Université catholique de Louvain

Overweight and obesity among adolescents in Ho Chi Minh City, Vietnam

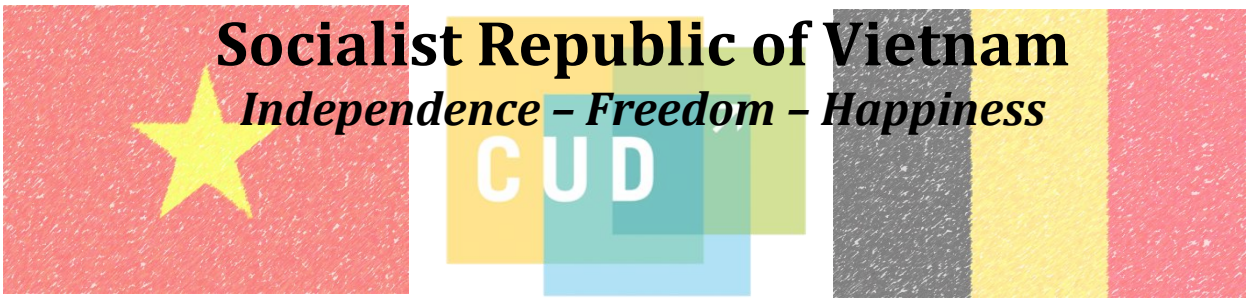
NGUYEN NGOC VAN Phuong, MD

Promotor: Prof. Annie Robert

Co-promotor: Prof. Tang Kim Hong

Submitted for the degree of "Docteur en Sciences Médicales"

Belgium, October 2013



Overweight and obesity among adolescents in Ho Chi Minh City, Vietnam, 2010

MEMBERS OF THE JURY

Promotor:

Professor Annie Robert, MSc, PhD
Pôle Epidémiologie et Biostatistique
Institut de Recherche Expérimentale et Clinique
Secteur des Sciences de la Santé
Faculté de Santé Publique
Université catholique de Louvain
Bruxelles – Belgique

Co-promotor:

Professor Tang Kim Hong, MD, PhD
Department of Epidemiology
Division of Community Health
University of Medicine Pham Ngoc Thach
Ho Chi Minh City – Vietnam

President of the jury:

Professor William D'Hoore, MD, PhD
Institut de recherche santé et société
Faculté de Santé Publique
Université catholique de Louvain
Bruxelles – Belgique

UCL Members:

Professor Dominique Maiter, MD, PhD
Pôle d'endocrinologie, diabète et nutrition (EDIN)
Institut de recherche expérimentale et clinique (IREC)
Faculté de médecine et médecine dentaire
Université catholique de Louvain
Bruxelles – Belgique

Professor Agnès Pasquet, MD, PhD
Institut de recherche expérimentale et clinique
Pôle de recherche cardiovasculaire
Faculté de médecine et médecine dentaire
Université catholique de Louvain
Bruxelles – Belgique

Professor Françoise Smets, MD, PhD
Pôle de Pédiatrie
Institut de recherche expérimentale et clinique
Faculté de médecine et médecine dentaire
Bruxelles – Belgique

Professor Jean-Paul Buts, MD, PhD
Pôle de Pédiatrie
Institut de recherche expérimentale et clinique
Faculté de pharmacie et des sciences biomédicales
Bruxelles – Belgique

External Members:

Professor Philippe Donnen, MD, MPH, PhD
Épidémiologie, Nutrition et Développement
École de Santé Publique
Université libre de Bruxelles
Bruxelles – Belgique

Professor Nguyen The Dung, MD, Vice rector
University of Medicine Pham Ngoc Thach
Ho Chi Minh City – Vietnam

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to those who helped me and played a major role in the achievement of this study.

From the bottom of my heart, I especially would like to thank my Promotor, Professor Annie Robert, for her valuable suggestions, time and patience during the preparation of my proposal, the analysis of the data, and in completing my thesis. All things she has done to help me complete this study would never be forgotten. Thanks for always encouraging me.

I particularly thank my Co-promotor, Professor Tang Kim Hong. This study came into being thanks to her fervor and scientific interest. I greatly appreciated her fruitful help in shaping up the core and main objectives of this research. Without her help, I could not finish it.

This study was supported by a grant from the Belgian government: CUD – CUI – UPNT03 (www.cud.be). I would like to thank to the CUD for providing me the scholarship and for funding to conduct the study.

I would like to express my gratefulness to the jury who accepted to judge this thesis with their expertise, the president, Professor William D'Hoore, Professor Dominique Maiter, Professor Agnès Pasquet, Professor Françoise Smets, Professor Philippe Donnen, and Professor Nguyen The Dung. I really appreciated that they spent their valuable time commenting this work, and helped me to go through the final stage of this work.

I would also like to express my respect and sincerest appreciation to Dr. Le Truong Giang, Head of the Biostatistics and Informatics Department, University of Medicine Pham Ngoc Thach, Ho Chi Minh City, Vietnam, for his kindness and helpful support during my study. I want to thank all of my colleagues in the Biostatistics and Informatics Department, UPNT, and Dr. Nguyen Hoang Hanh Doan Trang who supported me during my study. Special thanks to all investigators who were very kind and enthusiastic in helping me to collect data.

I would like to thank all principals and head teachers of the schools participating in our research. We also address special thanks to master/mistress, teaching staff and class coordinators who assisted me in the collection of data. Special thanks to all pupils and their parents who graciously availed themselves and participated in the study.

I would also like to express an unforgettable feeling towards all friends at Research division EPID, Epidemiology and Biostatistics Department, School of Public Health, Université catholique de Louvain, Brussels, since throughout 5-year period living in Belgium; we shared knowledge and kindness without limitations

And, last but not least, I owe my deepest gratitude to my family for their love, and support during my study. I would like to express my sincere love to my parents, my sisters for their understanding and unaccountable help on very step in my study and my life. My dear husband was very patient and gave me the strength to finish this thesis. I thank you for your love.

SUMMARY

Introduction

Vietnam has a nutrition transition leading to a rapid increase in the prevalence of overweight and obesity among adolescents whose lifestyles become more and more sedentary with lower levels of physical activity. Overweight and obesity among adolescents is growing with time in urban areas of Vietnam. Obesity in adolescence substantially increases the risk of cardiovascular diseases and their associated health deficiencies in adulthood. Additionally, obesity in adulthood is a high risk factor for chronic diseases.

Objectives

Our study aimed at assessing the physical activities, the sedentary behaviors, and the dietary intake with regard to the prevalence of overweight and obesity among junior high school students (11-14 years) in urban areas of Ho Chi Minh City, Vietnam.

Methods

A representative sample of 1,989 students aged 11-14 years was selected using a multistage cluster sampling method. 23 schools were randomly selected from the full list of all public junior high schools. In each selected school, 2 classes were chosen at random and all students from each selected class were examined. Age- and sex-adjusted overweight and obesity were defined using International Obesity Taskforce cut-offs. Physical activity, sedentary behaviors, and dietary intake were collected based on validated questionnaires for Vietnamese adolescents. Multiple logistic regressions were used to assess the predictive value of risk factors on prevalence of overweight or obesity.

Results

The prevalences of overweight and obesity were 17.8% and 3.2%, respectively. From 2004 to 2010, the prevalence of overweight and obesity significantly increased from 11.7% and 2% to 17.8% and 3.2%, respectively ($p = 0.001$). The annual rate of change in obesity prevalence was +1.02% per year. 53.8% spent more than 2 h/day in small-screen recreations (boys/girls=63%/46%, 95%CI:[1.26-1.48], $p = 0.001$). Adolescents spent 1.5 h/day (median) in physical activity, with higher values for boys than girls ($p = 0.001$), and 33.9% were categorized as inactive. Total energy intake exceeded the Vietnam Recommended Dietary Allowances 2007. Using multiple logistic regression, high use of small-screen recreations at younger age was predictive of overweight and obesity (OR=1.59, 95%CI:[1.06-2.38], $p = 0.02$). Younger boys and inactivity were significantly associated with overweight or obesity prevalence. In girls, an inverse association was observed between dietary intake and overweight or obesity.

Conclusions

In urban areas of Ho Chi Minh City, prevalence of overweight and obesity is still increasing among adolescents who have sedentary behaviors, few physical activities, and a total energy intake exceeding the Vietnam Recommended Dietary Allowances 2007. Public health programs should therefore be improved in order to promote good eating habits and physical activity among youths in Ho Chi Minh City.

LIST OF ABBREVIATIONS

APARQ	Adolescent Physical Activity Recall Questionnaire
ASAQ	Adolescent Sedentary Activity Questionnaire
BMI	Body Mass Index
CI	Confidence Interval
CDC	Center for Disease Control and Prevention
e	Expected precision
EAT	Eating among teens
FFQ	Food Frequency Questionnaire
g	Gram
GDP	Gross domestic product
h	Hour
ha	Hectare
HSE	The Health Survey for England
HCMC	Ho Chi Minh City
IOTF	The International Obesity Task Force
IQR	Interquartile
kcal	Kilocalorie
kg	Kilogram
km	Kilometer
MET	The Metabolic Equivalent of Task
mg	Milligram
mi	Mile
MVPA	Moderate-to-vigorous physical activity
NHES	The National Health Examination Survey
NHANES	The National Health and Nutrition Examination Survey
NHNES III	The Third National Health and Nutrition Examination Survey
NSHG	The National Study of Health and Growth
OO	Overweight and obesity
OR	Odds Ratio
p	Expected proportion of individuals in the sample with overweight

PAQ	Physical Activity Questionnaire
PPP	Purchasing power parity
RDA	Recommended Dietary Allowance
SD	Standard Deviation
sq	Square
SSR	Small-screen recreation
TV	Television
TimePA	Time spent on each activity per week
USA	The United States of America
USD	United States Dollars
VCD	Video Compact Disc
WHO	World Health Organization
WHZ	Weight-for-height Z-score
WHO-NCHS	World Health Organization – National Center for Health Statistics
$\mathbf{Z}_a$	Quantile a of a normal distributed variable Z

CONTENTS

Chapter 1 Introduction

1.1 Rational of the study

Overweight and obesity in children and adolescents has increased significantly in developed countries over the last decade, with the highest prevalence reported for the United States of America. A trend of increasing prevalence of overweight and obesity has also been reported in developing countries, especially in urban populations. This global epidemic represents a major public health problem, due to the consequences of childhood obesity both during childhood and adult life and the resulting heavy burden on health services. In East Asia and South East Asia, rapid urbanization and socio-economic development are leading to changes in diet and activity patterns which are promoting a nutrition transition and the emergence of obesity in both children and adults.

Vietnam is a country located in South East Asia with 84 million inhabitants. Vietnam experiences the same situation as others countries in the region: overweight and obesity among adolescents is growing with time. The prevalence of overweight among children under 5 years of age has rapidly increased from 3.2% in 2002 to 6.3% in 2005, a double rising after only 3 years. In Vietnam, many studies have been conducted on overweight and obesity among children 6-11 years but few studies have addressed the problem in adolescents (11-16 years). Adolescence is the middle age between childhood and adult, with a rapidly growth in physical body. Thus, providing not enough equilibrated macronutrients in food leads to nutritional deficiency and providing too much nutritional facts leads to overweight and obesity. Obesity in children impacts on their health in both the short and long term, especially overweight during adolescence strongly affects physical growth and adult stature.

Ho Chi Minh City is the largest city of Vietnam. According to the only two cross-sectional studies conducted among adolescents in 2002 and 2004, the prevalence of overweight and obesity defined by the International Obesity Task Force's cut-offs (IOTF's cut-offs) in Ho Chi Minh City was 5.9% and 0.7%, respectively in 2002, and 11.7% and 2.1%, respectively in 2004. These results indicated a high increase of overweight among secondary high school students in urban areas of Ho Chi Minh City over two years.

We conducted the present study in order to answer the question 'Does the prevalence of overweight and obesity in adolescents still increase in urban areas of Ho Chi Minh City in 2010, and is it related to physical activity, to sedentary behavior and to dietary intake? The findings aim to contribute to the understanding of adolescents' nutritional status in urban areas of Vietnam and we hope to offer elements for developing strategies to prevent obesity among adolescents in Ho Chi Minh City.

1.2 Aims of study

1.2.1 General objective

Our general objective was to assess the physical activities, the sedentary activities, and the dietary intake with regard to the prevalence of overweight and obesity among junior high school students (11-14 years) in urban areas of Ho Chi Minh City, Vietnam.

1.2.2 Specific objectives

1.2.2.1 To estimate the prevalence of overweight and obesity by age, gender, geographical region and family socioeconomic status among junior high school students (11-14 years) in urban areas in Ho Chi Minh City.

1.2.2.2 To assess physical and sedentary activities by age, gender, and economic status among junior high school students (11-14 years) in urban areas in Ho Chi Minh City.

1.2.2.3 To assess dietary intakes by age, gender and economic status among junior high school students (11-14 years) in urban areas in Ho Chi Minh City.

1.3 Thesis outline

The present work has been conducted in Ho Chi Minh City in Vietnam in 2010.

Chapter 1 presents the rationale of the study and the general objectives.

Chapter 2 describes background of epidemiology of overweight and obesity in children. This section presents also definitions of overweight and obesity. Situation of Vietnam and Ho Chi Minh are discussed in this chapter.

Chapter 3 describes methods used in this thesis: design study, sampling procedure, rational for sample size, data sources, key measurement tools, and also procedures for data analysis.

Chapter 4 provides results of prevalence of overweight and obesity in children as published in BMC Public Health. This chapter also reports comparison of prevalence of overweight and obesity between this study conducted in 2010 and the survey from 2004.

Chapter 5 shows sedentary behaviors and its relationship with body mass index status among adolescents in urban areas of Ho Chi Minh City. This chapter is divided into two parts. The first one addresses small-screen recreation time and overweight in adolescents of Ho Chi Minh City, Vietnam. The second part addresses the sedentary behaviors of adolescents in Ho Chi Minh City, Vietnam.

Chapter 6 describes physical activities and their relationship with overweight and obesity in adolescents.

Chapter 7 reports dietary intake and its relationship with body mass index in children. Macronutrient intakes are also presented in this chapter.

Chapter 8 presents a multivariate model of the independent determinants of overweight and obesity in adolescents of Ho Chi Minh City, after excluding food intake data.

Chapter 9 summarizes the main findings of our work about overweight and obesity among junior high school students in Ho Chi Minh City. Strengths and limitations are discussed in this chapter. Public health implications and recommendations are also presented.

Chapter 2 Background

2.1 Overweight and obesity among children

2.1.1 Definition of obesity

Obesity occurs when an individual takes more energy than necessary. Several criteria and various standards have been proposed to assess obesity including height and weight, body mass index, skin fold thickness, waist circumference, waist to hip ratio, waist to height ratio. According to each age group, appropriate indices were applied. The anthropometric indices recommended for adolescents are height- for- age, body mass index for age, and triceps and sub-scapular skin fold thicknesses- for- age.

Body mass index (BMI) is defined as weight in kilograms divided by the square of height in meters (kg/m^2), and it is often used as an indicator of weight status or adiposity. This measurement is highly correlated to the percentage of body fat [1]. Not only does BMI help to determine if someone is overweight, the higher the number the greater the risk a person has of developing complications from obesity, such as diabetes and heart diseases. Being overweight can cause serious health problems later in life. WHO has recommended cut-off values of BMI for defining overweight ≥ 25 kg/m^2 and obesity ≥ 30 kg/m^2 in adults (WHO, 1995). A limitation of BMI as a measure of overweight and obesity is that it does not account for the heavier weight of muscle mass compared to fat. As a result, the relationship between BMI and body fat content varies according to body build and proportion, and it has been shown that a given BMI may not correspond to the same degree of fatness across populations. For example the percentage of body fat mass increases with age up to 60-65 years in both sexes and is higher in women than in men of equivalent BMI. Differences have also been shown across ethnic groups.

Despite these limitations BMI provides the most useful, albeit crude, population-level measure of obesity because it is commonly collected in population health surveys, it has high subject acceptance and it has good reliability and validity [2, 3].

Until the past decade, there was no widely accepted BMI-based references to define childhood and adolescent underweight, overweight, and obesity. An interim reference (sex- and age-specific 85thpercentiles) was initially developed from the US NHANES I data to define adolescent overweight with what we termed the WHO-NCHS (World Health Organization–National Center for Health Statistics) reference [4][5].

CDC references

Published in 2002, the CDC 2000 growth reference was developed using five national health examination surveys (the National Health Examination Survey (NHES) and the National Health and Nutrition Examination Survey (NHANES) for girls and boys. Some limited supplementary information was collected from vital statistics on child birth weight, length, and head circumference sourced from birth certificates and hospital records (1963-1995).

The CDC 2000 growth reference defines children as at risk of overweight and obesity if their BMI exceeds the 85^{th} and 95^{th} centiles for most routine assessment [6]. The CDC 2000 reference population was based on USA data, and covered the age range of 2-20 years.

WHO standards and references

In 1995, WHO expert committee recommended these BMI 85th percentiles for international use to classify adolescent overweight, but they recommended the use of a weight-for-height *z* score (ie, a *z* score of 2, which corresponds to the 97.7^{th} percentile) for children aged <10 years [5]. They also suggested the use of both the BMI for age and the skin fold for age as the best indications for the assessment for obesity in adolescents; they proposed to define

overweight as a BMI ≥ 85th percentile with both the triceps and sub-scapular skin fold for age < 90th percentile while a BMI ≥ 85th percentile with both the triceps and sub-scapular skin fold with ≥ 90th percentile was considered as obese (WHO, 1995). The new WHO references for school age children and adolescents, released in 2007 for 5- to -19-year-olds based on data from US surveys [7]. The WHO 2007 growth reference defines children as at risk of overweight and obesity if their BMI exceeds +1SD and +2SD or, equivalently, if their BMI z-score exceeds +1 and +2. The WHO 2007 reference population was derived from a combination of Brazil, Ghana, Norway, India, Oman, and USA growth data, and covered the age range of 5-19 years [7].

The International Obesity Task Force (IOTF) references

Recently in 2000, the Childhood Obesity Working Group of the IOTF proposed new international age- and sex-specific BMI cutoff references, aimed to define childhood and adolescent obesity [8, 9]. In response to this recommendation, Cole *et al.* compiled data on BMI from six large nationally representative cross-sectional growth studies (Brazil, Great Britain, Hong Kong, the Netherlands, Singapore and the US). For each country, the two percentile values equivalent to a BMI of 25 and 30 at 18 years of age were determined for each gender. The BMI values at different childhood ages were then calculated for the same pair of percentiles for each of the six data sets to provide international age- and sex- specific cut-off points from 2 to 18 by 0.5 years of age.

These cutoff points are presented in Table 1 and are referred to as IOTF references. These IOTF references have several advantages. They are based on international data and, because they are built to pass through adult cut-offs which are linked with mortality rates, they are less arbitrary than other cut-offs. They are also less geographically and temporally dependent than some other references. In the last decade, IOTF cut-offs have been used in many

prevalence studies conducted in Europe and in other countries. The use of the IOTF definition also allows studying time trends [10].

Table 2.1 International cut off points for body mass index for overweight and obesity by sex between 2 and 18 years, defined to pass through body mass index of 25 and 30 kg/m2 at age 18, obtained by smoothing data from Brazil, Great Britain, Hong Kong, Netherlands, Singapore, and United States of America.

Age (years)	Body mass index 25 kg/m^2		Body mass index 30 kg/m^2	
	Males	Females	Males	Females
2	18.41	18.02	20.09	19.81
2.5	18.13	17.76	19.80	19.55
3	17.89	17.56	19.57	19.36
3.5	17.69	17.40	19.39	19.23
4	17.55	17.28	19.29	19.15
4.5	17.47	17.19	19.26	19.12
5	17.42	17.15	19.30	19.17
5.5	17.45	17.20	19.47	19.34
6	17.55	17.34	19.78	19.65
6.5	17.71	17.53	20.23	20.08
7	17.92	17.75	20.63	20.51
7.5	18.16	18.03	21.09	21.01
8	18.44	18.35	21.60	21.57
8.5	18.76	18.69	22.17	22.18
9	19.10	19.07	22.77	22.81
9.5	19.46	19.45	23.39	23.46
10	19.84	19.86	24.00	24.11
10.5	20.20	20.29	24.57	24.77
11	20.55	20.74	25.10	25.42
11.5	20.89	21.20	25.58	26.05
12	21.22	21.68	26.02	26.67
12.5	21.56	22.14	26.43	27.24
13	21.91	22.58	26.84	27.76
13.5	22.27	22.98	27.25	28.20
14	22.62	23.34	27.63	28.57
14.5	22.96	23.66	27.98	28.87
15	23.29	23.94	28.30	29.11
15.5	23.60	24.17	28.60	29.29
16	23.90	24.37	28.88	29.43
16.5	24.19	24.54	29.14	29.56
17	24.46	24.70	29.41	29.69
17.5	24.73	24.85	29.70	29.84
18	25	25	30	30

Source: [8]

2.1.2 Definition of underweight

Obesity and malnutrition represent opposite extremes on the spectrum of adiposity, and both are routinely quantified in terms of weight and height relative to the child's age.

Fifty years ago, Gomez introduced a malnutrition classification of weight below a specified percentage of median weight for a child's age [11]. This classification included three components: a measurement, a reference for age adjustment, and a set of cut offs. Later Seoane and Latham proposed splitting weight- for- age into weight- for- height and height for age [12] that allow underweight to be defined as wasting or stunting or both. Subsequently Waterlow *et al.* recommended the use of z scores for the definitions of underweight, wasting, and stunting, with the cut offs defined in terms of standard deviations (SDs) below the median rather than as percentages of the median [13][14]. This ensures that the false positive screening rate is constant across age as applied to a reference population.

In 2007, the World Health Organization (WHO) released growth references for 18-71 months and for 5-19 years [7] based on a representative sample of children aged 1-19 years collected between 1997 and 2003, living in favorable socioeconomic conditions in six developed and developing countries. The following indicators are the cut-offs suggested by WHO: thinness: < -2SD; severe thinness: <-3SD. All charts, tables and documentation related to this 2007 growth reference can be downloaded from: www.who.int/growthref/en.

Also in 2007, Cole *et al.* developed three grades of thinness, based on an international survey of nationally representative samples of children aged 6 to 18 years, between 1963 and 1993 [15]. International survey cut-offs (The IOTF cut-offs) were determined using mathematical models based on least square fitting methods and already applied in children to assess overweight and obesity [8]. The chosen cut off is a body mass index of 17kg/m^2 at the age of 18 years coinciding with the WHO grade 2 cut off for thinness in adults, and to a value of -2

in z-score for body mass index in Cole's combined dataset (Table 2). In addition, cut offs of 18.5kg/m^2 and 16kg/m^2 are also included to coincide with WHO grade 1 and grade 3 thinness in adults, allowing the distinction between different grades of under-nutrition and thus different levels of risk in children. Furthermore, a value of -2 in z-scores corresponds roughly to 80% of the median body mass index and is equivalent to the WHO definition of wasting (low weight- for- height) [16].

Few studies have compared the prevalence of thinness using either IOTF or WHO cutoffs in school-aged children. In studies in Russia [16] and Brazil [13,14], the prevalence of thinness was higher when assessed with the WHO than when assessed with the IOTF cut-offs, while the opposite was found in Bolivia [15]. Thus, the IOTF cut-offs and WHO standards and references should still be both used to assess thinness.

Table 2.2 International cut-off points for BMI for thinness grades 1, 2, and 3 by sex for exact ages between 2 and 18 years, defined to pass through BMI of 16, 17, and 18.5 at age 18, obtained by averaging data from Brazil, Great Britain, Hong Kong, Netherlands, Singapore, and USA.

Age (years)	Boys			Girls		
	16	17	18.5	16	17	18.5
2.0	13.37	14.12	15.14	13.24	13.90	14.83
2.5	13.22	13.94	14.92	13.10	13.74	14.63
3.0	13.09	13.79	14.74	12.98	13.60	14.47
3.5	12.97	13.64	14.57	12.86	13.47	14.32
4.0	12.86	13.52	14.43	12.73	13.34	14.19
4.5	12.76	13.41	14.31	12.61	13.21	14.06
5.0	12.66	13.31	14.21	12.50	13.09	13.94
5.5	12.58	13.22	14.13	12.40	12.99	13.86
6.0	12.50	13.15	14.07	12.32	12.93	13.82
6.5	12.45	13.10	14.04	12.28	12.90	13.82
7.0	12.42	13.08	14.04	12.26	12.91	13.86
7.5	12.41	13.09	14.08	12.27	12.95	13.93
8.0	12.42	13.11	14.15	12.31	13.00	14.02
8.5	12.45	13.17	14.24	12.37	13.08	14.14
9.0	12.50	13.24	14.35	12.44	13.18	14.28
9.5	12.57	13.34	14.49	12.53	13.29	14.43
10.0	12.66	13.45	14.64	12.64	13.43	14.61
10.5	12.77	13.58	14.80	12.78	13.59	14.81
11.0	12.89	13.72	14.97	12.95	13.79	15.05
11.5	13.03	13.87	15.16	13.15	14.01	15.32
12.0	13.18	14.05	15.35	13.39	14.28	15.62
12.5	13.37	14.25	15.58	13.65	14.56	15.93
13.0	13.59	14.48	15.84	13.92	14.85	16.26
13.5	13.83	14.74	16.12	14.20	15.14	16.57
14.0	14.09	15.01	16.41	14.48	15.43	16.88
14.5	14.35	15.28	16.69	14.75	15.72	17.18
15.0	14.60	15.55	16.98	15.01	15.98	17.45
15.5	14.86	15.82	17.26	15.25	16.22	17.69
16.0	15.12	16.08	17.54	15.46	16.44	17.91
16.5	15.36	16.34	17.80	15.63	16.62	18.09
17.0	15.60	16.58	18.05	15.78	16.77	18.25
17.5	15.81	16.80	18.28	15.90	16.89	18.38
18.0	16.00	17.00	18.50	16.00	17.00	18.50

Source: [15]

2.1.3 Epidemiology of overweight and obesity

Prevalence of overweight and obesity

The prevalence of overweight and obesity in the USA is one of the highest rates reported over the world [17]. Data from NHANES surveys (1976–1980 and 2003–2006) show that the prevalence of obesity increased in all age categories: from 5.0% to 12.4% in children aged 2–5 years, from 6.5% to 17.0% in children aged 6-11 years and from 5.0% to 17.6% in those aged 12-19 years [18]. In Canada, approximately 20% of Canadian youths aged 11-16 years were overweight in the year 2002, with 15% being pre-obese and 5% being obese. A greater percentage of boys compared to girls were pre-obese (18% versus 13%) and obese (6 % versus 4%) [19].

Childhood obesity is also a well recognized problem in Europe. High rates of obesity were observed in Eastern European countries [20] and Southern European countries as Italy, Spain and Greece[21]. Northern European countries [22], particularly the Nordic countries [23], tended to have overall lower rates. Ireland ranked amongst the countries with the highest levels of obesity amongst 13-15 years children in a survey of self reported height and weight conducted in 13 European countries, Israel and the United States of America in 1997–1998 [17]. A recent report showed that almost 23% of boys and over 28% of girls were either overweight or obese. In the Republic of Ireland, the highest prevalence of overweight was observed in girls aged 13 (32%) and obesity in girls aged 7 (11%). In Northern Ireland, the highest prevalence of overweight and of obesity were found in girls aged 11 and aged 8 respectively (33% and 13%) [24]. Some studies also show that overweight among young people is also increasing in Sweden [25] and France [26]. In contrast, data from Turkey [27] and Greece [28] reported a lower prevalence of obesity among adolescents, compared to other western countries.

In Asia, though the prevalence of overweight and obesity is not as high as in developed countries, adolescents overweight and obesity is becoming a public health concern. A study conducted between1991-1997 showed that the prevalence of overweight in adolescents increased in China [29], evidencing that the burden of nutritional problems was shifting from energy imbalance deficiency to excess among older children and adolescents. In Thailand, the prevalence of obesity in school children has increased from 12% in 1991 to 16% in 1993 [30]. In Bangkok, a retrospective study conducted in the Pediatric Department of an Adolescent Clinic in Chulalongkorn University also concluded that the number of obese patients in the Adolescent Clinic was increasing [31]. Despite certain limitations related to representativeness of the results, this raised an alarm of public concern about adolescent overweight/obesity issue. Similar increases in overweight and obesity in adolescents have also been reported in Taiwan [32], Malaysia [33] and Philippines [34]. Reports from India on the prevalence of overweight children indicate are contrasted, indicating either a low prevalence for children aged 9 to 16 (4.7%) [35] or a high prevalence of overweight for adolescents in urban India [36]. Interpretation of these studies is complicated because of differences in the sampled population and in the definition of overweight and obesity.

Recent trends

In United States of America, data from NHANES I (1971–1974) to NHANES II (2003–2006) show increases in overweight among all age groups. Among preschool-aged children (2–5 years), the prevalence of overweight increased from 5.0% to 12.4%.Among school-aged children (6–11 years), the prevalence of overweight increased from 4.0% to 17.0%.Among school-aged adolescents (12–19 years), the prevalence of overweight increased from 6.1% to 17.6% [37]. In the study of Flegal in 2000 [38], comparing BMI values between the third National Health and Nutrition Examination Survey (NHNES III: 1988-1994) with data from

earlier cross-sectional representative surveys in adults (20-74 years), children and adolescents (6-17 years), there was increasing skewness in all sex and age groups, with a greater shift in the upper part of the distribution so that, within each group, the heaviest subgroup was heavier in NHANES III than in prior surveys. For the youngest children, the lower part of the distribution showed virtually no change. With increasing age, distributions tended to shift upward slightly, suggesting an increase in BMI across the entire population. However, in the recent study of Odgen, based on the data of NHANES in the 4 time periods (1999-2000, 2001-2002, 2003-2004, 2005-2006), there was no significant trend over the time period 1999-2006 in BMI- for- age over the 95th percentile [18]. Previous analyses of trends with only 3 data points through 2003-2004 showed a significant increase in BMI for age above the 95th percentile over the period 1999-2004. In Brazil, Gloria *et al.* conducted household surveys (1975, 1989, 1997) of weight and statures in a random sample of about 50,000 Brazilian adolescents aged 10 to 19 years [39]. Overweight and obesity were defined by IOTF. This study showed that the prevalence of overweight tripled in boys (from 2.6% to 11.8%) and doubled in girls (from 5.8% to 15.3%) between 1975 and 1997.

Estimation of trends in obesity prevalence among adolescents in Europe is difficult because of the use of different definitions of obesity among adolescents. In England, data on children's height and weight that were collected in the National Study of Health and Growth (NSHG) between 1974-1994 and in the Health Survey for England (HSE) since 1995 showed that prevalence of obesity doubled between 1984 and 1994 among children aged 4-12 years in England, rising from 0.6% to 1.7% in boys and from 1.3 to 2.6% in girls. The most recent estimates suggest that by 2001, some 8.5% of the 6 years and 15% of the 15 years were obese [40]. In France, prevalence of childhood obesity reached 3.5 % and overweight was 18 % in 2002 with a fourfold increase since 1960 [41]. In the study of Kautiainen *et al.* (2002), the trends in overweight and obesity among Finish adolescents are described by the change in the

85th and 95th percentile cut-off points of BMI over time (1977-1999). Overweight and obesity increased linearly in all sex and age groups from 1977 to 1999. Depending on the age group, the average increase in the 85th percentile cut-off point of the BMI per 10 years was 0.6-1.1 kg/m^2 in boys and 0.3-0.7 kg/m^2 in girls. The prevalence of obesity in boys was 1.1% in 1977 and 2.7% in 1999 and 0.4 and 1.4% in girls, respectively [42].

2.1.4 Factors associated with children overweight and obesity

Socioeconomic Status

Overweight is a result of an increase in energy intake and a decrease in physical activity, both of which are influenced by social, economic and physical environments [43]. Socioeconomic factors are ethnicity, family size, and rearing conditions. The relationship between social factors and childhood obesity remains equivocal and poorly understood. Physical factors (for example, region, season and population density) [44], and social factors (for example, ethnicity [45], family size [46], excessive television viewing [47], short sleep duration [48], and rearing conditions [49]), have all been associated with adiposity in children and risk of overweight in young adulthood. The role of socioeconomic status has probably been studied the most extensively, but associations with trends in childhood obesity are inconsistent [49][50].

In USA, the Project EAT (Eating among teens) - II was a follow-up study of Project EAT-1 looking at trends in prevalence of overweight as a function of socioeconomic status during 5 years. In project EAT-1, students of 31 middle and high schools of Minnesota completed in-class surveys and anthropometric measures during the 1998-1999 academic years. Participants were surveyed again in Project EAT-II, 5 years later (2003-2004), as the younger cohort progressed from early adolescence to middle adolescence, and the older cohort

progressed form middle adolescence to late adolescence/young adulthood. Results showed an increase in prevalence of overweight for adolescents in the low-socioeconomic status group from 29.8% to 33.1% ($p = 0.001$) and a decrease for adolescents in the high-socioeconomic status group, from 23.1% to 19.2% ($p = 0.01$) [51].

Data from the 1946 British birth cohort showed that a low socioeconomic background in childhood and a high relative weight at the age of 14 were associated with higher mean BMI throughout adult life. Despite a partial confounding by educational attainment and by adult socioeconomic status, this study suggested a long-term impact of biological and behavioral processes on BMI [52].

Physical Activity

Change in patterns of physical activity is likely an important factor behind obesity. Declining levels of physical activity contribute to the increase in prevalence of overweight in US youths. In the study of Steven, physical activity was measured using 6 days of accelerometry and percentage of body fat was calculated using an age- and ethnicity-specific prediction equation. Sixth-grade girls with an average of 12.8 minutes of moderate-to-vigorous physical activity (MVPA) per day (15^{th} percentile) were 2 times more likely to be overweight than girls with 34.7 minutes of MVPA per day (85 percentile), and their percent body fat was 2.64 percentage points greater [53]. A survey commissioned by Sport England [54] showed that the proportion of young people spending two or more hours a week on sport in school declined from 46% in 1994 to 33% in 1999. There was a fall in the proportion of children walking to school. Since 1989/91, the proportion of primary school children walking to school has fallen from 62% to 56%, while over the same period; the number being driven by car to school has risen from 27% to 36%. There was a decline in the proportion of children

cycling to school. Only 2% of secondary pupils were cycling to school in 1999 compared with 5% in 1989/91. In Canada, results from the *Health Behaviors in School-aged Children Survey* indicated that physical inactivity and increased television viewing were strongly associated with overweight and obesity in Canadian youths. For example, the most physically active boys were only 30% as likely to be obese as the least active boys, while the most active girls were only 50% as likely to be obese as the least active girls.

Sedentary Behaviors

Sedentary behavior is rapidly emerging as an important issue in public health. Sedentary behavior refers to very low levels of energy expenditure through sitting and lying. In England, there was a rising in sedentary pastimes such as watching TV, playing computer games or accessing the internet [54]. An Independent Television Commission survey showed that the average 4-15 years watched about 2.5 hours of TV per day; the research also showed a strong correlation between the numbers of hours spent watching TV and prevalence of obesity. In 2002, about 50% of households with children had home internet access; on average, children logged on 10 times a month. A cross-sectional study showed that higher degrees of overweight with increase in TV viewing among children aged 10-16 years in 65% of the 34 countries involved in the report [55].

References

1. Gibson, R.S., *Principles of nutritional assessment*. 1990, New York ; Oxford: Oxford University Press. xvi, 691 p.
2. *Obesity: preventing and managing the global epidemic. Report of a WHO consultation.* World Health Organization technical report series, 2000. 894: p. i-xii, 1-253.
3. Lobstein, T., L. Baur, and R. Uauy, *Obesity in children and young people: a crisis in public health.* Obesity reviews : an official journal of the International Association for the Study of Obesity, 2004. 5 Suppl 1: p. 4-104.
4. Must, A., G.E. Dallal, and W.H. Dietz, *Reference data for obesity: 85th and 95th percentiles of body mass index (wt/ht2) and triceps skinfold thickness.* The American journal of clinical nutrition, 1991. 53(4): p. 839-46.
5. *Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee.* World Health Organization technical report series, 1995. 854: p. 1-452.
6. Kuczmarski, R.J., Ogden, C.L., Guo, S.S., *CDC growth charts for the United States: Methods and development: National Center for Health Statistics*. Vital Healthy Stat Vol. 11. 2002, Maryland: Centers for Disease Control and Prevention. 1-190.
7. de Onis, M., *et al.., Development of a WHO growth reference for school-aged children and adolescents.* Bulletin of the World Health Organization, 2007. 85(9): p. 660-7.
8. Cole, T.J., *et al.., Establishing a standard definition for child overweight and obesity worldwide: international survey.* BMJ, 2000. 320(7244): p. 1240-3.
9. Dietz, W.H. and T.N. Robinson, *Use of the body mass index (BMI) as a measure of overweight in children and adolescents.* The Journal of pediatrics, 1998. 132(2): p. 191-3.
10. Rolland-Cachera, M.F., *Childhood obesity: current definitions and recommendations for their use.* International journal of pediatric obesity : IJPO : an official journal of the International Association for the Study of Obesity, 2011. 6(5-6): p. 325-31.
11. Friedenberg, M.J., *Prevention and treatment of blood transfusion reactions.* Bulletin. Tufts-New England Medical Center, 1956. 2(2): p. 77-88.
12. Seoane, N. and M.C. Latham, *Nutritional anthropometry in the identification of malnutrition in childhood.* The Journal of tropical pediatrics and environmental child health, 1971. 17(3): p. 98-104.
13. Waterlow, J.C., *Classification and definition of protein-calorie malnutrition.* British medical journal, 1972. 3(5826): p. 566-9.
14. Waterlow, J.C., *et al.., The presentation and use of height and weight data for comparing the nutritional status of groups of children under the age of 10 years.* Bulletin of the World Health Organization, 1977. 55(4): p. 489-98.
15. Cole, T.J., *et al.., Body mass index cut offs to define thinness in children and adolescents: international survey.* BMJ, 2007. 335(7612): p. 194.
16. Cameron, N., *Body mass index cut offs to define thinness in children and adolescents.* BMJ, 2007. 335(7612): p. 166-7.
17. Lissau, I., *et al.., Body mass index and overweight in adolescents in 13 European countries, Israel, and the United States.* Archives of pediatrics & adolescent medicine, 2004. 158(1): p. 27-33.
18. Ogden, C.L., M.D. Carroll, and K.M. Flegal, *High body mass index for age among US children and adolescents, 2003-2006.* JAMA : the journal of the American Medical Association, 2008. 299(20): p. 2401-5.

