THE RELATIONSHIP BETWEEN TV VIEWING AND OBESITY OF CHILDREN IN CHINA

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A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science Program in Health Economics and Health Care Management
Faculty of Economics
Chulalongkorn University
Academic Year 2015

ความสัมพันธ์ระหว่าง การดูโทรทัศน์กับความอ้วนในเด็กชาวจีน

นางสาวจูกิ ลี

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
สาขาวิชาเศรษฐศาสตร์สาธารณสุขและการจัดการบริการสุขภาพ
คณะเศรษฐศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
ปีการศึกษา 2558

Thesis Title	THE RELATIONSHIP BETWEEN TV VIEWING AND OBESITY OF CHILDREN IN CHINA
By	Miss Shuqi Li
Field of Study	Health Economics and Health Care Management
Thesis Advisor	Assistant ProfessorKannika Damrongplasit, Ph.D.

Accepted by the Faculty of Economics, Chulalongkorn University in Partial Fulfillment of the Requirements for the Master's Degree

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จูกิ ลี : ความสัมพันธ์ระหว่าง การดูโทรทัศน์กับความอ้วนในเด็กชาวจีน (THE RELATIONSHIP BETWEEN TV VIEWING AND OBESITY OF CHILDREN IN CHINA) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: ผศ. ดร.กรรณิการ์ ดำรงค์พลาสิทธิ์, 71 หน้า.

#5885597529 MAJOR HEALTH ECONOMICS AND HEALTH CARE MANAGEMENT

KEY WORDS: TV WATCHING/ OBESITY/ CHILDREN/ CHINA

SHUQI LI: THE RELATIONSHIP BETWEEN TV VIEWING AND OBESITY OF CHILDREN IN CHINA. THESIS ADVISOR: KANNIKA DAMRONGPLASIT, Ph.D.

งานวิจัยนี้เป็นการประเมินผลของการดูโทรทัศน์ สถานะทางเศรษฐกิจสังคมและปัจจัยเสี่ยงอื่น ๆ ต่อความอ้วนของเด็กในประเทศจีน การศึกษานี้ในครั้งนี้ใช้ข้อมูลจาก China Health and Nutrition Survey ซึ่งเป็นการสำรวจของ University of North Carolina at Chapel Hillร่วมกับ Chinese Center for Disease Control and Prevention (CCDC) โดยข้อมูลที่ใช้เป็นการสำรวจเด็กอายุ 7 – 18 ปี ในปี พ.ศ. 2549 ซึ่งเป็นข้อมูลที่ครบถ้วนล่าสุดของการสำรวจนี้ หลังจากตรวจสอบและการแก้ไขข้อมูลที่ไม่ถูกต้อง เหลือข้อมูลในการวิเคราะห์ 847 ตัวอย่าง วิธีวิเคราะห์ที่ใช้มี 2 วิธีคือ (1) Ordinary least square multivariate linear regression ในการประเมินผลต่อเส้นรอบเอว และ (2)The binary logit regression ในกลุ่มเด็ก 2 กลุ่มคือ เด็กปกติและเด็กอ้วนซึ่งแบ่งกลุ่มด้วย body mass index (BMI) และ waist-to-height ratio (WHtR) ส่วน explanatory variables ได้แก่ เวลาในการดูโทรทัศน์ พฤติกรรมการกินในช่วงที่ดูโทรทัศน์ ความเกี่ยวข้องของผู้ปกครองในช่วงที่ดูโทรทัศน์ อายุ เพศ รายได้ของครอบครัว สถานที่พักอาศัย การออกกำลังกาย เวลาในการนอนหลับ ผลิตภัณฑ์มวลรวมในประเทศ(GDP) ของจังหวัด การทำงานของมารดา ผล BMI ของมารดาและความชอบอาหาร fast food ผลการศึกษาพบว่าเด็กที่ใช้เวลาในการดูโทรทัศน์มากกว่า 3 ชั่วโมงต่อวันมีโอกาสอ้วนมากกว่าเด็กที่ใช้เวลาในการดูโทรทัศน์น้อยกว่า 1 ชั่วโมงต่อวัน เด็กที่อายุมากมีแนวโน้มในการอ้วนลดลงแต่มีเส้นรอบเอวเพิ่มขึ้น ผลจากการประเมินทุก model พบว่า ผู้ชายอ้วนกว่าผู้หญิง เด็กที่อาศัยในชนบทมีโอกาสอ้วนน้อยกว่า เด็กที่มีโทรทัศน์ในห้องนอนพบว่ามีโอกาสในการอ้วนมากกว่า และมารดาที่อ้วนมักจะมีลูกที่อ้วน

สาขาวิชา เศรษฐศาสตร์สาธารณสุขและการจัดการบริการสุขภาพ ลายมือชื่อนิสิต .....

