1. Prevalence of overweight and obesity among students at Nguyen Tat Thanh Middle and High School

*** P < 0.001; P-values obtained by Chi-square test.*

The rate of overweight and obesity among students at Nguyen Tat Thanh Middle and High School was alarmingly high. The emergence of the COVID-19 pandemic led to disruptions in the lives of children and adolescents, affecting their dietary patterns and physical activities. This may also be one of the reasons leading to an increase in overweight and obesity among students at Nguyen Tat Thanh Middle and High School. Evidence from various countries, such as China and the United States, demonstrates an increase in obesity rates among adolescents in the aftermath of the COVID-19 pandemic [20].

Additionally, when assessing gender differences, the proportion of overweight boys surpassed that of girls in all 27 OECD countries examined. Among 15-year-olds, the prevalence of overweight or obesity was 22.1% for boys and 14.5% for girls, on average across countries in 2017-18. Notably, Greece, Poland, Italy, and the Czech Republic exhibited the widest gender gaps, with boys being 12-18 percentage points more overweight than girls [19].

2.2.2. Association of eating behaviors with overweight and obesity among students at Nguyen Tat Thanh Middle and High School

**** Characteristics of study subjects***

The characteristics of the study subjects are presented in Table 1.

Table 1. Characteristics of the study subjects

Parameter	Control (N = 341)	Case (N = 109)	*P*-value
Age (years)[a]	12.5 ± 1.1	12.4 ± 1.1	0.641
Weight (kg)[a]	47.6 ± 6.9	63.8 ± 11.6	*<0.0001*
Height (cm)[b]	157.0 (152.0-162.0)	160.0 (153.0-166.0)	*<0.0001*
BMI (kg/m^2)[b]	19.2 (18.0-20.5)	24.2 (22.9-26.4)	*<0.0001*

BMI, body mass index;

[a]Data are mean±SD, P-values obtained by Student T-test.

[b]Data are median (interquartile range). P-values obtained by Mann-Whitney U test.

Bold values indicate significant differences between cases and controls.

Although there were no variations in age among the research subjects, a statistically significant disparity was observed in height, weight, and BMI between the control group and the case group. These parameters were notably higher in the case group compared to the control group ($P < 0.05$).

**** Correlations among the CEBQ subscales***

The data in Table 2 showed significant correlations among the subscales of the CEBQ. Notably, the subscales "food approach" (FR, EF, EOE, and DD) and the subscales "food avoidance" (SR, SE, EUE, and FF) tended to exhibit positive intercorrelations. Specifically, within the "food approach" group, strong correlations were observed between FR-EF, EF-EOE, and FR-EOE ($P < 0.001$). In contrast, a moderate correlation was identified between the "food avoidant" subscales SR and SE, while weaker correlations were found for SR-FF, SE-FF, SR-EUE, and FF-EUE. Furthermore, it is worth noting that there were negative correlations or statistically insignificant

correlations between the "food approach" and "food avoidant" subscales. These correlation coefficients align with the findings reported in previous studies [21, 22].

Table 2. Pearson's correlations among the CEBQ subscales

	FR	**EF**	**EOE**	**DD**	**SR**	**SE**	**EUE**	**FF**
FR	1	*0.591***	*0.638***	*0.481***	0.054	0.098	0.005	-0.017
EF		1	*0.541***	*0.197***	-0.070	0.086	-0.105	*-0.156**
EOE			1	*0.290***	*0.160**	*0.188***	-0.059	0.068
DD				1	0.099	*0.182***	0.024	*0.185***
SR					1	*0.375***	*0.175***	*0.178***
SE						1	0.073	*0.183***
EUE							1	*0.181***
FF								1

** P < 0.05; ** P < 0.001 (two-sided)*

**** CEBQ subscale scores among students at Nguyen Tat Thanh Middle and High School***

The independent samples t-test was conducted to compare CEBQ scores between students categorized as overweight, obese, and normal weight (Table 3).

Table 3. CEBQ subscale scores among students

CEBQ subscales	**Control (N = 341)**	**Case (N = 109)**	***P*-value**
"Food approach" scales			
Food responsiveness (FR)	2.40 ± 0.82	2.64 ± 0.88	*0.045*
Enjoyment of food (EF)	3.25 ± 0.86	3.38 ± 0.92	0.306
Emotional overeating (EOE)	2.07 ± 0.92	2.48 ± 0.89	*0.002*
Desire for Drinks (DD)	2.15 ± 1.02	2.56 ± 0.84	*0.003*
"Food avoidant" scales			
Satiety responsiveness (SR)	2.77 ± 0.82	2.44 ± 0.77	*0.004*
Slowness in eating (SE)	2.19 ± 0.84	2.12 ± 0.89	0.564
Emotional under-eating (EUE)	3.61 ± 0.93	3.43 ± 1.02	0.175
Food fussiness (FF)	3.00 ± 0.92	2.89 ± 1.04	0.444

Data are mean±SD, P-values obtained by Student T test

The results indicated that in the case group, the scores on the "Food approach" scales, including FR, EOE, and DD, were significantly higher compared to the control group ($P < 0.05$). Conversely, the scores on the "Food avoidant" scales in the case group were

lower than those in the control group. To be more specific, the SR score in the case group was 2.44, while in the control group, it was 2.77 ($P = 0.004$).