19. Janssen, I., *et al..*, *Overweight and obesity in Canadian adolescents and their associations with dietary habits and physical activity patterns.* Journal of Adolescent Health, 2004. 35(5): p. 360-367.
20. Kromeyer-Hauschild, K., *et al..*, *Prevalence of overweight and obesity among school children in Jena (Germany).* International journal of obesity and related metabolic disorders : journal of the International Association for the Study of Obesity, 1999. 23(11): p. 1143-50.
21. Cruz, J.A., *Dietary habits and nutritional status in adolescents over Europe--Southern Europe.* European journal of clinical nutrition, 2000. 54 Suppl 1: p. S29-35.
22. Rolland-Cachera, M.F., F. Bellisle, and M. Deheeger, *Nutritional status and food intake in adolescents living in Western Europe.* European journal of clinical nutrition, 2000. 54: p. S41.
23. Samuelson, G., *Dietary habits and nutritional status in adolescents over Europe. An overview of current studies in the Nordic countries.* Eur J Clin Nutr, 2000. 54: p. S21-8.
24. Whelton, H., *et al..*, *Prevalence of overweight and obesity on the island of Ireland: results from the North South Survey of Children's Height, Weight and Body Mass Index, 2002.* BMC public health, 2007. 7: p. 187.
25. Berg, I.M., *et al..*, *Prevalence of overweight and obesity in children and adolescents in a county in Sweden.* Acta Paediatrica, 2001. 90(6): p. 671-676.
26. Klein-Platat, C., *et al..*, *Prevalence and sociodemographic determinants of overweight in young French adolescents.* Diabetes/metabolism research and reviews, 2003. 19(2): p. 153-158.
27. Önera, N., *et al..*, *Prevalence of underweight, overweight and obesity in Turkish adolescents.* order, 2004. 8: p. 10.
28. Karayiannis, D., *et al..*, *Prevalence of overweight and obesity in Greek school-aged children and adolescents.* European journal of clinical nutrition, 2003. 57(9): p. 1189-1192.
29. Wang, Y., C. Monteiro, and B.M. Popkin, *Trends of obesity and underweight in older children and adolescents in the United States, Brazil, China, and Russia.* The American journal of clinical nutrition, 2002. 75(6): p. 971-977.
30. Mo-suwan, L., C. Junjana, and A. Puetpaiboon, *Increasing obesity in school children in a transitional society and the effect of the weight control program.* The Southeast Asian journal of tropical medicine and public health, 1993. 24(3): p. 590-4.
31. Kantachuvessiri, A., *Obesity in Thailand.* J Med Assoc Thai, 2005. 88(4): p. 554-562.
32. Chu, N.F., *Prevalence of obesity in Taiwan.* Obesity reviews, 2005. 6(4): p. 271-274.
33. Noor, M.I., *The nutrition and health transition in Malaysia.* Public Health Nutrition, 2002. 5(1a): p. 191-195.
34. Tee, E., *Obesity in Asia: prevalence and issues in assessment methodologies.* Asia Pacific journal of Clinical Nutrition, 2002. 11(3): p. S694-S701.
35. de Onis, M., *et al..*, *The National Center for Health Statistics Reference and the growth of Indian adolescent boys.* The American journal of clinical nutrition, 2001. 74(2): p. 248-253.
36. Ramachandran, A., *et al..*, *Prevalence of overweight in urban Indian adolescent school children.* Diabetes Research and Clinical Practice, 2002. 57(3): p. 185-190.
37. Ogden, C.L., *et al..*, *Prevalence and trends in overweight among US children and adolescents, 1999-2000.* JAMA : the journal of the American Medical Association, 2002. 288(14): p. 1728-32.

38. Flegal, K.M. and R.P. Troiano, *Changes in the distribution of body mass index of adults and children in the US population.* International journal of obesity and related metabolic disorders : journal of the International Association for the Study of Obesity, 2000. 24(7): p. 807-18.
39. da Veiga, G.V., A.S. da Cunha, and R. Sichieri, *Trends in overweight among adolescents living in the poorest and richest regions of Brazil.* American journal of public health, 2004. 94(9): p. 1544-8.
40. Fox, K.R., *Tackling obesity in children through physical activity: A perspective from the United Kingdom.* Quest, 2004. 56(1): p. 28-40.
41. Rolland-Cachera, M.-F., *et al.., Body mass index in 7-9-y-old French children: frequency of obesity, overweight and thinness.* International journal of obesity, 2002. 26(12): p. 1610-1616.
42. Kautiainen, S., *et al.., Secular trends in overweight and obesity among Finnish adolescents in 1977-1999.* International journal of obesity and related metabolic disorders : journal of the International Association for the Study of Obesity, 2002. 26(4): p. 544-52.
43. Gordon-Larsen, P., L.S. Adair, and B.M. Popkin, *The relationship of ethnicity, socioeconomic factors, and overweight in US adolescents.* OBESITY RESEARCH, 2003. 11(1): p. 121-9.
44. Dietz, W. and S. Gortmaker, *Factors within the physical environment associated with childhood obesity.* The American journal of clinical nutrition, 1984. 39(4): p. 619-624.
45. Duran-Tauleria, E., R.J. Rona, and S. Chinn, *Factors associated with weight for height and skinfold thickness in British children.* Journal of epidemiology and community health, 1995. 49(5): p. 466-473.
46. Keiller, S., J. Colley, and R. Carpenter, *Obesity in schoolchildren and their parents.* Annals of human biology, 1979. 6(5): p. 443-455.
47. Andersen, R.E., *et al.., Relationship of physical activity and television watching with body weight and level of fatness among children: results from the Third National Health and Nutrition Examination Survey.* JAMA : the journal of the American Medical Association, 1998. 279(12): p. 938-42.
48. Locard, E., *et al.., Risk factors of obesity in a five year old population. Parental versus environmental factors.* International journal of obesity and related metabolic disorders: journal of the International Association for the Study of Obesity, 1992. 16(10): p. 721.
49. Lissau-Lund-Sorensen, I. and T.I. Sorensen, *Prospective study of the influence of social factors in childhood on risk of overweight in young adulthood.* International journal of obesity and related metabolic disorders : journal of the International Association for the Study of Obesity, 1992. 16(3): p. 169-75.
50. De Spiegelaere, M., M. Dramaix, and P. Hennart, *The influence of socioeconomic status on the incidence and evolution of obesity during early adolescence.* International journal of obesity and related metabolic disorders: journal of the International Association for the Study of Obesity, 1998. 22(3): p. 268.
51. Sherwood, N.E., *et al.., Peer Reviewed: Effect of Socioeconomic Status on Weight Change Patterns in Adolescents.* Preventing chronic disease, 2009. 6(1).
52. Hardy, R., M. Wadsworth, and D. Kuh, *The influence of childhood weight and socioeconomic status on change in adult body mass index in a British national birth cohort.* International journal of obesity, 2000. 24(6): p. 725-734.

53. Stevens, J., *et al.., Objectively Assessed Associations between Physical Activity and Body Composition in Middle-School Girls The Trial of Activity for Adolescent Girls.* American journal of epidemiology, 2007. 166(11): p. 1298-1305.
54. England, S., *Young People and Sport, National Survey 1999.* London: Sport England, 2000.
55. Janssen, I., *et al.., Comparison of overweight and obesity prevalence in school-aged youth from 34 countries and their relationships with physical activity and dietary patterns.* Obesity reviews, 2005. 6(2): p. 123-132.

2.2 Vietnam

2.2.1 Geography and population

Geography

Vietnam is a country located South East Asia with a form as an S-shaped strip on the eastern seaboard of Indochinese Peninsula, linking to the large Asian continent and looking out on the Pacific Ocean. Vietnam stretches 1,650 km from North to South. The widest area from East to West is 600 km and the narrowest only 50 km. With a borderline of 3,730 km, Vietnam is bordered by China in the North, Laos and Cambodia in the West and by the East Sea in the East with a coastline of 3,260 km. Its land area is about 331,668 km^2 of which 7.3 million ha is used for agriculture and 11,800 million ha used for forestry.

Vietnam is essentially a tropical country with a humid monsoon climate. The weather in the north has four seasons but the weather in the south has only two: the dry season and the rainy season. Vietnam has 7 different ecological regions: North Mountain and Midlands, Red River delta, North of Central Coast, South of Central Coast, Central Highlands, Northeast of Southlands, and the Mekong River delta.

Figure 2.1 Map of Vietnam

Population

According to the most recent Census, the population of Vietnam in 2010 was 86,747,807 people. Population density in the whole country is 263 person/km^2, lower than Belgium (355 person/km^2, www.statbel.fgov.be). Although a majority of the population lives in rural areas, 29.9% live in towns and cities [1]. The urban population has grown by 10% since 2007, and Vietnam has one of the world's highest population densities in cities [2]. Industrial zones and urban areas continue to attract migrants and, as Viet Nam continues to develop, the population distribution is shifting more and more from rural to urban areas where there are new economic opportunities. Ho Chi Minh is one of the cities attracting the largest number of migrants in the last decade.

Population of Vietnam is unevenly distributed, with density varying according to geographical and economic conditions. Demography has a so-called bipolarization around Ho Chi Minh, and Hanoi: Ho Chi Minh City concentrates 35% of the cities' population on 19% of the Vietnamese territory and Hanoi concentrates 27% of the population on 8%. The highest population densities are found in the big cities such as Ho Chi Minh, Ha Noi. Table 3 shows that five cities have highest average population in Vietnam. Ho Chi Minh City has the highest population and population density in comparison with other cities, with an average of 3,530 inhabitants/km^2, but with also big differences between rural and urban districts. The urban district N^{o}1 to N^{o}12 of Ho Chi Minh City have about 6,000,000 inhabitants on 300 km^2, with densities from 21,114 person/km^2 in District N^{o}8 to 44,089 person/km^2 in District N^{o}11 (that is 6.5 times higher than the 6,751 person/km^2 of Brussels), while rural districts have about 1,400,000 inhabitants on 1,600 km^2 with the lowest density of 97 person/km^2 in the District of Can Gio.

Table 2.3 Population and Population density in 2010 by region [2]

	Average population (person)	**Population density (person/km^2)**
Whole country	**86,927,700**	**263**
Ho Chi Minh	7,396,500	3530
Ha Noi	6,561,900	1962
ThanhHoa	3,406,800	306
Nghe An	2,917,400	177
An Giang	2,149,500	608

In 2010, children under 16 years of age accounted for 27.7% of the population [1]. In 2007, within this age group, the share of males and females was 52% and 48%, respectively [3, 4].

2.2.2 Educational System

The current Vietnamese education system has three levels: primary, secondary, and tertiary (post-secondary). Primary education consists of 5 grades, 1 to 5; children start attending school when they are 6 years old. Secondary education is divided into lower secondary education, which only covers four grades, 6 to 9 (also called junior high school with an expected aged of 11 to 14 years), with entry to grade six guaranteed for all those completing primary school. Upper secondary education consists of 3 grades, 10 to 12 (also called high school, with an expected of 15 to 18 years). Tertiary level is divided into undergraduate education and graduate education.

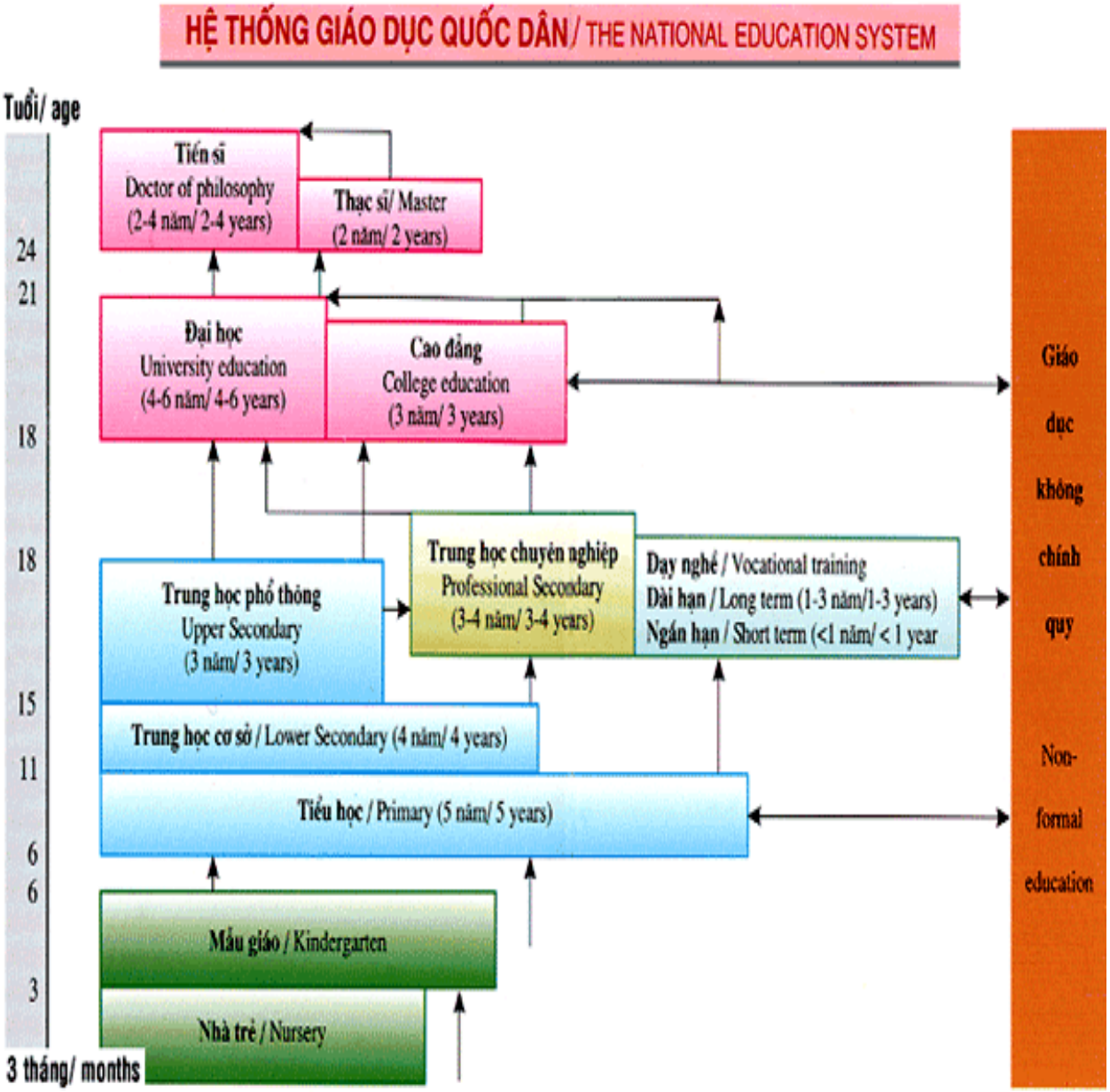


Figure 2.2 The Vietnam National Education System

(http://edu.net.vn/data/doc/hethonggiaoduc/)

Table 4 shows the net enrolment rates across different levels of education by socio-economic characteristic. The net enrolment rates in primary, lower secondary, upper secondary, junior college and university level were 95.5%, 82.6%, 56.7%, 6.7%, and 9.6%, respectively [5].

Table 2.4 Net enrolment rates at different levels of education by selected socio-economic characteristics, 2009

Expected age (yrs)	Primary (6 to 10)	Junior high school (11 to 14)	High school (15 to 17)	Junior College (18 and over)	University (18 and over)
All	95.5	82.6	56.7	6.7	9.6
Sex					
Boys (%)	95.5	81.4	53.1	6.0	9.1
Girls (%)	95.4	83.9	60.6	7.4	10.1
Urban-Rural residence					
Urban (%)	97.2	88.8	68.4	12.9	23.3
Rural (%)	94.9	80.6	52.8	3.7	3.0
Socio-economic status					
Very low (%)	88.9	59.0	23.2	0.3	0.3
Low (%)	95.3	78.7	44.2	1.8	1.0
Average (%)	97.0	86.7	56.1	7.8	5.5
High (%)	97.5	89.6	64.6	8.6	10.6
Very high (%)	98.3	94.9	82.3	11.6	26.3

Source: http://www.gso.gov.vn/default_en.aspx?tabid=515&idmid=5&ItemID=11080

In the educational system of Vietnam both public and non-public (private) schools coexist. Public schools are schools founded and funded by the government. Non-public schools are schools that have private owners (private schools) or socio-economic organizations (people-funded school) and operate quasi-independently of the government. There are also semi-public schools; the government supports physical infrastructure and pays the salary of half of their teaching staff. Semi-public schools have to find funds for their operations and pay the salary for the rest of the teachers using different resources, including fees and tuition. The total number of private schools in Vietnam is small but it is growing. By 2006-2008, private enrolment accounted for 6% of all students enrolled in Grades 1-12. In the general educational system, almost all primary schools are public as are the overwhelming majority of lower secondary school. Non-public schools are mainly concerned by upper secondary (≥ 15 year of age) and tertiary education (≥ 18 year of age) [6]. Each private school has to request a governmental agreement. All schools in Vietnam are evaluated each year for the National Education agreement. It should be underline that there are National exams at the end

of grade 5 (primary certificate), of grade 9 (junior high certificate), and of grade 12 (high school certificate) with the same questions within each province of Vietnam.

The school year begins in September and ends in May. The average class time at school in Vietnam is 3 to 4 hours a day (either in the morning or in the afternoon) during 5 days a week in public schools and it is 6 to 8 hours a day during 5 or 6 days a week in private school. However, most public schools organize an additional half day course each day of the week that has a financial cost for families; most students follow these extra lessons. The education system in Vietnam currently relies heavily on examination results for assessment and promotion. One recent and growing feature of the Vietnamese education system is a "shadow" education system existing alongside the mainstream education, where students attend extra class to acquire knowledge that they do not appear to obtain during their hours in school. These extra classes have become widespread in both urban and rural areas of Vietnam [7].

2.2.3 Nutrition Situation

In the last decade, Vietnam has shown remarkable achievements in improving health and nutritional status of the population. Since 1990, the economic growth of Vietnam, linked to the economic reform (called Doi Moi) in 1986, has changed Vietnam from a centrally planned to a free market economy. The annual gross domestic product (GDP) increased from 4.4% in the late 1980s to more than 7% and inflation rates were reduced significantly – regardless of the regional financial crisis in the late 1990s. During that time, per capita GDP (in purchasing power parity (PPP) terms) increase from less than $1,000 (USD) to almost $2,500 (USD) and the prevalence of the total population living under the poverty line was reduced from 70% in the early 1980s, to 58% in the mid 1990s and to 37% in the late 1990s

[3, 4]. The development of the agriculture sectors and economic growth in the last two decades transformed Vietnam (a) from a country highly dependent on food aid to a food exporter, (b) from a country of famine to one with a surplus of foods and, (c) from a country of staple-based diets to one with more balanced and nutritious diets [3, 8]. Compared with dietary data in 1990, the consumption of both meat and total fat doubled in 2000, the consumption of eggs tripled and the consumption of fruit was multiplied by 10 [8, 9].

The improvement of the nutrition status was also attributed to the successful implementation of the national nutrition policies in Vietnam. On 16 September 1995, the first national nutrition strategy has been officially approved in Vietnam. This first policy on nutrition (The National Plan of Action for Nutrition 1995-2000) focused on food insecurity and on child and mother malnutrition. On 22 February 2001, the follow-up policy (The National Nutrition Strategy 2001- 2010) added additional strategies to deal with nutrition-related health problems [8, 9].

Underweight

As a result of the successful economic reforms and nutrition policies from 1990 to 2010, prevalence of underweight *(weight for age)* in children under 5 has significantly been reduced, with a national average of 1.5% per year, from 31.9% in 2001 to 25.2% in 2005 and 17.5% in 2010 [10]. The progress in reduction of malnutrition in Vietnam has been acknowledged and highly appreciated by international organizations. Stunting rate (low height for age) in children under 5 has also been significantly reduced at the national level from 43.3% in 2000 to 29.3% in 2010. However, Vietnam still remains among the 36 countries with the highest stunting rates in the world (based on new WHO standards). Among adults, the prevalence of chronic energy deficiency (BMI < 18.5 kg/m^2) is 17.2% (in males: 15.8%; in females: 18.5%) [10].

Overweight/Obesity

The rapid increase in economic growth of Vietnam has led to changes in lifestyles and diet composition. The common diet based on cereals, tubers, and vegetables expanded to include meat, eggs, milk, fat and sugar. Traditional food consumption such as sesame, peanuts, tofu, green vegetables and fish has decreased [11]. A proportion of the urban population has embraced fast foods and drinks, as well as animal-based foods and refined carbohydrates (sugar, sweets), and that is significant phenomenon of the nutritional transition. In addition to under-nutrition burden, a number of nutrition-related chronic problems such as overweight and obesity are increasing rapidly, creating a double burden of malnutrition. For children under 5 years in National studies of 2010, the prevalence of overweight is 5.6% (6.5% and 4.2% for urban and rural areas, respectively), and the prevalence of obesity was 2.8% (children with WHZ $\geq$ 2SD were considered obese), 6 times higher than in the year 2000 [10]. For adults over 20 years, prevalence of overweight and obesity was 5.6% (in male: 4.9%, in female: 6.3%), with a maximum at the age of 55-59 years [10].

Today, malnutrition remains a major challenge in Vietnam, especially in remote and hard-to-reach areas and in areas regularly affected by natural disasters. In the same time, Vietnam faces new challenges with the rise of obesity, especially in urban centers.

2.3 Ho Chi Minh City

2.3.1 Geography – Demographics

Geography

Ho Chi Minh City is located in the Southeastern region of Vietnam, at 1,760 km (1,090 mi) south of Ha Noi. It borders Tay Ninh and Binh Duong provinces to the north, Dong Nai and Ba Ria-Vung Tau provinces to the east, Long An province to the west and the Indochine to the south with a coast 15 km long. The city covers an area of 2,095 km^2 (809 sq mi) (0.63% of the surface of Vietnam), extending up to Cu Chi (12 mi (19 km) from the Cambodian border) and down to Can Gio on the Bien Dong coast.

Demographics

HCMC is administratively divided into 24 districts: 5 rural districts (Cu Chi, Hoc Mon, Binh Chanh, Nha Be, Can Gio), 5 suburban districts (Districts N^o 2, 7, 9, 12, and Thu Duc), and 14 urban districts named District N^o 1, 3, 4, 5, 6, 8, 10, 11, Tan Binh, Tan Phu, Binh Thanh, Phu Nhuan, Binh Tan, and Go Vap. Urban Districts number 1, 3, 5, and 10 are classified as wealthy districts by the National Department of Statistics [12].

The population of Ho Chi Minh City, as of the 1 October 2010 Census, was 7,396,500 persons, making it the highest-concentrated city in the country. As explained before, Ho Chi Minh City has the highest population and population density in comparison with other cities, with an average of 3,530 inhabitants/km^2 but with also big differences between rural and urban districts. The urban district N^o1 to N^o12 of Ho Chi Minh City have about 6,000,000 inhabitants on 300 km^2, with densities from 21,114 person/km^2 in District N^o8 to 44,089 person/km^2 in District N^o11 (that is 6.5 times higher than the 6751 person/km^2 of Brussels),

while rural districts have about 1,400,000 inhabitants on 1,600 km^2 with the lowest density of 97 person/km^2 in the District of Can Gio.

Figure 2.3 Map of Ho Chi Minh City

2.3.2 Educational system

Educational system of Ho Chi Minh City follows the National education system. There are 12 school years for three levels: primary (aged 6-10 years), lower secondary (aged 11-14 years), and higher secondary (aged 15-17 years). There also have both public and non-public

(private) schools. In Ho Chi Minh City, private schools make up 15% of schools at all educational levels before the aged of 18 years; of these, preschool education is 42.2% private, primary schools are 5.5 percent private, lower secondary schools are 1.29% private, and upper secondary schools are only 0.3% private (Ho Chi Minh City Education Department statistics for 2006/2007) [6].

Most children, from preschool to school-aged, spend approximately 6 to 8 hours at school where they have lunch and snack. After a school day, almost all children continue attending private tutoring to be provided supplementary instruction in matters that they study in the mainstream education system.

2.3.3 Nutritional status

In the last decade, the socio-economies have rapidly developed in Ho Chi Minh City. The daily life has become more convenient and of better quality. This has contributed to changes in lifestyle and eating habits but this has resulted in changes in disease pattern of people living in Ho Chi Minh City. Therefore, during the last decade, many national health promotion programs, particularly in nutrition-related programs, have been implemented [13].

Underweight

The under-nutrition status in vulnerable population has been significantly improved. The prevalence of under-nutrition among children under 5 years decreased by half compared to those in 2001 (6% in 2009 vs 14.8% in 2001) while the prevalence of stunting (height for age) decreased from 9% (2001) to 6.7% (2009). According to national data, the prevalence of stunting in children aged less than 5 years in Ho Chi Minh City was 5 times lower than in the rest of the country in 2009 (6.7% vs 32.6%) [13].

Overweight and obesity

Parallel to improvements in under-nutrition, the prevalence of overweight and obesity was rapidly increasing. Prevalence of overweight and obesity in children under 5 years was 4 times higher than data of 1999 (8.8% in 2009 vs 2.2 in 1999). Approximately 30% of reproductive-aged people overweight or obese; an increase of 300% in ten year [13]. Among children aged 6 years, the prevalence of overweight and obesity increased from 4.4% in school year 1999-2000 to 10.4% in school year 2002-2003 [14]. Among adults, National Nutritional Institute showed that the prevalence of overweight and obesity (BMI $\geq$ 23) among age group 20-60 years was 32.6% in 2004 [15].

Between 1995 and 2004, National Nutritional Institute did not register data concerning overweight and obesity among adolescents. Previous studies investigating the nutritional status of the population of Ho Chi Minh City have focused on young children or adults [16, 17]. From 2004 until now, Hong *et al.* conducted 2 studies among adolescents in Ho Chi Minh City. Since 2005, adolescents are included in National nutrition surveys. Results of the study that was conducted in 2004 showed that urban adolescents in Ho Chi Minh City were undergoing remarkable increases in overweight and obesity, from 5.9% in 2002 to 11.7% in 2004 [18].

As consequence, the city implemented intervention and communication education activities on nutrition (such as setting up consultation on nutrition in local health stations, implementation of intervention project, nutritional education to people). Such health prevention programs have resulted in significant improvements on nutritional status of people living in Ho Chi Minh City during the last decade. However, the existence of stunting and the increase not only in obesity but also in non-communicable chronic diseases indicate that a comprehensive strategy should be established in the future to control and prevent these disorders in Ho Chi Minh City.

References

1. Office Gs: Statistical Yearbook of Vietnam. Ha Noi: Statistical Publishing House; 2010.
2. Statistical Handbook of Vietnam. Ha Noi: Statistical Publishing House; 2010.
3. Human Development Report. In. Edited by C D. New York: United Nations Development Programme; 2005.
4. National Human Development Report 2001: Doi Moi and Human Development in Vietnam. In. Ha Noi: National Centre for Social Sciences and Humanities - National Centre for Social Sciences and Humanities - Political Publishing House; 2001.
5. Vietnam Population and Housing Census 2009: Educational in Vietnam - An analysis of key indicators. In. Ha Noi: Ministry of Planning and Investment - General Statistics Office; 2011.
6. Tran TBL: Market-oriented education private (people-founded) upper-secondary schools in Ha Noi. In: *Education in Vietnam.* Edited by London JD. Singapore: Institute of Southeast Asian Studies; 2011: 132 - 152.
7. Dang HHA: The Determinants and Impact of Private Tuturing Classes in Vietnam. *Doctor of Philosophy*. Minnesota: University of Minnesota; 2007.
8. MoH-NIoN: Nutrition survey 2002. Ha Noi: Ha Noi Publishing House; 2003.
9. Hop L, Khan, NC.: Malnutrition and poverty alleviation in Vietnam during the last period 1985−2000. *Asia Pac J Clin Nutr* 2002, 11(s1):331-334.
10. Ministry of Health U: General Nutrition Survey 2009-2010. In. Ha Noi: National Institute of Nutrition; 2012: 1-10.
11. Nguyen CK, Pham, V.H.: Vietnam Recommended Dietary Allowances 2007. *Asia Pac J Clin Nutr* 2008, 7(S2):409-415.
12. Office HCMCS (ed.): Statistical yearbook of HoChiMinh City. Ho Chi Minh Statistical Publishing House; 2010.
13. Le TKQ: Trends of Nutritional Status and Its Related Diseases in Ho Chi Minh City In 2001-2010. *Journal of Food and Nutrition Sciences* 2010, 6(3+4):7-9.
14. Tran HM, Tran, H. L., Pham, N. O., Nguyen, N. T., Le, K. H.: Nutrition status among school aged children in school year 2002-2004 In. Ho Chi Minh: Nutrional Centre 2005.
15. Nguyen CK: National survey of overweight and obesity 2005. In. Ha Noi: National Nutritional Institue; 2006.
16. Cuong T, Dibley M, Bowe S, Hanh T, Loan T: Obesity in adults: an emerging problem in urban areas of Ho Chi Minh City, Vietnam. *European journal of clinical nutrition* 2006, 61(5):673-681.

17. Hanh TTM, Komatsu T, Hung NTK, Van Chuyen N, Yoshimura Y, Tien PG, Yamamoto S: Nutritional status of middle-aged vietnamese in ho chi minh city. *Journal of the American College of Nutrition* 2001, 20(6):616-622.
18. Hong TK, Dibley MJ, Sibbritt D, Binh PN, Trang NH, Hanh TT: Overweight and obesity are rapidly emerging among adolescents in Ho Chi Minh City, Vietnam, 2002-2004. *Int J Pediatr Obes* 2007, 2(4):194-201.

Chapter 3 Methods

3.1 Study design

We conducted a cross-sectional population-based study in the year 2010 in urban areas in Ho Chi Minh City, Vietnam.

3.2 Population and settings

The target population was Vietnamese adolescents (11-14 years) of both genders living in HCMC and attending public schools of the 14 urban districts only.

It is estimated that about 92% of adolescents living in HCMC are attending secondary high schools (also called junior high schools) [1]. Urban districts number 1, 3, 5, and 10 are classified as wealthy districts by the National Department of Statistics. These five districts have about one million inhabitants (20% of the urban population of HCMC) including 54,505 students in grades 6-9 attending the 45 public junior high schools (data provided by the City Department of Education for the year 2009-2010). In the remaining ten urban districts called less wealthy districts, there are 138,589 students in grades 6-9 attending the 99 public junior high schools.

3.3 Sample size

Because the purpose of the study was to assess the extent of overweight and obesity among Vietnamese adolescents living in urban areas of HCMC, Vietnam, the sample size calculation used the formula for estimating a single proportion:

$$n = \frac{Z_{1-\alpha/2}{}^2 p(1-p)}{e^2}$$

With:

- $Z_{1-\alpha/2}$ = Gaussian quintile at level $(1-\alpha/2)$ for a $(1-\alpha/2)100\%$ confident interval
- e = expected precision
- p = expected proportion of individuals in the sample with overweight

The result from the cross-sectional study conducted by Hong *et al.* in 2004 on junior high school students of HCMC reported a prevalence of high BMI of 17,7% in wealthy urban districts and 8,4% in less wealthy urban districts. Using this information and assuming a 95% confidence interval, with a precision of 0.05, the required sample sizes was 224 students in the wealthy stratum and 119 students in the less wealthy stratum. However, because of the similarity in characteristics of students in grade 6 and 7 as well as in grade 8 and 9, two strata (6-7 and 8-9) were defined, leading to sample sizes of 448 students in the wealthy urban areas and 238 students in the less wealthy areas. This sample size estimates needed to be adjusted for the effects of clustering (measuring all students in a class). The design effect can be calculated with the equation:

Design effect = 1 + (average class size-1) * intra-class correlation coefficient

From the previous study of Hong *et al.*, the intra-class correlation coefficient was estimated to 0.045 [2]. For an average of 44 students per class, and an intra-class correlation of 0.045, the design effect was 2.9. Therefore, the required sample size was 1320 students for each grade in wealthy urban districts and 704 students for each grade in less wealthy urban districts. This corresponds to a sample of approximately 30 classes for each grade of schools from wealthy areas and 16 classes for each grade from schools in less wealthy areas, and a total sample size of 2024 students.

Table 3.1 Number of classes, total of students, number of selected school, and number of selected students

Districts	Number of schools	Number of students	Number of selected schools	Number of selected students
Wealthy districts				
District N°1	10	86,230	4	373
District N°3	11	247,052	4	319
District N°5	11	4,679	4	361
District N°10	10	10,413	3	251
Less wealthy districts				
District N°4	6	6,678	1	91
District N°6	6	9,451	0	0
District N°8	10	11,994	1	88
District N°11	11	14,271	1	90
Go Vap	13	22,466	1	98
BinhThanh	15	17,966	1	90
Binh Tan	9	9,891	0	0
Tan Phu	8	17,,840	2	193
PhuNhuan	9	7,311	0	0
Tan Binh	12	20,721	1	97

The number of students actually selected was 1304 in wealthy districts areas and 747 in less wealthy districts areas, because of actual class sizes. In total, the sample size that was collected was 2051 students.

3.4 Sampling

The sampling unit for this study was a class in individual grade 6 to 9, with the sampling frame consisting of all grade 6-9 classes in schools in urban areas of HCMC. The urban areas of HCMC were divided into two strata; from districts 1, 3, 5, 10 considered as

wealthy, and ten Districts 4, 6, 8, 11, Tan Binh, Tan Phu, Binh Tan, Phu Nhuan, Binh Thanh, Go Vap considered as less wealthy by the National Department of Statistics [3], as explained in previous sections. The study used a multistage cluster sampling strategy as follows:

- Stage 1: In wealthy urban districts, we randomly selected 15 of the 45 public schools, using a probability proportional to the size of the target population (the number of students in grades 6-9 within each school). In the remaining ten less-wealthy urban districts, we randomly selected 8 of the 99 public schools, using also a probability proportional to the size of the target population (Table 3.1). Due to the random process, no school was selected in District N^{o}6, in District Binh Thanh, and in District Phu Nhuan. One school was selected within Districts N^{o}4, N^{o}8, N^{o}11, Tan Binh, Binh Tan, and Go Vap. Two schools were selected in District Tan Phu (Table 3.1). In total, 23 clusters (schools) were selected.
- Stage 2: In each selected school, we randomly selected one class among grades 6 to 7 and one class among grades 8 to 9 using a uniform probability model. All adolescents of a selected class were invited to participate to the study.

3.5 Data collection

3.5.1 Training

Two collectors were trained the week before survey to take anthropometric measurements of weight, height, waist circumference, hip circumference using standardized methods.

The interviewers were medical doctors and medical students from the University of Medicine Pham Ngoc Thach who were trained the week before the study about interviewing techniques and the use of the survey questionnaires.

3.5.2 Data collection schedule

Data were collected during three visits to each school.

The initial visit was to explain the survey and distribute information sheets, consent forms, parent questionnaires. These forms were collected 2 weeks later.

The second visit took place at a date fixed by the school supervisors. During this second visit, we collected anthropometry measurements and we administered the questionnaire to the adolescents.

At the third visit, the research team collected and checked the completed questionnaires that students filled at home and. Any consenting participant who was absent at the second visit was also measured at this third visit.

3.6 Measurements

3.6.1 Anthropometric measurements

The anthropometric measurements were taken by two trained data collectors. These measurements were standardized before the data collection. Weight was measured with shoes and heavy clothes removed using a Tanita electronic scale (Tanita BF 571, Tanita Corporation, Japan) and was recorded to the nearest 100g. Standing height was measured with a suspended Microtoise tape to the nearest 0.1 cm using standard methods [4]. Waist and hip circumference was measured by non-stretch tape, and recorded to the nearest 0.1cm.

3.6.2 Student's form

Student's form included two parts. The first part was filled by investigators and contained data on birth date, gender, and on anthropometric measurements. The second part was self-assessed pubertal status which included date of the first menstruation for girls, date of voice

change for boys, and Tanner's diagrams illustrating the five stages of pubertal development (male genitalia, male pubic hair, and female breast). The details of this form can be found in Appendix 1.

3.6.3 The Food Frequency Questionnaire

For collecting data on dietary intake, we used a food frequency questionnaire that was validated for Vietnamese adolescents in Ho Chi Minh City [5].

Students were asked about the frequency and portion size of 160 food items that they consumed during the last 6 months. These foods are divided into 6 principal groups (1) Rice, Bread, Cereal; (2) Meat, Fish, Seafood; (3) Made-food; (4) Fruit and Vegetables; (5) Sweet and Snack; (6) Miscellaneous. The frequency of consumption was categorized in six options (never, ≤1time/month, 2-3times/month, 1time/week, 2-4times/week, 5-6times/week, 1time/day, 2-3times/day). For portion size, each kind of food has three own standard options (0.5, 1, and 1.5 standard portion) that were illustrated by photos attached. The details of this form can be found in Appendix 2.

3.6.4 The Physical Activity Questionnaire

We asked students information about their physical activity by using a validated Physical Activity questionnaire on adolescents in Ho Chi Minh City [6]. This questionnaire has three parts.

The first part focused on organised and non-organised sports, games, activities that student usually did before and after schools during schools term and summer holidays, how many times per week, and usual amount of time they spent at doing them. In Ho Chi Minh City, school terms are 38 weeks and summer holidays are 14 weeks.

The second part included 12 questions of means and time spent for school transportation. Children were asked about number of days they used each type of transport and the time they spent using type of transport.

The third part recorded sedentary behaviours of students. Children were asked about time spent on watching TV, watching Video/VCD, using computer for fun, using computer for working, doing homework after school at home, studying at private tutoring classes, travelling, reading for fun, doing hobbies, chatting without using computer, playing a musical instrument or drawing on weekdays and weekends. The details of this form can be found in Appendix 3.

3.6.5 The Home and Community Environment Questionnaire

This questionnaire was developed for the parents. Parents were asked about their own weight and height, education and occupation, family activity and eating habits, about the size of their family, and about ownership of 14 household assets: bicycle, motorbike, television, radio, video, cassette player, computer, gas stove, CD player, car, microwave oven, refrigerator, telephone, and air-conditioners. These household assets were chosen based on a report of the Bureau of Statistics of Ho Chi Minh City that listed the most common assets used by the Ho Chi Minh City population. In addition, parents were asked about accessibility to public facilities, children's transportation to school, game shops, side-walks, play-yards around the house, family behaviors such as adults playing sport with children, family rules for playing games, household assets. The questionnaire was self-administered. The details of this form can be found in Appendix 4.

3.6.6 The School Environment Questionnaire

The school environment questionnaire contained questions about the school playground, the recess exercises, the school sport meetings, and the number of physically educational sessions per week. It was sent to the school principles to be self administered.

3.7 Data entry and analysis

3.7.1 Data entry

Data were entered into computer files using Epi-Data program version 3.02 with check-files (Epi Data Association 2000-2005). Data cleaning was standardized through a flow chart. All data were checked for missing values and outliers and cleaned prior to data analysis. Analyses were undertaken using Stata Statistical Software.

3.7.2 Analysis

Estimation of prevalence of overweight and obesity

Body mass index (BMI) was calculated as the weight in kilograms divided by the square of the height in meters (kg/m^2). It was categorized into four groups: underweight, normal weight, overweight, and obesity based on the IOTF cut-offs. BMI z- scores were also calculated using the WHO 2007 reference of BMI-for-age in children aged 5-19 years. Descriptive statistics are presented as mean and standard deviation, median and range, or proportions. When combining data for wealthy and non wealthy districts, weights of 0.17 and 0.83 were used to correct for the lower proportion of students in wealthy districts (28%) than in non wealthy districts (72%).

Characteristics of students

The age of children was divided into four groups: 11 years, 12 years, 13 years, and 14 years. For each student, pubertal stage was assessed as pre-pubescent or pubescent according to the WHO definition [7]. For girls, the pre-pubescent corresponds to breasts at stage 1 and no menarche while pubescent corresponds to breasts at stage 2 or more and post-menarche. For boys, prepubescent corresponds to genitalia at stage 2 or less, and pubescent corresponds to genitalia at stage 3 or more.

Diet intake

For each student, energy and nutrient intakes (ENI) for each food item were calculated using the following formula:

ENI = Reported daily frequency of consumption * Reported portion size for each food item * Standard portion size of the food item (in grams) * Nutrients per 100 grams

Data on standard portion size and nutrients per 100 grams were obtained from the Vietnam National Food Composition Tables and the Vietnam Nutrients and Composite Foods Database Software (Eiyokun-Nutrition Centre HCMC) [8]. Energy and nutrient intake for each food item was then added up to obtain the total intake score per day for each subject.