ลายมือชื่อ อ.ที่ปรึกษาหลัก .....

ปีการศึกษา 2558

5885597529 : MAJOR HEALTH ECONOMICS AND HEALTH CARE MANAGEMENT
KEYWORDS: TV WATCHING/ OBESITY/ CHILDREN/ CHINA

SHUQI LI: THE RELATIONSHIP BETWEEN TV VIEWING AND OBESITY OF CHILDREN IN CHINA. ADVISOR: ASST. PROF.KANNIKA DAMRONGPLASIT, Ph.D., 71 pp.

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This research is investigating the effect of TV viewing, socioeconomic-demographic variables and other risk behavioral variables on the obesity of children in China.

This study uses the China Health and Nutrition Survey conducted by the University of North Carolina at Chapel Hill and the Chinese Center for Disease Control and Prevention (CCDC) as the main data source. This research utilized the 2006 cross-sectional data with children aged 7-18 years old to conduct the analysis, as it is the latest complete and available data. After omitting the missing data, the sample comprised 847 children.

For data analysis, two methods were employed as follows: (1) Ordinary least square multivariate linear regression to investigate the continuous measures of waist circumference (WC). (2)Binary logit regression to look at two groups of children (normal and obese) based on body mass index (BMI) and waist-to-height ratio (WHtR) cutoff value. The explanatory variables included TV watching time, eating habits when watching TV, parent's involvement when watching TV, age, gender, family income per capita, location, physical activity, length of time in bed, gross domestic product (GDP) per capita of the province, mother presently working or not, mother's BMI, and fast food preference.

The results show that children with TV watching time of more than 3 hours per day are more likely to be obese than children watching TV less than 1 hour per day. The children will become less obese as they become older but they tend to have a bigger WC. In all of the research models, males are fatter than females. Children in rural areas and poor areas are less likely to be obese. Children with a TV in the bedroom are more likely to be obese. A fatter mother tends to have fatter children.

Field of Study:	Health Economics and Health Care Management	Student's Signature	.....
		Advisor's Signature	.....
Academic Year:	2015		

ACKNOWLEDGEMENTS

My deepest gratitude goes first to my advisor, Assistant Professor Kannika Damrongplasit, Ph.D., for her support, patience and valuable comments. She always does her best for me even though she is very busy. Without her, this research would not have reached its present form. I would also like to send my great thanks to my committee members, Dr. Touchanun Komonpaisarn, Associate Professor Sothitorn Mallikamas, Ph.D. and Professor Porntep Siriwanarangsun, M.D., Ph.D. for their expert suggestions and comments which were affect a lot on my thesis.

I have to send my sincere appreciations to Associate Professor Siripen Supakankunti, Ph.D. for her helping and caring to me in the whole year as much as she can. She also encouraged me a lot and makes me become more confident to myself. She always offered her help to me on both life and study and makes me feel not alone during one year of my stay in Thailand.

I would like to send my great thanks to my classmates for their selfless help on both life and study. They always try their best to help me and that did support me a lot during the whole time in Thailand. It is my pleasure to be their classmate and friend.

Finally, I have to send my gratitude to Faculty of Economics, Chulalongkorn University for giving me a chance to join in the wonderful master program of Health Economics. I also would like to send my thanks to my parents and families for their strongly economic support, love and unconditional trust. They paid out everything to make me have a better future.

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ABBREVIATIONS

BMI	Body Mass Index
WC	Waist Circumference
WHtR	Waist-to-Height Ratio
CHNS	China Health and Nutrition Survey
TV	Television
ICSPH	Chinese students' physical constitution and health status
GDP	Gross Domestic Product
PCOD	Polycystic Ovary Disease
HFMD	Hand, Food and Mouth Disease
OECD	Organization for Economic Co-operation and Development
NBSC	National Bureau of Statistics of China
WHO	World Health Organization
NINH	National Institute for Nutrition and Health
CCDC	Chinese Center for Disease Control and Prevention

CHAPTER 1

INTRODUCTION

1.1. Problems and Significance

Since 1985, the government of China has investigated Chinese students' physical constitution and health status (ICSPH) once every 5 years. This covers almost the entire country, and the sampled schools vary from primary school up to university level. According to the first round of ICSPH conducted in 1985, the biggest problem confronting Chinese girls and boys is being undernourished. After 25 years, the 2010 ICSPH now indicates the opposite problem – that of obesity – as currently a serious issue for Chinese children and adolescents (Wu, 2011).

According to Ng (2014) and Burkitt (2014), from 1980 to 2013, the prevalence of obesity among Chinese males aged 20 years or below increased from 6.9% to 23% while that of Chinese females also increased from 4.5% to 14%. Since 2014, China has become a country with the second largest number of obese children and adolescents in the world behind America.

