Research Article

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The association between ultra-processed food consumption and obesity indicators in children and adolescents in Ho Chi Minh City

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Abstract

Objectives

To evaluate the association between ultra-processed food (UPF) consumption and obesity indicators in children and adolescents in Ho Chi Minh City (HCMC).

Methods

A cross-sectional study with a convenience sample of 153 children aged 6- to 18-year-old was conducted in HCMC. Usual dietary intake was determined through a validated food frequency questionnaire. Daily intake of each food was obtained from the intake frequency. Subsequently, foods were classified as raw and minimally processed, cooking ingredients or UPFs, and their caloric contribution to the total energy value was calculated. Anthropometric variables were also investigated. BMI cut off values proposed by International Obesity Task Force (IOTF) were used to define overweight and obesity. Abdominal obesity was evaluated by the Waist-to-Height Ratio (WHtR) with a cut-off value of 0.5 was used to define abdominal obesity. The associations were tested by chi-square test and Cochran–Armitage trend test.

Results

The frequency of overweight/obesity was 41.79%, and 39.60% presented high WHtR. The average energy intake was 3,176kcal/day, of which 58.8% was derived from UPFs. The categories with the highest caloric contributions among UPFs were industrial loaves/cakes (16.2%), sweets and candy (6.2%), pastas (6.0%) and sweetened drinks (5.1%). No association was found between UPF consumption and anthropometric indicators.

Conclusion

Although UPF consumption has not been shown as a factor associated with excess weight, the significant contribution of UPFs to daily calories is evidence of a poor diet of this population. Therefore, there is an urgent need for public policies that discourage the consumption of these products and encourage the return to a traditional diet.

Keywords: Children, Adolescents, Ultra-processed Food, Overweight, Obesity

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1. INTRODUCTION

Obesity in children and adolescents is becoming a significant public health problem in Vietnam [1]. Obesity in early stage of life (i.e., childhood and adolescence) is linked to developing diseases, including type II diabetes, cardiovascular diseases, stroke, and other metabolic disorders [2], especially in young

adulthood [3]. The increase in obesity has occurred in parallel with changes in food system, which currently makes available a wide variety of ready-to-eat foods and beverages, known as ultra-processed foods (UPFs) which are often low in fiber and protein, and high in sodium, fats and sugars [4, 5]. In addition, their convenience and aggressive advertising, are making the stimulation of the consumption become more popular and varied by countries or regions all over the world [6].

In recent years, dietary habits among Vietnamese adolescents have shifted toward increased energy and macronutrient intakes [7]. In Western countries, UPFs dominate the food supply and are strongly correlated with increases in the prevalence of obesity, cardiovascular diseases, and metabolic disorders [8, 9]. The relationship between UPF consumption and metabolic disorders and overweight/obesity in adults is well documented [10, 11]; however, there is still a lack of research on this relationship in children and adolescents, especially in the Asian population. To our knowledge, very few studies have evaluated the relationship between UPF consumption and metabolic syndrome and overweight/obesity in children and adolescents.

In Ho Chi Minh City (HCMC), a study in a representative sample of adolescents revealed a significant association between carbohydrate (CHO), fat and percentage of energy from CHO, fat consumption and high BMI [7]. While some studies found greater UPF consumption was strongly associated with metabolic disorders in children and adolescents with obesity [12, 13], the others stated that no association was found between UPF consumption and anthropometric indicators [14]. Considering the finding discussed above and that most published studies prioritize adult populations, the objective of this study was to evaluate the relationship between UPF consumption and overweight/obesity in children and adolescents in HCMC.

2. MATERIALS AND METHODS

Population and study location

This was a secondary data analysis of a cross-sectional study performed in 153 students from five elementary, junior, and senior high schools in HCMC, that was published previously [15]. Studied subjects were chosen using convenience sampling method. The sample size was originally calculated to estimate bone mineral density mean of children aged 6 to 18 y old accounting for 15% refusing to participate, yielding a total sample size of 140 children with 14 children in each grade with the equal ratio of males and females. The study was approved by The Ethics Committee of Pham Ngoc Thach University of Medicine (Decision No. 2300/2019/HD-TDHYKPNT).