Physical activity

The physical activity data was calculated separately for school term and summer holidays and for organized and non organized activities [9]. Each activity was assigned a MET value based on the compendium of physical activities, and the sum of these MET value for each children was categorized into low, moderate, or vigorous activity levels [10-12].One MET represents the resting metabolic rate equivalent to 3.5 mL/kg body weight/minute oxygen consumption. A value greater than one indicates energy expenditure related to activity [13, 14]. Time spent on each activity per week (TimePA) investigated the role of organized and non-organized

activities. Total time spent on each activity per week is calculated as follows, considering 38 weeks of school term out of the 52 weeks of a year:

Total TimePA = [(TimePA organized in school term + TimePA non organized activity per week in school term)*38/52] + [(TimePA organized per week in summer holidays + TimePA non organized per week in summer holidays)*14/52]

*With: TimePA = Average duration per time * Frequency of participation per week.*

The volume of each physical activity (PA) was computed in terms of MET-minutes/week using the following formula:

PA score = MET * Total TimePA

Physical activity was also categorized into 2 levels: vigorous activity or moderate activity. Vigorous activity was defined as vigorous-intensity activities (METs ≥ 6.0). Moderate activity was defined as moderate-intensity activities (3.5-5.9 METs). An adolescents was considered to be "inactive" if he or she takes part in less than 60 min/day for moderate to vigorous physical activity [15].

Sedentary behaviors

Time spent on activities after class (such as viewing TV/Video/DVD, using computer for fun, traveling, studying at private classes, reading for fun, doing hobbies, chatting, playing musical instrument or drawing) are presented as median and interquartile range (IQR) or proportions.

Small- screen recreation was defined as a set of activities like watching TV/Video/DVD and using computer for fun (including e-communications, e-games, and surfing on the net). Total small-screen recreation time was defined as the sum of time spent watching TV/Video/DVD and time spent using computer for fun. Times were also categorized into either <2h/day or ≥2h/day (i.e. high users) spent watching TV/Video/DVD, using computer for fun or in both small-screen recreations [16, 17].

Economic status

To assess economic status, a household wealth index was calculated as the first principal component of the variance-covariance matrix of 14 dummy variables coding for ownership of the 14 assets presented in section 3.6.5. This wealth index was categorized into 5 subgroups according to quintiles.

3.8 Ethical issues

Standards of ethics for studies conducted in Vietnam were respected. The study protocol was ethically approved by the Health Service of HCMC and the Department of Education and Training of HCMC. The study was a collaboration between University of Medicine Pham Ngoc Thach and Université catholique de Louvain (Brussels, Belgium). The protocol was also approved by the Ethical Review Committee of both universities. Informed consent was obtained from each parent, from each student and from each school principal with standard assurances of confidentiality. Participants were informed that answering the anonymous questionnaire was voluntary.

References

1. Office, G.s., *Statistical Yearbook of Vietnam*. 2010, Ha Noi: Statistical Publishing House. 879.
2. Hanh, M.T.T., *et al.., Anaemia status of junior high school of Ho Chi Minh City: An investigation at the beginning of the academic year: 2002-2003*, in *Anaemia and iron deficiency*. 2003, Nutrition Center: Ho Chi Minh City. p. 30-39.
3. Department of Statistics, *Report on economic status of populations in Ho Chi Minh City*, in *Statistics of Ho Chi Minh City, 2004*. 2004, Bureau of Statistics: Ho Chi Minh City.
4. WHO Expert Committee on Physical Status: The Use and Interpretation of Anthropometry, *Physical status: The use and interpretation of anthropometry: report of a WHO expert committee (WHO Technical Report Series; 854)*. 1995, Geneva: World Health Organization. 454.
5. Hong, T.K., M.J. Dibley, and D. Sibbritt, *Validity and reliability of an FFQ for use with adolescents in Ho Chi Minh City, Vietnam.* Public Health Nutrition, 2009. 13(3): p. 368.
6. Hong, T.K., *et al.., Validity and reliability of a physical activity questionnaire for Vietnamese adolescents.* Int J Behav Nutr Phys Act (MS 4835073026381536), 2012.
7. Chakar, H. and P.R. Salameh, *Adolescent obesity in Lebanese private schools.* European Journal of Public Health, 2006. 16(6): p. 648-51.
8. Hanh, T., *Eiyokun: software for calculatin Vietnamese dietary intake*. 2004, Ho Chi Minh Medical Publishing House of Vietnam.
9. Booth, M.L., *et al.., The reliability and validity of the adolescent physical activity recall questionnaire.* Medicine and science in sports and exercise, 2002. 34(12): p. 1986-1995.
10. Ainsworth, B.E., *et al.., Compendium of physical activities: classification of energy costs of human physical activities.* Medicine and science in sports and exercise, 1993. 25(1): p. 71-80.
11. Ainsworth, B.E., *et al.., Compendium of physical activities: an update of activity codes and MET intensities.* Medicine and science in sports and exercise, 2000. 32(9; SUPP/1): p. S498-S504.
12. Kimm, S., *et al.., Relation between the changes in physical activity and body-mass index during adolescence: a multicentre longitudinal study.* The Lancet, 2005. 366(9482): p. 301-307.
13. Gordon-Larsen, P., R.G. McMurray, and B.M. Popkin, *Adolescent physical activity and inactivity vary by ethnicity: The National Longitudinal Study of Adolescent Health.* The Journal of pediatrics, 1999. 135(3): p. 301-306.
14. Gordon-Larsen, P., R.G. McMurray, and B.M. Popkin, *Determinants of adolescent physical activity and inactivity patterns.* Pediatrics, 2000. 105(6): p. e83-e83.
15. Strong, W.B., *et al.., Evidence based physical activity for school-age youth.* The Journal of pediatrics, 2005. 146(6): p. 732-737.
16. Janssen, I., *et al.., Comparison of overweight and obesity prevalence in school-aged youth from 34 countries and their relationships with physical activity and dietary patterns.* Obesity reviews : an official journal of the International Association for the Study of Obesity, 2005. 6(2): p. 123-32.
17. Barlow, S.E., *Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report.* Pediatrics, 2007. 120 Suppl 4: p. S164-92.

Chapter 4 Overweight and obesity among adolescents in Ho Chi Minh City, Vietnam

4.1 Prevalence of overweight and obesity

Article: High prevalence of overweigh among adolescents in Ho Chi Minh City, Vietnam

Authors: Phuong Van Ngoc Nguyen, Tang Kim Hong, Truong Hoang, Dung The Nguyen, Annie Robert

Journal: BMC Public Health 2013, 13:141.

Abstract

Background

Two previous surveys conducted in Ho Chi Minh City revealed an increasing prevalence of overweight and obese adolescents, from 5.9% in 2002 to 11.7% in 2004. From 2004 to 2010, the government set up and implemented health promotion programs to promote physical activity and good nutritional habits in order to prevent overweight and obesity in children and adolescents. Our study aimed to estimate the prevalence of overweight and obesity among adolescents in urban areas of Ho Chi Minh City in 2010.

Methods

A representative sample of 1,989 students aged 11–14 years was selected using a multistage cluster sampling method. 23 schools were randomly selected from the full list of all public junior high schools. In each selected school, 2 classes were chosen at random and all students from the class were examined. Age- and sex-adjusted overweight and obesity were defined using International Obesity Taskforce cut-offs.

Results

The prevalences of overweight and obesity were 17.8% and 3.2%, respectively. Prevalences of overweight and obesity were significantly higher in boys (22%, 5.4%) than in girls (13.3%, 1.3%, p=0.001) and higher in children from districts with a high economic level (20.5% , 3.8%) than in those from districts with a low economic level (12.1%, 3.8%, p=0.001). Additionally, children living in wealthier families were more overweight and obese than those living in less wealthy families. When using WHO cutoffs, the overall prevalences of overweight and obesity reached 19.6% and 7.9%, respectively.

Conclusion

Our study's findings suggest that the prevalence of overweight and obesity among secondary school students remains high, especially among boys living in wealthier families. Public health programs should therefore be developed or improved in order to promote good eating habits and physical activity among youth in HCMC.

Keywords: Adolescent overweight; Ho Chi Minh City; IOTF definition; Obesity; Prevalence; Socioeconomic; Vietnam

Nguyen et al. BMC Public Health 2013, 13:141
http://www.biomedcentral.com/1471-2458/13/141

BMC Public Health

RESEARCH ARTICLE Open Access

High prevalence of overweight among adolescents in Ho Chi Minh City, Vietnam

Phuong Van Ngoc Nguyen[1*], Tang Kim Hong[1], Truong Hoang[1], Dung The Nguyen[1] and Annie R Robert[2,3]

Abstract

Background: Two previous surveys conducted in Ho Chi Minh City revealed an increasing prevalence of overweight and obese adolescents, from 5.9% in 2002 to 11.7% in 2004. From 2004 to 2010, the government set up and implemented health promotion programs to promote physical activity and good nutritional habits in order to prevent overweight and obesity in children and adolescents. Our study aimed to estimate the prevalence of overweight and obesity among adolescents in urban areas of Ho Chi Minh City in 2010.

Methods: A representative sample of 1,989 students aged 11–14 years was selected using a multistage cluster sampling method. 23 schools were randomly selected from the full list of all public junior high schools. In each selected school, 2 classes were chosen at random and all students from the class were examined. Age- and sex-adjusted overweight and obesity were defined using International Obesity Taskforce cut-offs.

Results: The prevalences of overweight and obesity were 17.8% and 3.2%, respectively. Prevalences of overweight and obesity were significantly higher in boys (22%, 5.4%) than in girls (13.3%, 1.3%, p<0.001) and higher in children from districts with a high economic level (20.5% , 3.8%) than in those from districts with a low economic level (12.1%, 3.8%, p<0.001). Additionally, children living in wealthier families were more overweight and obese than those living in less wealthy families. When using WHO cutoffs, the overall prevalences of overweight and obesity reached 19.6% and 7.9%, respectively.

Conclusion: Our study's findings suggest that the prevalence of overweight and obesity among secondary school students remains high, especially among boys living in wealthier families. Public health programs should therefore be developed or improved in order to promote good eating habits and physical activity among youth in HCMC.

Keywords: Adolescent overweight, Ho Chi Minh City, IOTF definition, Obesity, Prevalence, Socioeconomic, Vietnam

Background

The prevalence of overweight and obesity among children and adolescents is gradually increasing worldwide. Although the highest prevalence rates of childhood obesity are observed in developed countries, obesity is also increasing in developing countries [1]. In East Asia and South East Asia, rapid urbanization and socio-economic development combined with changes in eating habits and in physical activities have led to an increase in obesity in adults, as well as in children [2].

Vietnam is a country located in South East Asia with 86,927,700 inhabitants [3]. Over the past decade, eating habits of Vietnamese people changed substantially [4]. There was a rapid and sustained reduction in prevalence of underweight (weight-for-age z-score < −2) from 33.8% in 2000 to 18.9% in 2009 among children aged under 5 [5]. At the same time, prevalence of overweight and obesity increased rapidly, especially among children and adolescents and in urban areas. In 2005, the National Survey on overweight and obesity showed that the prevalence among adults in Vietnam was about 16.3% in urban areas. The prevalence among children less than 5 years almost doubled in 3 years, rising from 3.2% in 2002 to 6.3% in 2005 [6].

In Vietnam, many studies about overweight and obesity have been conducted in children less than 10 years of age. Few studies have looked at this issue among adolescents (11–14 years of age). Obesity in adolescence substantially increases the risk of and its associated health deficiencies

* Correspondence: nnvanphuong@yahoo.com
[1]Pham Ngoc Thach Medical University, 86/2 Thanh Thai Street, District 1, Ho Chi Minh City, Vietnam
Full list of author information is available at the end of the article

Nguyen et al. BMC Public Health 2013, 13:141
http://www.biomedcentral.com/1471-2458/13/141

in adulthood. Additionally, obesity in adulthood is a high risk factor for cardiovascular diseases and chronic diseases, such as hyperlipidaemia, hyperinsulinemia, hypertension, and early atherosclerosis [7,8].

Ho Chi Minh City (HCMC) is the largest city in Vietnam. According to a study conducted in 2004, which used International Obesity Taskforce (IOTF) cutoffs, the prevalences of overweight and obese adolescents in HCMC were 11.7% and 2.1%, respectively. A cross-sectional study in 2002 reported a prevalence of overweight and obesity among adolescents of HCMC of 5.9% and 0.7% [9]. These results demonstrate the high increase of overweight and obesity in adolescents from HCMC over two years.

From 2004 to 2010, the government set up and implemented health promotion programs to promote physical activity and good nutritional habits to prevent overweight and obesity in children and adolescents [10,11]. Our study was conducted in order to estimate the prevalence of overweight and obesity among adolescents in Ho Chi Minh City in 2010. The findings aim to contribute to the understanding of adolescents' nutritional status in urban areas of Vietnam and we hope to offer elements for developing strategies for prevention and control among adolescents of Ho Chi Minh City.

Methods

Study design

We conducted a cross-sectional survey among grades 6–9 (11–14 years) of HCMC junior high schools in 2010. It is estimated that about 92% of adolescents living in HCMC are attending secondary high schools [12]. HCMC is administratively divided into 24 districts: 5 rural districts, 5 suburban (districts numbers 2, 7, 9, and 12), and 14 urban districts [13]. This study was conducted in urban districts only.

Urban districts number 1, 3, 5, and 10 are classified as wealthy districts by the National Department of Statistics. There are about one million inhabitants (20% of the urban population of HCMC) including 54,505 students in grades 6–9 attending the 45 public junior high schools (data provided by the City Department of Education for the year 2009–2010). We randomly selected 15 of these 45 schools, using a probability proportional to the size of the target population (the number of students in grades 6–9 within each school).

In the remaining ten urban districts, there are 138,589 students in grades 6–9 attending the 99 public junior high schools. We randomly selected 8 of these 99 schools, using also a probability proportional to the size of the target population. Due to the random process, no schools were selected in district 6, the Phu Nhuan district, and the Binh Tan district, while two schools were selected in the Tan Phu district. One school was selected per district for the six remaining districts.

In each selected school, we randomly selected a class in grades 6–7 and one class in grades 8–9 using a uniform probability model. All adolescents of a selected class were invited to participate to the study.

For such a multistage cluster sampling method, a sample size of 1,530 students was required to have a precision of 0.05 on the estimated prevalence, with a correction for clustering effect of 2.1 and with a prior prevalence of 12% in wealthy districts and 2% in less wealthy districts [9]. With an expected missing data rate of around 25%, 2000 students needed to be enrolled in the study. Based on the detailed data of the HCMC Department of Education, we computed a mean number of 45 students per class. With 46 classes (23 schools), the expected number of students was 2,070: 1,350 in wealthy districts and 720 in less wealthy districts.

When combining data for wealthy and non wealthy districts, weights of 0.17 and 0.83 corrected for the lower proportion of students in wealthy districts (28%) than in non wealthy districts (72%).

Data collection

Self-administered questionnaires were used to collect information from students and their parents. The researcher and trained interviewers gave students standardized instructions for filling out the questionnaires, which were completed in the classroom in 2 h. Interviewers were present during questionnaires completion to answer questions as necessary. The questionnaire for students included a pubertal questionnaire concerning the date of their first menstruation (for girls) and the date of voice change (for boys), as well as Tanner photographs illustrating five stages of pubertal development for male genitalia, male pubic hair, and female breasts.

The questionnaire for parents included height and weight information, socio-demographic data and household information such as family size, education and occupation, whether they owned domestic assets (telephone, radio, video cassette player, CD system, DVD player, air conditioner, refrigerator, computer, gas stove, microwave, bicycle, motorbike, car, TV). The questionnaire for parents was brought home by the student and returned to school on the next day.

Measures

Anthropometric measures

Students were weighed while wearing light clothes without shoes using a Tanita electronic scale (Tanita BF 571, Tanita Corporation, Japan). Heights were measured using a suspended Microtoise tape with standard methodology. Measurements were recorded by a trained worker. Body mass index (BMI) was calculated as the weight in kilograms divided by the square of the height in meters.

Nguyen et al. BMC Public Health 2013, 13:141
http://www.biomedcentral.com/1471-2458/13/141

Table 1 Anthropometric measurements by age and gender of 1989 pupils from Ho Chi Minh City

Characteristics		≤ 11 yrs (Mean± SD)	12 yrs (Mean± SD)	13 yrs (Mean± SD)	≥ 14 yrs (Mean± SD)	Total
N	Boys	193	227	326	201	947
	Girls	190	301	332	219	1042
Weight (kg)	Boys	42 ± 12	46 ± 11	51 ± 12	53 ± 12	48 ± 12
	Girls	40 ± 9	44 ± 8	47 ± 8	46 ± 8	45 ± 8
Height (cm)	Boys	145 ± 8	152 ± 8	158 ± 8	163 ± 8	155 ± 10
	Girls	146 ± 7	152 ± 6	153 ± 6	154 ± 6	152 ± 7
BMI	Boys	19.8 ± 3.8	19.9 ± 3.7	20.0 ± 4.0	19.7 ± 3.6	19.9 ± 3.8
(kg/m^2)	Girls	18.5 ± 3.1	19.1 ± 2.7	19.9 ± 3.0	19.5 ± 2.9	19.3 ± 3.0
BMI z-score	Boys	0.74 ± 1.42	0.50 ± 1.35	0.22 ± 1.42	−0.17 ± 1.31	0.31 ± 1.42
	Girls	0.13 ± 1.20	0.11 ± 1.03	0.09 ± 1.07	−0.31 ± 1.05	0.02 ± 1.09

BMI z-score: z-score based on WHO 2007 reference values [17].

Assessment of the pubertal stage

For each student, pubertal stage was assessed as pre-pubescent or pubescent according to the WHO definition [14]. For girls, the pre-pubescent corresponds to breasts at stage 1, and no menarche; pubescent corresponds to breasts at stage 2 or more and post-menarche. For boys, prepubescent corresponds to genitalia at stage 2 or less, and pubescent corresponds to genitalia at stage 3 or more.

Data analysis

Analyses were conducted using STATA 10 (STATA Corporation, College Station, TX, USA, 2008). In order to compare our prevalences to previous surveys conducted in HCMC, the IOTF cutoffs were used [15,16]. However, BMI z-scores were also calculated using the WHO 2007 reference of BMI-for-age in children aged 5–19 years [17].

A household wealth index was calculated as the first principal component of the variance-covariance matrix of 14 dummy variables coding for ownership of 14 assets. This wealth index was categorized into 5 subgroups according to quintiles. Prevalence ratios were used as comparison indices. Trends across categories were tested using Cochran $\chi 2$ tests. Trends across ages were tested using linear slope tests. The statistical significance level was set to 0.05.

Ethical considerations

Standards of ethics in studies conducted in Vietnam were respected. The study protocol was approved by the Health Service of HCMC and by the Department of Education and Training of HCMC. The study was a collaboration between Pham Ngoc Thach Medical University and the Catholic University of Louvain (Brussels, Belgium). The protocol was approved by both universities. Informed consent was obtained from parents, students, and from principals with standard assurances of confidentiality.

Table 2 Anthropometric measurements by age and school location of 1989 pupils from Ho Chi Minh City

Characteristics		≤ 11 yrs ($\bar{x}$ ± SD)	12 yrs ($\bar{x}$ ± SD)	13 yrs ($\bar{x}$ ± SD)	≥ 14 yrs ($\bar{x}$ ± SD)	Total
n	Wealthy districts (n*)	261 (7)	328 (5)	454 (12)	236 (6)	1279 (30)
	Less wealthy districts (n*)	122 (5)	200 (12)	204 (8)	184 (6)	710 (31)
Boys (%)	Wealthy districts	50.2	40.2	47.6	48.3	45.8
	Less wealthy districts	50.8	47.5	53.9	51.1	50.8
Weight (kg)	Wealthy districts	42 ± 10	46 ± 10	50 ± 10	51 ± 12	47 ± 11
	Less wealthy districts	39 ± 9	43 ± 9	46 ± 10	48 ± 9	45 ± 10
Height (cm)	Wealthy districts	146 ± 7	152 ± 7	156 ± 7	158 ± 8	153 ± 8
	Less wealthy districts	144 ± 7	151 ± 7	155 ± 7	158 ± 8	153 ± 9
BMI	Wealthy districts	19.5 ± 3.6	19.7 ± 3.2	20.3 ± 3.6	20.0 ± 3.5	19.9 ± 3.5
(kg/m^2)	Less wealthy districts	18.5 ± 3.4	18.9 ± 3.1	19.2 ± 3.2	19.2 ± 3.0	19.0 ± 3.1
BMI z-score	Wealthy districts	0.56 ± 1.32	0.39 ± 1.16	0.28 ± 1.25	−0.11 ± 1.20	0.30 ± 1.25
	Less wealthy districts	0.15 ± 1.38	0.09 ± 1.23	0.12 ± 1.23	−0.41 ± 1.14	−0.09 ± 1.25

BMI z-score: z-score based on WHO 2007 reference values [17]. n: number of missing data.*

Nguyen et al. BMC Public Health 2013, 13:141
http://www.biomedcentral.com/1471-2458/13/141

Table 3 Prevalence of overweight and obesity among adolescents by age, gender, and puberty stage

Charateristics	[a]Overweight		[b]Obesity	
	%	PR (95% CI)	%	PR (95% CI)
Gender				
Boys	22.0	**1.65(1.42, 2.10)**	5.4	**4.15(2.31, 7.74)**
Girls	13.3	**1**	1.3	**1**
Age				
11 years	23.6	**2.23(1.59, 3.10)**	4.8	2.18 (1.00, 4.82)
12 years	18.4	**1.74(1.24, 2.42)**	2.8	1.27 (0.59, 3.00)
13 years	18.5	**1.75(1.26, 2.40)**	3.3	1.50 (0.69, 3.22)
≥ 14 years	10.6	**1**	2.2	**1**
Pubertal stage				
Pre-pubertal	21.0	1.21 (0.94, 1.55)	5.5	**1.90 (1.07, 3.33)**
Pubertal	17.3	**1**	2.9	**1**
Total	17.8		3.2	

[a,b]*IOTF's definition for overweight and obesity in adolescents* [15].
PR: Prevalence ratio.

Results

2,051 students participated in this study. Anthropometric measurements were gathered from 2,050 students. Family forms were missing (not returned) for 61 students, yielding 1,989 cases available for analyses.

In this study, the proportion of boys was 47.6%. Mean weight, height, BMI, and BMI z-score for each age group and gender are presented in Table 1. Boys were significantly heavier and taller than girls within each age group. As expected, the mean weight, height and BMI progressively increased with age in boys and in girls. However, the mean BMI z-score decreased with age in both genders; in boys, its decrease was 0.30 ± 0.04 per year of age, two times higher than the decrease observed among girls 0.14 ± 0.03 per year of age ($p < 0.002$).

Table 2 summarizes the anthropometric parameters by age and school location of 1989 pupils from HCMC. The mean weight, height, and BMI were higher in pupils studying in schools located in a wealthy district than in pupils studying in schools located in a less wealthy district. As shown in Table 2, BMI z-score decreased significantly with age in both wealthy and less wealthy districts but scores were higher in wealthy districts than in less wealthy districts, at each age.

The overall prevalence of overweight and obesity were 17.8% and 3.2%, respectively (Table 3). As shown in Table 3, the prevalence of overweight and obesity was significantly higher in boys than in girls ($p<0.001$).

Across age groups, there was a decreasing trend with age in overweight and obesity but this trend was only significant for overweight ($p<0.001$).

Pupils who had reached puberty had lower prevalence of overweight and obesity than those who had not yet reached puberty although the differences were only significant for obesity ($p<0.05$).

Figure 1 shows the age-and-sex adjusted BMI categories using IOTF cutoffs. Prevalence of overweight decreased significantly as age increased for boys and for girls ($p<0.007$ for boys and $p<0.001$ for girls). There was also a decreasing trend in obesity with age for both genders but it was not significant.

Table 4 shows the association between overweight, obesity and socio-economic indicators. As expected, the prevalence of overweight and obesity was lower in pupils studying in schools located in less wealthy districts and in poor families. These differences, however, were only significant for overweight ($p<0.001$).

Figure 2 illustrates trends of overweight and obesity across economic levels. There was an increasing trend in overweight and obesity from poorest to richest families and the trend was significant for overweight ($p<0.001$). Again, prevalence of overweight and obesity was higher in boys than in girls within each quintile of economic status.

Discussion

Our study reports the most recent prevalence of overweight and obesity among adolescents in Ho Chi Minh City. The overall prevalences of overweight and obesity in this representative sample of secondary high schools students of urban areas in Ho Chi Minh City were 17.8% and 3.2%, respectively. Compared to the results of the survey conducted in 2004 in Ho Chi Minh City, which

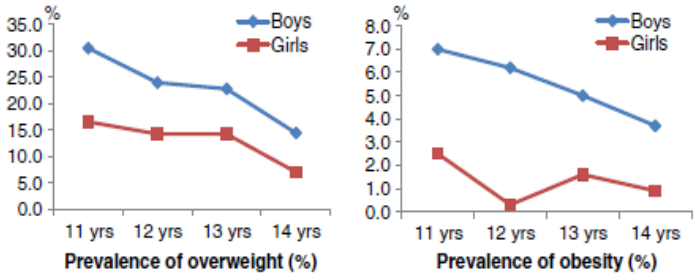


Figure 1 Prevalence of overweight and obesity by age and sex of teenagers from HCMC.

Nguyen et al. BMC Public Health 2013, 13:141
http://www.biomedcentral.com/1471-2458/13/141

Table 4 Prevalence of overweight and obesity among adolescents by gender, school location, and economic status of family

Characteristics	Overweight		Obesity	
	%	PR (95% CI)	%	PR (95% CI)
School location				
Wealthy districts	20.6	**1.70 (1.35, 2.13)**	3.8	1.81 (1.0, 3.15)
Less wealthy districts	12.1	**1**	2.1	**1**
Household wealthy index				
Poorest (1st quintile)	12.3	**1**	3.6	**1.0**
2nd quintile	11.7	0.95 (0.65, 1.39)	1.3	0.36 (0.13, 0.99)
3rd quintile	19.9	**1.62 (1.18, 2.27)**	1.9	0.53 (0.22, 1.22)
4th quintile	20.8	**1.69 (1.23, 2.41)**	5.3	1.47 (0.77, 3.00)
Richest (5th quintile)	24.4	**1.98 (1.46, 2.76)**	4.3	1.19 (0.62, 2.47)

PR: Prevalence ratio. [ab]IOTF definition for overweight and obesity in adolescents [15].

showed a prevalence of 11.7% and 2.1%, respectively [9], our finding indicates a continuing increase of overweight and obesity prevalence.

These prevalences depend upon the IOTF definition. Still today, age- and sex-specific BMI cutoffs for Asian children that are linked to the adult accepted BMI of 23 and 27.5 kg/m^2 for defining of overweight and obesity do not exist. It is important to establish references in populations of Asian children. The IOTF cutoffs were developed using several data sets and are therefore an international references that can be used to compare world-wide populations which is useful for epidemiology research [18]. These cutoffs were used for defining overweight and obesity among adolescents (11–14 years old) in our study. However, it should be kept in mind that the IOTF BMI cutoffs may not be appropriate for Asian adolescent populations as these cutoffs are mainly based on Caucasian populations; lower cut offs have been reported as more appropriate for defining BMI-related health risk in Asian populations [19]. Using IOTF cutoffs could result in underestimating the overweight and obesity prevalence among Vietnamese adolescents. The CDC 2000 or WHO 2007 definitions were two alternatives. The CDC 2000 growth reference defines children as at risk of overweight and obesity if their BMI exceeds the 85th and 95th centiles [20]. The CDC 2000 reference population is based on USA data, and covered the age range of 2–20 years. The WHO 2007 growth reference defines children as at risk of overweight and obesity if their BMI exceeds +1SD and +2SD or, equivalently, if their BMI z-score exceeds +1 and +2. The WHO 2007 reference population was derived from a combination of Brazil, Ghana, Norway, India, Oman, and USA growth data, and covered the age range of 5–19 years [17]. Prevalences based on these 3 definitions are presented in Table 5. For overweight, IOTF cutoffs resulted in higher prevalences than when using CDC cutoffs in all age- and sex categories, in higher prevalences than when using WHO cutoffs in boys, and in lower prevalences than when using WHO cutoffs in girls. For obesity, IOTF cutoffs resulted in lower prevalences than when using CDC or WHO cutoffs in all age- and sex categories. Such comparisons suggest that the actual prevalences of overweight and obesity are higher than our estimates in adolescents of urban areas of HCMC; the public health problem might be more severe than what is pictured by our data.

There are some difficulties when trying to compare our findings in Ho Chi Minh City to the results in other countries because the estimates of prevalence of overweight and obesity are based on different reference data, different cutoff values or different age groups. Using the same IOTF criteria, a cross-sectional study conducted in Thailand in 2007 reported prevalences of overweight and obesity in school children (6–15 years old) of 12.8% and 9.4%, respectively [21]. Another cross-sectional study conducted in the northern region of Malaysia among secondary high school children (11–15 years) published in 2006, reported a prevalence of 19.4% for overweight in urban areas, using the WHO definition of a sex- and age-BMI > 85th percentile [22], quite similar to our findings.

The results show that there is a two- to fourfold increase in prevalence for overweight and obesity when comparing boys and girls. From the poorest to the

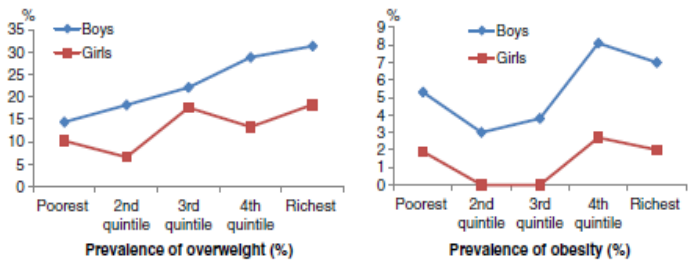


Figure 2 Prevalence of overweight and obesity by economic level and sex of teenagers from HCMC.

Nguyen et al. BMC Public Health 2013, 13:141
http://www.biomedcentral.com/1471-2458/13/141

Table 5 Prevalence (%) of overweight and obesity in boys and girls of HCMC in 2010, using different definitions

Age (yrs)	Boys				Girls				Total
	11	12	13	14	11	12	13	14	
Overweight (%)									
IOTF	30.5	24.0	22.8	14.5	16.6	14.3	14.4	7.1	17.8
CDC	21.5	17.5	15.7	9.8	15.0	13.3	14.0	5.8	14.1
WHO	28.2	24.8	20.0	14.1	22.4	19.0	19.0	10.0	19.6
Obesity (%)									
IOTF	7.0	6.2	5.0	3.7	2.5	0.4	1.6	0.9	3.2
CDC	18.1	13.0	12.1	7.8	4.2	1.4	2.2	2.3	7.2
WHO	21.6	14.3	12.8	7.2	4.7	2.1	2.2	1.8	7.9

IOTF: International Obesity Taskforce [15]. *CDC: The Centers for Disease Control* [20]. *WHO: World Health Organization* [17].

richest households, boys have a higher prevalence of overweight and obesity than girls. In other studies using IOTF cutoff values conducted in Ho Chi Minh City [23], Thailand [24], and Greece [25], similar findings were observed. This difference could be explained by a higher attention to physical appearance among teenage girls as teenage girls fear obesity more than boys.

Another explanation stems from the mentality of male-supremacy in Vietnam. Vietnamese families with sons usually want to feed them as much as possible. There are also differences in physical activities and eating habits between boys and girls [26,27].

Another interesting point to note is a decrease in prevalence of overweight and obesity as age increases, in boys as well as in girls. This trend was also observed in a study conducted in Italy in 2006 [28], and in another study conducted in Singapore [29]. Older teenagers are less dependent of their parents for daily activities; as results they are free to do more activities outside their home or school. In addition, dietary habits of younger children are more dependent on parental control and parents are more likely to encourage younger children to eat more weight and height gain [26].

Our study shows that the prevalences of overweight and obesity are almost doubled in wealthy districts. Such findings are similar to the survey conducted in 2004 [23]. In Vietnam, especially in Ho Chi Minh City, most schools with a high academic standard are located in the wealthy urban areas. Children in affluent families are often sent to these high-standard educational institutions with a high consideration for academic achievement, even if it is detrimental for their health in terms of physical activity or other activities [26].

Children living in wealthier families are more likely to be overweight and obese than those living in less wealthy families. These findings are similar to other studies conducted in developing countries [30] but quite different from industrialized countries where overweight and obesity are more frequent in lower socioeconomic status [31]. In developing countries, obesity is associated with higher socioeconomic status [2]. It is well accepted today that physical inactivity is a major determinant of obesity [32,33,34]. Wealthier Vietnamese families have a comfortable lifestyle at home, including numerous household electronic appliances that reduce the level of physical activity. Additionally, children in wealthier families are well equipped with modern recreational amenities such as computers, internet, TVs. They therefore spend a lot of time doing sedentary leisure. A recent study among Vietnamese junior high schools students showed that 24.3% of students from junior high schools were inactive [27].

Conclusions

Our study reports an important emerging public health problem of overweight and obesity in Ho Chi Minh adolescents. Overweight and obesity prevalences continue to increase among secondary-school students. There is therefore an urgent need to setup more aggressive intervention programs targeting good diet habits and physical activities for adolescents in Ho Chi Minh City.

Abbreviations

BMI: Body mass index; HCMC: Ho Chi Minh City; IOTF: International obesity task force; WHO: World health organization.

Competing interests

None of the authors of the above manuscripts has declared any conflict of interest statement.

Authors' contribution

NNVP participated in the design, carried out the study, performed the statistical analysis and drafted the manuscript. TKH provided advice in the design of the study and the analytical strategy and contributed to the manuscript revision. HT helped in the data analysis and report. AR and NTD are head of the project, provided advice about the structure, data analysis and presentation, and supervised the manuscript redaction. All authors read and approved the final manuscript. No author has any financial or private interest in this research project. No organization sponsors this research granted by the University Development Cooperation (www.cud.be), which is a Belgian public governmental funding. The corresponding author has full access to all the data in the study and has final responsibility for the decision to submit for publication.

Acknowledgment

This study was supported by a grant from the Belgian government: CUD – CUI – UPNT03 (www.cud.be). We would like to thank all principals and head teachers of the schools participating in our research. We also address a special thanks to master/mistress, teaching staff and class coordinators who assisted us in the collection of data. Special thanks to all pupils and their parents who graciously availed themselves and participated in the study.

Author details

[1]Pham Ngoc Thach Medical University, 86/2 Thanh Thai Street, District 1, Ho Chi Minh City, Vietnam. [2]Université catholique de Louvain - SSS/IREC/EPID, Institut de Recherche Expérimentale et Clinique, Clos Chapelle-aux-Champs 30 – UCL B1.30.13, B1200, Brussels, Belgium. [3]Research division EPID, Epidemiology and Biostatistics, School of Public Health, Brussels, Belgium.

Received: 22 July 2012 Accepted: 12 February 2013
Published: 15 February 2013

References

1. Mahfouz AA, Abdelmoneim I, Khan MY, Daffalla AA, Diab MM, Al-Gelban KS, Moussa H: **Obesity and related behaviors among adolescent school boys in Abha City, Southwestern Saudi Arabia.** *J Trop Pediatr* 2008, **54**(2):120–124.
2. Monteiro CA, Moura EC, Conde WL, Popkin BM: **Socioeconomic status and obesity in adult populations of developing countries: a review.** *Bull World Health Organ* 2004, **82**(12):940–946.
3. **Population and population density in 2010 by province of Vietnam.** In *General Statistics of Vietnamese Government*. http://www.gso.gov.vn/default_en.aspx?tabid=467&idmid=3&ItemID=11728 (accessed on February 15, 2013).
4. Nguyen CK, Pham VH: **Vietnam Recommended Dietary Allowances 2007.** *Asia Pac J Clin Nutr* 2008, **7**(S2):409–415.
5. National Institutue of Nutrition UNCsF: *A review of the nutrition situation in Vietnam 2009–2010*. Ha Noi: Medical Publishing house; 2011.
6. Nguyen CK: *The national general survey on overweight and obesity 2005*. Vietnam: National Institute of Nutrition; 2005.
7. Berenson GS, Srinivasan SR, Bao W, Newman WP, Tracy RE, Wattigney WA: **Association between multiple cardiovascular risk factors and atherosclerosis in children and young adults. The Bogalusa heart study.** *New Engl J Med* 1998, **338**:1650–1656.
8. Mahoney LT, Burnst TL, Stanford W: **Coronary risk factors measured in childhood and young adult life are associated with coronary artery calcification in young adults: the Muscatine study.** *J Am Coll Cardiol* 1996, **27**:277–284.
9. Hong TK, Dibley MJ, Sibbritt D, Binh PN, Trang NH, Hanh TT: **Overweight and obesity are rapidly emerging among adolescents in Ho Chi Minh City, Vietnam, 2002–2004.** *Int J Pediatr Obes* 2007, **2**(4):194–201.
10. Le TKQ: **Trends of Nutritional Status and Its Related Diseases in Ho Chi Minh City In 2001–2010.** *J Food Nutr Sci* 2010, **6**(3+4):7–9.
11. Le TKQ, Do TND, Nguyen VT, Tran TTT, Nguyen KD, Nguyen THX, Tran QC, *et al*: **Effectiveness of nutrition intervention and physical excercise on overeweight/obesity control in primary school children in district 10 of Hocminh city in 2008–2009.** *J Food Nutr Sci* 2010, **6**(3+4):93–106.
12. Office GS: *Statistical Yearbook of Vietnam*. Ha Noi: Statistical Publishing House; 2010.
13. Office HCMCS (Ed): *Statistical yearbook of HoChiMinh City*.: Ho Chi Minh Statistical ublishing House; 2010.
14. Chakar H, Salameh PR: **Adolescent obesity in Lebanese private schools.** *Eur J Public Health* 2006, **16**(6):648–651.
15. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH: **Establishing a standard definition for child overweight and obesity worldwide: international survey.** *BMJ* 2000, **320**(7244):1240–1243.
16. Cole TJ, Flegal KM, Nicholls D, Jackson AA: **Body mass index cut offs to define thinness in children and adolescents: international survey.** *BMJ* 2007, **335**(7612):194.
17. de Onis M, Onyango AW, Borghi E, Siyam A, Nishida C, Siekmann J: **Development of a WHO growth reference for school-aged children and adolescents.** *Bull World Health Organ* 2007, **85**(9):660–667.
18. Lobstein T, Baur L, Uauy R: **Obesity in children and young people: a crisis in public health.** *Obes Rev* 2004, **5**(Suppl 1):4–104.
19. Consultation W: **Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies.** *Lancet* 2004, **363**:157–163.
20. Kuczmarski RJ, Ogden CL, Guo SS: *CDC growth charts for the United States: Methods and development: National Center for Health Statistics*, Volume 11. Maryland: Centers for Disease Control and Prevention; 2002.
21. Sanguansak R, Lakkana R: **Prevalence of Overweight and Obesity Among School Children in Suburb Thailand Defined by the International Obesity Task Force standard.** *J Med Assoc Thai* 2010, **93**(2):527–31.
22. Zalilah MS, Mirnalini K, Khor GL, Merlin A, Bahaman AS, Norimah K: **Estimates and Distribution of Body Mass Index in a Sample of Malaysian Adolescents.** *Med J Malaysia* 2006, **61**(1):48–58.
23. Tang HK, Dibley MJ, Sibbritt D, Tran HM: **Gender and socio-economic differences in BMI of secondary high school students in Ho Chi Minh city.** *Asia Pac J Clin Nutr* 2007, **16**(1):74–83.
24. Supinya In-iw SS: **Boonying Manaboriboon, Chulathida Chomchai: Obesity in Thai Adolescents: Lifestyles, Health Attitudes and Psychosocial Concerns.** *Siriraj Med J* 2010, **62**(6):245–249.
25. Tzotzas T, Kapantais E, Tziomalos K, Ioannidis I, Mortoglou A, Bakatselos S, Kaklamanou M, Lanaras L, Kaklamanos I: **Epidemiological survey for the prevalence of overweight and abdominal obesity in Greek adolescents.** *Obesity (Silver Spring)* 2008, **16**(7):1718–1722.
26. Tang KH, Nguyen HH, Dibley MJ, Sibbritt DW, Phan NT, Tran TM: **Factors associated with adolescent overweight/obesity in Ho Chi Minh city.** *Int J Pediatr Obes* 2010, **5**(5):396–403.
27. Trang NH, Hong TK, Dibley MJ, Sibbritt DW: **Factors associated with physical inactivity in adolescents in Ho Chi Minh City, Vietnam.** *Med Sci Sports Exerc* 2009, **41**(7):1374–1383.
28. Lazzeri SR G, Pammolli A, Pilato V, Pozzi T, Giacchi MV: **Underweight and overweight among children and adolescents in Tuscany (Italy). Prevalence and short-term trends.** *J Prev Med Hyg* 2008, **49**:13–21.
29. Low S, Chin MC, Deurenberg-Yap M: **Review on epidemic of obesity.** *Ann Acad Med Singapore* 2009, **38**(1):57–59.
30. Wang Y: **Cross-national comparison of childhood obesity: the epidemic and the relationship between obesity and socioeconomic status.** *Int J Epidemiol* 2001, **30**(5):1129–1136.
31. Gordon-Larsen P, Adair LS, Popkin BM: **The relationship of ethnicity, socioeconomic factors, and overweight in US adolescents.** *Obes Res* 2003, **11**(1):121–129.
32. Andersen LB, Harro M, Sardinha LB, Froberg K, Ekelund U, Brage S, Anderssen SA: **Physical activity and clustered cardiovascular risk in children: a cross-sectional study (The European Youth Heart Study).** *Lancet* 2006, **368**(9532):299–304.
33. Li CL, Lin JD, Lee SJ, Tseng RF: **Associations between the metabolic syndrome and its components, watching television and physical activity.** *Public Health* 2007, **121**(2):83–91.
34. Schmitz KH, Jacobs DR Jr, Hong CP, Steinberger J, Moran A, Sinaiko AR: **Association of physical activity with insulin sensitivity in children.** *Int J Obes Relat Metab Disord* 2002, **26**(10):1310–1316.

doi:10.1186/1471-2458-13-141
Cite this article as: Nguyen *et al.*: High prevalence of overweight among adolescents in Ho Chi Minh City, Vietnam. *BMC Public Health* 2013 **13**:141.