According to Zhu (2013), "From 1979 to 2012, GDP grew of China was at an average annual rate of 9.8%". People have become richer, meaning more families can now afford a television. However, too much TV watching by a child may increase their risk of obesity (Wang, Xu, Zheng et al.2012).

William H. Dietz (1998) found that obesity among children can lead to many diseases as they age. These include hyperlipidemia, glucose intolerance, hepatic steatosis and cholelithiasis, hypertension, polycystic ovary disease (PCOD), among others. These diseases are a heavy economic burden to society, government and even the child's own family.

Up until now, there has been much research investigating the factors affecting childhood obesity. In China, there have also been some studies that look at the effect of

TV watching on a child's likelihood of obesity. However, only half of them have used econometric modeling in their analyses. Also, none of the previous papers have employed a nationally representative data set of children.

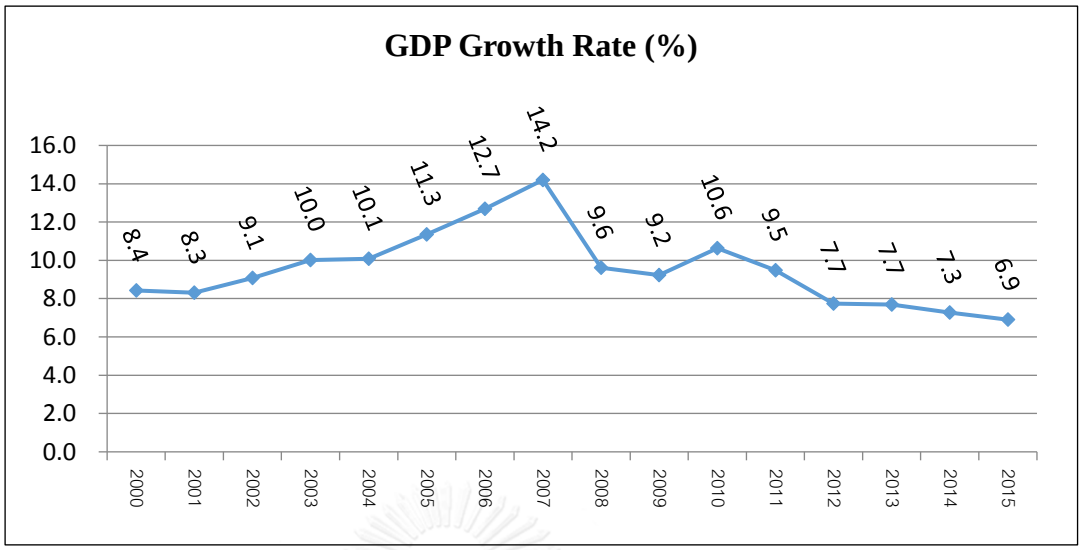
1.2. General Information of China

China is a country located in eastern Asia with a land area of 9,600,000 km^2 and population of 1.37 billion people (The World Bank, 2015). The survey year of 2006 was also the year that saw the fastest rate in Chinese economic development. There are over twenty-two provinces, five autonomous regions, four direct-controlled municipalities (Beijing, Tianjin, Shanghai and Chongqing) and two mostly self-governing special administrative regions (Hong Kong and Macau).

Figure 1 shows the GDP growth rate from 2000 to 2015, which is the percentage of GDP growth compared to the previous year. The GDP growth rate in 2000 and 2001 was about 8.3%, and this continued to grow to 10% in 2003 and 2004. The highest GDP growth rate was in 2007 at 14.2%. Since 2008, the GDP growth rate began to fall to 9.2% until 2009 but increased again to 10.6% in 2010. After 2010, the GDP growth rate has continued to decrease to 6.9% in 2015.

In conclusion, the speed of economic development of China has been continual since 2000 and up until 2007. Since 2008, Chinese economic growth rate has slowed down. Many significant events occurred in 2008 in China, including the Olympic Games in Beijing, a severe earthquake in Sichuan, the epidemic of HFMD (hand, food and mouth disease) and unrest in Tibet. Also the global economic crisis also happened in this year. These all could have contributed to the sharp decrease in GDP growth rate (from 14.2% to 9.6%) in 2008.

Figure 1. GDP growth rate (2000-2015)



Source: OECD, 2015

Table 1 shows GDP per capita, health expenditure per capita and life expectancy of China in the years 2000, 2006 and 2010. The GDP per capita in 2000, 2006 and 2010 was 954.55 dollars, 2082.18 dollars and 4514.94 dollars, respectively. The GDP per capita in 2006 was about twice that of 2000 and only half that of 2010.