Food intake

Usual food intake was evaluated by a Food Frequency Questionnaire (FFQ) for adolescents validated for energy [16]. The FFQ comprised 160 food items divided into eight groups: (i) processed foods; (ii) rice, breads and cereals; (iii) meat, fish and seafood; (iv) fruits and vegetables; (v) sweets and snacks; (vi) milk and dairy; (vii) drinks; and (viii) miscellaneous, with their average portions and evaluates intake in the last six months. This tool has seven frequency categories that range from never to two or more times/day. The portions presented in the FFQ represent the average intake, in grams, of each food. Daily intake frequency and the daily intake of each food in grams (daily frequency x average portion of the food in grams) were calculated from the frequency reported for each food. Daily calories from each food were obtained by multiplying the daily amount consumed (in grams) by the average portion of calories (previously known), divided by the average portion (in grams). IYOKUN v.1.[23,24], a nutrient

database developed from Vietnamese food consumption tables, to calculate foods' energy, protein, CHO and fat content. Total daily nutrient intakes were then calculated by summing nutrient values for the individual foods from the frequency of consumption, the mean amount consumed and the nutrients per gram. The daily Total Energy Intake (TEI) was obtained from the sum of the calories of each consumed food. Total calorie values < 500 kcal/d or > 5000 kcal/d were considered outliers [17].

Food classification according to the degree of processing

The 160 foods were divided into three main groups based on the four groups proposed by the NOVA classification, which considers processing extent and purpose [18]. The first group consisted of "raw and minimally processed foods", which are those that have not undergone any changes since they were extracted from nature (raw) or those that have undergone processes such as those for the removal of inedible or undesirable parts of the food, drying, grinding or milling and pasteurization, among others (minimally processed). The second category was "processed cooking ingredients", which includes substances extracted directly from foods from the first group or nature and consumed as cooking ingredients. The third group consisted of "ultra-processed foods", which includes industrial formulations typically composed of five or more ingredients; these include substances and additives used in the manufacture of processed foods such as sugar, oils, fats and salt, as well as antioxidants, stabilizers and preservatives. In the FFQ used, no food item could be classified in the category "processed foods" as proposed by NOVA. For each group, the caloric contribution (%) was calculated in relation to the daily TEI.

Indicators of nutritional status

We measured the main outcome variables (anthropometric measurements) and the exposure factors annually at each assessment round occurred at the beginning of the school year. Standing height was measured with a suspended Microtoise tape using standard methodology with a precision of 0.1 cm. Body weight was measured using a Tanita BF 571 electronic scale, Tanita Corporation with a precision of 0.1 kg. Anthropometric measurements were performed by trained researchers using standardized techniques [19]. Waist Circumference (WC) was taken at the waist line at the midpoint between the last rib and the iliac crest using an inelastic tape measure. BMI was calculated as weight/height^2 (kg/m^2). Children and adolescents' overweight/obesity status was classified according to the International Obesity Task Force's definition [20]. As Waist-to-Height Ratio (WHtR) was proved to be an inexpensive alternative to BMI that is better than other indicators in predicting fat mass in pediatrics hence it was used in this study. WHtR was the quotient between WC and Height and a cut-off value of 0.5 was used to define abdominal obesity in children and adolescents [21]. All anthropometric measures were duplicated using the mean value.

Information on age, sex was also collected by during interviewing. Physical activity time was measured using the validated Physical Activity Recall Questionnaire (PARQ) [22] that includes physical activities during leisure time in the last 12 months. The average weekly time (in minutes) that some physical activity was performed was calculated from this information. Activities were then categorized into moderate and vigorous subgroups based on the type and the intensity of the activity defined by the Compendium of Physical Activities [23]. Children were classified as "active" or

"inactive" based on the definition that the children should have three or more sessions of at least 20 minutes/week of vigorous activity, five or more sessions of at least 30 minutes/week of moderate activity [24].