4.2 Comparisons of prevalence of overweight and obesity 2004 – 2010

Article: Trends in overweight and obesity among adolescents in Ho Chi Minh City, Vietnam, 2004-2010

Authors: Phuong Van Ngoc Nguyen, Tang Kim Hong, Truong Hoang, Dung The Nguyen, Annie Robert

Journal: ready to submit to BMJ Open

Abstract

Introduction

Ho Chi Minh is the largest city in Vietnam. According to the two surveys in 2002 and 2004, the prevalence of overweight and obesity among adolescents was increasing from 5.9% and 0.7% in 2002 to 11.7% and 2.1% in 2004, respectively. From 2005 to 2010, there were some intervention programs to reduce the overweight and obese prevalence among children. Thus, we conducted a new survey in 2010 to assess the trend in the overweight and obesity prevalence between 2004 and 2010.

Methods

Two cross-sectional studies in urban area in HCMC using multi-stage cluster sampling, sample size was 2678 students in 2004 and 1989 students in 2010. International Obesity Taskforce (IOTF) sex and age specific BMI cut-offs were used to define overweight and obesity. Based on the US Centers for Disease Control and Prevention (CDC) 2000 growth reference, underweight was defined as BMI-for-age z-score < -2.

Results

The average of weight, height, BMI and BMI z-score in survey 2010 was higher than those in survey 2004. From 2004 to 2010, the prevalence of overweight and obesity significantly increased from 11.7% and 2% to 17.8% and 3.2%, respectively ($p < 0.001$). In contrast, there was a statistically significant decrease in prevalence of underweight ($p < 0.001$) (6.7% in 2004, 4.4% in 2010). The annual rate of change in obesity prevalence was +1.02%. The 77% overall increase in prevalence of overweight in girls was significantly greater than the 47% overall increase in boys ($p < 0.01$). The highest increase in prevalence was observed in the poorest families but the absolute prevalence was highest in the richest families.

Conclusions

The findings highlight a continuing increase in obesity and overweight prevalence in adolescent population in urban area in Ho Chi Minh City. The prevalence of overweight and obesity has begun increase in students from the poorest households. Therefore, these results alert to have more aggressive intervention programs in Ho Chi Minh City.

Introduction

Ho Chi Minh City, one of the largest cities in Vietnam, has undergone rapid economic and social developments over the last two decades. These developments have contributed in changes in lifestyle, eating habits of adults and children living in Ho Chi Minh City. These changes improved the under-nutrition status in vulnerable population, especially in children and adolescents. In parallel of a decreasing under-nutrition, the prevalence of overweight and obesity is rapidly increasing. The results of two cross-sectional nutritional surveys showed that the prevalence of overweight and obesity doubled, rising from 5.8% in 2002 to 13.7% in 2004 [1] during 2 years. However, the 2002 survey was primarily conducted to examine the prevalence of iron deficiency anemia so that the survey design could not be optimal to describe changes of overweight and obesity prevalence. As a consequence, there were some limitations to compare the prevalence of overweight and obesity among adolescents in the city. But the high prevalence observed in 2004 was a call to watch the problem. We conducted a study aimed at comparing prevalence of overweight and obesity among adolescents in HCMC between 2004 and 2010 in order to assess if the high prevalence of 2004 still maintained.

Methods

Study design and populations

Both 2004 and 2010 surveys were conducted based on cross-sectional population-based study among representative samples from junior high school students living in Ho Chi Minh City and attending schools.

Sampling and sample size

Survey 2004

In the 2004 survey, 2678 students were selected from a sample of 31 junior high schools across wealthy and less wealthy urban districts from a sampling frame of

140 secondary high schools which was stratified by wealthy (93 schools) and less wealthy (47 schools) urban districts. According to the Bureau of Statistics, Districts N^{o} 1, 3, 5, and 10 are the wealthy urban districts and the remainders are called less wealthy. From each of the selected schools, one class from grade six and seven, and one class from grade eight and nine were randomly selected. All students in each of the selected classes were examined. Seventeen schools from wealthy urban areas (1252 students) and 14 schools from less wealthy urban areas (1426 students) were investigated [1].

Survey 2010

As described in part 4.1, the sampling method in 2010 was similar to the sampling method of the survey conducted in 2004. In the survey conducted in 2010, 1,989 students from 23 schools were investigated.

Statistical analysis

Definition of overweight and obesity

Body mass index (BMI) was calculated as weight/height^2 (kg/m^2) and BMI cut off values were used to define overweight and obesity. Note that in this chapter, overweight and obesity have been combined when examining trends in prevalence across gender, age group, school location and economic status of family.

Definition of underweight

Underweight was defined as children with a BMI Z-score < -2 derived from the CDC 2000 Growth Reference [2] because this definition was used in survey 2004, and because it was recommended by a WHO expert committee [3].

Economic status

In both surveys, to assess economic status, a household wealth index was calculated as the first principal component of the

variance-covariance matrix of 14 dummy variables coding for ownership of 14 assets.This wealth index was categorized into 5 subgroups according to quintiles. Prevalence ratios were used as comparison indices. Trends across categories were tested using Cochran $\chi 2$ tests. Trends across ages were tested using linear slope tests. The statistical significance level was set to 0.05

Results

Table 4.2.1 summarized the characteristics of the participants in 2004 and 2010 surveys. For both boys and girls, students in survey 2010 were significantly heavier and taller, inducing a significantly higher BMI, and significantly higher BMI z-scores than students in survey 2004. Using IOTF definition, overweight and obesity prevalence increased from 11.7% and 2% in 2004 to 17.8% and 3.2% in 2010, respectively (p = 0.001) (Table 4.2.2). The annual rate of change between 2004 and 2010 was +1.02% for overweigh and +0.20% per year for obesity. In contrast, the prevalence of underweight significantly decreased from 6.7% in 2004 to 4.4% in 2010 (p = 0.001) corresponding to an annual rate change of -0.38% per year.

Table 4.2.1 Characteristics among adolescents in 2004 and 2010

Characteristics	**2004** (Reference)	**2010** (Mean ± SD)	**p – values**
Boys			
n	1347	947	
Weight	45	48 ± 12	
Height	153	155 ± 10	
BMI	19.0	19.9 ± 3.8	0.001
BMI z-score	- 0.10	0.13 ± 1.27	0.001
Girls			
n	1337	1042	
Weight	43	45 ± 8	
Height	151	152 ± 7	
BMI	18.6	19.3 ± 3.0	0.001
BMI z-score	- 0.20	- 0.01 ± 0.98	0.001

Table 4.2.2 Prevalence of underweight, overweight, obesity in 2004 and 2010

Characteristics	**2004** (reference)	**2010** (n = 1989)		p - values
	%	%	95% CI	
Obesity	2.0	3.2	[2.4, 4.0]	0.001
Overweight	11.7	17.8	[15.7, 20.0]	0.001
Underweight	6.7	4.4	[3.5, 5.3]	0.001

Considering overweight and obesity as a whole, Table 4.2.3 indicates an increase in prevalence of overweight and obesity from 2004 to 2010 across all gender and age groups, with a more important increase at ages 12, 13, and 14 years. The 77% overall increase in prevalence of overweight in girls was significantly greater than the 47% overall increase in boys ($p < 0.01$) but prevalences remained about twice higher in boys than in girls, at all ages. When looking at household wealth index, the highest increase in prevalence was observed in the poorest families but the absolute prevalence was the highest in richest families, for boys as well as for girls. The percentage increase in overweight and obesity was higher in adolescents from the poorest households.

Table 4.2.3 Prevalence of overweight/obesity in 2004 and 2010 by demographic characteristics

	Boys			**Girls**		
	2004 (Reference)	2010 (%)	PR* (95%CI)	2004 (Reference)	2010 (%)	PR* (95%CI)
Age group						
11 years	33.6	37.5	1.12 (0.77, 2.16)	14.1	19.1	1.35 (0.94, 2.56)
12 years	18.0	30.1	1.67 (1.25, 3.49)	6.5	14.7	2.26 (1.25, 3.49)
13 years	16.4	27.8	1.70 (1.14, 3.13)	8.7	15.9	1.83 (1.23, 3.42)
14 years	10.5	18.1	1.72 (0.97, 2.64)	4.3	8.0	1.86 (0.95, 2.59)
Household wealth index						
Poorest	8.2	18.8	2.29 (1.32, 3.74)	3.8	12.2	3.21 (1.38, 3.97)
2nd quintile	17.2	21.2	1.23 (0.83, 2.29)	6.8	6.6	0.97 (0.49, 1.63)
3rd quintile	20	26.0	1.30 (0.92, 2.51)	9.3	17.6	1.89 (1.16, 3.19)
4th quintile	26.6	37.0	1.39 (1.03, 2.80)	11.5	16.0	1.39 (0.83, 2.29)
Richest	27.3	38.3	1.40 (1.01, 2.75)	11.0	20.3	1.85 (1.24, 3.46)
TOTAL	19.2	28.3	1.47 (1.20, 3.32)	8.2	14.5	1.77 (1.38, 3.97)

**PR: Prevalence ratio.*

Discussion

Our study in junior high school students in Ho Chi Minh City showed that over a six-year period from 2004 to 2010, prevalence of overweight and obesity increased substantially (with +1.02% annual rate for overweight, +0.20% annual rate for obesity) while prevalence of underweight decreased (by -0.38% per year). Similar findings have been reported in a cross-sectional comparison between surveys in 2002 and 2004 showing a significant increase in overweight and obesity (overweight, and obesity were based on IOTF definition) of adolescents in Ho Chi Minh City (from 5% to 11.7% for overweight, and from 0.6% to 2% for obesity), and a significant decrease in underweight (from 13.1% to 6.7%) [1]. Annual rate of overweight prevalence (+1.02%/year) was still important from 2004 to 2010, compared to +3.4%/year from 2002 to 2004. From 2004 to 2010, HCMC has known a rapid socio-economic development with a GDP of US$1800 per capita in 2004 to a GDP of US$3010 per capita in 2010 [4, 5]. In addition, diet of students has shifted toward a diet with high fat, high energy density and low fiber [6]. Moreover, junior high school students in HCMC are more and more physical inactive [7, 8]. These changes have resulted in an increase in prevalence of overweight and obesity, and a decrease in prevalence of underweight among adolescents.

Our absolute prevalences are sometimes difficult to compare with other countries because of the current lack of consistency and agreement between different studies over the classification of overweight and obesity in children and adolescents. Using the same IOTF criteria, data from the China Health and Nutrition Survey among 12- to 18-year-old adolescents, showed that the prevalence of overweight in boys increased from 7.5% to 12.6% ($p=0.03$) between 2004 and 2009, while overweight in girls increased from 5.3% to 9.3% ($p>0.05$) [9]. Similarly, in a study of

school children aged 11 to 15 years in Sicily, there was an increase in the prevalence of overweight and obesity (using IOTF cut off values) in both boys and girls. The prevalence of overweight and obesity increased from 23.8%, and 7.9% in 1999-2001 to 27.5%, and 13.7% in 2009-2010, respectively, but only significantly for obesity [10]. In 2004 and 2010, the average prevalence of overweight in Vietnamese adolescents was higher than the corresponding prevalence for adolescents in China and in Sicily, but the prevalence of obesity in Vietnamese adolescents was lower than that in Chinese and in Sicilian adolescents.

Although the findings of our study showed that prevalence of overweight and obesity was higher in boys (28.3%) than in girls (14.5%), percentage increase in overweight and obesity were higher in girls than in boys (+76.8% vs +47.4%), in contrast to Hong's study conducted to compare prevalence of overweight and obesity (using the same IOTF cut off values) among adolescents (11-16 years) in HCMC between 2002 and 2004 where percentage increase in overweight and obesity were higher in boys than in girls (+113% in boys vs +39% in girls) [1]. The study in Sicily, from 1999-2001 to 2009-2010, also revealed that the increase in obesity was significantly higher in boys (9.7% vs 17.6%, p=0.001) than in girls (6.3% vs 9.8%, p=0.04). Our findings are in line with results of a cross-sectional study conducted in Lebanon, among 10-19 years adolescents, obesity prevalence (obesity defined based on WHO definition) was almost double in girls as compared to boys (+8.9% vs +4.5%). Sex differences in overweight and obesity were observed in many studies [1,9,11]. Wisniewski *et al*. suggested that boys and girls differ in body composition, patterns of overweight gain, hormone biology and susceptibility to certain social, ethnic, genetic, and environmental factors, which explaining the gender differences [12]. Our finding showed that overweight and

obesity were common in children living in wealthier families. These results were similar to other studies conducted in the Asian region [1, 13-16]. Our percentage of changes in prevalence of overweight and obesity were the greatest in the poorest families while in the study comparing surveys in 2002 and 2004 among adolescents in HCMC, the greatest increase in prevalence of overweight and obesity was observed in the richest families [1]. This might be explained by the fact that food outlets, such as bakeries, fast-food restaurant and snack shops, were more available and accessible in urban areas in 2004-2010 than in 2002-2004. In addition, this finding can be related to the fact that urban population in HCMC has become wealthy enough for children, even from the lower socio-economic groups, to experience excess weight gain [17], as in other fast-growing economic [13].

Nevertheless, prevalences of overweight and obesity in Vietnam in 2010 were higher than in 2004, in all age groups, and for both gender. Therefore, there is a need for the development of efficient policy and the introduction of legislation to prevent childhood overweight in Vietnam.

Conclusions

From 2004 to 2010, the prevalence of overweight and obesity increased significantly among both boys and girls at all ages, touching 1 boy in 3 and 1 girl in 5 in wealthier families in HCMC. Notably, the percentage increase in prevalence of overweight and obesity was higher in girls than in boys and fastest in children living in the poorest families. If this rapid growth isn't stopped, overweight and obesity among adolescents will seriously detriment to healthcare resources and produce significant increase in the economic costs of obesity and obesity-related illnesses. Therefore, public health prevention programs are urgently needed to reduce the prevalence of overweight and obesity in adolescents in Ho Chi Minh City.

References

1. Hong, T.K., *et al.., Overweight and obesity are rapidly emerging among adolescents in Ho Chi Minh City, Vietnam, 2002-2004.* International journal of pediatric obesity : IJPO : an official journal of the International Association for the Study of Obesity, 2007. 2(4): p. 194-201.
2. Kuczmarski, R.J., Ogden, C.L., Guo, S.S., *CDC growth charts for the United States: Methods and development: National Center for Health Statistics*. Vital Healthy Stat Vol. 11. 2002, Maryland: Centers for Disease Control and Prevention. 1-190.
3. Committee, W.E., *Physical status: The use and interpretation of anthropometry*, in *WHO Technical Report Series* 1995.
4. *Statistical Handbook of Vietnam*. 2010, Ha Noi: Statistical Publishing House.
5. Office, H.C.M.C.S., ed. *Statistical yearbook of HoChiMinh City*. 2010, Statistical Publishing House: Ho Chi Minh
6. Tang, K.H., *et al.., Factors associated with adolescent overweight/obesity in Ho Chi Minh city.* International journal of pediatric obesity : IJPO : an official journal of the International Association for the Study of Obesity, 2010. 5(5): p. 396-403.
7. Trang, N.H., *et al.., Factors associated with physical inactivity in adolescents in Ho Chi Minh City, Vietnam.* Medicine and science in sports and exercise, 2009. 41(7): p. 1374-83.
8. Trang, N.H.H.D., T.K. Hong, and M.J. Dibley, *Cohort profile: Ho Chi Minh City Youth Cohort—changes in diet, physical activity, sedentary behaviour and relationship with overweight/obesity in adolescents.* BMJ open, 2012. 2(1).
9. Seo, D.-C. and J. Niu, *Trends in Underweight and Overweight/Obesity Prevalence in Chinese Youth, 2004–2009.* International journal of behavioral medicine, 2013: p. 1-9.
10. Parrino, C., *et al.., Secular trends in the prevalence of overweight and obesity in Sicilian schoolchildren aged 11–13 years during the last decade.* PloS one, 2012. 7(4): p. e34551.
11. Yu, Z., *et al.., Trends in Overweight and Obesity among Children and Adolescents in China from 1981 to 2010: A Meta-Analysis.* PloS one, 2012. 7(12): p. e51949.
12. Wisniewski, A.B. and S.D. Chernausek, *Gender in childhood obesity: family environment, hormones, and genes.* Gender medicine, 2009. 6: p. 76-85.
13. Aekplakorn, W. and L. Mo-suwan, *Prevalence of obesity in Thailand.* Obesity reviews, 2009. 10(6): p. 589-592.
14. Li, M., *et al.., Factors associated with adolescents' overweight and obesity at community, school and household levels in Xi'an City, China: results of hierarchical analysis.* European journal of clinical nutrition, 2007. 62(5): p. 635-643.
15. Collins, A.E., B. Pakiz, and C.L. Rock, *Factors associated with obesity in Indonesian adolescents.* International Journal of Pediatric Obesity, 2008. 3(1): p. 58-64.
16. Tee, E., *et al.., Regional study of nutritional status of urban primary schoolchildren. 3. Kuala Lumpur, Malaysia.* Food & Nutrition Bulletin, 2002. 23(1): p. 41-47.
17. O'dea, J.A. and M.P. Eriksen, *Childhood Obesity Prevention: International Research, Controversies, and Interventions*. 2010: Oxford University Press.

Chapter 5 Sedentary behaviors and overweight among adolescents in Ho Chi Minh City

5.1 Small-screen recreation time and overweight

Article: Small-screen recreation time and overweight in adolescents of Ho Chi Minh City, Vietnam

Authors: Phuong Van Ngoc Nguyen, Tang Kim Hong, Truong Hoang, Dung The Nguyen, Annie Robert

Journal: BMC Public Health (under review)

Abstract

Background

Obesity in adolescence increases the risk of cardiovascular- and chronic diseases in adulthood. Small-screen recreation activities (SSR-A) have increased among youths but their impact on obesity is not well documented. Our study aimed to assess time spent on SSR-A and its relationship with body mass index (BMI) in adolescents of Ho Chi Minh City (HCMC) in Vietnam.

Methods

In a cross-sectional study of 2024 junior high school students of HCMC, adolescents were measured for BMI and questioned on time spent on watching television/Video/DVD or using computer for fun. High users were defined as time ≥2h/day. Internal Obesity Task Force BMI cutoffs were used to define overweight and obesity (OO).

Results

Adolescents spent 2.2 h/day (median) in SSR-A, with higher values for boys than girls ($p<0.001$), and 53.8% were high users (boys/girls=63%/46%, 95%CI:[1.26-1.48], $p<0.001$). Time spent on using computer for fun increased with age without a decrease in time spent on watching TV/Video/DVD, and it increased with household wealthy index. Prevalence of OO was 21.1%. Time in SSR-A increased with BMI in girls aged 13-14 ($p<0.047$), and OO tended to be more prevalent in high users (OR=1.34, 95%CI:[0.99-1.81], p=0.062) among adolescents aged 11-12. Using multiple logistic regression, high user at younger age was predictive of OO (OR=1.59, 95%CI:[1.06-2.38], p=0.02).

Conclusion

In HCMC, a majority of adolescents spent ≥2h/day in SSR-A, with a significant increase in overweight and obesity among younger adolescents. Public health intervention programs are needed to reduce inactive time spent by adolescents in small-screen recreation activities.

Key words: Adolescents, computer, Ho Chi Minh City, overweight, obesity, television, Vietnam.

Background

In recent years, overweight and obesity among adolescents have been reported as a major public health problem, not only in developed countries but also in developing countries [1], where the rapid changes in economy and society have induced a change in childhood lifestyles, such as increasing sedentary behaviors, and decreasing physical activity [2].

By contributing to the energy imbalance, sedentary behavior is considered as an important determinant of obesity [3], as demonstrated in many studies [4, 5]. Sedentary behavior includes a wide range of activities such as screen-based activities, reading and doing homework. Screen-based activities, such as watching television (TV), videos, DVDs, and using computers for fun have become common sedentary behaviors among young people [6]. There is also some evidence that youths spending more time in screen-based activities have an increased risk of developing obesity [7], and chronic diseases (such as diabetes type 2, hypertriglyceridemia, cardiovascular) later in life [8, 9].

Ho Chi Minh City (HCMC), the largest and most economically dynamic urban area of Vietnam, is undergoing a nutrition transition where under- and over-nutrition co-exist in the same population [10]. The rapid change in socio-economy has strongly affected the lifestyle and dietary habits of the people, contributing to the emerging epidemic of overweight/obesity in the city, especially among adolescents [11]. A recent study among adolescents of HCMC showed that the prevalence of combined overweight/obesity increased from 14.2% in 2004 to 21.8% in 2009, and that time spent on sedentary behaviors increased while time spent on physical activities decreased in the same 5-year period [12].

Recent studies have been conducted in HCMC to describe risk factors of overweight and obesity among adolescents, such as active commuting to

school or physical inactivity [13][14]. Although these studies also referred to sedentary behaviors, they did not report on small-screen recreation time (i.e. watching television, videos, DVDs and using computer for fun), that is known to be the most popular sedentary leisure activity in adolescents. This article aims to assess time spent in small-screen recreation activities (i.e. television, video, DVD, and computer) and its relationship with body mass index (BMI) in adolescents from various socio economic levels of HCMC in Vietnam.

Methods

Study design

The design of the present study has been described in details in a recent paper [15]. Briefly, a cross-sectional survey was conducted among grades 6-9 (11-14 years) junior high schools of HCMC in 2010. Classes were selected using a multistage stratified cluster sampling method. In a first stage, we stratified all public schools by wealthy and less wealthy urban districts. In a second stage, schools were selected using a step proportionate to population size within each stratum. In each selected school, we prepared two lists of classes by grade (grade 6-7 and grade 8-9), and one class was chosen at simple random on each list. All students from selected classes were invited to participate. In total, there were 23 schools out of 144 public schools, with 2024 out of 193,094 secondary high-school students in HCMC.

Measures

Anthropometric measures

Students' weight was measured in light clothes without shoes to the nearest 0.1 kg using a Tanita electronic scale (Tanita BF 571, Tanita Corporation, Japan). Height was measured to the nearest 0.1 cm using a suspended Microtoise tape with standard methodology. Measurements were taken once and recorded by one trained worker. Body mass index (BMI) was calculated as

weight in kilograms divided by squared height in meters. The International Obesity Task Force (IOTF) BMI cutoff values were used to define underweight, and combined overweight and obesity.

Small-screen recreation

Small- screen recreation was defined as a set of activities like watching TV/Video/DVD and using computer for fun (including e-communications, e-games, and surfing on the net). Total small-screen recreation time was defined as the sum of time spent watching TV/Video/DVD and time spent using computer for fun. Time measurements were based on self-administrated questionnaires. Questions of sedentary behaviors were based on the Adolescent Sedentary Activity Questionnaire [16], adapted to Vietnamese adolescents [17]. Students were asked about time spent on watching TV/Video/DVD and using computer for fun each day during a week, including weekdays and weekend days. Times were also categorized in either <2h/day or ≥2h/day (i.e. high users) spent watching TV/Video/DVD, using computer for fun or in both small-screen recreations [18, 19].

Data analysis

Analyses were conducted using STATA V.11 (STATA Corporation, 2009) and data were weighted for taking into account the multi-stage cluster sampling design. Age was classified into two groups of 11-12 years and of 13-14 years that roughly correspond to children in grades 6-7 and 8-9, respectively. These two age groups have different time at school, different study load, and different homework charges after school. A household wealthy index was calculated as the first principal component of the variance-covariance matrix of 14 dummy variables for ownership of 14 assets. This wealthy index was divided into 3 categories based on tertiles. Descriptive statistics are presented as median and interquartile range (IQR) or proportions. Since time data were not normally distributed, time spent watching

television, using computer for fun, or both (total small-screen recreation) was compared between the two groups using Mann-Whitney rank sum tests. Pearson chi-square tests were used to compare proportions. Trends across ordered categories were tested using Kruskal-Wallis or Cochran chi-square trend test. Odd ratios (OR) and 95% confidence interval (95%CI) were used as association indices. Multiple logistic regressions with interactions were used to assess the predictive value of high user on prevalence of overweight and obesity, and results are reported as odds ratios with 95% confidence intervals. High user (coded 1/0), boys (coded 1/0), younger age (11-12 years, coded 1/0), and interactions between high user and boy and between high user and younger age were submitted to a stepwise backward elimination procedure using maximum likelihood chi-square statistic to remove variable, but keeping a hierarchical model. The statistical significance level was set to 0.05.

Ethical considerations

Standards of ethics in studies conducted in Vietnam were respected. The study protocol was ethically approved by the Health Service of HCMC and the Department of Education and Training of HCMC. The study was a collaboration between Pham Ngoc Thach University of Medicine and Université catholique de Louvain (Brussels, Belgium). The protocol was also approved by the Ethical Review Committee of both universities. Informed consent was obtained from parents, students and school principals with standard assurances of confidentiality. Participants were informed that answering the anonymous questionnaire was voluntary.

Results

The sample consisted of 2,051 students. Anthropometric measurements were gathered from 2,050 students. Family form was missing in 60 cases, yielding to 1,989

cases available for analyses. Students spent a median of 129 min/day (IQR:[73, 210]) corresponding to 2.2h/day in total small-screen recreation. The total proportion of children watching TV/Video/DVD, using computer for fun, and spending time on small-screen recreation more than 2h/day was 29.6%, 16.9%, and 53.8%, respectively.

For each age and gender stratum, median of daily time spent in small-screen recreation and prevalence of ≥2h/day spent in small-screen recreation are shown in Table 1. Boys spent significantly more time watching TV, using computer for fun, and in both small-screen recreation than girls, but the difference was not significant for time spent watching TV among children group aged 11-12 years. In boys as well as in girls, students aged 11-12 spent more time watching TV/Video/DVD than using computer for fun. But at the age of 13-14 years, there was an increase in time spent using computer for fun, without a decrease in time spent watching TV/Video/DVD.

Proportion of high users in total small-screen recreation was higher in boys than in girls (boys/girls=63%/46%, 95%CI:[1.26-1.48], p<0.001). The proportion spending more than 2h/day at using computer for fun nearly doubled in youths aged 13-14, as compared with youths aged 11-12 (31.5% vs. 16.4% in boys and 12.7% vs. 6.5% in girls). Both time spent watching TV/Video/DVD and time spent using computer for fun increased with age (TV/Video/DVD viewing: from 69 [34, 120] min/day to 81 [46, 131] min/day; using computer for fun: from 31 [9, 69] min/day to 51 [17, 103] min/day; total small-screen recreation: from 107 [59, 184] min/day to 141 [86, 231] min/day). The prevalence of at least 2h/day spent watching TV/Video/DVD, using computer for fun, and in total small-screen recreation was significantly higher in students aged 13-14 years than in students aged 11-12 years

(TV/Video/DVD viewing: 32.3% versus 26.3%; using computer for fun: 21.9% versus 11.1%; total small-screen recreation: 60.4% versus 45.9%).

Table 5.1.1 Time (minutes/day) spent on watching TV/Video/DVD, using computer for fun, and in total small-screen recreation according to gender and age

	11-12 years			13-14 years		
	Boys	**Girls**	**p**	**Boys**	**Girls**	**p**
n	420	491		527	551	
Viewing TV/Video/DVD						
Median*** (min/day)	73 (35, 129)	62 (34, 111)	0.06	86 (47, 141)	77 (43, 129)	**0.04**
≥ 2h/day (%)	28.8	24.2	0.12	34.2	30.5	0.20
Using computer for fun*						
Median*** (min/day)	43 (17, 86)	21 (2, 51)	**0.001**	69 (26, 133)	34 (9, 77)	**0.001**
≥ 2h/day	16.4	6.5	**0.001**	31.5	12.7	**0.001**
Total small-screen recreation**						
Median*** (min/day)	133 (69, 211)	94 (51, 159)	**0.001**	167 (99, 257)	124 (73, 197)	**0.001**
≥ 2h/day	54.3	38.7	**0.001**	69.1	52.1	**0.001**

**Using computer for fun includes e-communications, e-games, surfing the net.* ****Small-screen recreation: watching TV/Video/DVD plus using computer for fun.* ******Median (IQR)*

Table 2 provides stratification by age and socio-economic status of time (minutes/day) spent watching TV, using computer for fun, and in total small-screen recreation, with the prevalence of at least 2h/day spent in small-screen recreation. Students studying in schools located in wealthy districts spent more time engaged in viewing TV, using computer for fun, and total small-screen recreation than students studying in schools located in less wealthy districts, with highly significant differences in using computer for fun in youth aged 13-14 years. For TV/Video/DVD viewing, the prevalence of students spending more than two hours per day was significantly higher for schools located in wealthy districts than for schools located in less wealthy districts, in both age groups. A similar

higher prevalence in wealthy district was observed when looking at students spending ≥2h/d using computer for fun, mainly at the age of 13-14 years (25% versus 17%, p<0.002). For the total small-screen recreation time among students aged 13-14 years, 64% spent ≥2h/d for schools from wealthy districts, against 55% for schools from less wealthy districts (p<0.006).

According to our household wealthy index, we also observed an increasing median of time spent at using computer for fun with increasing index, in children aged 11-12 years (from 17 to 39 min/day, p<0.001). In youths aged 13-14 years, the median time was increasing with the household index for both activities (watching TV/Video/DVD and using computer for fun), leading to a total small-screen recreation time increasing from 136 min/day in the poorest to 154 min/day in the richest families, with a proportion spending ≥2h/day that increased from 56% to 64% (trend p<0.04).

Table 5.1.2 Time spent on watching TV/Video/DVD, using computer for fun, and in small-screen recreation according to school location and household wealthy index.

	Watching TV/Video/DVD				Using computer for fun*				Total small-screen recreation**			
	Median*** (min/day)	p	≥ 2h/day	p	Median*** (min/day)	p	≥ 2h/day	p	Median*** (min/day)	p	>= 2h/day	p
Age 11-12 yrs												
School location		0.57		**0.04**		**0.02**		0.41		0.15		0.22
Less wealthy districts	64 (36, 111)		22.4		26 (6, 60)		9.9		99 (58, 171)		43.2	
Wealthy districts	69 (34, 128)		28.5		34 (9, 73)		11.7		111 (56, 189)		47.4	
Household wealthy index		0.64		0.64		**0.001**		0.91		0.06		0.12
Poorest	69 (34, 120)		25.7		17 (0, 56)		11.3		99 (51, 171)		42.6	
2nd	72 (39, 120)		25.9		34 (9, 69)		11.0		112 (64, 176)		46.4	
Richest	64 (34, 124)		27.4		39 (16, 81)		11.0		116 (61, 193)		48.7	
Age 13-14 yrs												
School location		0.16		**0.04**		**0.001**		**0.002**		**0.001**		**0.006**
Less wealthy districts	76 (43, 129)		28.4		39 (15, 86)		16.8		132 (77, 208)		54.9	
Wealthy districts	86 (47, 137)		34.5		51 (17, 116)		24.8		150 (87, 240)		63.5	
Household wealthy index		0.64		0.72		**0.001**		**0.001**		**0.004**		**0.04**
Poorest	77 (43, 137)		33.1		34 (9, 77)		14.6		137 (75, 204)		56.3	
2nd	81 (46, 137)		31.9		51 (17, 111)		24.0		146 (81, 236)		60.8	
Richest	86 (47, 137)		31.9		60 (26, 120)		27.0		154 (94, 249)		64.1	

** Using computer for fun: e-communications, e-games, surfing the net.* *** Small-screen recreation: watching TV/Video/DVD and using computer for fun.* **** Median IQR*

According to IOTF definition, 12.6% of adolescents were underweight and 21.1% were overweight or obese. Prevalence of underweight was close between boys (12.3%) and girls (13.0%) but overweight and obesity was much higher in boys (28.3%) than in girls (14.5%). Relationships between BMI categories and time spent watching TV/Video/DVD, using computer for fun, or both are illustrated in Figure 1, Figure 2, and Figure 3, respectively. There was an increase in time spent watching TV/Video/DVD across BMI status in boys and in girls aged 11-12 years (Figure 1), while in children aged 13-14, we didn't observe such increasing trend. Figure 2 also shows that time spent using computer for fun tended to increase across BMI categories, but it was only significant among girls aged 13-14 ($p<0.042$). As shown on Figure 2, overweight and obese boys spent more time using computer for fun than overweight and obese girls of the same age (youths aged 11-12: 51 vs 27 min/day, $p<0.001$; youths aged 13-14: 60 vs 41 min/day, $p<0.02$).

Figure 3 also shows that in girls aged 13-14 years, there was a significant increase in time spent in total SSR as BMI category increased ($p<0.047$). This increasing trend was also observed in boys aged 11-12 but without reaching statistical significance ($p<0.08$). It should be underlined that time spent on total small-screen recreation in overweight and obese boys aged 11-12 (Median: 149 min/day, IQR:[81, 249]) was as much as in overweight and obese girls aged 13-14 (Median: 139 min/day, IQR:[77, 223]). Although there was no increasing trend in boys aged 13-14, median time spent on total small-screen recreation was higher than the median of all other children groups.

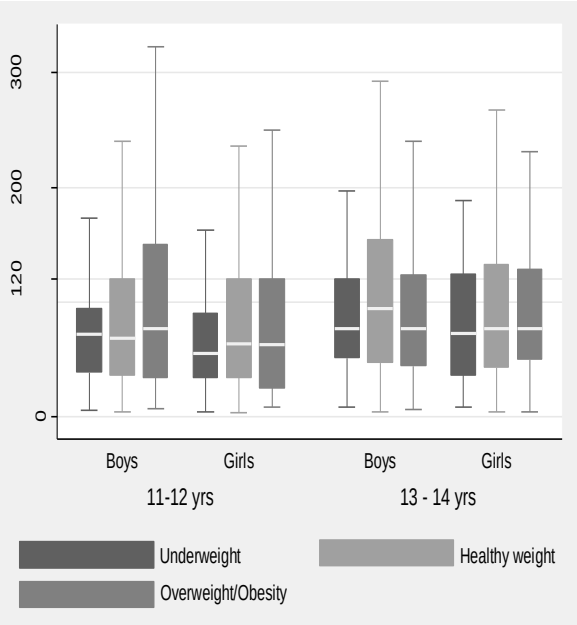


Figure 1 Relationship between BMI categories and time spent watching TV/Video/DVD by age and gender

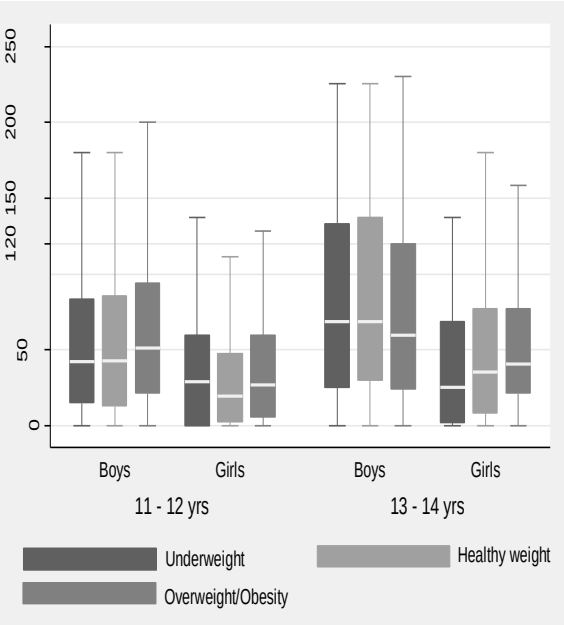


Figure 2 Relationship between BMI categories and time spent using computer for fun by age and gender

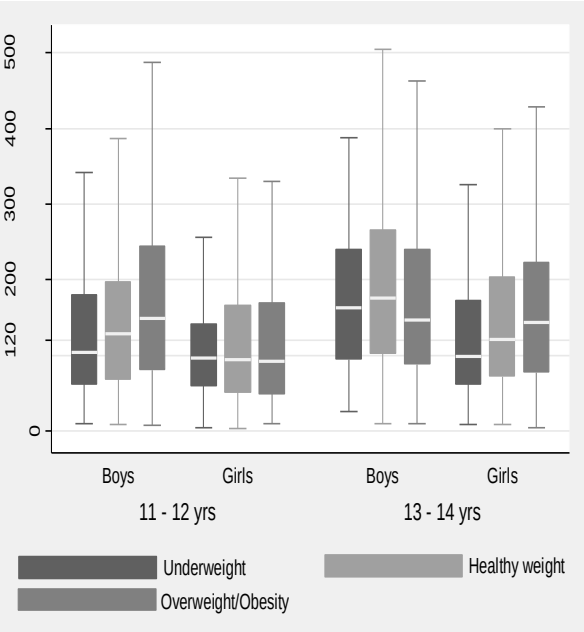


Figure 3 Relationship between BMI categories and time spent in total small-screen recreation by age and gender

Among adolescents aged 11-12, the prevalence of overweight and obesity was higher in children spending ≥2h/day than in children spending <2h/day (OR=1.34, 95%CI:[0.99-1.81], p=0.062). In multiple logistic regression, interaction between high user and boy was not significantly associated with prevalence of overweight and obesity (p=0.89) and this interaction was therefore removed from multiple logistic regression model. Interaction between high user and younger age was

however significant (OR=1.59, 95%CI:[1.06-2.38], p<0.02). Our final multiple logistic regression model included high user, younger age, interaction between high user and younger age, and boy (adjusted OR=2.66, 95%CI:[2.06-3.44], p<0.001). In adolescents aged 13-14, high user was not significantly associated with overweight and obesity prevalence (adjusted OR=0.74, 95%CI:[0.51-1.07], p=0.11), but in adolescents aged 11-12, high user was predictive of overweight and obesity (adjusted OR=1.48, 95%CI:[1.09-1.99], p<0.02).