**** Logistic regression analysis of the association of CEBQ with overweight and obesity among students at Nguyen Tat Thanh Middle and High School***

A series of independent regression analyses were employed to examine each subscale of the CEBQ individually about overweight and obesity among students at Nguyen Tat Thanh Middle and High School. These analyses were adjusted for potential confounding variables, including the child's gender and age, and the results are summarized in Table 4. The findings indicated that the 'food approach' subscales of the CEBQ were associated with an increased risk of overweight and obesity (β = 0.167 to 0.528), while the 'food avoidant' subscales were associated with a protective effect (β = -0.091 to -0.5). Notably, statistically significant relationships were observed for FR, EOE, DD, and SR ($P < 0.05$). Specifically, higher scores on FR, EOE, and DD were linked to a 1.59 to 1.69 times greater risk of overweight and obesity, while higher scores on SR were associated with a reduced risk of overweight and obesity (OR = 0.61; $P = 0.009$).

Table 4. Logistic regression analysis of the association of CEBQ with overweight and obesity adjusting for age and sex

CEBQ subscales	OR (95% CI)	*P*-value	Standardized β coefficient
"Food approach" scales			
Food responsiveness (FR)	1.69 (1.49-1.98)	*0.040*	0.365
Enjoyment of food (EF)	1.05 (0.61-1.17)	0.310	0.167
Emotional overeating (EOE)	1.60 (1.43-1.84)	*0.003*	0.514
Desire for Drinks (DD)	1.59 (1.43-1.82)	*0.002*	0.528
"Food avoidant" scales			
Satiety responsiveness (SR)	0.61 (0.42-0.88)	*0.009*	-0.500
Slowness in eating (SE)	0.91 (0.66-1.27)	0.592	-0.091
Emotional under-eating (EUE)	0.84 (0.62-1.13)	0.240	-0.180
Food fussiness (FF)	0.87 (0.65-1.18)	0.374	-0.135

OR: odd ratio; 95% CI: confidence interval

Child gender and age were forced into the models before adding each of the CEBQ scales separately.

A cross-sectional study including 240 children aged 3-13 years in Portugal indicated that all CEBQ sub-scales exhibited statistically significant associations with BMI z-scores ($P = 0.03$ to < 0.001). Specifically, "food approach" scales displayed positive correlations with BMI z-scores (β = 0.33 to 0.51), while "food avoidance" scales exhibited negative correlations (β = -0.17 to -0.46) [23]. A systematic review and meta-analysis were

conducted to quantify the relationships between the CEBQ and indicators of child adiposity. The findings reveal that among the ten cross-sectional studies included, three traits (FR, EF, and EOE) displayed positive associations, while three traits (SR, SE, and EUE) exhibited negative associations with BMIz ($\beta = -0.31$ [SR] to $\beta = 0.22$ [FR]). The study demonstrates that CEBQ-assessed appetitive traits consistently correlate with various measures of childhood obesity in cross-sectional analyses [24]. A study involving 135 primary school children aged 6 and 7 in the Netherlands showed that linear regression analyses unveiled a positive association between BMI z-scores and the 'food approach' subscales of the CEBQ, which include FR, EF, and EOE (β's ranging from 0.15 to 0.22). Conversely, a negative association was observed with the 'food avoidant' subscales, encompassing SR, SE, EUE, and FF (β's ranging from -0.09 to -0.25) [22]. A case-control study conducted in Bac Ninh province involving 338 students with normal BFP and 68 students with high BFP revealed that, after adjusting for age and gender, FR and EOE increased the risk of high BFP by 1.88 times ($P < 0.0001$) and 1.66 times ($P = 0.007$), respectively [25].

Our study possesses several notable strengths. Firstly, it adopted a two-phase research approach, combining both cross-sectional and case-control designs, thus providing a comprehensive perspective on the link between eating behaviors and overweight/obesity. Secondly, the study benefited from a substantial sample size, encompassing 1,136 students, which significantly bolsters the potential for findings to apply to the intended population. Thirdly, the utilization of the CEBQ, a well-validated tool for assessing children's eating behaviors, greatly contributes to the research's credibility and dependability. Nonetheless, certain limitations should be acknowledged. Firstly, the study's restriction to a single school in Hanoi City limits the external generalizability of its results, given that eating behaviors and obesity prevalence can differ across various educational institutions and geographic regions. Convenience sampling, which the study employed, does not always accurately represent the entire population, thereby challenging the ability to extend the findings to a broader context. Secondly, the study's primary design was cross-sectional, meaning that it could only establish associations rather than causation. To explore causal relationships between eating behaviors and overweight/obesity, longitudinal data would be necessary. Lastly, the study offered limited information about demographics, physical activity levels, and family history, factors that could have an impact on the relationship between eating behaviors and overweight/obesity.

3. Conclusions

In conclusion, our findings indicated that the prevalence of overweight and obesity among students at Nguyen Tat Thanh Middle and High School (satisfying both IOTF and WHO 2007 criteria) was relatively high, with rates of 28.5% and 7.8%, respectively. Moreover, the prevalence of overweight and obesity was significantly higher among male students compared to their female counterparts ($P < 0.001$).

There were differences in the CEBQ subscale scores between overweight/obese students and normal-weight students. Students in the overweight/obese group exhibited significantly higher scores in the 'Food approach' scales, including FR, EOE, and DD,

compared to the control group ($P < 0.05$). Conversely, the SR score was notably lower in the case group (2.44) compared to the control group (2.77), a statistically significant difference ($P = 0.004$).

Our linear regression analysis showed noteworthy relationships between these eating behavior subscales and the risk of overweight and obesity. Elevated scores on FR, EOE, and DD were associated with a 1.59 to 1.69 times greater risk of overweight and obesity ($\beta = 0.365$ to 0.528). Meanwhile, a higher SR score was linked to a reduced risk of these conditions (OR = 0.61; $\beta = -0.500$; $P = 0.009$).

These findings underscore the importance of addressing eating behaviors in interventions aimed at reducing the prevalence of overweight and obesity among school-aged students. This study provides valuable insights into the complex interplay between eating behaviors and weight status among adolescents and highlights the need for targeted strategies to promote healthy eating habits and combat the growing obesity epidemic in this population.

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