Statistical analysis

We express the results as means and standard deviations and the frequencies were estimated for the main anthropometric and consumption indicators. We compared the participant characteristics by sex and tested any differences using the Student's t test (or Kruskal–Wallis if needed) and χ^2 tests. Cochran–Armitage trend tests were used to evaluate the association between UPF consumption quartiles (% of TEI) and anthropometric indicators. ANOVA was used to evaluate the differences in Body Mass Index (BMI) by quartiles of UPF consumption. Statistical analyses were performed using Stata (Stata Corporation, College Station, Texas, United States) version 15.0, and the level of significance was set at 5%.

3. RESULTS

Among studied subject, 47.7% were male, and the mean of age was 11.16 (± 3.19). The mean weight of female students was 42.62 kg (± 12.75) which was significantly lower than that of males (49.02 ± 17.96). There were significant differences in the mean values of BMI, WHtR by gender. The frequency of overweight/obesity was 43.79%, and 39.60% presented high WHtR. Physical activity was insufficient in more than 69.97% of the subjects (Table 1).

The average energy intake was 3,176kcal/day, and UPF consumption contributed 58.8% of the total calories consumed, while minimally processed foods accounted for 25.3% (Table 2). On average, grains (rice and corn) and beans accounted for more than 1/4 of the calories eaten. Fruits (5.6%) and milk (4.0%) also had a substantial contribution to the minimally processed foods group. Among UPFs, the categories with the highest caloric contributions were industrial breads (16.2%), sweets and candies (6.2%), pasta (6.0%) and sweetened beverages (5.1%) (Table 2).

When analyzing the relationship between personal characteristics such as gender, age group, nutritional status, physical activity and the contribution of UPFs to total caloric intake by quartiles, no factors showed a positive and significant association with UPF consumption (Table 3). However, though no significant association was found between the contribution UPFs in the diet and anthropometric indicators and the mean BMI was not significantly different for the different intake quartiles, a higher prevalence of overweight, obesity and abdominal obesity was revealed in the first quartile (Table 4).

4. DISCUSSION

In this study, UPFs accounted for the largest portion of food consumed by studied subjects, and a larger share was contributed by processed breads, cakes and sweets, pasta and sweetened beverages. Although no significant association was found between UPF consumption and obesity, a high prevalence of excess weight (overweight/obese) was observed in the participants.

UPFs are typically prepared with refined ingredients, fats, salt and sugars with high energy density, high glycemic load and high palatability. These foods also contain large amounts of chemical additives and have low protein and fiber content. In addition, because they are marketed frequently and aggressively, they may influence the development of eating habits [25]. Previous studies have consistently demonstrated associations between certain types of UPFs (e.g., sweetened beverages, sweets, etc.) and body fatness in childhood

[26]. It was stated that UPFs, especially sweetened beverages, fast food and snacks with high energy density, are the main factors related to obesity, diabetes, cardiovascular diseases and various cancers [4].

In Vietnam, the accessibility and availability of UPFs are on the rise in both rural and urban areas, likely contributing to the dietary shift [27]. The higher contribution of UPFs (50.6%) to total calories found in the present study is in agreement with the findings of other national and international studies, both in adult populations and in younger populations [28]. In a systematic review of participants with different age groups all over the world, UPFs contributed up to 80.0% of the total calories ingested [29]. In research published recently, the researchers in UK found that a mean of 66% of adolescents' energy intake came from UPF consumption during this period, though there was a slight fall from 68% to 63% between 2008/09 and 2018/2019 [30]. A report from the Global Food Research Program also indicated that UPFs now account for roughly half or more of total calories consumed in the US, UK and Canada and about 20-40% of calories in other high- and middle-income countries with sales growing rapidly every year [31].