Discussion

In our study the median time that students spent on total small-screen recreation was 2.2h/day; 53.8% spending more than two hours per day in total small-screen recreation. These results are higher than the recommended maximum time of 2h/day [19]. It is not easy to compare our findings in HCMC to results reported for other countries because the estimates of time spent on small-screen recreation are based on different age groups, different sedentary questionnaires, or different definition of small-screen recreation. Using the same sedentary questionnaire in our study, a cross-sectional study conducted in Australia in 2004 reported a mean of 3.1h/day spent in small-screen recreation, with 62% of children spending at least two hours per day in small-screen recreation among children aged 11-15 years [20]. Another cross-sectional survey conducted in 2006 among Chinese adolescents aged 13-18 years reported a median screen time of approximately 1.4h/day with 44.3% of boys and 34.7% of girls exceeding the screen time guidelines [21]. Although Vietnamese students spent less time in small-screen recreation than students in developed countries did, our results highlighted the high proportion of students exceeding the recommended daily limit of 2h in small-screen recreation.

We found that small-screen recreation time was associated with sex and age with boys spending significantly more time, and a higher proportion of boys than girls spending more than the recommended time on it. These results were consistent with those of other studies [20][4, 22]. This sex difference may be partly explained by the fact that girls are taking part in more varied activities other than screen behaviors, such as homework [23, 24]. From an age view, older children spend more time in small-screen recreation than younger children do [6, 25]. This is probably because older children are less dependent on their parents for daily activities; consequently, they are free to watch TV, video, DVD, or to use computers for fun.

Our results showed that students in richer families spend significantly more time using computer for fun, and more time in total small-screen recreation at the age of 11-12 years and also at 13-14 years, there was no significant gender difference in watching TV/Video/DVD. Among children aged 13-14 years, students from high more wealthy households were more likely to be spent more than 2h/day in using computer for fun, and in total small-screen recreation, compared with those from less wealthy households. These findings are consistent with other studies [26]. This is probably because parents from wealthier households usually provide their children with a "modern" life, including up-to-date recreational facilities such as computers. In addition, school location was associated with total small-screen recreation time among children aged 13-14 years, but not among children aged 11-12 years. Among children aged 13-14 years, 63.5% of students from schools located in wealthy districts spent more than 2h/day in total small-screen recreation. In HCMC, most schools with a high academic standard are located in the wealthy urban districts and therefore attract students from higher socio-economic families.

Body mass index category was not consistently associated with small-screen recreation time on a continuous scale in our study. Association between weight status and television/Video/DVD viewing was significant neither at the age of 11-12 years nor at the age of 13-14 years. These findings are not in line with those of other studies [18,21,27] which pointed television viewing as a leading factor associated with adolescent obesity. A cross-sectional survey assessing factors associated with adolescent overweight/obesity (11-14 years) in HCMC in 2004 showed that the number of hours spent watching TV was positively associated with obesity, with an apparent dose-response relationship [17]. However, there is still a debate because some other studies conclude that the relationship between television viewing and weight status is often small or inconsistent [28,29]. A possible explanation might be that the recent huge increase in computer activities has reduced the attractiveness of watching TV among teenagers. Overweight and obese girls aged 13-14 spent more time using computer for fun, and in total screen recreation than normal- or underweight girls. Such finding is consistent with other reports which shown a positive association between overweight and using computer for fun [20,27,30]. In a developing country like Vietnam, screen use was related to the economic prosperity of the country [21]. In Vietnam, from 2004 to 2010, the percentage of households having a computer was doubled (from 16.1% to 35.5%) in urban area, and there were 46 computers per 100 urban households in 2010 [30]. As a result, there was a high increase in the proportion of adolescents engaged in using computer for fun; TV time has been substituted by other multiple new entertainment options, like using computer for fun [31]. This highlights the need to implement programs that address the time spent using computer for fun and not just watching television among adolescents.

Using multiple logistic regression, we found that children aged 11-12 who spent more than 2h/day had a higher risk of overweight and obesity. Such finding is not easy to compare with results in other studies because of differences in age groups, in definition of SSR, in potential confounders introduced in models, and because of interactions considered in the modeling. A cross-sectional survey conducted in 2002 among Japanese adolescents (12-13 years) showed that watching TV and playing video game ≥2h/day in girls were strongly associated with overweight [15]. In this study, logistic regression analysis were performed with adjustment for age but separately for boys and girls and without interaction testing. Authors did not sum up time in the two activities. In Norwegian children (6-15 years), Kristiansen and collaborators developed a modeling of high users (y) with obesity included as an explanatory (x) rather than being the dependent variable (y); authors found that overweight and obesity was predictive of a screen time (watching TV/DVD and using computer) ≥2h/day [31]. In another cross-sectional study conducted in 2001 among Finnish children aged 14, 16 and 18 [27], Kautiainen did not find interaction between age and time spent on SSR in a logistic regression model developed to evaluate impact of time spent on viewing television, playing games and using computer on overweight, with adjustment on biological maturation, intensity of weekly physical activity and guardian's education. Their findings showed that increased time spent on watching TV and using computer were associated with increased prevalence of overweight (obesity inclusive) among girls. These findings are in line with ours. Small-screen recreation is usually associated with snaking foods and bad eating habits which lead to an increase in energy intake [32, 33]. An additional problem is that time spent on SSR reduces time spent on physical activities [14,34,35]. However,

this theory still debates. Some studies showed that using SSR and physical activity are independently associated with metabolic risk factors [36, 37]. Maher *et al*. indicated that screen time is interacting with weight status through pathways over and above displacement of physical activity [26].

The cross-sectional design of our study is a limitation. It is not possible to determine whether a cause-and-effect relationship exists between SSR time and overweight or obesity. Nevertheless, our study is based on a random sample of students from all public schools in HCMC and allows inferring results at the city level. Our study provides a comprehensive description of sedentary behaviors in small-screen recreation, which has been identified as the most popular sedentary leisure time activity among young Vietnamese adolescents aged 11-14 years in HCMC.

Conclusions

Our study shows that in HCMC, a majority of adolescents aged 11-14 years exceed the recommended daily limit of 2h in small-screen recreation time. As compared with children spending <2h/day in SSR, our results show that overweight and obesity tend to be more prevalent in boys aged 11-12 years and is clearly more prevalent in girls aged 13-14 years who spend more time in SSR. We found that interaction between younger age and high SSR user was predictive of overweight and obesity. There is an urgent need to set up public health intervention programs to reduce inactive time spent by adolescents on small-screen recreation activities, especially programs focusing on young adolescents and programs aiming at reducing time spent using computer for fun.

References

1. Lobstein T, Baur L, Uauy R: Obesity in children and young people: a crisis in public health. *Obes Rev* 2004, 5 Suppl 1:4-104.
2. Parizkove J, Chin, MK., Chia, M, Yang, J.: An international perspective on obesity, health and physical activity: current trends and challenges in China and Asia. *Journal of Exercise Science and Fitness* 2007, 5(1):7-23.
3. Proctor MH, Moore LL, Gao D, Cupples LA, Bradlee ML, Hood MY, Ellison RC: Television viewing and change in body fat from preschool to early adolescence: The Framingham Children's Study. *Int J Obes Relat Metab Disord* 2003, 27(7):827-833.
4. Sisson SB, Church TS, Martin CK, Tudor-Locke C, Smith SR, Bouchard C, Earnest CP, Rankinen T, Newton RL, Katzmarzyk PT: Profiles of sedentary behavior in children and adolescents: the US National Health and Nutrition Examination Survey, 2001-2006. *Int J Pediatr Obes* 2009, 4(4):353-359.
5. Pearson N, Biddle SJ: Sedentary behavior and dietary intake in children, adolescents, and adults. A systematic review. *Am J Prev Med* 2011, 41(2):178-188.
6. Currie C: Young people's health in Context: Health behaviour in School-aged Children (HBSC) Study: international report from the 2001/2002 survey. In. Copenhagen: Worlh Health Organization; 2004.
7. Hu FB, Li TY, Colditz GA, Willett WC, Manson JE: Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women. *JAMA* 2003, 289(14):1785-1791.
8. Nelson MC, Story M, Larson NI, Neumark-Sztainer D, Lytle LA: Emerging adulthood and college-aged youth: an overlooked age for weight-related behavior change. *Obesity (Silver Spring)* 2008, 16(10):2205-2211.
9. Pearson N, Salmon J, Campbell K, Crawford D, Timperio A: Tracking of children's body-mass index, television viewing and dietary intake over five-years. *Prev Med* 2011, 53(4-5):268-270.
10. Hong TK, Dibley MJ, Sibbritt D, Binh PN, Trang NH, Hanh TT: Overweight and obesity are rapidly emerging among adolescents in Ho Chi Minh City, Vietnam, 2002-2004. *Int J Pediatr Obes* 2007, 2(4):194-201.
11. TKQ L: Trends of Nutritional Status and its related diseases in Ho Chi Minh City in 2001-2010. *Journal of Food and Nutrition Sciences* 2010, 6(3+4):7-9.
12. Trang NH, Hong TK, Dibley MJ: Cohort profile: Ho Chi Minh City Youth Cohort--changes in diet, physical activity, sedentary behaviour and relationship with overweight/obesity in adolescents. *BMJ Open* 2012, 2(1):e000362.
13. Trang NH, Hong TK, Dibley MJ: Active commuting to school among adolescents in Ho Chi Minh City, Vietnam: change and predictors in a longitudinal study, 2004 to 2009. *Am J Prev Med* 2012, 42(2):120-128.
14. Trang NH, Hong TK, Dibley MJ, Sibbritt DW: Factors associated with physical inactivity in adolescents in Ho Chi Minh City, Vietnam. *Med Sci Sports Exerc* 2009, 41(7):1374-1383.

15. Nguyen PV, Hong TK, Hoang T, Nguyen DT, Robert AR: High prevalence of overweight among adolescents in Ho Chi Minh city, Vietnam. *BMC Public Health* 2013, 13(1):141.
16. Hardy LL, Booth ML, Okely AD: The reliability of the Adolescent Sedentary Activity Questionnaire (ASAQ). *Prev Med* 2007, 45(1):71-74.
17. Tang KH, Nguyen HH, Dibley MJ, Sibbritt DW, Phan NT, Tran TM: Factors associated with adolescent overweight/obesity in Ho Chi Minh city. *Int J Pediatr Obes* 2010, 5(5):396-403.
18. Janssen I, Katzmarzyk PT, Boyce WF, Vereecken C, Mulvihill C, Roberts C, Currie C, Pickett W: Comparison of overweight and obesity prevalence in school-aged youth from 34 countries and their relationships with physical activity and dietary patterns. *Obes Rev* 2005, 6(2):123-132.
19. Barlow SE: Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. *Pediatrics* 2007, 120 Suppl 4:S164-192.
20. Hardy LL, Dobbins TA, Denney-Wilson EA, Okely AD, Booth ML: Descriptive epidemiology of small screen recreation among Australian adolescents. *J Paediatr Child Health* 2006, 42(11):709-714.
21. Cui Z, Hardy LL, Dibley MJ, Bauman A: Temporal trends and recent correlates in sedentary behaviours in Chinese children. *Int J Behav Nutr Phys Act* 2011, 8:93.
22. Roemmich JN, Epstein LH, Raja S, Yin L: The neighborhood and home environments: disparate relationships with physical activity and sedentary behaviors in youth. *Ann Behav Med* 2007, 33(1):29-38.
23. Tang KH: Diet, Physical activity, environments and their relationship to the emergence of adolescent overweight and obesity in Ho Chi Minh City, Vietnam *Doctor of Philosophy in Clinical Medicine and Community Health.* Newcastle: The University of Newcastle; 2005.
24. Hardy LL, Dobbins T, Booth ML, Denney-Wilson E, Okely AD: Sedentary behaviours among Australian adolescents. *Aust N Z J Public Health* 2006, 30(6):534-540.
25. Hoyos Cillero I, Jago R, Sebire S: Individual and social predictors of screen-viewing among Spanish school children. *Eur J Pediatr* 2011, 170(1):93-102.
26. Pate RR, Mitchell JA, Byun W, Dowda M: Sedentary behaviour in youth. *British Journal of Sports Medicine* 2011, 45(11):906-913.
27. Rey-López JP, Vicente-Rodríguez G, Biosca M, Moreno LA: Sedentary behaviour and obesity development in children and adolescents. *Nutrition, Metabolism and Cardiovascular Diseases* 2008, 18(3):242-251.
28. Marshall SJ, Biddle SJ, Gorely T, Cameron N, Murdey I: Relationships between media use, body fatness and physical activity in children and youth: a meta-analysis. *Int J Obes Relat Metab Disord* 2004, 28(10):1238-1246.
29. Saelens BE: Helping individuals reduce sedentary behavior. *Obesity: Etiology, assessment, treatment, and prevention* 2003:217-238.

30. Office GS: Result of the Viet Nam - Household living standards survey 2010. Ha Noi: Statistical Publishing House; 2010.
31. Samdal O, Tynjälä J, Roberts C, Sallis JF, Villberg J, Wold B: Trends in vigorous physical activity and TV watching of adolescents from 1986 to 2002 in seven European Countries. *The European Journal of Public Health* 2007, 17(3):242-248.
32. Epstein LH, Roemmich JN, Paluch RA, Raynor HA: Influence of changes in sedentary behavior on energy and macronutrient intake in youth. *Am J Clin Nutr* 2005, 81(2):361-366.
33. Blass EM, Anderson DR, Kirkorian HL, Pempek TA, Price I, Koleini MF: On the road to obesity: Television viewing increases intake of high-density foods. *Physiol Behav* 2006, 88(4-5):597-604.
34. Boulos R, Vikre EK, Oppenheimer S, Chang H, Kanarek RB: ObesiTV: how television is influencing the obesity epidemic. *Physiol Behav* 2012, 107(1):146-153.
35. Sisson SB, Broyles ST, Baker BL, Katzmarzyk PT: Screen time, physical activity, and overweight in U.S. youth: national survey of children's health 2003. *J Adolesc Health* 2010, 47(3):309-311.
36. Jackson DM, Djafarian K, Stewart J, Speakman JR: Increased television viewing is associated with elevated body fatness but not with lower total energy expenditure in children. *Am J Clin Nutr* 2009, 89(4):1031-1036.
37. Ekelund U, Brage S, Froberg K, Harro M, Anderssen SA, Sardinha LB, Riddoch C, Andersen LB: TV viewing and physical activity are independently associated with metabolic risk in children: the European Youth Heart Study. *PLoS Med* 2006, 3(12):e488.

5.2 Sedentary behaviors and overweight

Article: Sedentary behaviors among adolescents in Ho Chi Minh City, Vietnam

Authors: Phuong Van Ngoc Nguyen, Tang Kim Hong, Truong Hoang, Dung The Nguyen, Annie Robert

Journal: ready to submit to Journal of Adolescents Health

Abstract

Introduction

Sedentary behavior is rapidly emerging as an important issue in public health. Young people who spend a large amount of time in sedentary behaviors are at risk of overweight and chronic diseases. A clear understanding of adolescents' patterns of sedentary behaviors is required to develop effective intervention programs to promote healthy living. Our study aimed to describe sedentary behaviors and their relationship with body mass index (BMI) status among adolescents in Ho Chi Minh City.

Methods

In a cross-sectional study of 2024 junior high school students of HCMC in 2010, students were measured for BMI and questioned on their sedentary behaviors based on validated sedentary behavior questionnaire. Sedentary behaviors were grouped into three categories: small-screen recreation, learning after school, and other sedentary activities. Overweight and obesity definition were based on the age- and sex-related Internal Obesity Task Force BMI cutoff values.

Results

Students spent 365 ± 198 min per day (around 6h/day) in sedentary activities with 129 min/day in small-screen recreation, 120 min/day in learning after school, and 51 min/day in other sedentary activity. Sedentary activities were associated with gender ($p<0.01$), and with socioeconomic level ($p<0.01$). There was also a significant association between BMI categories and time spent for learning after school ($p<0.01$).

Conclusions

Adolescents spent a lot of time in sedentary activities, especially in learning after school and small-screen recreations. There was a positive association between time spent in learning after school and overweight or obesity. Intervention programs should be set up to reduce the pressure of education on children and to promote physical activities among teenagers in Ho Chi Minh City.

Key words: Adolescents, Ho Chi Minh City, overweight, obesity, sedentary behaviors, Vietnam.

Introduction

Sedentary behavior is rapidly emerging as an important issue in public health [1]. By contributing to the energy imbalance, sedentary behavior is considered as an important determinant of obesity [2], as demonstrated in many studies [1,3]. Among children and adolescents, sedentary behaviors may decrease time spent on physical activity that lead to overall lower energy expenditure. Young people who spend a large amount of time in sedentary behavior are at risk of chronic diseases [4]. A clear understanding of children's patterns of sedentary behaviors is required to develop effective and sustainable intervention programs to promote healthy living.

Sedentary behavior includes a wide range of activities. The most common sedentary activities that were considered for association with overweight are small-screen recreation activities, including television-view and computer use [3, 5, 6] even if there are other sedentary activities in which children engaged that have an important role in children daily life, such as sitting and talking with friends, drawing, reading for pleasure, or learning after school [7].

Our study aimed to describe sedentary behaviors and their relationship with body mass index (BMI) status among junior high school students in order to provide more information to intervention programs targeting a reduction in overweight and obesity among children.

Methods

Study design

As presented in Chapter 3, we conducted a cross-sectional survey among junior high school students in Ho Chi Minh City. Using a 2 – stages sampling method, 1989 students were selected from 23 schools in the city.

Measurement

Anthropometric measures

As presented in Chapter 3, children were in light clothes without shoes. Then, standing height was measured using a suspended Microtoise tape with standard methodology, and body weight was measured using a digital scale. Measurements were taken once and recorded by one trained worker. Body mass index (BMI) was calculated as weight in kilograms divided by squared height in meters. The International Obesity Task Force (IOTF) BMI cutoff values were used to define underweight, and combined overweight and obesity.

Sedentary behavior

Sedentary behavior was a set of activities such as watching TV, Video/DVD, using computer for fun, using a computer for homework, doing homework without using a computer, following out-of-school-hours tutoring, reading for fun, doing hobbies, playing a musical instrument or hanging out. Time measurements were based on self-administrated questionnaires. Questions on sedentary behaviors were based on the Adolescent Sedentary Activity Questionnaire [8], adapted to Vietnamese adolescents [9]. Students were asked about time spent on each sedentary activity per day during a week, including weekdays and weekend days. Sedentary behaviors were grouped in three categories, as presented in Table 5.2.1. The time spent in each category was calculated and the total daily time spent in sedentary behavior was defined as the sum over each category.

Table 5.2.1 Categories of sedentary behavior and corresponding activities.

Sedentary category	Sedentary activity
Small-screen recreation	-Watching TV -Watching Video/DVD - Using computer for fun: mail, chat, games, surfing the net
Learning after school	- Using a computer for homework - Doing homework not use a computer - Out-of-school-hours tutoring
Other sedentary activity	- Reading for fun - Doing hobbies - Playing a musical instrument - Hanging out

Data analysis

Analyses were conducted using STATA V.11 (STATA Corporation, 2009) and data were weighted for taking into account the multi-stage cluster sampling design. Age was classified into two groups of 11-12 years and of 13-14 years that roughly correspond to children in grades 6-7 and 8-9, respectively. A household wealthy index was calculated as the first principal component of the variance-covariance matrix of 14 dummy variables for ownership of 14 assets. This wealthy index was divided into 3 categories based on tertiles. Descriptive statistics are presented as median and interquartile range (IQR) or proportions. Since time data were not normally distributed, time spent in small-screen recreation, in learning after school, and in other sedentary behaviors was compared between the two groups using Mann-Whitney rank sum tests. Pearson chi-square tests were used to compare proportions. Trends across ordered categories were tested using Kruskal-Wallis or Cochran chi-square trend test. The statistical significance level was set to 0.05.

Results

As a whole, students spent 365 ± 198 min per day (around 6h/day) in sedentary activities. Table 5.2.2 presents the mean time per day according to demographic characteristics, and BMI categories. There was no difference between boys and girls. Time spent in sedentary behavior increased significantly as age of children increased. Children studying in schools located in wealthy districts, and children living in wealthier families spent more time in sedentariness than those studying in schools located in less wealthy districts, or those living in poorer families ($p<0.001$). Small-screen recreation activities were the most time consuming, with a median of 129 min/day, (IQR: 73, 210). Time spent for education after school had a median of 120 min/day (IQR: 73, 184). Youths spent a median of 51

min/day (IQR: 17, 103) at other sedentary activities.

Table 5.2.2 Mean time (min/day) of sedentary behavior by demographic characteristics and body mass index categories.

Characteristics	n	Mean (SD)	p-value
Gender			0.70
Boys	947	367 (196)	
Girls	1,042	364 (200)	
Age (years)			**0.001**
11	383	291 (178)	
12	528	361 (183)	
13	658	388 (210)	
14	420	405 (196)	
School locations			**0.001**
Wealthy	1,279	389 (208)	
Less wealthy	710	333 (175)	
Wealthy household Index			**0.001**
Poorest	669	332 (184)	
2nd	657	378 (198)	
Richest	663	388 (207)	
BMI category			**0.03**
Underweight	256	329 (179)	
Healthy weight	1,321	369 (200)	
Overweight/Obesity	412	378 (200)	

Table 5.2.3 describes the median of time spent per day in the three different categories of sedentary behavior, by characteristics of the students. The findings show that there were consistent associations with gender, age, school location, wealthy household index. Time spent on small-screen recreation was higher in boys than in girls ($p<0.001$) while girls spent more time in education after school, and in other sedentary activities ($p<0.001$). Time spent in all three categories of sedentary behavior increased time with age increase. Notably, children studying in school located in wealthy districts, or living in the wealthiest household index spent more time in all three behavior activities than those studying in school located in less wealthy districts, or living in the poorest households ($p<0.001$). With regard to BMI categories, time spent at small-screen

recreation activities was higher among overweight and obese children, but not significantly (p=0.07). There was a significant association between BMI categories and time spent for education after school; overweight and obese children spent more time in education after school than others (p < 0.001).

Table 5.2.3 Median time (min/day) spent in each of the 3 categories of sedentary behavior according to age, gender, socio-economic levels and BMI categories.

	[*]Small-screen recreation		[**]Education after school		[***]Other sedentary activities	
Characteristics	Median (IQR)	p	Median (IQR)	p	Median (IQR)	p
Gender		**0.001**		**0.001**		**0.001**
Boys	150 (86, 240)		111 (64, 176)		39 (6, 89)	
Girls	109 (60, 180)		129 (79, 189)		59 (24, 116)	
Age (years)		**0.001**		**0.001**		**0.001**
11	89 (50, 163)		99 (60, 154)		34 (9, 77)	
12	125 (69, 195)		125 (75, 184)		54 (20, 104)	
13	137 (86, 223)		129 (73, 184)		56 (19, 110)	
14	150 (81, 240)		135 (86, 216)		54 (17, 111)	
School locations		**0.002**		**0.001**		**0.01**
Wealthy districts	133 (76, 219)		129 (77, 193)		54 (17, 107)	
Less wealthy districts	118 (65, 189)		109 (64, 171)		43 (17, 94)	
Wealthy household index		**0.001**		**0.001**		**0.001**
Poorest	119 (60, 189)		107 (60, 166)		41 (13, 91)	
2nd	133 (76, 219)		133 (81, 189)		54 (21, 104)	
Richest	137 (77, 219)		133 (81, 197)		56 (18, 109)	
BMI category		0.07		**0.001**		0.64
Underweight	129 (72, 189)		109 (58, 174)		42 (12, 89)	
Healthy weight	129 (69, 210)		120 (71, 184)		53 (19, 106)	
Overweight/Obesity	137 (77, 228)		134 (86, 193)		43 (9, 94)	

[*]*Small screen: watching TV, Video/DVD, using computer for fun, mail, chat, games, surfing the net.* [**]*Education after school: using a computer for homework, doing homework without computer, out-of-school-hours tutoring.* [***]*Other behaviors: reading for fun, doing hobbies, playing a musical instrument, hanging out.BMI: Body mass index.*

Table 5.2.4 Median time (min/day) spent in each of the 3 categories of sedentary behavior by demographic characteristics and BMI categories.

		*Small-screen recreation		**Learning after school		***Other sedentary activities	
Characteristics	**n**	Median(IQR)	p	Median(IQR)	p	Median(IQR)	p
11 – 12 yrs							
Boys			0.08		**0.002**		0.76
Underweight	**38**	104 (62, 180)		66 (48, 139)		26 (10, 69)	
Healthy weight	**243**	129 (69, 197)		99 (60, 163)		39 (10, 81)	
Overweight/ Obesity	**139**	149 (81, 249)		116 (77, 176)		30 (10, 77)	
Girls			0.90		0.06		0.54
Underweight	**50**	96 (60, 141)		103 (60, 163)		38 (17, 89)	
Healthy weight	**362**	94 (51, 166)		124 (77, 180)		55 (26, 114)	
Overweight/ Obesity	**79**	92 (50, 169)		133 (86, 193)		54 (17, 103)	
13 – 14 yrs							
Boys			0.52		**0.001**		0.89
Underweight	**81**	163 (94, 240)		103 (43, 171)		47 (10, 88)	
Healthy weight	**322**	176 (103, 266)		120 (71, 189)		43 (13, 99)	
Overweight/ Obesity	**124**	147 (88, 240)		146 (90, 208)		43 (10, 105)	
Girls			**0.04**		0.42		0.25
Underweight	**87**	99 (60, 173)		137 (81, 201)		54 (18, 129)	
Healthy weight	**394**	121 (72, 204)		133 (84, 206)		64 (28, 124)	
Overweight/ Obesity	**70**	139 (77, 223)		142 (103, 214)		75 (26, 119)	

**Small screen: watching TV, videos/DVDs, using computer for fun, mail, chat, games, surfing the net. **Education after school: using a computer for homework, doing homework not use a computer, out-of-school-hours tutoring. ***Other behaviors: reading for fun, doing hobbies, playing a musical instrument, hanging out.*

Table 5.2.4 shows association between BMI status and each different category of sedentary behaviors by age and gender. For boys, overweight and obese children aged 11-12 years tended to spend more time in small-screen recreation and in learning after school compared with other students but only significantly in learning after school ($p < 0.002$). Overweight and obese boys aged 13-14 years tended to spend significantly more time in learning after school ($p < 0.001$). Notably, time spent in small-screen recreation by boys aged 13-14 years was high in all BMI categories, while time spent in learning after school increased with age. For girls

aged 11-12 years, time spent at small-screen recreation activities was lower than in other age- and sex subgroups, and it didn't correlate with BMI categories. But for these girls aged 11-12 years, time spent for learning after school increased across BMI categories: overweight and obese children tended to spent more time on learning after school ($p = 0.06$). For girls aged 13-14 years, time spent at small-screen recreation activities increased with BMI categories: overweight and obese girls spent significantly more time in small-screen recreations ($p = 0.04$) and also more time for learning after school or at other sedentary activities, but not significantly. For this last category of activities, there was no correlation between time spent and BMI categories, but nearby all median times were lower than 1 hour per day.

Discussion

This section reports descriptive data on sedentary behavior and its relationship with BMI status among adolescents in HCMC. Until now, there is no international standard questionnaire for assessing sedentary behaviors among school- aged children outside of school hours. It is therefore quite difficult to compare studies across countries. In our study, questionnaire of sedentary behaviors was based on the Adolescent Sedentary Activity Questionnaire (ASAQ) that was developed through a literature review on common sedentary activities among adolescents [10, 11] and it appears that ASAQ was the best available tool for assessing time spent in a range of sedentary behaviors among adolescents for observational studies [8]. The questionnaire used in our study was modified and validated for Vietnamese adolescents [12] to be used in annual nutritional surveys in HCMC since 2004 [9, 13]. Although sedentary questionnaires are different, they have almost similar main information on sedentary activities such as viewing TV, playing games, using

computer, doing homework, using motorized transport, sitting and talking, or behavioral hobbies. So, it makes sense to compare time spent in each of these sedentary activities between studies.

For total sedentary behavior, our findings show that time increase with age; and that children living in wealthier households spent more time than others. Children spent more time in small-screen recreation than in other sedentary activities. As a whole, time spent in sedentary behavior was higher among overweight and obese students. These results are similar with a cross-sectional study conducted among Australian adolescents aged 11-15 years in 2004 with the same sedentary behavior questionnaire [7]. Adolescents attending higher grades had more extracurricular academic activities like homework and night classes. Also, wealthier families have a greater access to sedentary technologies, so, their children are more likely to engage in private study outside school hours, and their children are less likely to spend time helping with housework [14].

Our findings showed that time spent in small-screen recreation was higher among overweight and obese students, but this association was not consistently statistically significant across age and sex subgroups; girls aged 11-12 spent less time in such activities and boys aged 13-14 spent more time in such activities.

Our study found that Vietnamese children spent about 2 hours per day in learning after school (111 min/day for boys, and 129 min/day for girls). A cross-sectional study conducted among Chinese children aged 13-18 years published in 2008 showed that average time of learning after school was 102 min/day for boys and 114 min/day for girls [5]. While another survey conducted in 2004 among Hungary youths aged 13-18 years, showed that daily time spent in learning after school was 78 min/day for all boys and girls [15]. In Australia, an observational study in 2004 indicated that Australian children aged 11-15 years spent about 39 min/day in

learning after school for boys and 45 min/day for girls [7]. For learning after school, Vietnamese children spent as much time as Chinese children but spent more time than children of a developed country. Such differences may be explained by the fact that Vietnamese children like other Asian children have an academic-oriented culture, with a high priority placed on academic education; pressure is put on students by their parents and by schools. This is supported by literature reporting that Asian Australian children spend more time on homework than Caucasian children [7]. We found that there is not a consistent association between small-screen recreation time and overweight and obesity while there is an association between learning after school and BMI status. Our findings are similar with results in Chinese children [5]. Adolescents may shift from screen-based behavior to non-screen ones like learning after school. These results highlight the need to have strategies to reduce excessive educational sitting. Our study found that time spent in other sedentary behaviors was higher in girls than in boys, and increased with age. These findings were also consistent with other studies [5, 7, 14]. This might be explained by our Vietnamese culture because girls are expected to help their mothers with household activities and cleaning while boys may follow their fathers' behavioral patterns, which allow for more screen time. Older teenagers are less dependent of their parents for daily activities, and as a result, they are more exposed to schools, peers, and other socialization agents. In our study, we did not find an association between other sedentary activities and BMI status. This results was similar with a cross-sectional study conducted in Australian adolescents in 2004 [7].

A limitation of the survey was the use of self-report questionnaire, however the questionnaire used in this study was the only instrument measuring a comprehensive range of sedentary

behaviors among adolescents. Besides, nowadays there have more active electronic games such as PlayStation, Nintendo, and Wii, calling for develop another questionnaire with separate items for these new activities.

Conclusions

Our study showed that the increase in overweight and obesity among adolescents of HCMC is related to time spent in sedentary behaviors especially in small-screen recreation and in learning after school. There is therefore a need to increase awareness of the population, especially parents and children, about the bad effects of sedentary behaviors on health. Intervention programs should be setup to reduce the pressure of education on children and to promote physical activities among teenagers in Ho Chi Minh City.

References

1. Pearson, N. and S.J. Biddle, *Sedentary behavior and dietary intake in children, adolescents, and adults. A systematic review.* American journal of preventive medicine, 2011. 41(2): p. 178-88.
2. Proctor, M.H., *et al.., Television viewing and change in body fat from preschool to early adolescence: The Framingham Children's Study.* International journal of obesity and related metabolic disorders : journal of the International Association for the Study of Obesity, 2003. 27(7): p. 827-33.
3. Sisson, S.B., *et al.., Profiles of sedentary behavior in children and adolescents: the US National Health and Nutrition Examination Survey, 2001-2006.* International journal of pediatric obesity : IJPO : an official journal of the International Association for the Study of Obesity, 2009. 4(4): p. 353-9.
4. Hamilton, M.T., D.G. Hamilton, and T.W. Zderic, *Role of low energy expenditure and sitting in obesity, metabolic syndrome, type 2 diabetes, and cardiovascular disease.* Diabetes, 2007. 56(11): p. 2655-67.
5. Cui, Z., *et al.., Temporal trends and recent correlates in sedentary behaviours in Chinese children.* The international journal of behavioral nutrition and physical activity, 2011. 8: p. 93.
6. Roemmich, J.N., *et al.., The neighborhood and home environments: disparate relationships with physical activity and sedentary behaviors in youth.* Annals of behavioral medicine : a publication of the Society of Behavioral Medicine, 2007. 33(1): p. 29-38.
7. Hardy, L.L., *et al.., Sedentary behaviours among Australian adolescents.* Australian and New Zealand journal of public health, 2006. 30(6): p. 534-540.
8. Hardy, L.L., M.L. Booth, and A.D. Okely, *The reliability of the Adolescent Sedentary Activity Questionnaire (ASAQ).* Preventive medicine, 2007. 45(1): p. 71-4.
9. Tang, K.H., *et al.., Factors associated with adolescent overweight/obesity in Ho Chi Minh city.* International journal of pediatric obesity : IJPO : an official journal of the International Association for the Study of Obesity, 2010. 5(5): p. 396-403.
10. Larson, R.W. and S. Verma, *How children and adolescents spend time across the world: work, play, and developmental opportunities.* Psychological bulletin, 1999. 125(6): p. 701.
11. Fitzgerald, M., *et al.., Leisure activities of adolescent schoolchildren.* Journal of Adolescence, 1995. 18(3): p. 349-358.
12. Tran LN., T.L., Hong TK., *Validation study of the sedentary questionnaire used for adolescents in Ho Chi Minh City, Vietnam*, in *Youth Scientific Conference*. 2008: Pham Ngoc Thach University of Medicine.
13. Trang, N.H.H.D., T.K. Hong, and M.J. Dibley, *Cohort profile: Ho Chi Minh City Youth Cohort—changes in diet, physical activity, sedentary behaviour and relationship with overweight/obesity in adolescents.* BMJ open, 2012. 2(1).

14. Trang, N.H., *et al..*, *Longitudinal sedentary behavior changes in adolescents in Ho Chi Minh City.* American journal of preventive medicine, 2013. 44(3): p. 223-230.
15. Hamar, P., *et al..*, *The prevalence of sedentary behaviours and physical activity in Hungarian youth.* The European Journal of Public Health, 2010. 20(1): p. 85-90.

Chapter 6 Physical activity and overweight among adolescents in Ho Chi Minh City

Article: Physical activity and overweight among adolescents in Ho Chi Minh City, Vietnam

Authors: Phuong Van Ngoc Nguyen, Tang Kim Hong, Truong Hoang, Dung The Nguyen, Annie Robert

Journal: ready to submit to Journal of Adolescents Health

Abstract

Introduction

Ho Chi Minh City, a largest city of Vietnam, has a nutrition transition leading to increase rapidly in the prevalence of overweight/obesity among adolescents whose lifestyles are becoming more sedentary with lower levels of physical activity (PA). Adolescence obesity increases the risk of cardiovascular- and chronic diseases in adulthood. Our study aimed to assess time spent in moderate to vigorous physical activity and its relationship with body mass index (BMI) among adolescents of Ho Chi Minh City (HCMC) in Vietnam.

Methods

In a cross-sectional study of 2024 junior high school students of HCMC in 2010, students were measured for BMI and questioned on their PA based on validated PA questionnaire. Level of activity was classified as physical active or inactive using standard criteria. Overweight and obesity definition was based on the age- and sex-related Internal Obesity Task Force BMI cutoff values.

Results

Adolescents spent 1.5 h/d (median) in PA, with higher values for boys than girls ($p<0.001$), and 33.9% were categorized as inactive. Children living in richest family spent significantly higher time spent in PA than the others ($p<0.001$). Prevalence of overweight/obesity was 21.1%. Among children aged 13-14 years, overweight/obesity boys spent less time in moderate to vigorous PA ($p>0.18$) while overweight/obesity girls spent more time in moderate to vigorous PA ($p<0.02$).The percentage of inactive tended to increase across BMI category among boys ($p<0.04$) but the trend decreased among girls ($p<0.04$). Using multiple logistic regression, younger boys and inactivity were significantly associated with overweight or obesity prevalence.

Conclusions

In HCMC, there are a considerable percentage of adolescents who are inactive. Younger boys and inactivity were significantly associated with overweight or obesity prevalence public health intervention programs are needed to reduce inactive time among adolescents especially in boys.

Key words: Adolescents, Ho Chi Minh City, overweight, obesity, physical activity, Vietnam.

Introduction

Ho Chi Minh City (HCMC), a largest city of Vietnam, knows a nutritional transition leading to a rapid increase in the prevalence of overweight/obesity among children and adolescents [1-3] whose lifestyles are becoming more sedentary with lower levels of physical activity (PA) [4]. From 2002 to 2004, the prevalence of overweight and obesity among Vietnamese adolescents in HCMC doubled, from 5.9% to 11.7% [1]. Evidence suggests that obese children tend to become obese adults but also that overweight and obesity in childhood and adolescence have adverse consequences on premature mortality and physical morbidity in adulthood [5, 6].

By contributing to the energy imbalance, it was suggested that a decrease in physical activity or an increase in inactivity is probably the main factor accounting for the reduction of total energy expenditure, leading to an increase in prevalence of overweight and obesity [4]. Physical activity has been associated with a wide range of beneficial health outcomes in adults, such as those related to bone health, cardiovascular diseases, and selected cancers [7]. Physical activity during childhood and adolescence may have a positive impact on growth and development [8]. Thus, it is necessary to assess the physical activity of children and adolescents in order to provide critical information for intervention programs aiming at healthy behavior in children and adolescents in HCMC.

The objectives of this study were to describe physical activity and its relationship with body mass index (BMI) among adolescents of HCMC in Vietnam.

Methods

Study design

This cross-sectional study was conducted in 2010 and used multistage cluster sampling with stratification by groups of districts (wealthy and less wealthy districts) in the first stages. 23 junior high

schools were selected in the first stage using a proportionate to school population size (PPS) method based on a sampling frame of all junior high schools in urban areas of HCMC. In each selected school, two lists of children grade 6 and 7, and grade 8 and 9 were prepared. Then, one class was selected from each list by systematic random sampling. There were 2024 students participated in this study.

Measurements

Anthropometric measures

Students' weight was measured in light clothes without shoes to the nearest 0.1 kg using a Tanita electronic scale (Tanita BF 571, Tanita Corporation, Japan). Heights were measured to the nearest 0.1 cm using a suspended Microtoise tape with standard methodology. Measurements were taken once and recorded by one trained worker. Body mass index (BMI) was calculated as weight in kilograms divided by squared height in meters. The International Obesity Task Force (IOTF) BMI cutoff values were used to define underweight, and combined overweight and obesity.

Physical activity

Physical Activity Questionnaire (PAQ) was based on the Adolescent Physical Activity Recall Questionnaire (APARQ) [9] that was developed and validated among Australian adolescents. The PAQ was modified and validated for use in Vietnam [10]. Children were asked to think a normal week and write in a table the sports and games they usually did, how many times per week, and the usual amount of time they spent at doing them. In HCMC, there is not winter season. Thus, physical activities in summer and winter school terms from original questionnaire were modified to assess usual physical activity during the school terms and the annual summer holidays. Children reported their physical activities on organized and non-organized sports and games at schools, before and after school hours, and on weekends during the school

term (38 weeks/year) and the summer holidays (14 weeks/year).

Data analysis

Analyses were conducted using STATA V.11 (STATA Corporation, 2009) and data were weighted for taking into account the multi-stage cluster sampling design.

Each physical activity was calculated separately for school term and summer holidays and for organized and non-organized activities. Based on the compendium of physical activities, each activity was assigned a MET value [11, 12]. One MET is defined as the energy cost at rest and is equivalent to a caloric consumption of 1 kcal/kg/h [8, 13]. The total sum of MET values was calculated for each student. The level of physical activity was divided into two groups: active and inactive. Children were considered as inactive if they spent less than 60 min/day for moderate (3,5 – 5,9 METs) to vigorous physical activity (METs ≥ 6,0) [14] or active if they spent ≥ 60 min/day for moderate to vigorous physical activity.

Age was classified into two groups of 11-12 years and of 13-14 years that roughly correspond to children in grades 6-7 and 8-9, respectively. A household wealthy index was calculated as the first principal component of the variance-covariance matrix of 14 dummy variables for ownership of 14 assets. This wealthy index was divided into 5 categories according to quintiles. Descriptive statistics are presented as median and interquartile range (IQR) or proportions.

Since time data were not normally distributed, time spent for moderate to vigorous physical was compared between groups using Mann-Whitney rank sum tests. Pearson chi-square tests were used to compare proportions. Trends across ordered categories were tested using Kruskal-Wallis or Cochran chi-square trend test. Multiple logistic regressions were used to assess the predictive value of inactive on prevalence of overweight or

obesity, and results are reported as odds ratios with 95% confidence intervals. Inactive (coded 1/0), boys (coded 1/0), younger age (11-12 years, coded 1/0) and their interactions were entered into regression models. The statistical significance level was set to 0.05.

Results

Our study enrolled 2,051 students from 16 public junior high schools of HCMC. Information was collected about their level of physical activity in a usual week during school time and summer time. Anthropometric measurements were gathered from 2,050 students. Form was missing in 60 cases, yielding to 1,989 cases available for analyses. Students spent a median of 92 min/day (IQR: [45, 167]) for moderate to vigorous physical activity. Of these 1,989 participants, 671 (33.9%) were classified as inactive. Table 6.1 shows time spent for moderate to vigorous physical activity and proportion of inactive according to gender, school location, wealthy household index, and BMI categories. Among boys, 21.2% were categorized as inactive and 45.4% among girls. Children studying in schools located in wealthy districts tend to be more inactive than those studying in schools located in less wealthy districts. However, for both boys and girls, children living in wealthier families spent significantly more time for moderate to vigorous physical activity than those living in less wealthy families. Girls in wealthier families were more active than girls in less wealthy families ($p<0.001$). Among boys, overweight children spent less time for moderate to vigorous physical activity than others and overweight boys were more inactive than the others ($p = 0.04$). Among girls, overweight children spent more time for moderate to vigorous physical activity ($p<0.046$) and were more active ($p<0.04$) than the others.

Table 6.1 Time spent in moderate to vigorous physical activity and proportion of inactive* among 1989 students in HCMC: demographical data

		Total sample			
Characteristics	n	Median (IQR)	p	Inactive (%)	p
Gender			**0.001**		**0.001**
Boys	947	124 (69, 212)		21.2	
Girls	1042	67 (35, 127)		45.4	
School locations					
Boys			0.98		**0.04**
Wealthy	586	123 (64, 219)		23.2	
Less wealthy	361	124 (74, 200)		17.5	
Girls			0.25		0.23
Wealthy	693	65 (33, 124)		46.6	
Less wealthy	349	72 (38, 131)		42.7	
Wealthy household index					
Boys			**0.03**		0.15
Poorest	197	117 (56, 190)		25.9	
2nd	174	125 (71, 196)		21.3	
3rd	219	126 (69, 221)		19.0	
4th	172	121 (68, 203)		20.4	
Richest	185	130 (74, 236)		19.7	
Girls			**0.001**		**0.01**
Poorest	203	58 (34, 104)		51.4	
2nd	221	65 (35, 113)		47.1	
3rd	223	74 (36, 140)		44.0	
4th	186	62 (30, 127)		48.4	
Richest	209	81 (42, 148)		37.0	
BMI category					
Boys			0.14		**0.04**
Underweight	119	137 (82, 215)		13.7	
Healthy weight	565	125 (65, 205)		21.5	
Overweight/Obesity	263	116 (65, 221)		23.9	
Girls			**0.046**		**0.04**
Underweight	137	62 (30, 108)		49.1	
Healthy weight	756	66 (36, 124)		46.5	
Overweight/Obesity	149	85 (34, 150)		37.0	

**Inactive: time spent < 60min/day for moderate to vigorous physical activity*

Table 6.2 presents the median of time spent for moderate to vigorous physical activity according to gender, age groups and BMI categories. Overweight and obese boys tended to spend less time in physical activity than other boys (but not significantly) in both age groups. Surprisingly, overweight and obese girls aged 13-14 years spent more time in physical activity ($p < 0.02$).

Table 6.2 Median time (min/day) spent in moderate to vigorous physical activity among 1989 students by gender, BMI categories and age groups

	11-12 years			13-14 years		
	n	Median (IQR*)	p-value	n	Median (IQR*)	p-value
Boys			0.74			0.18
Underweight	78	137 (75, 192)		81	137 (85, 224)	
Healthy weight	243	121 (60, 190)		322	129 (68, 217)	
Overweight/Obesity	139	113 (58, 220)		124	119 (73, 225)	
Girls			0.63			**0.02**
Underweight	50	73 (33, 131)		87	58 (28, 104)	
Healthy weight	362	61 (33, 113)		394	71 (38, 139)	
Overweight/Obesity	74	74 (31, 152)		70	97 (35, 148)	

IQR: Interquartile.*

Table 6.3 presents the proportion of inactive children according to gender, age groups, and BMI categories. Among boys, overweight and obese children were less active than their non-overweight peers but only significantly in boys aged 13-14 years. Conversely, among girls, overweight children aged 13-14 years were less inactive than other girls ($p < 0.02$).

Table 6.3 Proportion spending < 60 min/day in moderate to vigorous physical activity among 1989 students by gender, BMI categories and age groups

	11-12 years			13-14 years		
	n	*Inactive (%)	p-value	n	*Inactive (%)	p-value
Boys			0.85			**0.03**
Underweight	78	23.7		81	8.6	
Healthy weight	243	24.7		322	18.9	
Overweight/Obesity	139	25.2		124	21.8	
Girls			0.51			**0.02**
Underweight	50	44.0		87	51.7	
Healthy weight	362	49.5		394	43.4	
Overweight/Obesity	74	40.5		70	32.9	

**Inactive: time spent < 60min/day for moderate to vigorous physical activity.*

In multiple logistic regression analysis, our model for boys (Table 6.4) showed that age 11-12 and inactivity were significantly associated with overweight or obesity prevalence. Children spending less 60 min/day in moderate for vigorous physical activity were more likely to be overweight or obese, whatever the age.

Table 6.4 Association between physical activity and overweight or obesity in boys using multiple logistic regression.

Characteristics	OR	95% CI*	p-value
Age (11-12 years)	1.59	[1.19, 2.12]	0.002
Inactive (activity < 60 min/day)	1.18	[1.18, 1.66]	0.035

**CI: Confidence Interval*

For girls, none of the covariates was significant in multiple logistic regression.

Discussion

The purpose of this study was to provide update description of physical activity among adolescents in HCMC and to link overweight and obesity in Vietnamese youth with physical activity. Measurement of activity in children is problematic since there is no valid and easy- to-use method for assessing activity levels in large field studies. Discrepancies between studies are more likely caused by methodological differences or thresholds selection, than by true differences between populations of children [4].

In our study, daily time spent in moderate to vigorous physical activity among children had a median of 92 min/day. Using the same adolescent physical activity questionnaire, a cross-sectional study conducted among adolescents aged 11-16 years in HCMC in 2004, showed that children spent a median time of 83 min/day in moderate to vigorous physical activity [15]. Despite a lower median value in the study in 2004, prevalence of inactive children was 24.3% [16] while it was 40% in the study conducted in 2010. These comparisons showed that time spent in moderate to vigorous physical activity among adolescents of HCMC has increased between 2004 and 2010, but not yet enough. The first study of overweight adolescents in 2004 alarmed about the rapid increase in overweight and obesity among adolescents of HCMC. The local government subsequently carried out many activities in the whole city; consultations

on nutrition were setup in commune health stations, and nutritional education was provided to people [17]. Data of 2010 showed that these activities had preliminary effects but not enough to reduce the prevalence of inactivity. There is still a need for more efficient intervention programs to promote physical activities among adolescents in HCMC.

Many studies revealed that girls are less active than boys [8, 16, 18, 19], including a study of Vietnamese adolescents in California [20]. Consistent with these studies, our results have continually shown that boys are more active than girls (21.2% for boys vs 45.4% for girls). Sallis *et al.* explained that the gender differences in levels of physical activity could be due to girls perceiving more barriers to and/or disliking physical activity than boys [21]. In addition, there may be a decrease in accessibility to structured activity for adolescent girls and a decrease in the social desirability of physical activity for girls at puberty undergoing breast development [22]. Thus, intervention program should focus on motivating inactive girls.

Overweight and obesity are caused by an imbalance between energy intake and expenditure, but the exact reasons behind this phenomenon in adolescents are unclear. The influence of physical activity on body weight and body fat in adolescents is controversial, with several studies indicating that overweight status is inversely related to physical activity [23, 24] and others reporting no association [25, 26]. In our study, among children aged 13-14 years, we found that BMI status was positively related to physical activity for boys; overweight boys were less active than those in other BMI categories while in girls, this association was negative: overweight or obese girls were more active. Among children aged 11-12 years, there was no association between physical activity and BMI status for both boys and girls. The results of multiple regression logistic showed that

there was not associated between inactivity and overweight or obesity among girls but a strong association was observed in boys. The study conducted in 2004 in HCMC with the same physical activity questionnaire, also showed that overweight was strongly associated with inactivity in boys but not in girls [16]. Another study in China among junior high schools used self-reported physical questionnaire and showed that low physical activity was associated with overweight or obesity in boys but not in girls [27]. These findings indicate that lack of physical activity associated with overweight and obesity are gender specific. Therefore, further research needs to identify better predictors of physical inactivity in adolescent girls.

There are a few limitations in our study. First, the self-reported questionnaire that was used to estimate the frequency and duration of physical activity of adolescents instead of using objective measurements, may lead to over reporting of activity. The physical questionnaire used in our study was however validated for Vietnamese adolescents, especially for those living in HCMC. Second, this is a cross-sectional study, so a causative link between obesity and lack of physical activity cannot be made. However, the use of representative data allows us an opportunity to extrapolate to the overall adolescent population of HCMC.

Conclusions

Our study revealed that there are still a huge number of adolescents in HCMC who are inactive, especially in girls, and that there is a clear association between overweight and physical inactivity in boys. Future directions for interventional strategies could focus on influencing school policy on matters related to health and physical education adolescents. Additionally, further research need to indentify better predictors of physical activity among adolescent girls.

References

1. Hong, T.K., *et al.., Overweight and obesity are rapidly emerging among adolescents in Ho Chi Minh City, Vietnam, 2002-2004.* International journal of pediatric obesity : IJPO : an official journal of the International Association for the Study of Obesity, 2007. 2(4): p. 194-201.
2. Nguyen, C.K., *National survey of overweight and obesity 2005*. 2006, National Nutritional Institue: Ha Noi.
3. Tran, H.M., Tran, H. L., Pham, N. O., Nguyen, N. T., Le, K. H., *Nutrition status among school aged children in school year 2002-2004* 2005, Nutrional Centre Ho Chi Minh.
4. Molnár, D. and B. Livingstone, *Physical activity in relation to overweight and obesity in children and adolescents.* European journal of pediatrics, 2000. 159(1): p. S45-S55.
5. Reilly, J. and J. Kelly, *Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: systematic review.* International journal of obesity, 2010. 35(7): p. 891-898.
6. Maffeis, C. and L. Tato, *Long-term effects of childhood obesity on morbidity and mortality.* Hormone Research in Paediatrics, 2004. 55(Suppl. 1): p. 42-45.
7. Andersen, R.E., *et al.., Relationship of physical activity and television watching with body weight and level of fatness among children: Results from the third national health and nutrition examination survey.* JAMA : the journal of the American Medical Association, 1998. 279(12): p. 938-942.
8. Gordon-Larsen, P., R.G. McMurray, and B.M. Popkin, *Adolescent physical activity and inactivity vary by ethnicity: The National Longitudinal Study of Adolescent Health.* The Journal of pediatrics, 1999. 135(3): p. 301-306.
9. Booth, M.L., *et al.., The reliability and validity of the adolescent physical activity recall questionnaire.* Medicine and science in sports and exercise, 2002. 34(12): p. 1986-1995.
10. Hong, T.K., *et al.., Validity and reliability of a physical activity questionnaire for Vietnamese adolescents.* Int J Behav Nutr Phys Act (MS 4835073026381536), 2012.
11. Ainsworth, B.E., *et al.., Compendium of physical activities: classification of energy costs of human physical activities.* Medicine and science in sports and exercise, 1993. 25(1): p. 71-80.
12. Ainsworth, B.E., *et al.., Compendium of physical activities: an update of activity codes and MET intensities.* Medicine and science in sports and exercise, 2000. 32(9; SUPP/1): p. S498-S504.
13. Gordon-Larsen, P., R.G. McMurray, and B.M. Popkin, *Determinants of adolescent physical activity and inactivity patterns.* Pediatrics, 2000. 105(6): p. e83-e83.
14. Strong, W.B., *et al.., Evidence based physical activity for school-age youth.* The Journal of pediatrics, 2005. 146(6): p. 732-737.
15. Tang, H.K., *Physical activity and sedentary behaviors among junior high school students of Ho Chi Minh City* in *Youth Scientific Conference* 2013: Pham Ngoc Thach University.

16. Trang, N.H., *et al..*, *Factors associated with physical inactivity in adolescents in Ho Chi Minh City, Vietnam.* Medicine and science in sports and exercise, 2009. 41(7): p. 1374-83.

17. Le, T.K.Q., *Trends of Nutritional Status and Its Related Diseases in Ho Chi Minh City In 2001-2010.* Journal of Food and Nutrition Sciences, 2010. 6(3+4): p. 7-9.

18. Nguyen, T., *et al..*, *Association between physical activity and metabolic syndrome: a cross sectional survey in adolescents in Ho Chi Minh City, Vietnam.* BMC public health, 2010. 10(1): p. 141.

19. Li, M., *et al..*, *Factors associated with adolescents' physical inactivity in Xi'an City, China.* Medicine and science in sports and exercise, 2006. 38(12): p. 2075.

20. Kaplan, C.P., *et al..*, *Health-compromising behaviors among Vietnamese adolescents: the role of education and extracurricular activities.* Journal of Adolescent Health, 2003. 32(5): p. 374-383.

21. Sallis, J.F., *et al..*, *Ethnic, socioeconomic, and sex differences in physical activity among adolescents.* Journal of clinical epidemiology, 1996. 49(2): p. 125-134.

22. Goran, M.I., *et al..*, *Developmental changes in energy expenditure and physical activity in children: evidence for a decline in physical activity in girls before puberty.* Pediatrics, 1998. 101(5): p. 887-891.

23. Janssen, I., *et al..*, *Overweight and obesity in Canadian adolescents and their associations with dietary habits and physical activity patterns.* Journal of Adolescent Health, 2004. 35(5): p. 360-367.

24. Sigmundová, D., *et al..*, *Trends of overweight and obesity, physical activity and sedentary behaviour in Czech schoolchildren: HBSC study.* The European Journal of Public Health, 2013.

25. Marti, B. and E. Vartiainen, *Relation between leisure time exercise and cardiovascular risk factors among 15-year-olds in eastern Finland.* Journal of epidemiology and community health, 1989. 43(3): p. 228-233.

26. Bandini, L.G., D.A. Schoeller, and W.H. Dietz, *Energy expenditure in obese and nonobese adolescents.* Pediatric research, 1990. 27(2): p. 198-202.

27. Li, M., *et al..*, *Factors associated with adolescents' overweight and obesity at community, school and household levels in Xi'an City, China: results of hierarchical analysis.* European journal of clinical nutrition, 2007. 62(5): p. 635-643.

Chapter 7 Dietary intake and overweight among adolescents in Ho Chi Minh City

Article: High total energy intake among adolescents in Ho Chi Minh City, Vietnam

Authors: Phuong Van Ngoc Nguyen, Tang Kim Hong, Truong Hoang, Dung The Nguyen, Annie Robert

Journal: ready to submit to Asia Pacific Journal of Public Health

Abstract

Introduction

Vietnam has experienced marked nutritional changes and rapid urbanization in recent decades. Overweight and obesity are increasing in adolescents. Obesity in adolescence substantially increases the risk of cardiovascular diseases and its health deficiencies in adulthood. Studying the dietary intake of adolescents is important because nutrition status is an acknowledged predictor of adult nutrition status. This study aims at describing the energy and macronutrient intakes and their relationship with body mass index (BMI) among adolescents in Ho Chi Minh City.

Methods

In a cross-sectional study of 2,024 junior high school students of HCMC in 2010, students were measured for BMI and questioned on their dietary intakes based on validated food frequency questionnaire. The energy conversion factors used for protein, fat and carbohydrate were 4 kcal/g, 9 kcal/g and 4 kcal/g, respectively. The energy from each macronutrient energy source was divided by the total energy intake and multiplied by 100 to produce the percentage contribution. Overweight and obesity definition was based on the age- and sex-related Internal Obesity Task Force BMI cutoff values.

Results

Median of total energy was 2,774 kcal per day. Median percentages of energy from protein, lipid, and carbohydrate were 14.6%, (IQR: 13.2-16.8), 21.9% (IQR: 17.9-27.2), 63.5% (IQR: 58.9-69.5), respectively. Boys had higher macronutrient intakes than girls ($p < 0.001$). Children living in wealthier families had higher percentages of energy from macronutrients than those living in less wealthy families ($p < 0.01$). Among boys, there were no associations between BMI status and macronutrient intakes, or percentages of energy from macronutrients. Overweight and obese girls had an inverse association with macronutrient intakes ($p < 0.01$).

Conclusions

Total energy intake of adolescents exceeded the Vietnam Recommended Dietary Allowances published in 2007 but percentages of energy from proteins, lipids, and carbohydrates met the recommendations. Our methodology cannot however avoid a reporting bias. There is a need to conduct future studies to develop better food questionnaires and to monitor changes in dietary patterns. Nutritional education programs should focus on healthy eating for both children and their parents.

Key words: Adolescents, Ho Chi Minh City, overweight, obesity, physical activity, Vietnam.

Introduction

In recent years, obesity among children and adolescents has emerged as a global epidemic [1-5], becoming a serious public health problem in developing countries [6, 7]. In Vietnam, a country that has experienced marked nutritional changes and rapid urbanization in recent decades, some cross-sectional studies assessing body mass index in children and adolescents have pointed out a rising trend in overweight and obesity over the last decade [8-10]. Obesity in adolescence substantially increases the risk of cardio vascular diseases and its associated health deficiencies in adulthood [11, 12].

Diet is a major contributor to the nutritional status and health of the population. Diet contributes to obesity and other chronic health problems such as heart disease, diabetes, and several types of cancer [13]. Studying the dietary intake of adolescents is important because adolescent nutrition status is an acknowledged predictor of adult nutrition status [14], and adolescents offers an important window of opportunity to prevent risk factors for diet-related non-communicable diseases, which can track later into adulthood [15]. In addition, adolescents represent a large share of the population in low and middles income countries such as Vietnam.

Although there is evidence that the adolescent population in the urban areas of Ho Chi Minh City (HCMC) is also undergoing a "nutrition transition" [8], comprehensive epidemiological studies related to the adolescent nutrition are very rare in HCMC. The purpose of this study is to describe the energy and macronutrient intake and its relationship with body mass index (BMI) among junior high school students of HCMC. The findings would provide important information to understand the high prevalence of overweight and obesity in adolescents of HCMC.

Methods

Study design

A cross-sectional study was conducted in 2010 using multistage cluster sampling with stratification by groups of districts (wealthy and less wealthy districts) at the first stage.

23 junior high schools were selected in the first stage using a proportional- to- school-population- size (PPS) probability sampling method based on a sampling frame of all junior high schools in urban areas of HCMC. In each selected school, two lists of classes of children in grades 6 and 7, and in grades 8 and 9 were prepared. From each list, one class was selected by random sampling and all students from the selected class were systematically invited to participate. There were 1,989 students enrolled in this study.

Measurements

Anthropometric measures

Students' weight was measured in light clothes without shoes to the nearest 0.1 kg using a Tanita electronic scale (Tanita BF 571, Tanita Corporation, Japan). Height was measured to the nearest 0.1 cm using a suspended Microtoise tape with standard methodology. Measurements were taken once and recorded by one trained worker. Body mass index (BMI) was calculated as weight in kilograms divided by squared height in meters. The International Obesity Task Force (IOTF) BMI cutoff values were used to define underweight, and combined overweight and obesity [16, 17].

Dietary measurement

Subject dietary intake was assessed using a validated 160 items Food Frequency Questionnaire (FFQ) to provide information on intake of macronutrients over 6 months [18].

The interviews were conducted by medical doctors and medical students from the University of Medicine Pham Ngoc Thach who had been trained in interviewing techniques and in using the FFQ.

Energy intake and macronutrients per day for each child were calculated using the following formula:

*[Reported daily frequency of consumption] * [Reported portion size for each food item] *[Standard portion size of the food item (in grams)] * [Nutrients per 100 grams]*

The nutrient values per 100 grams of food were obtained from the Vietnam National Food Composition Tables and the Vietnam Nutrients and Composite Foods Database Software [19]. Energy and macronutrient intake for each food item was then summed

up to obtain the total intake score per day for each student.

Data analysis

Analyses were conducted using STATA V.11 (STATA Corporation, 2009) and data were weighted for taking into account the multi-stage cluster sampling design.

The energy conversion factors used for protein, fat and carbohydrate were 4 kcal/g, 9 kcal/g and 4 kcal/g, respectively. The energy from each macronutrient energy source was divided by the total energy intake and multiplied by 100 to produce the percentage contribution.

Age was classified into two groups of 11-12 years and of 13-14 years that roughly correspond to children in grades 6-7 and 8-9, respectively. A household wealthy index was calculated as the first principal component of the variance-covariance matrix of 14 dummy variables for ownership of 14 assets [20]. This wealthy index was divided into 3 categories based on tertiles.

Since data were not normally distributed, total energy intake and macronutrient intakes are reported as median and interquartile range (IQR) and they were compared between groups using Mann-Whitney rank sum tests. Trends across ordered categories were tested using Kruskal-Wallis test. The statistical significance level was set to 0.05.

Results

In our study, median of total energy intake was 2,774 Kcal. Macronutrient intake contributions were 98g for protein, 64g for lipid, and 455g for carbohydrate. Median percentages of energy from protein, lipid, and carbohydrate were 14.6%, (IQR: 13.2-16.8), 21.9% (IQR: 17.9-27.2), 63.5% (IQR: 58.9-69.5), respectively. Boys were observed to have higher macronutrient intakes than girls. Total energy intake for boys was also higher than for girls ($p < 0.001$).

Table 7.1 shows the median and IQR of total energy intake and macronutrients intake in boys and girls, and also stratified by age and by household wealth index. In boys, there were no significant differences in total energy intake or in macronutrients intake across age groups. In girls, total

energy intake and each macronutrient intake significantly decreased with age increased. Despite not significant, the total energy intake and each macronutrient intake tended to increase as the household wealth index increased in boys and in girls, except for protein and carbohydrate intake in girls. Table 7.2 presents energy intake as percentages of protein, lipid, and carbohydrate intakes in boys and in girls. Percentages of protein and lipid intake were not correlated with aged in both boys and girls. Percentage of carbohydrate intake decreased significantly in boys and in girls, as age increased. Less clearly in boys than in girls, percentage of protein intake increased with household wealth index. But for lipid intake, percentage significantly increased with household wealth index in both boys and girls while percentage of carbohydrate intake significantly decreased as the household wealth index increased ($p = 0.01$ in boys and $p = 0.03$ in girls). There was no significant relationship between each macronutrient intake and BMI categories in boys (Table 7.3). Overweight and obese girls had significantly lower intakes of protein, lipid and carbohydrates than healthy or underweight girls within each age group.

Table 7.1 Total energy intake and macronutrient intakes of adolescents by gender, age and household wealth index

	Total energy intake (Kcal)		Protein intake (g)		Lipid intake (g)		Carbohydrate intake (g)	
	Median (IQR)	p	Median (IQR)	p	Median (IQR)	p	Median (IQR)	p
Boys								
Total	3,038 (2,252-3,584)		104 (75-146)		66 (43-106)		498 (376-648)	
Age		0.46		0.35		0.39		0.56
11	3,102 (2,273-3,655)		104 (70-161)		68 (38-122)		508 (399-671)	
12	3,050 (2,320-3,564)		106 (78-162)		67 (46-117)		497 (383-665)	
13	2,943 (2,233-3,576)		100 (74-137)		65 (44-93)		497 (372-632)	
14	3,051 (2,148-3,546)		109 (75-141)		68 (43-100)		492 (368-626)	
Household wealth index		0.86		0.51		0.28		0.96
Poorest	2,939 (2,158-3,691)		100 (68-148)		65 (38-104)		498 (357-643)	
Medium	3,038 (2,306-3,562)		105 (77-145)		67 (44-104)		496 (391-644)	
Richest	3,119 (2,265-3,534)		107 (77-144)		70 (46-111)		502 (376-653)	
Girls								
Total	2,546 (1,940-3,421)		92 (67-132)		61 (42-93)		411 (314-562)	
Age		**0.005**		**0.04**		**0.046**		**0.007**
11	2,860 (2,132-3,583)		103 (72-144)		68 (48-109)		463 (342-610)	
12	2,559 (1,931-3,583)		92 (66-133)		60 (38-92)		414 (313-561)	
13	2,463 (1,891-3,386)		91 (66-126)		61 (43-91)		386 (305-549)	
14	2,473 (1,917-3,313)		89 (67-125)		57 (42-90)		397 (308-534)	
Household wealth index		0.74		0.51		0.60		0.61
Poorest	2,534 (1,962-3,388)		91 (67-131)		60 (41-91)		414 (325-558)	
Medium	2,548 (1,978-3,554)		94 (68-135)		61 (43-96)		405 (313-584)	
Richest	2,553 (1,895-3,391)		93 (66-131)		62 (43-98)		405 (308-559)	

Table 7.2 Percentages of energy from macronutrients in adolescent feedings by gender, age, and household wealth index.

	Protein intake (%)		Lipid intake (%)		Carbohydrate intake (%)	
	Median (IQR)	p	Median (IQR)	p	Median (IQR)	p
Boys						
Total	14.3 (13.0-16.9)		21.1 (16.9-27.3)		65.2 (60.6-71.2)	
Age		0.43		0.14		**0.03**
11	14.3 (12.9-17.5)		21.5 (16.2-31.3)		66.4 (60.8-75.1)	
12	14.7 (13.0-18.0)		22.2 (17.0-29.1)		65.8 (60.1-71.7)	
13	14.1 (12.9-16.2)		20.6 (16.9-25.5)		65.1 (372-632)	
14	14.1 (13.1-16.3)		20.4 (17.6-26.6)		64.2 (61.1-70.6)	
Household wealth index		0.07		**0.02**		**0.01**
Poorest	14.1 (12.7-16.5)		20.7 (15.8-26.6)		66.3 (61.5-72.5)	
Medium	14.5 (13.1-17.0)		21.1 (16.9-26.7)		65.2 (60.6-70.6)	
Richest	14.4 (13.1-17.0)		21.5 (18.0-28.2)		64.4 (60.0-70.6)	
Girls						
Total	14.8 (13.4-16.8)		22.6 (18.8-27.2)		62.0 (57.7-67.3)	
Age		0.55		0.72		**0.045**
11	14.8 (13.4-17.5)		22.9 (19.2-28.5)		62.4 (58.2-69.1)	
12	14.8 (13.4-16.9)		21.9 (18.2-26.9)		62.7 (58.6-68.3)	
13	14.9 (13.5-16.7)		23.2 (19.2-27.1)		61.2 (56.8-65.7)	
14	14.7 (13.2-16.7)		22.6 (18.5-26.8)		61.9 (57.7-67.2)	
Household wealth index		**0.03**		**0.009**		**0.03**
Poorest	14.5 (13.3-16.4)		21.9 (18.2-26.5)		62.5 (58.4-69.0)	
Medium	14.8 (13.5-17.0)		22.6 (18.7-26.8)		62.0 (57.8-66.4)	
Richest	15.0 (13.6-16.9)		23.5 (19.3-27.6)		61.6 (57.1-67.2)	

Table 7.3 Macronutrient intakes of adolescents by gender, age group and BMI category

	Protein		Lipid		Carbohydrate	
	Average (g)	p	Average (g)	p	Average (g)	p
Age 11-12 years						
Boys		0.18		0.19		0.13
Underweight	112 (74-172)		60 (41-120)		542 (322-742)	
Healthy weight	109 (77-165)		73 (45-127)		511 (399-688)	
Overweight/Obesity	96 (72-144)		64 (40-106)		477 (389-610)	
Girls		**0.01**		**0.02**		**0.001**
Underweight	109 (80-175)		71 (47-128)		490 (409-669)	
Healthy weight	96 (68-136)		63 (41-99)		432 (327-585)	
Overweight/Obesity	84 (64-129)		55 (38-87)		371 (286-503)	
Age 13-14 years						
Boys		0.20		0.06		0.19
Underweight	102 (73-137)		70 (45-101)		468 (361-605)	
Healthy weight	107 (77-140)		68 (45-100)		521 (385-647)	
Overweight/Obesity	96 (69-129)		56 (39-89)		471 (340-608)	
Girls		**0.001**		**0.001**		**0.001**
Underweight	103 (79-141)		72 (54-104)		472 (363-632)	
Healthy weight	88 (67-126)		59 (42-91)		392 (306-549)	
Overweight/Obesity	77 (53-105)		51 (30-74)		334 (256-398)	

Figure 7.1 presented total energy intake and macro nutrients of adolescents by gender, aged group and BMI category. In all age- and sex subgroups, reported total energy intake and reported macronutrients intake were higher in underweight children and lower in overweight children. Such consistence across subgroups suggests a high reporting bias. In all subgroups, total energy intake was not correlates with other covariates but physical activity ($r = 0.14$, $p=0.05$)

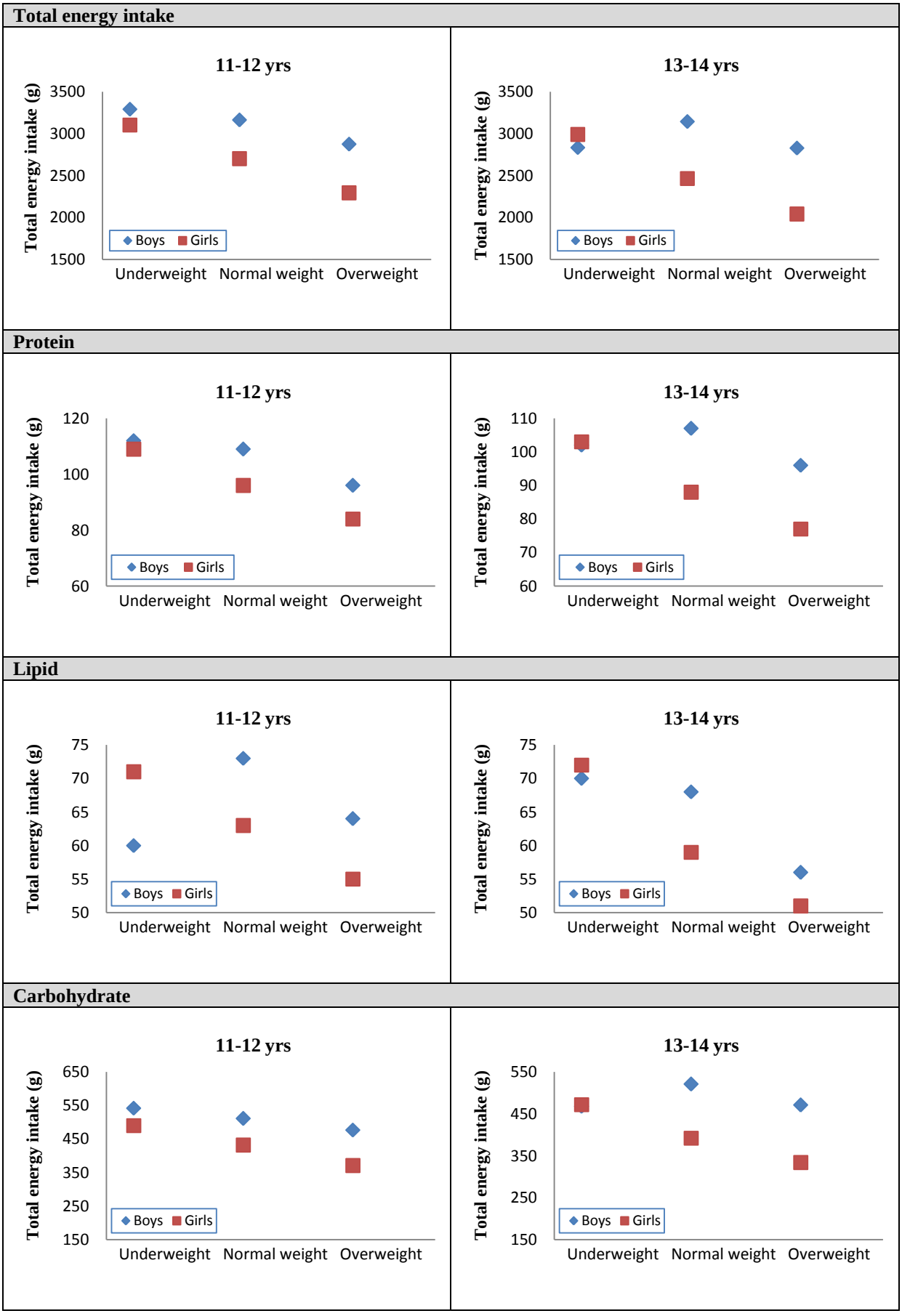


Figure 7.1 Total energy intake of adolescents by gender, age groups and BMI categories

Discussion

Because adolescents enrolled in the study were randomly selected using a multistage cluster sampling of school classes within districts of HCMC and because of a high participation rate, our results can be considered as representative of children aged 11-14 years in urban areas of HCMC.

Food Frequency Questionnaire (FFQ) was chosen in order to estimate dietary intakes because this questionnaire was validated for use in epidemiological studies of diet and lifestyle in adolescents living in urban areas in HCMC [18]. Validation was validated FFQ showed a high reliability and validity in previous studies [18]. FFQ also provides a reproducible and relatively inexpensive tool to assess and monitor the eating habits of large populations of adolescents [22]. Our analysis found that median energy intake in adolescents was 3,038 kcal for boys and 2,546 kcal for girls. These results exceeded Recommended Energy Intake of Vietnamese children aged 13-15 years (2,650 kcal for boys and 2,200 kcal for girls). When expressed as percentages of protein, lipid, and carbohydrate energy intakes, our results are in line with the Recommended Diet Allowances for Vietnamese adolescents which suggest that proteins should account for 12-15%, lipids should not exceed 25%, and carbohydrates should contribute to 61-70% of total calories [23] . In Vietnamese food, it is common to use fewer lipids and more carbohydrates than in other countries. Although there are methodological differences between our study and other dietary studies, the percentages of energy from macronutrients among Vietnamese children were higher for carbohydrates (63.5%) and lower for lipids (21.9%) than in children from Malaysia (49.9% carbohydrate, 36.0% lipid) [24], from Belgium (49.0% of carbohydrates, 35.7% of lipids) [25], or from France (48.1% of carbohydrates , 36.9% of lipids) [26].

The median of energy, protein, carbohydrate and fat intake was higher in

boys than in girls. These results are similar with those of another cross-sectional study conducted among adolescents of HCMC in 2004 that used the same Food Frequency Questionnaire (unpublished report). The gender difference in dietary patterns was matching with the significantly higher levels of overweight and obesity in boys, recently published [8, 27].

The household wealth status appears to have an impact on food intake patterns in this adolescent population. Children living in wealthiest families had a higher intake of protein and fat, and a lower intake of carbohydrates than children living in less wealthy families. In our study, the role of household wealth status on food habits differs from that reported in developed countries. In the United States, lower community and household socioeconomic status have been reported as associated with greater consumption of high energy foods and a lower consumption of fruit and vegetables [28]. In our study, higher socioeconomic status was related to higher lipid consumption and lower carbohydrate intakes.

Our results showed that there was no association between macronutrient intakes and BMI among boys but among girls this association was inversely. Our findings are similar to the results in cross-sectional studies conducted in United States with Food Frequency Questionnaire [29], in Spain with a prospective 7-consecutive-days food record [30], and in Malaysia with a two-day dietary record [24]. However, other researchers have reported that energy intake was positively related to weight status [24,31,32]. There are some explanations for these results. The consumption of foods and nutrients being lower among the overweight participants than among other children may be due to underreporting of food intake by overweight participants, as pointed out by several authors [33,34]. In our study, children were informed that they were invited to participate in a study on obesity, because this is an ethical issue. This could

lead to an underreporting of actual food intake by overweight children. In addition, FFQ may result in errors such as under- or over- estimation of food quantities [21]. The methodology we used to measure food consumption has maybe induced a high reporting bias [35]. It is also possible that obese children were already on a diet for body weight control because of family or health advices [35]. Further studies need to identify better questionnaire to estimate dietary intake of Vietnamese adolescents.

Conclusions

Our findings indicate that total energy intake of adolescents exceeded the Vietnam Recommended Dietary Allowances while percentages of energy from proteins, lipids, and carbohydrates met the recommendation. Overweight and obese girls had lower macronutrient intakes than their peers. However, overweight children tended to report lower energy intake and underweight children tended to report higher total energy intake because of reporting bias. Future research needs to develop better food questionnaires in order to appropriately estimate dietary intake in adolescents and to monitor changes in dietary patterns before providing evidence for promoting nutritional intervention programs. Because of a potential bias in our quantitative estimates, nutrition covariates were not considered in multivariate regression model to find the factors associated with overweight and obesity.