The lack of an association between UPF consumption and obesity in children and adolescents observed in the present study is different from other studies that also investigated the same relationship [32, 33]. A study of a representative sample of adolescents and adults in many countries [32] identified a relationship between UPF consumption and obesity. It is likely that the findings of the present study were divergent due to the limited sample type and size. Another notable result is the high prevalence of obesity (43.79%) found among studied subjects, which was higher than in other studies with similar populations. A meta-analysis involving 21 studies and a sample of 18,463 Brazilian children and adolescents found a prevalence of obesity of 14.1% [34]. This discrepancy in the prevalence of obesity compared with other studies may be related to the unique characteristics of the studied sample in which the presence of food insecurity and food choices may come from low-income households where foods of low nutritional value and high energy density may be predominant. Food choices are known to be determined not only by physiological needs but also by the influence of environmental factors such as food quality, availability, accessibility, convenience, advertising and price. In this context, the replacement of raw and minimally processed foods by UPFs becomes widely favored. With regard to price, raw or minimally processed foods such as milk, meat, vegetables and fruits tend to be more expensive than UPFs produced by industry on a large scale. A Study of Household Purchasing Patterns, Eating, and Recreation [SHOPPER] in Chicago, US showed that lower income households purchase less healthful foods compared with higher income households [35]. According to PAHO surveys in 2013, in countries that sell less ultra-processed food and where traditional food is still prevalent, as in Peru and Bolivia, the average BMI of the population is lower, whereas in countries that sell more ultra-processed food, as in Chile and Mexico, the BMI tends to be higher [33].

This study showed some limitations. Firstly. the sample size of 153 children and adolescents, which may have contributed could be insufficient to detect the statistical association between UPFs and obesity due to the low power of the statistical test. The tool used to evaluate food intake (FFQ) and the interviewee's memory bias may also have contributed to an overestimation of consumption. Finally, as this is a convenience sample, where a specific population has been included, the results

should be interpreted with caution. However, despite these, the present study was the first one investigating the association between UPF consumption and adiposity indicators in children and adolescents of HCMC. The findings of this study may have implications for future public health strategies and research.

5. CONCLUSION

The substantial contribution of UPFs to total calories shows the poor quality of children and adolescents' diets, although this poor quality has not been shown to be associated with overweight and obesity. Considering these results, the urgent need for public policies that discourage the consumption of these products and intervene in their production, commercialization and advertising may be warranted. On the contrary, establishing policies that incentivize and promote a return to traditional diets is fundamental.

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Table 1: Demographic, anthropometric characteristics of participants, stratified by gender

Variables	Total (n=153)	Male (n=73)	Female (n=80)	*p-value*[a]
	Mean (SD)	Mean (SD)	Mean (SD)	
Age (year)	11.88 (3.23)	12.02 (3.31)	11.76 (3.17)	0.623
Weight (kg)	45.77 (15.89)	49.05 (18.09)	42.70 (12.90)	0.015*
Height (cm)	145.82 (16.34)	147.88 (18.24)	143.90 (14.20)	0.141
WC (cm)	71.66 (11.42)	73.75 (11.93)	69.70 (10.63)	0.030*
WHtR	0.49 (0.06)	0.50 (0.06)	0.48 (0.06)	0.146
BMI (kg/m^2)	20.88 (4.01)	21.59 (3.96)	20.21 (3.97)	0.035*
	n (%)	n (%)	n (%)	
Nutritional status				
Normal	86 (56.21)	40 (55.56)	17 (22.08)	0.185[c] [c]
Overweight	44 (28.76)	21 (29.17)	21 (27.27)	
Obesity	23 (15.03)	11 (15.28)	39 (50.65)	
Abdominal obesity				
Yes	59 (38.56)	31 (40.26)	28 (36.36)	0.404[b]
No	94 (61.44)	46 (59.74)	48 (63.64)	
Physical Activity				
Inactive	104 (67.97)	47 (61.04)	57 (74.0)	0.245 [b]
Active	49 (30.03)	30 (38.96)	19 (26.0)	

WC: Waist Circumference; WHtR: Waist-to-Height Ratio; BMI: Body Mass Index;

*[a] t-test, [b] chi-square test, [c] Cochran–Armitage trend test, * Statistical significance at p<0.05.*

Table 2. Food caloric contribution in daily total energy intake according to the degree of processing