References

1. Campagnolo, P., *et al..*, *Prevalence of overweight and associated factors in southern Brazilian adolescents.* Public health, 2008. 122(5): p. 509-515.
2. Ko, G.T., *et al..*, *The problem of obesity among adolescents in Hong Kong: a comparison using various diagnostic criteria.* BMC Pediatrics, 2008. 8: p. 10.
3. Tzotzas, T., *et al..*, *Epidemiological survey for the prevalence of overweight and abdominal obesity in Greek adolescents.* Obesity, 2008. 16(7): p. 1718-22.
4. Sardinha, L.B., *et al..*, *Prevalence of overweight and obesity among Portuguese youth: a study in a representative sample of 10-18-year-old children and adolescents.* International journal of pediatric obesity : IJPO : an official journal of the International Association for the Study of Obesity, 2011. 6(2-2): p. e124-8.
5. Sigmundová, D., *et al..*, *Trends of overweight and obesity, physical activity and sedentary behaviour in Czech schoolchildren: HBSC study.* The European Journal of Public Health, 2013.
6. Raj, M. and R.K. Kumar, *Obesity in children & adolescents.* The Indian journal of medical research, 2010. 132: p. 598-607.
7. Sanguansak, R., Lakkana, R., *Prevalence of Overweight and Obesity Among School Children in Suburb Thailand Defined by the International Obesity Task Force standard.* J Med Assoc Thai, 2010. 93(2): p. S27-31.
8. Hong, T.K., *et al..*, *Overweight and obesity are rapidly emerging among adolescents in Ho Chi Minh City, Vietnam, 2002-2004.* International journal of pediatric obesity : IJPO : an official journal of the International Association for the Study of Obesity, 2007. 2(4): p. 194-201.
9. Le, T.K.Q., *Trends of Nutritional Status and Its Related Diseases in Ho Chi Minh City In 2001-2010.* Journal of Food and Nutrition Sciences, 2010. 6(3+4): p. 7-9.
10. Tran, H.M., Tran, H. L., Pham, N. O., Nguyen, N. T., Le, K. H., *Nutrition status among school aged children in school year 2002-2004* 2005, Nutrional Centre Ho Chi Minh.
11. Berenson, G.S., Srinivasan, S.R., Bao, W., Newman, W.P., Tracy, R.E., Wattigney, W.A., *Association between multiple cardiovascular risk factors and atherosclerosis in children and young adults. The Bogalusa heart study.* New Engl J Med, 1998. 338: p. 1650-6.
12. Mahoney, L.T., Burnst, T.L., Stanford, W., *Coronary risk factors measured in childhood and young adult life are associated with coronary artery calcification in young adults: the Muscatine study.* J Am Coll Cardiol, 1996. 27: p. 277-84.
13. Health, U.D.o. and H. Services, *The Surgeon General's call to action to prevent and decrease overweight and obesity*. 2001, Department of Health and Human Services, Public Health Service, Office of the Surgeon General. US GPO, Washington Rockville^ eMD MD.
14. Gordon-Larsen, P., *et al..*, *Five-year obesity incidence in the transition period between adolescence and adulthood: the National Longitudinal Study of Adolescent Health.* The American journal of clinical nutrition, 2004. 80(3): p. 569-575.

15. Who, J. and F.E. Consultation, *Diet, nutrition and the prevention of chronic diseases.* WHO technical report series, 2003. 916.
16. Cole, T.J., *et al..*, *Body mass index cut offs to define thinness in children and adolescents: international survey.* BMJ, 2007. 335(7612): p. 194.
17. Cole, T.J., *et al..*, *Establishing a standard definition for child overweight and obesity worldwide: international survey.* BMJ, 2000. 320(7244): p. 1240-3.
18. Hong, T.K., M.J. Dibley, and D. Sibbritt, *Validity and reliability of an FFQ for use with adolescents in Ho Chi Minh City, Vietnam.* Public Health Nutrition, 2009. 13(3): p. 368.
19. Hanh, T., *Eiyokun: software for calculatin Vietnamese dietary intake*. 2004, Ho Chi Minh Medical Publishing House of Vietnam.
20. Filmer, D. and L.H. Pritchett, *Estimating Wealth Effects Without Expenditure Data—Or Tears: An Application To Educational Enrollments In States Of India*.* Demography, 2001. 38(1): p. 115-132.
21. Slater, B., *et al..*, *Validation of a semi-quantitative adolescent food frequency questionnaire applied at a public school in São Paulo, Brazil.* European journal of clinical nutrition, 2003. 57(5): p. 629-635.
22. Willett, W., *Nutritional epidemiology*. Vol. 40. 2012: Oxford University Press.
23. Nguyen, C.K., Pham, V.H., *Vietnam Recommended Dietary Allowances 2007.* Asia Pac J Clin Nutr2008. 7(S2): p. 409-415.
24. Rezali, F.W., *et al..*, *Obesity-related behaviors of Malaysian adolescents: a sample from Kajang district of Selangor state.* Nutrition research and practice, 2012. 6(5): p. 458-465.
25. Matthys, C., *et al..*, *Estimated energy intake, macronutrient intake and meal pattern of Flemish adolescents.* European journal of clinical nutrition, 2003. 57(2): p. 366-375.
26. Rolland-Cachera, M.F., F. Bellisle, and M. Deheeger, *Nutritional status and food intake in adolescents living in Western Europe.* European journal of clinical nutrition, 2000. 54: p. S41-6.
27. Nguyen, P.V.N., *et al..*, *High prevalence of overweight among adolescents in Ho Chi Minh City, Vietnam.* BMC public health, 2013. 13(1): p. 141.
28. Xie, B., *et al..*, *Effects of Ethnicity, Family Income, and Education on Dietary Intake among Adolescents.* Preventive medicine, 2003. 36(1): p. 30-40.
29. Rockett, H.R., *et al..*, *Cross-sectional measurement of nutrient intake among adolescents in 1996.* Preventive medicine, 2001. 33(1): p. 27-37.
30. Garaulet, M., *et al..*, *Differences in dietary intake and activity level between normal-weight and overweight or obese adolescents.* Journal of pediatric gastroenterology and nutrition, 2000. 30(3): p. 253-258.
31. Tucker, L.A., G.T. Seljaas, and R.L. Hager, *Body fat percentage of children varies according to their diet composition.* Journal of the American Dietetic Association, 1997. 97(9): p. 981-986.
32. Andersen, R.E., *et al..*, *Relationship of physical activity and television watching with body weight and level of fatness among children.* JAMA: the journal of the American Medical Association, 1998. 279(12): p. 938-942.

33. Bandini, L.G., D.A. Schoeller, and W.H. Dietz, *Energy expenditure in obese and nonobese adolescents.* Pediatric research, 1990. 27(2): p. 198-202.
34. Livingstone, M.B., *et al.*., *Validation of estimates of energy intake by weighed dietary record and diet history in children and adolescents.* The American journal of clinical nutrition, 1992. 56(1): p. 29-35.
35. Rodríguez, G. and L.A. Moreno, *Is dietary intake able to explain differences in body fatness in children and adolescents?* Nutrition, metabolism and cardiovascular diseases, 2006. 16(4): p. 294-301.

Chapter 8 Multivariate determinants of overweight and obesity among adolescents in Ho Chi Minh City

Introduction

Adolescent overweight and obesity are an important public health issue not only in developed countries but also in developing countries. In a developing country such as Vietnam, overweight and obesity are now becoming significantly more prevalent mainly in urban areas as a consequence of a rapid urbanization with important changes in food access and in occupation of people since the Doi Moi in 1990; the environment is now characterized by easily available, cheap, high caloric foods combined with sedentary lifestyles [1-4]. Overweight and obesity often manifest very early in life and are associated with an increased risk of serious diseases during childhood and adolescence [5, 6]. It is also well established that obese children and adolescents are likely to become obese adults and adulthood obesity is associated with an increase in various chronic diseases and premature deaths [7].

Although there are both genetic and environmental causes of obesity, the increase in obesity prevalence is more likely to be related to changes in environmental factors in Ho Chi Minh City (HCMC) [8]. Genetic factors may account for individual variability in body weight and can influence an individual's predisposition towards obesity [9], but genetic factors alone cannot explain the growing global obesity epidemic in big cities of Vietnam. This epidemic is thought to be the consequence of changing environments that influence behaviors and lead to energy imbalance [10]. This ecological hypothesis considers obesity as a physiological response to a "pathological obesogenic environment" [11]. Environmental factors in Ho Chi Minh City play a role in promoting increased

energy intake, such as advertising for energy dense foods, marketing of larger portion sizes, and use of fast food [12]. Adolescents aged 11 to 14 years in 2010 in Ho Chi Minh City were born between 1996 and 1999, a couple of years after the Doi Moi. This new generation has been exposed to rich food when they were less than 3 years of age, a window in life when body fat develops and impacts on body fat during childhood [13]. Some other environmental factors in HCMC may also play a role in promoting a sedentary lifestyle with decreasing energy expenditure, such as a lower use of bicycle and less walking than before the Doi Moi, lower involvement in parent's work than before, and a very easy access to all screen activities in the streets of HCMC. This decrease in physical activity has translated into an increase in overweight and obesity among youths.

The emergence of adolescent obesity is still in an early phase in Ho Chi Minh City, but it is important to identify the key obesogenic risk factors in this population and to begin to plan efficient interventions to prevent the further development of this potential epidemic. The best time to prevent an obesity epidemic is when it emerges because the environmental and behavioral risk factors can be addressed before the emergence of associated diseases later in life.

This chapter aims to identify risk factors related to overweight and obesity in adolescents in urban areas of Ho Chi Minh City.

Methods

Statistic analysis

Overweight and obesity were combined as a single outcome corresponding to an equivalent BMI over 25 kg/m^2 for the age- and sex- IOTF cutoffs, and called "overweight" in subsequent analyses.

Univariate analyses were performed to examine the association between overweight and each single variable. Age of children was categorized by design in 2

groups: 11-12 years and 13-14 years. Economic status was estimated using household wealthy index that was divided into 3 groups according to tertiles and richest was defined as the third tertile of the index. School location was divided into two groups: less wealthy districts and wealthy districts as defined by the National Department of Statistics of HCMC. The classification of time spent in screening activities (ST) was based on the review from 34 countries [14] with two categories: ST < 2 hours per day or ≥ 2 hours per day (called highuser). Physical activity of a child was defined as active when the child spend ≥ 1hours per day for moderate (3.5-5.9 METs) to vigorous (METs ≥ 6) physical activities, and as inactive otherwise. Dietary intake was not introduced into models because total energy intake was not correlated with other covariates but physical activity (r=0.14) and because our dietary intake estimates are likely to be biased by our survey methodology.

The factors potentially associated with overweight in adolescents were examined in a multivariable logistic regression model with interaction terms for correlated covariates. A stepwise backward elimination procedure was applied using maximum likelihood chi-square test to adjust for confounding and to identify effect modifiers [15]. The significance level was set to 0.05.

Results

Figure 8.1 shows the relationship between physical activity and sedentary behaviors according to gender, age groups and BMI categories (points are median values). The association between physical activity and sedentary behavior was low (r = 0.14). There were no clear cutoffs for sedentary behaviors in both overweight and underweight groups.

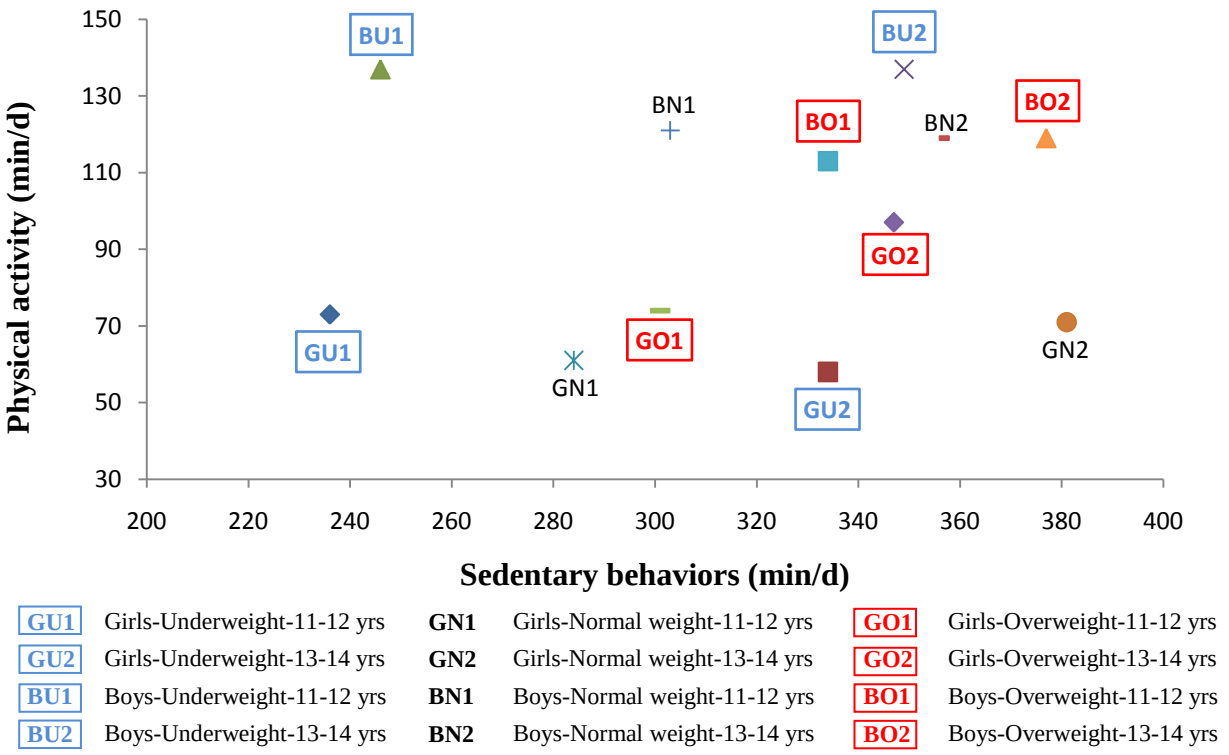


Figure 8.1 Relationship between physical activity and sedentary behavior

Results of the multivariate logistic regression are summarized in Table 8.1. The final multivariate model included the five following risk predictors: male gender, age 11-12 years, richest families, high screen user, and physical inactive adolescents. Because of an absolute correlation coefficient lower than 0.05, no other interactions were introduced in the final model than the interaction between age 11-12 years and high user and the interaction between high user and inactive. School location was removed because highly correlated with wealthy household index. After controlling for study factors, the results showed that independent factors contributing significantly to overweight risk in adolescents were: (1) Male gender, (2) To live in the richest family, and (3) Age ≤ 12 years. Screen time and low physical activity did not contribute significantly to the risk, despite an increased risk for young high users (OR = 1.32*1.46*1.03 = 1.99).

Table 8.1 Multiple logistic regression with all covariates and interactions

	Overweight and obesity risk		
	OR	**95% CI**	**p-value**
1. Boy	2.33	[1.8 – 3.0]	< 0.001
2. Richest (3rd tertile)	1.95	[1.6 – 2.4]	< 0.001
3. Age ≤ 12 yrs	1.46	[1.2 – 1.8]	< 0.001
4. High user (ST > 2h/d)	1.03	[0.8 – 1.4]	0.82
5. Inactive (PA < 1h/d)	0.84	[0.6 – 1.3]	0.40
Interaction (3) and (4)	1.32	[0.8 – 2.1]	0.22
Interaction (4) and (5)	1.01	[0.9 – 1.1]	0.64

ST: screen time; PA: physical activity; h/d: hours per day

Discussion

Our multivariate results are consistent with findings from studies in many countries. Many studies have pointed out differences in adolescent overweight and obesity across gender and age groups with an increased risk of overweight and obesity in male adolescents [16-23]. In this study the odds of being overweight in adolescents was significantly higher among boys than among girls and in the younger age group than in the older age group. Because of the cross-sectional nature of our study, the relationship between overweight and male gender as well as between overweight and age of children cannot be considered as cause-effect relationships. These differences might be already present in the early life of these adolescents. Because born later after the Doi Moi, younger adolescents might have been exposed to higher energy foods in early childhood than older children, resulting in an earlier adiposity rebound than older children and adiposity rebound at an age less than 6 years is linked with a higher final adiposity than if adiposity rebound occurs at an age of 7 years or more, whatever the subject's adiposity at one year of age [24]. The age effect might also be explained by the fact

that the dietary practices of children aged 11-12 are still dependent on parental control in HCMC, and parents are more likely to encourage their younger children to eat more. Adolescent girls tend to be more self-aware of their appearance and more likely to be concerned about their weight than boys and this might contribute to the gender effect. The hypothesis of an effect of oral contraceptives in girls is unlikely in HCMC at the age of 11-14 years.

Our findings showed that children living in the richest families had a higher risk of overweight than children living in less wealthy families. This result is consistent with studies conducted in developing countries [25, 26] but contrasts with studies conducted in industrialized countries [27-29]. In developed countries, overweight and obesity in children and adolescents is more likely to occur in those living in lower socio-economic families. In developing countries, wealthier families are more likely to be able to purchase ample food including "junk" food. Their comfortable life style at home includes numerous "labour saving" devices and household helpers that reduce the level of activity needed for daily household chores. These different patterns of factors associated with overweight need to be taken into account when designing interventions to prevent obesity in populations such as the residents of Vietnamese cities.

Screen time and low physical activity did not contribute significantly to the multivariate risk of overweight despite an increased risk for young high users, with a multivariate odds nearly doubled. The power of our study might be too low for such effect because our study sample size was based on the prevalence of obesity and not on association size; even with 1989 adolescents, the sample size may be too low to reach significant results for associations.

A limitation of the present study is the lack of any time dimension in assessing factors

associated with overweight and obesity due to the cross-sectional design of the study. Because both the outcome and the risk factors were examined at one point in time, we do not know whether these factors preceded or followed the onset of overweight and obesity. Thus the risk factors may be either the causes or the results of overweight/obesity.

Another limitation of this study was the potential problem of measurement instruments. In this study, sedentary behavior, physical activity and dietary intake were measured using questionnaires which depended on subjects' memory. Although these questionnaires have been validated before use, some differences in sedentary behavior, physical activity and dietary intake between overweight and not overweight students might not be detected with our questionnaires because these factors are complex behaviors and usually difficult to measure with simple questionnaire methods. In addition, the lack of relationship between these factors with overweight and obesity in these adolescents may be due to reporting bias by participants. In our dietary data, we observed a systematic inverse relationship between food intakes and overweight. At the time of data collection, youths were informed about the aim of our study on obesity when they filled the questionnaires on food intake and there is evidence in our data that their answers were either overestimated in underweight children or underestimated in overweight children. Questions such as "do you want to lose weight?", "Do you think obesity is a problem in youths?", "Do you like eating?"…were not introduced in our questionnaire, as suggested by recent surveys conducted in Europe.

Conclusions

Our findings demonstrate that obesity is higher in adolescents born later after the Doi Moi of Vietnam than in adolescents born earlier, suggesting that the obesity epidemic will still increase in HCMC in the next years, with the rapid urbanization and the rapid increase in socio-economic level of families of HCMC. Such findings

point out an urgent need to control obesity in children of HCMC, not only in families living in the wealthiest districts of the city, but also in those living in districts with a fast urbanization. All citizens of HCMC should be taught about the danger of over feeding small children; all citizens of HCMC should be encouraged to promote physical activities in youths; walking and cycling should be re-introduced in daily life rather than using motorbike for every small course in HCMC.

References

1. Li M, Dibley M, Sibbritt D, Yan H: Factors associated with adolescents' overweight and obesity at community, school and household levels in Xi'an City, China: results of hierarchical analysis. *European journal of clinical nutrition* 2007, 62(5):635-643.
2. Maddah M: Risk factors for overweight in urban and rural school girls in Iran: Skipping breakfast and early menarche. *International journal of cardiology* 2009, 136(2):235-238.
3. Freedman DS, Khan LK, Dietz WH, Srinivasan SR, Berenson GS: Relationship of childhood obesity to coronary heart disease risk factors in adulthood: the Bogalusa Heart Study. *Pediatrics* 2001, 108(3):712-718.
4. Swinburn B, Egger G, Raza F: Dissecting obesogenic environments: the development and application of a framework for identifying and prioritizing environmental interventions for obesity. *Prev Med* 1999, 29(6):563-570.
5. Power C, Lake J, Cole T: Measurement and long-term health risks of child and adolescent fatness. *International journal of obesity and related metabolic disorders: journal of the International Association for the Study of Obesity* 1997, 21(7):507-526.
6. Must A, Jacques PF, Dallal GE, Bajema CJ, Dietz WH: Long-term morbidity and mortality of overweight adolescents: a follow-up of the Harvard Growth Study of 1922 to 1935. *New England journal of medicine* 1992, 327(19):1350-1355.
7. Ebbeling CB, Pawlak DB, Ludwig DS: Childhood obesity: public-health crisis, common sense cure. *The Lancet* 2002, 360(9331):473-482.
8. Wabitsch M: Overweight and obesity in European children: definition and diagnostic procedures, risk factors and consequences for later health outcome. *European journal of pediatrics* 2000, 159(1):S8-S13.
9. Dietz WH, Gortmaker SL: Preventing obesity in children and adolescents 1. *Annual review of public health* 2001, 22(1):337-353.
10. Hill JO, Peters JC: Environmental contributions to the obesity epidemic. *Science* 1998, 280(5368):1371-1374.
11. Egger G, Swinburn B: An" ecological" approach to the obesity pandemic. *BMJ: British Medical Journal* 1997, 315(7106):477.
12. French SA, Story M, Jeffery RW: Environmental influences on eating and physical activity. *Annual review of public health* 2001, 22(1):309-335.
13. Williams SM, Goulding A: Early adiposity rebound is an important predictor of later obesity. *Obesity (Silver Spring)* 2009, 17(7):1310-1310.
14. Janssen I, Katzmarzyk P, Boyce W, Vereecken C, Mulvihill C, Roberts C, Currie C, Pickett W: Comparison of overweight and obesity prevalence in school-aged youth from 34 countries and their relationships with physical activity and dietary patterns. *Obesity reviews* 2005, 6(2):123-132.
15. Greenberg RS, Kleinbawm D: Mathematical modeling strategies for the analysis of epidemiologic research. *Annual review of public health* 1985, 6(1):223-245.
16. Campagnolo P, Vitolo M, Gama C, Stein A: Prevalence of overweight and associated factors in southern Brazilian adolescents. *Public Health* 2008, 122(5):509-515.
17. Chakar H, Salameh PR: Adolescent obesity in Lebanese private schools. *Eur J Public Health* 2006, 16(6):648-651.
18. Chu NF: Prevalence of obesity in Taiwan. *Obesity reviews* 2005, 6(4):271-274.
19. Collins AE, Pakiz B, Rock CL: Factors associated with obesity in Indonesian adolescents. *International Journal of Pediatric Obesity* 2008, 3(1):58-64.
20. Dinsa G, Goryakin Y, Fumagalli E, Suhrcke M: Obesity and socioeconomic status in developing countries: a systematic review. *Obesity reviews* 2012, 13(11):1067-1079.

21. Isasi CR, Whiffen A, Campbell E, Florez Y, Freeman K, Wylie-Rosett J: High prevalence of obesity among inner-city adolescent boys in the Bronx, New York: forgetting our boys. *Prev Chronic Dis* 2011, 8(1):A23.
22. Tang KH, Nguyen HH, Dibley MJ, Sibbritt DW, Phan NT, Tran TM: Factors associated with adolescent overweight/obesity in Ho Chi Minh city. *Int J Pediatr Obes* 2010, 5(5):396-403.
23. Zhang M, Guo F, Tu Y, Kiess W, Sun C, Li X, Lu W, Luo F: Further increase of obesity prevalence in Chinese children and adolescents–cross-sectional data of two consecutive samples from the city of Shanghai from 2003 to 2008. *Pediatric Diabetes* 2012, 13(7):572-577.
24. Han JC, Lawlor DA, Kimm SYS: Childhood obesity. *The Lancet*, 375(9727):1737-1748.
25. Pérez-Cueto A, Almanza M, Kolsteren P: Female gender and wealth are associated to overweight among adolescents in La Paz, Bolivia. *European journal of clinical nutrition* 2004, 59(1):82-87.
26. Wang Y: Cross-national comparison of childhood obesity: the epidemic and the relationship between obesity and socioeconomic status. *Int J Epidemiol* 2001, 30(5):1129-1136.
27. Parrino C, Rossetti P, Baratta R, La Spina N, La Delfa L, Squatrito S, Vigneri R, Frittitta L: Secular trends in the prevalence of overweight and obesity in Sicilian schoolchildren aged 11–13 years during the last decade. *PloS one* 2012, 7(4):e34551.
28. Gordon-Larsen P, Adair LS, Popkin BM: The relationship of ethnicity, socioeconomic factors, and overweight in US adolescents. *Obes Res* 2003, 11(1):121-129.
29. Klein-Platat C, Wagner A, Haan M, Arveiler D, Schlienger J, Simon C: Prevalence and sociodemographic determinants of overweight in young French adolescents. *Diabetes/metabolism research and reviews* 2003, 19(2):153-158.

Chapter 9 Discussion and Conclusions

9.1 Discussion

9.1.1 Major findings of the study

This manuscript describes the prevalence of overweight and obesity, the sedentary behaviors, the physical activity and the dietary intake in a representative sample of urban adolescents of population in Ho Chi Minh City (HCMC), Vietnam.

High prevalence of overweight and obesity among adolescents in HCMC

The study revealed a high prevalence of overweight and obesity among junior high school students in HCMC. Using IOTF [1], the prevalence of overweight, and obesity were 17.8%, and 3.2%, respectively. During 6 years, the prevalence of overweight and obesity significantly increased from 11.7% and 2% in 2004 to 17.8% and 3.2% in 2010, respectively ($p < 0.001$) with an annual increase of +1.02% per year. Our prevalence of overweight and obesity was quite similar to prevalences reported in other South East Asian countries [3, 4]. Compared to the results of a study conducted in 2004 in the same city [5], our results showed that the prevalence of overweight and obesity in urban adolescents in HCMC highly increased from 2004 to 2010. This result is consistent with studies conducted in China [6, 7] and other South East Asian countries [8, 9] while in some developed countries, there is a plateau in the prevalence of overweight and obesity [10-12]. In developing countries, the rapid urbanization and socioeconomic development have induced changes in eating habits and lifestyle. These changes have also induced a high increase in prevalence of obesity in children and adolescents.

Determinants of overweight: male gender, younger children, and children living in richest families

In our study, the prevalence of overweight and obesity were higher in boys (22%, 5.4%) than in girls (13.3%, 1.3%). These results were consistent with other studies. Adolescent girls are expected to be more self-aware of their appearance and they are more likely to be concerned about their weight than boys and this might contribute to the gender effect. Another plausible explanation is that adiposity rebound occurs earlier in life for boys than for girls, leading to a higher prevalence of overweight and obesity in boys than in girls at the age of 11-14 years. In Ho Chi Minh City, the use of oral contraceptives among girl aged 11-14 years is unlikely and there is therefore no effect of these drugs on their weight.

Our findings showed that a decreasing trend in prevalence as age increased ($p < 0.001$); younger children were more likely to be overweight. Such trend was also observed in other studies. This might be explained by the fact that older children are less dependent of their parents for daily activities, so they can be free to do more activities outside home or school. Another explanation is that younger adolescents were more exposed to high caloric foods because they were born more later after the Renovation of socioeconomic since 1990 (called 'Doi Moi') than older children who were born at the beginning of Renovation.

We found that prevalence of overweight and obesity were higher in children studying in schools located in wealthy districts (20.5%, 3.8%) than those studying in less wealthy districts (12.1%, 3.8%), and also higher in children from richest families. These results are in line with studies conducted in other developing countries [13-15], but it contrasts to the situation in developed countries where children from families with a low-socioeconomic level have a higher prevalence of overweight and obesity. This is usually explained by a greater access to energy-dense diets and more chance of a passive lifestyle [16, 17], which is also the case for children living in families with a high socio-economic level in developing

countries. The social inequalities for obese adolescents might be partly explained by a more rapid increase in weight around the age of 3 years which is a vitally important determinant of early adiposity rebound (before 6 years of age) in children living in families with a high socioeconomic status. In Vietnam, the socioeconomic status and the urbanization have rapidly developed since 1990. Literature also establishes that under-nutrition in fetal life or during the first years after birth may programme a thrifty metabolism that will exert adverse effects later in life if the growing child is exposed to over-nutrition. Children living in wealthier families and born more recently could have been more exposed to high energy and protein foods in their childhood. Consequently, these children had a higher increase of weight after an early adiposity than children in less wealthier families.

Sedentary behavior were common but there was no association between sedentary behaviors and overweight among adolescents in HCMC

In 2010, adolescents spent a mean of 6h/day in sedentary behaviors. Studying after school and small-screen recreation time accounted for more than two thirds of total sedentary time among Vietnamese children. They spent more time using small-screen recreations (129 min/day) than studying after school (120 min/day) and other sedentary activities (51 min/day). Our findings showed that Vietnamese adolescents spend time in sedentary activities as much as children in developed countries [18, 19]. However, in contrast to children in some developed countries such as United States or Australia, Vietnamese children spent more time in learning after school while formers spent more time in small-screen recreations [19-21]. Our findings are in line with studies in Asian countries [22, 23]. Such differences may be explained by the fact that in Vietnam, like in other Asian countries, advanced education is generally viewed as a pathway to economic security, so parents and schools put academic pressure on students to obtain high educational achievements. Therefore, children in these countries have higher pressure for learning after school.

As in some other studies, our findings showed an association between sedentary activities and gender [20,24,25]. Socioeconomic status had also a positive relationship with all sedentary behaviors, as in other studies conducted in developing countries but quite different results have been reported in industrialized countries [19, 26]. In developing countries, children in wealthy families are well equipped with modern recreational amenities such as computers, internet, TVs and they have usually low pressure for learning after school. They therefore spend more time in doing sedentary activities.

With regard to BMI status, univariate analysis showed that younger children and high users of small-screen recreations are more often overweight or obese [22,27,28]. However, in multiple logistic regression model, this relationship was no more significant, even if there was an increased risk for young high users. It might be due to our sample size that was based on the prevalence of overweight and obesity and not on association size; even with 1989 adolescents, the sample size may be too low to reach significant results for associations.

Although 40% of children spend < 1h/d in physical activities, no association between physical activity and overweight was detected among adolescents in Ho Chi Minh City

Children spent 92 min/day for moderate or vigorous physical activities (MVPA) and 33.9% spend less than 60 min/day for MVPA. Despite the use of different measuring tools for collecting physical activity data, other studies conducted in Asian countries reported similar findings [29-31]. Compared with Western countries, youth adolescents in our study had low physical activity levels [32, 33]. The explanation of Rowlands *et al.* is that Asian culture gives more value to formal education and is less concerned about the physical activity of its young people [34]. Children spent a large amount of time on school-based activities and in doing homework or learning after school [31, 35].

In our study, boys spent more time in MVPA than girls. This result is consistent with many studies [36-39]. This is maybe a matter of fact but this can also be explained by a greater

access to structured activity for boys than for girls, and by a decrease in the social desirability of physical activity for girls at the age of puberty and breast development [40, 41].

Using univariate analysis, we found that inactive boys aged 11-12 years were more likely to be overweight and obese. This finding is in line with other studies [36, 42]. This also indicates that the association between a lack of physical activity and overweight or obesity is gender specific. However, in multiple logistic regression model, physical inactivity was no more associated with overweight and obesity in adolescents.

Energy intake exceeded the Vietnam Recommended Dietary Allowances 2007 but there was a high reporting bias in total energy intake

We found that total energy intake among Vietnamese adolescents in urban areas in HCMC exceeded Vietnam Recommended Diet Allowances 2007 [2]. Overweight and obese girls had lower energy intakes than their peers. As in other studies [50-52], we found no association between macronutrient intakes and BMI among boys but an inverse association among girls which is inconsistent with other studies [53, 54]. These findings might be due to reporting bias because our data clearly showed that overweight children tended to report lower energy intake while underweight children tended to report higher energy intake. At the time of the study, children were informed that they would participate in a study on obesity, as an ethical issue. This has maybe led overweight or obese children to underreport their actual food intake. In addition, FFQ may result in errors such as under- or over- estimation of food quantities [21]. Because of a potential bias in our quantitative estimates, nutrition covariates were not considered in multivariate regression model for factors associated with overweight and obesity.

9.1.2 Strengths and limitations of the study

This is the most recent study reporting prevalence of overweight and obesity among adolescents in urban areas of Ho Chi Minh City. In this study, a well designed, representative sample of urban adolescents was randomly selected from the population by using multistage cluster sampling and our findings therefore reflect the extent of obesity in all adolescents of Ho Chi Minh City. Our study provides helpful information for public health intervention programs because we conducted this study in an understudied population. In addition, early adolescence (aged 11-14) is an interesting period because it deals with the transition between pre-adolescence and adolescence. This is a critical period for the development of overweight that may depend on the prevalence of many other obesigenic risk factors. Our study has also an internal validity because we used three questionnaires (food frequency questionnaire, physical activity questionnaire, and sedentary behavior questionnaire) which were validated for adolescents living in urban areas to collect main factors related to overweight and obesity. These validated questionnaires had a high reliability and validity in previous studies [58-60]. Besides, economic status was assessed using a household wealthy index based on a list of household facilities and assets. This index provided a validated tool for assessing the association of economic status with the BMI status of adolescents in the survey.

There were however, several limitations in our study. Our design study was a cross-sectional design where both overweight and obesity and the risk factors were assessed at the same time. Thus the risk factors may be either the causes or the results of overweight and obesity. Also, using BMI to assess weight status does not account for the wide variation in body fat distribution, and it may not correspond to the same degree of fatness or associated health risk in different individuals and populations. It can also misclassify some subjects like athletes, very short or very tall persons. Nevertheless, the use of BMI as an indicator of adiposity is valuable for screening and for epidemiological studies. IOTF definition might also

underestimate prevalence of overweight and obesity among Vietnamese adolescents because the IOTF reference population represents children from some high- and upper-middle-income countries.

When comparing IOTF definition to other definitions (WHO 2007, CDC 2000), the prevalence of obesity with IOTF was lower than that by using WHO 2007 or CDC 2000. IOTF cutoffs are based on international data sets and extrapolate the adult BMI cutoffs for overweight and obesity to children. Those cutoffs are based on the assumption that children with those BMI values have inherent health risks. Therefore, IOTF reference values have been proposed for international use in prevalence studies. We used IOTF in order to compare our results with previous studies in HCMC. Potential limitations can also be attributed to our measurement instruments. In this study physical activity, sedentary behavior and dietary intake were measured using questionnaires which depended on subjects' memory. Reporting bias and inaccurate recall cannot be avoided. Although these questionnaires have been validated before using, some differences in physical activity, sedentary behavior and dietary intake between overweight and non overweight children might not be detected because they are complex factors and usually not easily measured with a simple questionnaire method.

9.2 Public health implications and recommendations

This study showed that overweight and obesity are still increasing since 2004 reaching 21% of adolescents. The finding gives a high alarm of an increase in overweight and obesity among adults in the next few years in HCMC. As a consequence, diet-related non-communicable diseases will also become a public health issue in HCMC. Although overweight in adolescence track to overweight in adulthood, and prevalence of overweight among adolescents in HCMC is rapidly increasing, the city government has not yet shown an interest in this problem. Policy makers should implement appropriate intervention programs

aimed to prevent obesity epidemic and should introduce health-watch systems to monitor obesity in adolescents. These intervention strategies need however, to be tailored to sex differences and priority should be placed on adolescents from high socioeconomic status families who are more likely to be overweight or obese.

Our results help to focus and prioritize the direction of future research in Vietnam on the prevention of overweight and obesity in adolescents. Firstly, longitudinal studies are needed among children aged 3 to 14 years to determine the age of adiposity rebound in Vietnamese children and to demonstrate that restraining weight gain in early childhood can delay adiposity rebound and prevent obesity in adulthood. These studies can provide a full understanding of changes in diets, in levels of physical activity, in environments, with their relationship to the emergence of overweight and obesity in adolescents of Ho Chi Minh City. This would also confirm risk factors for overweight and obesity among adolescents, allowing development of detailed plans for interventions. Secondly, because of a high reporting bias in dietary intake, further studies should be conducted in order to have better tools, to develop adequate food questionnaire for estimating dietary intake in adolescents.

9.3 Conclusions

Urban areas of Ho Chi Minh City currently confront a high increase in overweight and obesity among adolescents. Although the emergence of adolescent obesity is still in an early phase in Ho Chi Minh City, it is important to identify the key obesogenic risk factors in this population and to begin planning interventions to prevent the further development of this potential epidemic. In Ho Chi Minh City, overweight and obesity are occurring in richest families. It will be better to prevent the problem in this socioeconomically advantaged group before the poorer families catch up. All citizens of HCMC should be taught about the danger of over feeding small children; all citizens of HCMC should be encouraged to promote

physical activities in youths; walking and cycling should be re-introduced in daily life rather than using motorbike for every small course in HCMC.

References

1. Cole, T.J., *et al..*, *Establishing a standard definition for child overweight and obesity worldwide: international survey.* BMJ, 2000. 320(7244): p. 1240-3.
2. Nguyen, C.K., Pham, V.H., *Vietnam Recommended Dietary Allowances 2007.* Asia Pac J Clin Nutr2008. 7(S2): p. 409-415.
3. Sanguansak, R., Lakkana, R., *Prevalence of Overweight and Obesity Among School Children in Suburb Thailand Defined by the International Obesity Task Force standard.* J Med Assoc Thai, 2010. 93(2): p. S27-31.
4. Zalilah, M.S., Mirnalini, K., Khor, G.L., Merlin, A., Bahaman, A.S., Norimah, K., *Estimates and Distribution of Body Mass Index in a Sample of Malaysian Adolescents.* Med J Malaysia, 2006. 61(1): p. 48-58.
5. Hong, T.K., *et al..*, *Overweight and obesity are rapidly emerging among adolescents in Ho Chi Minh City, Vietnam, 2002-2004.* International journal of pediatric obesity : IJPO : an official journal of the International Association for the Study of Obesity, 2007. 2(4): p. 194-201.
6. Cui, Z., *et al..*, *Temporal trends in overweight and obesity of children and adolescents from nine Provinces in China from 1991–2006.* International Journal of Pediatric Obesity, 2010. 5(5): p. 365-374.
7. Zhang, M., *et al..*, *Further increase of obesity prevalence in Chinese children and adolescents–cross-sectional data of two consecutive samples from the city of Shanghai from 2003 to 2008.* Pediatric Diabetes, 2012. 13(7): p. 572-577.
8. Julia, M., *et al..*, *Tracking for underweight, overweight and obesity from childhood to adolescence: a 5-year follow-up study in urban Indonesian children.* Hormone Research in Paediatrics, 2008. 69(5): p. 301-306.
9. Mo-suwan, L., *Childhood obesity: an overview.* Siriraj Medical Journal-สารศิริราช, 2008. 60(1): p. 37-40.
10. Olds, T., *et al..*, *Evidence that the prevalence of childhood overweight is plateauing: data from nine countries.* International Journal of Pediatric Obesity, 2011. 6(5-6): p. 342-360.
11. Olds, T.S., *et al..*, *Trends in the prevalence of childhood overweight and obesity in Australia between 1985 and 2008.* International journal of obesity, 2009. 34(1): p. 57-66.
12. Hardy, L., *et al..*, *Shifting curves? Trends in thinness and obesity among Australian youth, 1985 to 2010.* Pediatric obesity, 2012. 7(2): p. 92-100.
13. Dinsa, G., *et al..*, *Obesity and socioeconomic status in developing countries: a systematic review.* Obesity reviews, 2012. 13(11): p. 1067-1079.
14. Monteiro, C.A., *et al..*, *Socioeconomic status and obesity in adult populations of developing countries: a review.* Bulletin of the World Health Organization, 2004. 82(12): p. 940-6.
15. Collins, A.E., B. Pakiz, and C.L. Rock, *Factors associated with obesity in Indonesian adolescents.* International Journal of Pediatric Obesity, 2008. 3(1): p. 58-64.

16. Klein-Platat, C., *et al.., Prevalence and sociodemographic determinants of overweight in young French adolescents.* Diabetes/metabolism research and reviews, 2003. 19(2): p. 153-158.
17. Gordon-Larsen, P., L.S. Adair, and B.M. Popkin, *The relationship of ethnicity, socioeconomic factors, and overweight in US adolescents.* OBESITY RESEARCH, 2003. 11(1): p. 121-9.
18. Whitt-Glover, M.C., *et al.., Disparities in physical activity and sedentary behaviors among US children and adolescents: prevalence, correlates, and intervention implications.* Journal of Public Health Policy, 2009: p. S309-S334.
19. Hardy, L.L., *et al.., Sedentary behaviours among Australian adolescents.* Australian and New Zealand journal of public health, 2006. 30(6): p. 534-540.
20. Utter, J., *et al.., Couch potatoes or French fries: are sedentary behaviors associated with body mass index, physical activity, and dietary behaviors among adolescents?* Journal of the American Dietetic Association, 2003. 103(10): p. 1298-1305.
21. Biddle, S.J., *et al.., Temporal and environmental patterns of sedentary and active behaviors during adolescents' leisure time.* International journal of behavioral medicine, 2009. 16(3): p. 278-286.
22. Tudor-Locke, C., *et al.., Cross-sectional comparison of physical activity and inactivity patterns in Chinese and Filipino youth.* Child: care, health and development, 2007. 33(1): p. 59-66.
23. Cui, Z., *et al.., Temporal trends and recent correlates in sedentary behaviours in Chinese children.* The international journal of behavioral nutrition and physical activity, 2011. 8(1): p. 93.
24. Cui, Z., *et al.., Temporal trends and recent correlates in sedentary behaviours in Chinese children.* The international journal of behavioral nutrition and physical activity, 2011. 8: p. 93.
25. Karaca, A., *et al.., Screen time of adolescents in an economically developing country: the case of Turkey.* Annals of human biology, 2011. 38(1): p. 28-33.
26. van Sluijs, E.M., *et al.., Behavioural and social correlates of sedentary time in young people.* British journal of sports medicine, 2010. 44(10): p. 747-755.
27. Kristiansen, H., *et al.., TV viewing and obesity among Norwegian children: the importance of parental education.* Acta Paediatrica, 2013. 102(2): p. 199-205.
28. Kautiainen, S., *et al.., Use of information and communication technology and prevalence of overweight and obesity among adolescents.* International journal of obesity, 2005. 29(8): p. 925-933.
29. Liou, Y.-M. and L.-C. Chiang, *Levels of physical activity among school-age children in Taiwan: A comparison with international recommendations.* Journal of Nursing Research, 2004. 12(4): p. 307-316.
30. Wang, C.J., *et al.., Patterns of physical activity, sedentary behaviors, and psychological determinants of physical activity among Singaporean school children.* International Journal of Sport and Exercise Psychology, 2006. 4(3): p. 227-249.
31. Wang, C.J., *et al.., A latent profile analysis of sedentary and physical activity patterns.* Journal of Public Health, 2012. 20(4): p. 367-373.

32. Leggett, C., *et al..*, *Factors associated with physical activity among Canadian high school students.* International journal of public health, 2012. 57(2): p. 315-324.
33. Gorely, T., *et al..*, *The prevalence of leisure time sedentary behaviour and physical activity in adolescent girls: An ecological momentary assessment approach.* International Journal of Pediatric Obesity, 2007. 2(4): p. 227-234.
34. Rowlands, A.V., *et al..*, *Physical activity levels of Hong Kong Chinese children: Relationship with body fat.* 2002.
35. Robertson, A., *et al..*, *Food and health in Europe: a new basis for action.* WHO regional publications. European series, 2004(96): p. i-xvi, 1-385, back cover.
36. Trang, N.H., *et al..*, *Factors associated with physical inactivity in adolescents in Ho Chi Minh City, Vietnam.* Medicine and science in sports and exercise, 2009. 41(7): p. 1374-83.
37. Gordon-Larsen, P., R.G. McMurray, and B.M. Popkin, *Adolescent physical activity and inactivity vary by ethnicity: The National Longitudinal Study of Adolescent Health.* The Journal of pediatrics, 1999. 135(3): p. 301-306.
38. Nguyen, T., *et al..*, *Association between physical activity and metabolic syndrome: a cross sectional survey in adolescents in Ho Chi Minh City, Vietnam.* BMC public health, 2010. 10(1): p. 141.
39. Chung, A.E., *et al..*, *Physical activity and BMI in a nationally representative sample of children and adolescents.* Clinical Pediatrics, 2012. 51(2): p. 122-129.
40. Goran, M.I., *et al..*, *Developmental changes in energy expenditure and physical activity in children: evidence for a decline in physical activity in girls before puberty.* Pediatrics, 1998. 101(5): p. 887-891.
41. Sallis, J.F., *et al..*, *Ethnic, socioeconomic, and sex differences in physical activity among adolescents.* Journal of clinical epidemiology, 1996. 49(2): p. 125-134.
42. Li, M., *et al..*, *Factors associated with adolescents' overweight and obesity at community, school and household levels in Xi'an City, China: results of hierarchical analysis.* European journal of clinical nutrition, 2007. 62(5): p. 635-643.
43. Matthys, C., *et al..*, *Estimated energy intake, macronutrient intake and meal pattern of Flemish adolescents.* European journal of clinical nutrition, 2003. 57(2): p. 366-375.
44. Rolland-Cachera, M.F., F. Bellisle, and M. Deheeger, *Nutritional status and food intake in adolescents living in Western Europe.* European journal of clinical nutrition, 2000. 54: p. S41-6.
45. Zalilah, M., *et al..*, *Dietary intake, physical activity and energy expenditure of Malaysian adolescents.* Singapore medical journal, 2006. 47(6): p. 491-498.
46. Gharib, N. and P. Rasheed, *Energy and macronutrient intake and dietary pattern among school children in Bahrain: a cross-sectional study.* Nutr J, 2011. 10(62): p. 1-12.
47. Zhang, C.-X., *et al..*, *Food group intake among adolescents in Guangzhou city compared with the Chinese dietary guidelines.* Asia Pacific journal of clinical nutrition, 2012. 21(3): p. 450.
48. Xie, B., *et al..*, *Effects of Ethnicity, Family Income, and Education on Dietary Intake among Adolescents.* Preventive medicine, 2003. 36(1): p. 30-40.

49. Groth, M.V., S. Fagt, and L. Brøndsted, *Social determinants of dietary habits in Denmark.* European journal of clinical nutrition, 2001. 55(11): p. 959-966.
50. Rezali, F.W., *et al..*, *Obesity-related behaviors of Malaysian adolescents: a sample from Kajang district of Selangor state.* Nutrition research and practice, 2012. 6(5): p. 458-465.
51. Garaulet, M., *et al..*, *Differences in dietary intake and activity level between normal-weight and overweight or obese adolescents.* Journal of pediatric gastroenterology and nutrition, 2000. 30(3): p. 253-258.
52. Rockett, H.R., *et al..*, *Cross-sectional measurement of nutrient intake among adolescents in 1996.* Preventive medicine, 2001. 33(1): p. 27-37.
53. Tucker, L.A., G.T. Seljaas, and R.L. Hager, *Body fat percentage of children varies according to their diet composition.* Journal of the American Dietetic Association, 1997. 97(9): p. 981-986.
54. Andersen, R.E., *et al..*, *Relationship of physical activity and television watching with body weight and level of fatness among children: Results from the third national health and nutrition examination survey.* JAMA : the journal of the American Medical Association, 1998. 279(12): p. 938-942.
55. Bandini, L.G., D.A. Schoeller, and W.H. Dietz, *Energy expenditure in obese and nonobese adolescents.* Pediatric research, 1990. 27(2): p. 198-202.
56. Livingstone, M.B., *et al..*, *Validation of estimates of energy intake by weighed dietary record and diet history in children and adolescents.* The American journal of clinical nutrition, 1992. 56(1): p. 29-35.
57. Rodríguez, G. and L.A. Moreno, *Is dietary intake able to explain differences in body fatness in children and adolescents?* Nutrition, metabolism and cardiovascular diseases, 2006. 16(4): p. 294-301.
58. Hong, T.K., *et al..*, *Validity and reliability of a physical activity questionnaire for Vietnamese adolescents.* Int J Behav Nutr Phys Act (MS 4835073026381536), 2012.
59. Hong, T.K., M.J. Dibley, and D. Sibbritt, *Validity and reliability of an FFQ for use with adolescents in Ho Chi Minh City, Vietnam.* Public Health Nutrition, 2009. 13(3): p. 368.
60. Tran LN., T.L., Hong TK., *Validation study of the sedentary questionnaire used for adolescents in Ho Chi Minh City, Vietnam*, in *Youth Scientific Conference*. 2008: Pham Ngoc Thach University of Medicine.

Appendix 1 Student form

Appendix 1.1 Anthropometry recording form

District name _____School name _____ grade __student's name _____
Student code_____ Student's name: _____

No.	Contents	Code	*Variable*
1	Gender male female	 [ ] 1 [ ] 2	*A1*
2	Birth date: *(yy/mm/dd)*	19___ ___/___ ___/___ ___	*A2*
3	Measurement data: *(yy/mm/dd)*	2010/___ ___/ ___ ___	*A3*
4	Weight:	___ ___ ___.___ kg	*A4*
5	Height:	___ ___ ___.__cm	*A5*
6	Waist circumference:	___ ___ .___cm	*A6*
7	Hip circumference :	___ ___ ___.___cm	*A7*
8	Upper arm circumference:	____ ____.___cm	*A8*
	Signature of measurer: _____ code:	____ ____	
9	Tricept skinfold:	____ ____.___mm	*A9.1*
		____ ____.___mm	*A9.2*
	(If second is more than 5mm different, then do third)	____ ____.___mm	*A9.3*
10	Subcaspular skinfold:	____ ____.___mm	*A10.1*
		____ ____.___mm	*A10.2*
	(If second is more than 5mm different, then do third)	____ ____.___mm	*A10.3*
11	Medial calf skinfold :	____ ____.___mm	*A11.1*
		____ ____.___mm	*A11.2*
	(If second is more than 5mm different, then do third)	____ ____.___mm	*A11.3*
12	Abdominal skinfold :	____ ____.___mm	*A11.1*
		____ ____.___mm	*A11.2*
	(If second is more than 5mm different, then do third)	____ ____.___mm	*A11.3*
	Signature of measurer: _____ code:	____ ____	

Appendix 1.2 Self-reported for boys

Health Service of HCMC
University of Medicine Pham Ngoc Thach

Questions for Male students at interview only

District _____ School _____Class _____
Student's code _____ Student's name _____

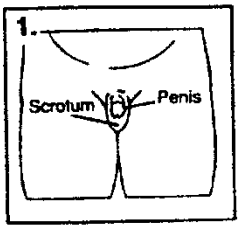
Response to this Questionnaire is entirely confidential

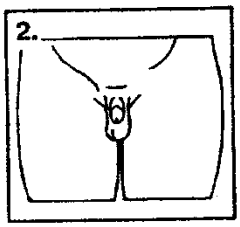
Assessment of Pubertal Status

There should be ONE tick on each size of the page

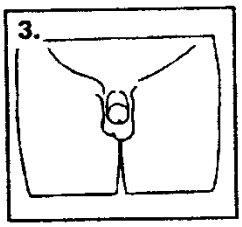
- Please look at the **Penis** and **Scrotum** only in these pictures.
- Please put a tick in the box that looks most like you now.

Scrotum and Penis same size as when you were younger.

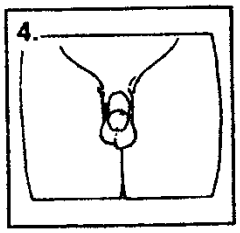




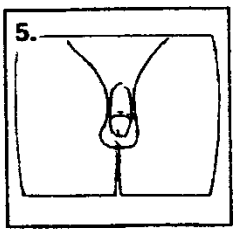
The Scrotum has lowered a bit and the Penis is a little larger.



The Penis is longer the Scrotum is larger.



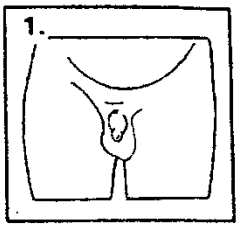
The Penis is longer and wider the Scrotum is darker and bigger than before

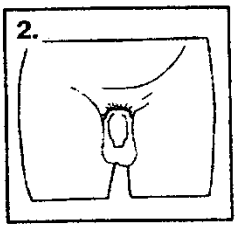


The Penis and Scrotum are the size and shape of an adult.

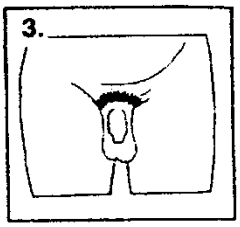
- Please look at the **Pubic Hair** only in these pictures.
- Please put a tick in the box that looks most like you now.

No hairs

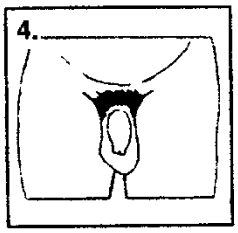




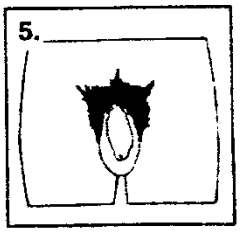
Very little hair



Quite a lot of hair



The hair has not spread over the thighs



The hair has spread over the thighs

Appendix 1.3 Self-reported for girls

Health Service of HCMC
University of Medicine Pham Ngoc Thach

Questions for Female students at interview only

District _____ School _____Class _____
Student's code _____ Student's name _____

Response to this Questionnaire is entirely confidential

Assessment of Pubertal Status

- Have you had your first period? Yes ☐ No ☐
- If yes, at what age did you have your first period: Year _____ Month _____
  For example: ***2005*** ***July***

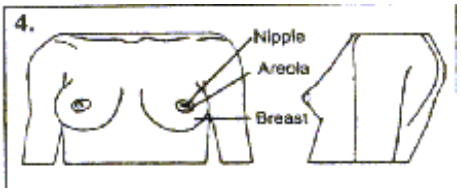
If you cannot remember exactly the date of your first period, which grade did you have it?
Grade 6 ☐ Grade 7 ☐ Grade 8 ☐ Grade 9

Please put a tick **(X)** in the box that looks most like you now

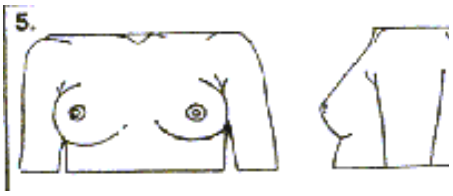
The breasts are flat

The breasts form small mounds

The breasts form larger mounds than in 2



The nipple and the surrounding part (the Areola) make up a mound that sticks up above the



Only the nipple sticks out beyond the breast

Appendix 2 The Food Frequency Questionnaire

This questionnaire consists of 160 questions that were contains in 47 pages. This question is available on request.

PHAM NGOC THACH Beginning time: __:__
UNIVERSITY OF MEDICINE
Date of interview: ID: __ __ __
__/__/__

FOOD FREQUENCY QUESTIONNAIRE

Child's name: Class: School:
1 Date of birth: ___ / ___ / ___
2 Gender: 1 [ ] Male 2 [ ] Female
3 Weight: **4** Height:

Instructions:

1- Tell the interviewee that the recall time is ***the last 6 months***

2- Repeat these two types of question for each food and record the response into the corresponding places. One question is about ***frequency*** (on the left) and another about the ***portion size*** (on the right):

a/ *Frequency*: "**During the last 6 months, how often have you eaten [FOOD NAME]?**". Fill in the corresponding box with X mark.

b/ *Portion size*: "**How much have you eaten [FOOD NAME] per time**?" Fill in the corresponding box with X mark.

3- Help the interviewee choose the most appropriate portion size from the picture book

Remark: In the case that the response is different from the options listed, please kindly note the differences adjacent to that question

QUESTIONNAIRE REFERS TO WHAT THE CHILD ATE OVER THE LAST 6 MONTHS

11a	**Soft drink**			**11b**	
0 [ ]	Never			10	1/4 bottle or can
1 [ ]	Once a month or less			11	1/2 bottle or can
2 [ ]	3-4 times per month			12	3/4 bottle or can
3 [ ]	Once a week	5 [ ]	Once a day	13	1 bottle or can
4 [ ]	2-6 times/week	6 [ ]	2-3 times/day		

12a	**Coconut juice**			**12b**	
0 [ ]	Never			10	1/2 glass (Picture 1.10)
1 [ ]	Once a month or less			11	1 glass = 1/2 coconut (P 1.11)
2 [ ]	3-4 times per month			12	3/4 coconut (P 1,12)
3 [ ]	Once a week	5 [ ]	Once a day	13	1 coconut (P1,13)
4 [ ]	2-6 times/week	6 [ ]	2-3 times/day		

13a	**Fruit juice/sugar can**			**13b**	
0 [ ]	Never			10	1/4 glass (P 2.10)
1 [ ]	Once a month or less			11	1/2 glass (P 2.11)
2 [ ]	3-4 times per month			12	3/4 glass (P 2.12)
3 [ ]	Once a week	5 [ ]	Once a day	13	1 glass (P 2.13)
4 [ ]	2-6 times/week	6 [ ]	2-3 times/day		

14a	**Green leaf juice with sugar**			**13b**	
0 [ ]	Never			10	1/4 glass (P 2.10)
1 [ ]	Once a month or less			11	1/2 glass (P 2.11)
2 [ ]	3-4 times per month			12	3/4 glass (P 2.12)
3 [ ]	Once a week	5 [ ]	Once a day	13	1 glass (P 2.13)
4 [ ]	2-6 times/week	6 [ ]	2-3 times/day		

15a	**Icetea/Nestea**			**15b**	
0 [ ]	Never			10	1 pack for a glass
1 [ ]	Once a month or less			11	1/2 pack for a glass (P 3.11)
2 [ ]	3-4 times per month			12	1/4 p + 1-2 tp of sugar (P 3.12)
3 [ ]	Once a week	5 [ ]	Once a day	13	1/4 p + 3-4 tp of sugar (P 3.12)
4 [ ]	2-6 times/week	6 [ ]	2-3 times/day		

16a	**Bird nest/Tonic drink**			**16b**	
0 [ ]	Never			10	1/4 can
1 [ ]	Once a month or less			11	1/2 can
2 [ ]	3-4 times per month			12	3/4 can
3 [ ]	Once a week	5 [ ]	Once a day	13	1 can
4 [ ]	2-6 times/week	6 [ ]	2-3 times/day		

Appendix 3 The Physical Activity Questionnaire

JUNIOR HIGH SCHOOL PHYSICAL ACTIVITY QUESTIONNAIRE

Dear all, this questionnaire is to assess about your physical activities. Below is lists of activities that may be done by yourselves. Please fill in the column of activities what you have been doing (basing on the lists below) accompanied with activity codes. If you do these activities please record how many times per week you do that as normal and/or how many times per week you prepare for competition. Furthermore, please record time for conductingorganised and non-organised activities. If there are other activities that are not listed below please also add them into the tables.

District _____ School _____ Class _____
Student's code _____ Student's name _____

DURING SCHOOL YEAR

1. ORGANISED SPORT OR GAMES DURING SCHOOL YEAR

Code	SPORT or GAME	Number of times per week you usually do this sport or game	The usual amount of time you spend doing this activity each time you do it
		Training	_____ hours _____ minutes
		Competition	_____ hours _____ minutes
		Training	_____ hours _____ minute
		Competition	_____ hours _____minutes
		Training	_____ hours _____minutes
		Competition	_____ hours _____minutes
		Training	_____ hours _____minutes
		Competition	_____ hours _____minutes
		Training	_____ hours _____minutes
		Competition	_____ hours _____minutes
		Training	_____ hours _____minutes
		Competition	_____ hours _____minutes
		Training	_____ hours _____ minutes
		Competition	_____ hours _____minutes
		Training	_____ hours _____minutes
		Competition	_____ hours _____minutes
		Training	_____ hours _____minutes
		Competition	_____ hours _____ minutes
		Training	_____ hours _____ minutes
		Competition	_____ hours _____ minutes
		Training	_____ hours _____ minutes

		Competition	_____ hours _____ minutes
		Training	_____ hours _____minutes
		Competition	_____ hours _____minutes
		Training	_____ hours _____ minutes
		Competition	_____ hours _____ minutes
		Training	_____ hours _____minutes
		Competition	_____ hours _____minutes
		Training	_____ hours _____minutes
		Competition	_____ hours _____minutes

01	Short running	09	Fitness		Basketball
02	Shot putting	10	Gymnastics		Kungfu
03	High jumping	11	Line-up		Swimming
04	Long jumping	12	Table tennis		Dancing
05	Rope skipping	13	Badminton		Shuttle cock
06	Cycling (competitive	14	Football		Bowling
07	Breaktime physical exercises	15	Volleyball		Physical games
08	Aerobics	16	Handball		Marbles playing

* Physical games include all such as chasing."hide and find", etc

2. NON-ORGANISED ACTIVITIES DURING SCHOOL YEAR

Code	**SPORT or GAME**	**Number of times per week you usually do this sport or game**	**The usual amount of time you spend doing this activity each time you do it**
			hour _____ minute_____
			hour _____ minute_____
			hour _____ minute_____
			hour _____ minute_____
			hour _____ minute_____
			hour _____ minute_____
			hour _____ minute_____
			hour _____ minute_____
			hour _____ minute_____
			hour _____ minute_____
			hour _____ minute_____
			hour _____ minute_____
			hour _____ minute_____
			hour _____ minute_____
			hour _____ minute_____

LIST OF ACTIVITIES/GAMES MAY BE DONE BY JUNIOR HIGH SCHOOL STUDENTS

01 Short running
05 Rope skipping
08 Aerobics
12 Table tennis
13 Badminton
14 Football
16 Handball
17 Basketball
18 Kungfu
19 Swimming
20 Dancing
21 Shutlle cock
22 Bowling
25 Cycling for fun
26 Cycling for transport
27 Walking for pleasure
28 Walking for transport
29 Sweeping, vacuuming
30 Floor cleaning
31 Dish washing
32 Clothes washing (by hand)
33 Clothes washing (by machine)
34 Cooking, arranging food
35 Pet feeding
36 House work
37 Stair climbing
38 Ironing
39 Clothes hanging
40 Car/Motorbike washing
41 Shopping
42 Tree watering
43 House arranging

DURING SCHOOL HOLIDAYS (SUMMER HOLIDAYS)

3. ORGANISED SPORT OR GAMES DURING SCHOOL HOLIDAYS (SUMMER HOLIDAYS)

Code	**SPORT or GAME**	**Number of times per week you usually do this sport or game**	**The usual amount of time you spend doing this activity each time you do it**
		Training	_____ hours _____ minutes
		Competition	_____ hours _____minutes
		Training	_____ hours _____minutes
		Competition	_____ hours _____minutes
		Training	_____ hours _____minutes
		Competition	_____ hours _____minutes
		Training	_____ hours _____minutes
		Competition	_____ hours _____minutes
		Training	_____ hours _____minutes
		Competition	_____ hours _____minutes
		Training	_____ hours _____minutes
		Competition	_____ hours _____minutes

01 Short running
02 Shot putting
03 High jumping
04 Long jumping
05 Rope skipping
06 Cycling (competitive
07 Breaktime physical exercises
08 Aerobics
09 Fitness
10 Gymnastics
11 Line-up
12 Table tennis
13 Badminton
14 Football
15 Volleyball
16 Handball
17 Basketball
18 Kungfu
19 Swimming
20 Dancing
21 Shuttle cock
22 Bowling
23 Physical games
24 Marbles playing

* Physical games include all such as chasing."hide and find", etc

4. NON-ORGANISED ACTIVITIES DURING SCHOOL HOLIDAYS (SUMMER HOLIDAYS)

Code	SPORT or GAME	Number of times per week you usually do this sport or game	The usual amount of time you spend doing this activity each time you do it
			hour _____ minute_____
			hour _____ minute_____
			hour _____ minute_____
			hour _____ minute_____
			hour _____ minute_____
			hour _____ minute_____
			hour _____ minute_____
			hour _____ minute_____
			hour _____ minute_____
			hour _____ minute_____
			hour _____ minute_____
			hour _____ minute_____
			hour _____ minute_____
			hour _____ minute_____
			hour _____ minute_____

LIST OF ACTIVITIES/GAMES MAY BE DONE BY JUNIOR HIGH SCHOOL STUDENTS

01 Short running
05 Rope skiping
08 Aerobics
12 Table tennis
13 Badminton
14 Football
16 Handball
17 Basketball
18 Kungfu
19 Swimming
21 Shutlle cock
22 Bowling
25 Cycling for fun
26 Cycling for transport
27 Walking for pleasure
28 Walking for transport
29 Sweeping, vacuuming
30 Floor cleaning
31 Dish washing
32 Clothes washing (by hand)
33 Cooking, arranging food
33 Pet feeding
34 House work
35 Stair climbing
36 Ironing
37 Clothes hanging
38 Car/Motorbike washing
39 Shopping
40 Tree watering
41 House arranging

5. How do you travel to school in a usual week? (Please indicate the number of days you use each type of transport and the time you spend on that type of transport)

	On how many days a week do you use this type of transport to go to school?					**How long do you spend on this transport on the way to school?**
	Mon	Tues	Wed	Thurs	Fri	
Walking						____ hours __minutes
Bicycle						____ hours __minutes
Motorbike						____ hours __minutes
Taken by parents						____ hours __minutes
Bus						____ hours __minutes
Minibus						____ hours __minutes

6. How do you travel home from school in a usual week? (Please indicate the number of days you use each type of transport and the time you spend on that type of transport)

	On how many days a week do you use this type of transport to go to school?					**How long do you spend on this transport on the way to school?**
	Mon	Tues	Wed	Thurs	Fri	
Walking						____ hours __minutes
Bicycle						____ hours __minutes
Motorbike						____ hours __minutes
Taken by parents						____ hours __minutes
Bus						____ hours __minutes
Minibus						____ hours __minutes

7. What would make walking to school better, or encourage you to walk?

- ◯ Wider footpaths
- ◯ Better lights
- ◯ Less traffic
- ◯ Slower traffic
- ◯ More friends to walk with
- ◯ Parents don't have time to take to school
- ◯ Safer places to cross the road
- ◯ An entrance away from cars
- ◯ It is not too far to walk

8. Think about a normal school week, and write down how long you spend doing the following activities before and after school each day

	Monday	Tuesday	Wednesday Friday	Thursday
Watching TV				
Watching videos/VCD				
Using the computer for fun				
Using the computer for doing homework				
Doing homework				
Reading for fun				
Being tutored				
Travel				
Doing hobbies				
Sitting around				
Playing a musical instrument?				

9. Think about a normal school week, and write down how long you spend doing the following activities on the weekend

	Saturday	Sunday
Watching TV		
Watching videos/VCD		
Using the computer for fun		
Using the computer for doing homework		
Doing homework		
Reading for fun		
Being tutored		
Travel		
Doing hobbies		
Sitting around		
Playing a musical instrument		

Appendix 4 The Family Questionnaire

HOUSEHOLD AND PARENTAL INFORMATION QUESTIONNAIRE

Dear parents: your child _____ has been invited to participate to a survey conducted by the Nutrition Centre. We want to know the health status of junior high school students from Ho Chi Minh city, and the factors associated with health in school children. If you agree your child to join in this activity, please answer the questions below. This form can be completed by the student's parents or an adult who take care of the child and know well about the child as well as the child's family. It will take you about 15 minutes to complete form and I hope you can find this time to make the survey successful. At last we will feed back the outcomes to you. Please feel free to phone 08-9911106 for more information if you have any questions. How to complete the form? For some questions which has options you need to put a "√" in the [ ] against the option.For example, in question number 1, if you are the child's mother and will fiil in the form, you should handwrite a "√" in the [ ] against "the child's mother'.Let the other four [ ] blank.in some questions there are "yes [ ] no [ ]" in the answer column, an example is question no.6 ,if there are three people including the child ,the child's father and the child's mother in your houshold, you then handwrite a "√" in the "yes [ ]"against "the child's father" and the "yes [ ]" against "the child's mother". and hand write a "√" in the "no[ ]" against other options.In some places, you have to write your answer on a line in the answer column.

no.	**Content**	**answer**	***Variable***
Now I would like to ask some information about the person filling in the form.			
1	Who is filling in the form? the child's father the child's mother the child's grandfather the child's grandmother other guardians , Please specify who _____	 [ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5	*P1*
Now we will ask information about the child.			
2	what is the child's name _____		*P2*
3	When was the child born? (dd/mm/yy) e.g. 01/01/1 9 9 2	____/__ __/19__ __	*P3*
4	what was the child's birth weight? *(record the weight in grams in the answer column. if you don't know, leave it blank)*	__ __ __ __g	*P4*
5	where did you get the information about the birth weight? birth record remember don't know	 [ ]1 [ ]2 [ ]3	*P5*
6	who does the child live with? *(please tick if any of the following people live with the child. Record answer in every option)*	1 2	*P6*
	the child's father	[ ] Yes [ ] No	*P6.1*
	the child's mother	[ ] Yes [ ] No	*P6.2*
	the child's grandfather	[ ] Yes [ ] No	*P6.3*

	the child's grandmother	[ ] Yes [ ] No	*P6.4*
	the child's uncle	[ ] Yes [ ] No	*P6.5*
	the child's aunt	[ ] Yes [ ] No	*P6.6*
	the children's brothers or sisters	[ ] Yes [ ] No	*P6.7*
	other children that not mentioned above	[ ] Yes [ ] No	*P6.8*
	other adults that not listed above	[ ] Yes [ ] No	*P6.9*
Now we would like to record some information about the child's parents. We'll start by asking information of his or her father.			
7	What is the nationality of the child's father :		*P7*
	Kinh	[ ] 1	
	Hoa	[ ] 2	
	Cham	[ ] 3	
	Other	[ ] 4	
8	What is the highest school level the child's father has completed?		*P8*
	no schooling	[ ] 1	
	incomplete primary school	[ ] 2	
	completed primary	[ ] 3	
	incomplete junior high school	[ ] 4	
	completed junior high school	[ ] 5	
	incomplete senior high school	[ ] 6	
	completed senior high school	[ ] 7	
	technical secondary school	[ ] 8	
	tertiary education	[ ] 9	
9	How many years of education has the child's father completed? *(please write a number on the line in the answer column)*	_____years	*P9*
10	What is the main occupation of the child's father?		*P10*
	Peasant	[ ] 1	
	Worker	[ ] 2	
	Soldier	[ ] 3	
	office worker	[ ] 4	
	Teacher	[ ] 5	
	medical worker	[ ] 6	
	Self-employed worker	[ ] 7	
	Housewife	[ ] 8	
	Other (other occupations not listed above), please specify _____	[ ] 9	
11	How much does the child's father weigh?	__ __ __ (kg)	*P11*
12	How much is the height of the child's father?	__ __ __(cm)	*P12*
now we'd like you to record some informaiton about the child's mother.			
13	Which is the race of father's child?		*P13*
	Kinh	[ ] 1	
	Chinese	[ ] 2	
	Cham		
	Other	[ ] 3	
14	What is the highest school level the child's mother has completed?		*P14*

	no schooling incomplete primary school completed primary incomplete junior high school completed junior high school incomplete senior high school completed senior high school technical secondary school tertiary education	[ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5 [ ] 6 [ ] 7 [ ] 8 [ ] 9	
15	How many years of education has the child's mother completed? *(please write a number on the line in the answer column)*	_____years	*P15*
16	What is the main occupation of the child's mother? Peasant Worker Soldier office worker	 [ ] 1 [ ] 2 [ ] 3 [ ] 4	*P16*
	Teacher medical worker Self-employed worker Housewife Other (other occupations not listed above), please specify _____	[ ] 5 [ ] 6 [ ] 7 [ ] 8 [ ] 9	
17	What is the weight of the child's mother?	__ __ __(kg)	*P17*
18	What is the height of the child's mother?	__ __ __(cm)	*P18*
Next are questions about your household and what is in you house.			
19	Your family address：(please fill in content column only.)		
	No._____ street _____ suburb_____ postcode_____		*P19.1* *p19.2* *p19.3* *p19.4*
20	how many levels or floors are there in building you live in? *(please write a number on the line in the answer column)*	____level	*P20*
21	Which level or floor do you live on? *(please write a number on the line in the answer column)*	____level	*P21*
22	Is there an elevator in the building? yes no	 [ ] 1 [ ] 2	*P22*
23	How does you child usually go up and down to your home？ by stairs by elevator	 [ ] 1 [ ] 2	*P23*

	no need to go up and down	[ ] 3	
24	Is this house your own property? yes no	 [ ] 1 [ ] 2	*P24*
25	If no, do you pay rent or is it free? rent free	 [ ] 1 [ ] 2	*P25*
26	How many square meters is your house or apartment?	_____sq. m	*P26*
27	Does your child have his or her own bedroom? yes no		*P27*
28	Does your house have the following possessions? *(please record answer in every option)* telephone camera VCD or DVD player washing machine refrigerater air conditioner computer	1 2 [ ] Yes [ ] No [ ] Yes [ ] No [ ] Yes [ ] No [ ] Yes [ ] No [ ] Yes [ ] No [ ] Yes [ ] No [ ] Yes [ ] No	*P28* *P28.1* *p28.2* *P28.3* *P28.4* *P28.5* *P28.6* *P28.7*
29	Which of the following do you have in the kitchen? gas stove coal stove microwave oven	1 2 [ ] Yes [ ] No [ ] Yes [ ] No [ ] Yes [ ] No	*P29* *P29.1* *P29.2* *P29.3*
30	Does any of your family members own the following articles? *(please record ansere in every option)* bike motorcycle automobile	1 2 [ ] Yes [ ] No [ ] Yes [ ] No [ ] Yes [ ] No	*P30* *P30.1* *P30.2* *P30.3*
31	how many TVs do you have in you house or apartment? *(please write a number on the line in the answer column)*	____set	*P31*
32	Which room in your home has a TV? *(if you don't have TV in the room tick No)* living room the child's parents 's bedroom the child's bedroom dinning room other rooms	1 2 [ ] Yes [ ] No [ ] Yes [ ] No [ ] Yes [ ] No [ ] Yes [ ] No [ ] Yes [ ] No	*P32* *P32.1* *P32.2* *P32.3* *P32.4* *P32.5*
33	Usually which of the following foods are stored or available in your home? *(please record answer in every option)* soft drink meat, eggs, fish biscuits or cakes milk Candy, chocolate or sweets vegetables	1 2 [ ] Yes [ ] No [ ] Yes [ ] No [ ] Yes [ ] No [ ] Yes [ ] No [ ] Yes [ ] No [ ] Yes [ ] No	*P33* *P33.1* *P33.2* *P33.3* *P33.4* *P33.5* *P33.6*

	fruits	[ ] Yes [ ] No	*P33.7*
	ice-cream and ice-block	[ ] Yes [ ] No	*P33.8*
	fried food	[ ] Yes [ ] No	*P33.9*
	preserved fruits	[ ] Yes [ ] No	*P33.10*
We would like to know about your neighborhood and what recreational resources are available as well as your thoughts about their suitability for children to play.			
34	What space is available around your home which is suitable for children to play in? *(please record answer in every line)*	1 2	*P34*
	house yard	[ ] Yes [ ] No	*P34,1*
	vacant field	[ ] Yes [ ] No	*P34.2*
	side walks	[ ] Yes [ ] No	*P34.3*
	lanes	[ ] Yes [ ] No	*P34.4*
35	What is your feeling about the safety of your neighborhoods?		*P35*
	very safe and children can play without supervision	[ ] 1	
	safe but better to have supervision	[ ] 2	
	not safe but children can play with supervision	[ ] 3	
	not safe and children should not play outside	[ ] 4	
36	How does the child go to school?		*P36*
	by foot	[ ] 1	
	by bicycle	[ ] 2	
	use motorized transportation to school	[ ] 3	
37	How many minutes does it take the child to go to school? *(please write a number on the line in the answer column)*	____ min	*P37*
38	Are there any of the following recreational places and faciliaties available in your neigbourhood? *(please put a tick in the bracket of "yes" if you have, otherwise tick the one of "no")*		
		[ ] Yes [ ] No	*P38.1.1*
	how many minutes does it take you to walk to the open square? *(record number of ninutes on the line in the answer column)*	__ __ minutes	*P38.1.2*
	is it suitable for children to play?	[ ] Yes [ ] No	*P38.1.3*
	playground	[ ] Yes [ ] No	*P38.2.1*
	how many minutes does it take you to walk the playground? *(write a number on the line in the answer column if you put a tick of yes. Otherwise write 0)*	__ __	*P38.2.2*
	is it suitable for children to play?	[ ] Yes [ ] No	*P38.2.3*
	park	[ ] Yes [ ] No	*P38.3.1*

	how many minutes does it take you to walk the park? *(write a number on the line in the answer column if you put a tick of yes. Otherwise write 0)*	__ __	*P38.3.2*
	is it suitable for children to play?	[ ] Yes [ ] No	*P38.3.3*
	playfield or sports oval (including basketball court, volleyball court, badminton court, tennis court)	[ ] Yes [ ] No	*P38.4.1*
	how many minutes does it take you to walk the playfield or oval? *(write a number on the line in the answer column if you put a tick of yes. Otherwise write 0)*	__ __	*P38.4.2*
	is it suitable for children to play?	[ ] Yes [ ] No	*P38.4.3*
	stadium	[ ] Yes [ ] No	*P38.5.1*
	how many minutes does it take you to walk the stadium? *(write a number on the line in the answer column if you put a tick of yes. Otherwise write 0)*	__ __	*P38.5.2*
	is it suitable for children to play?	[ ] Yes [ ] No	*P38.5.3*
	swimming pool	[ ] Yes [ ] No	*P38.6.1*
	how many minutes does it take you to walk the swimming pool? *(write a number on the line in the answer column if you put a tick of yes. Otherwise write 0)*	__ __	*P38.6.2*
	is it suitable for children to play?	[ ] Yes [ ] No	*P38.6.3*
	sport club	[ ] Yes [ ] No	*P38.7.1*
	how many minutes does it take you to walk the sport club? *(write a number on the line in the answer column if you put a tick of yes. Otherwise write 0)*	__ __	*P38.7.2*
	is it suitable for children to play?	[ ] Yes [ ] No	*P38.7.3*
39	How often on the average do you or other adults in your family exercise with the child? once every day or more than once 3-4 times a week 1-2 times a week less than once a week	 [ ] 1 [ ] 2 [ ] 3 [ ] 4	*P39*
40	how many minutes on a daily basis do you or other adults in your family exercise with the child? *(please write a number on the line in the answer column)*	____ min	*P40*
41	Are there any fast food style restaurants in the neighborhood? yes no	 [ ] 1 [ ] 2	*P41*

42	how many minutes does it take you to go to this fast food style restaurants? *(please write a number on the line in the answer column)*	____ min	*P42*
43	how often does the child go to this fast food style restaurants? less than once a month	[ ] 1	*P43*
	1-3/month 1-2/week 3-4/week 5 times per week or more	[ ] 2 [ ] 3 [ ] 4 [ ] 5	
44	who usually decide the child has meals at the fast food restaurants?		*P44*
	the child decides himself or herself the child 's parents decide the child's grandparents decide by the whole family after discussing	[ ] 1 [ ] 2 [ ] 3 [ ] 4	
45	Does the child have pocket money ? yes no	[ ] 1 [ ] 2	*P45*
46	If yes, how does the child get the pocket money? the child's parents give him or her the child's relatives *(e.g. grandparents or uncles or aunts)* the child get bonus *(e.g. good performance in study or do some housework)*	[ ] 1 [ ] 2 [ ] 3	*P46*
47	What is your attitude to the children buying snacks with the pocket money? the child can buy snacks with the pocket money freely the child can buy snacks with the pocket money after getting permissions the child is not allowed to buy snacks	[ ] 1 [ ] 2 [ ] 3	*P47*
48	Are there any game shops near your house or video machine at you home? game shops game machine at home	1 2 [ ] yes [ ] No [ ] yes [ ] No	*P48*
49	How many minutes can the child get to the game shop on foot? *(please record your time on the line in the answer column)*	____ min	*P49*
50	How often does the child go to the game shop or play games at home?		*P50*
	less than once a month 1-3/month	[ ] 1 [ ] 2	
	1-2/week 3-4/week 5 times per week or more	[ ] 3 [ ] 4 [ ] 5	
51	What do you feel the child play video games or surf on the internet?		*P51*

	the children can do this whenever he or she wants to the child can do this after getting permission there is a rule about the time the child do this the child is not allowed to do this	[ ] 1 [ ] 2 [ ] 3 [ ] 4	

Please check and be sure that this form has been completed. Thank you for your help.