Food group	Absolute ingestion (kcal/day)		Relative intake (% total kcal)	
	Mean	SD	Mean	SD
Group 1: Raw and minimally processed foods	*803.4*	*680.5*	*25.3*	*21.0*
Milk	157.2	99.2	4.0	1.3
Fruits	235.7	157.4	5.6	2.3
Vegetables and greens	17.2	11.4	0.4	0.01
Beans	476.6	219.1	12.9	7.5
Grains (rice and corn)	521.9	313.1	14.6	10.5
Roots/tubers	72.9	57.5	1.5	0.1
White meat	141.2	113.6	3.2	0.3
Red meat	125.4	92.5	3.2	0.3
Eggs	55.1	25.0	1.3	0.1
Group 2: Processed Cooking Ingredients	*503.8*	*90.8*	*15.9*	*0.2*
Sugar	71.6	58.6	1.8	0.1
Vegetable oil	32.2	29.4	0.8	0.1
Group 3: UPFs	*1868.8*	*1443.3*	***58.8***	*21.6*
Breads/cookies/cake	703.2	349.1	16.2	4.6
Sweets and candies	290.1	190.7	6.2	1.3
Soft drinks/sweetened beverages	215.2	125.3	5.1	1.3
Sausages	148.2	111.2	3.2	0.2
Fast food snack[a]	165.4	96.4	3.4	0.2
Industrial snack[b]	81.6	61.0	1.8	0.2
Fried, salted and stuffed baked goods	178.2	120.1	3.7	0.3
Pastas	280.8	115.5	6.0	2.4
Creams and sauces[c]	111.6	79.3	2.8	0.2
Cheeses	22.0	13.3	0.5	0.1
Cottage cheese/processed yogurt	72.3	61.5	1.7	0.1

[a]*Includes hot dogs, pizza, and cheeseburgers;*
[b]*Includes industrial chips and industrial snack;*
[c]*Includes margarine and mayonnaise.*

Table 3. Characteristics of adolescents by quartiles of caloric contribution of UPFs to daily total energy intake*

	Quartiles of UPF intake								
	Quartile 1		Quartile 2		Quartile 3		Quartile 4		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	p-values
Gender									0.474[a]
Male	33.4	1.3	45.4	0.6	55.7	0.4	67.1	1.4	
Female	32.5	1.4	45.6	0.7	55.5	0.5	69	1.1	
Age (years)									0.536[b]
6-10	37.9	2.2	46.8	1.9	57.1	2.0	72.2	1.5	
11-15	33.5	0.9	45.6	0.5	56.5	0.4	68.6	1.0	
16-18	28.6	3.9	44.1	2.0	56.2	1.1	66.6	1.1	

Nutritional status									0.383[b]
Normal	32.5	1.6	46.1	0.7	55.8	0.5	68.9	1.9	
Overweight	33.0	2.1	45.5	0.8	55.7	1.1	68.3	1.4	
Obese	33.1	1.3	44.7	0.8	55.4	0.5	67.8	1.0	
Abdominal Obesity									0.122[a]
High risk	33.2	1.1	45.8	0.5	55.7	0.4	68.3	1.1	
None	32.3	1.9	43.4	1.4	54.9	0.5	68.5	1.1	
Physical activity									0.526[a]
Inactive	36.2	4.1	45.9	1.8	56.7	1.3	68.6	5.7	
Active	32.8	1.5	45.4	0.5	55.5	0.3	68.3	0.9	

** caloric contribution of UPFs to daily total energy intake (Kcal/day),*
[a]T-test [b]ANOVA test

Table 4. Obesity indicators according to quartiles of the contribution of UPFs to the daily caloric intake of participants.

Quartiles of UPFs intake (% total energy)	BMI[a*]		Overweight[b*]	Obesity[b*]	Abdominal Obesity[b*]
	Mean	SD			
Quartile 1	21.9	5.65	28.1	33.3	38.5
Quartile 2	19.4	4.71	22.3	16.1	15.4
Quartile 3	20.4	4.35	25.6	25.3	20.5
Quartile 4	19.9	3.82	24.0	25.3	25.6

*[a]ANOVA test; [b] Cochran–Armitage trend test, *p>0.05*