Health expenditure per capita in 2000 was 43.63 dollars – less than half of the health expenditure per capita in 2006 (94.05 dollars). Health expenditure per capita in 2010 was 220.08 dollars which is more than twice that of 2006 and about five times that of 2000. Health expenditure has also increased greatly over subsequent years.The life expectancy of the Chinese people also increased from 71.73 years old in 2000 to 75.01 years old in 2010.

Table 1 Selected indicators of China

Indicators	**2000**	**2006**	**2010**
GDP per capita ($)	954.55	2082.18	4514.94
Health expenditure per capita (current $)	43.63	94.05	220.08
Life expectancy	71.73	74.07	75.01

Source: National Bureau of Statistics of China (NBSC)

Table 2 presents the prevalence of overweight and obese males, females and both of them (>=18 years old) in 2010 and 2014 in China. For males, 31.1% of them were overweight, and 4.3% of them were obese in 2010. However, both of these two figures increased to 36.2% and 5.9% in 2014, respectively.

Prevalence among females showed the same trend as males. The number of overweight females increased from 29.1% in 2010 to 32.3% in 2014, while those obese also increased from 6.4% in 2010 to 8% in 2014. Compared to males, the prevalence of both overweight and obese females in 2010 and 2014 is lower.

As regards the data for both, the number of overweight individuals increased from 30.1% in 2010 to 34.4% in 2014. The prevalence of obesity also increased from 5.3% in 2010 to 6.9% in 2014. In conclusion, the Chinese are fatter in 2014 than 2010 according to the data from the Commission on Ending Childhood Obesity (CECO) of World Health Organization (WHO).

Table 2 Prevalence of overweight and obesity among the Chinese

	Male	**Female**	**Both**
Prevalence of obesity (>=18)			
2010	4.3%	6.4%	5.3%
2014	5.9%	8%	6.9%
Prevalence of overweight (>=18)			
2010	31.1%	29.1%	30.1%
2014	36.2%	32.3%	34.4%

Source: Commission on Ending Childhood Obesity, WHO

Table 3 shows the GDP and rankings of GDP of 31 provinces in China in 2006 and 2014. The positive or negative sign of ranking accompanying 2014 refers to the ranking change compared with 2006. The 31 provinces are separated into six geographical areas: North China, Northeast China, East China, South China, Southwest

China and Northwest China. Also, the provinces belonging to each geographical area are listed as further described below.

First of all, the GDP of each province increased substantially from 2006 to 2014, but the rankings of GDP of some provinces differ from 2006 to 2014. For North China, the GDP of Tianjin, Shanxi and Inner Mongolia increased from about 436 billion Yuan, 475 billion Yuan and 479 billion Yuan in 2006 to about 1573 billion Yuan, 1276 billion Yuan and 1692 billion Yuan in 2014, respectively. Also, the rankings of these respective provinces also increased from 21st, 20th, and 17th in 2006 to 17th, 16th and 15th. However, the ranking of Tianjin fell from 10th in 2006 to 13th in 2014. The GDP of Hebei was 1166 billion Yuan in 2006 and increased to 2942 billion Yuan in 2014 with no ranking change.

In Northeast China, the GDP of Liaoning and Tianjin in 2014 (925 and 428) were about three times what they were in 2006 (2721 and 1305), and the rankings also increased from 8th and 22nd in 2006 to 7th and 21st in 2014, respectively. However, the ranking of Heilongjiang fell from 14th to 18th in 2014 with GDP increasing from about 619 billion Yuan in 2006 to 1446 billion Yuan in 2014.

There are seven provinces in East China. The GDP of Shanghai, Jiangxi and Shandong increased from 1037 billion Yuan, 467 billion Yuan and 2208 billion Yuan in 2006 to 2082 billion Yuan, 1441 billion Yuan and 5523 billion Yuan in 2014 with their rankings decreasing from 7th, 19th and 2nd to 12th, 20th and 3rd, respectively. The rankings of Jiangsu and Anhui rose from 3rd and 15th in 2006 to 2nd and 14th in 2014, respectively. There were no ranking changes for Zhejiang and Fujian with their GDPs increasing from 1574 billion Yuan and 762 billion Yuan in 2006 to 3776 billion Yuan and 2187 billion Yuan in 2014 in that order.

In South China, only the rankings of Hubei, Hunan and Guangxi changed. The rankings of Hubei and Hunan rose from 12th and 13th to 6th and 10th in 2014, respectively. Guangxi had a lower ranking in 2014 (19th) than 2006 (16th) with a higher

GDP in 2014 (1445 billion Yuan > 483 billion Yuan). Henan, Guangdong and Hainan remained ranked at 5th, 1st and 28th with a higher GDP in 2014.

Two provinces in Southwest China increased their rankings in 2014 compared to 2006 – those of Chongqing and Sichuan from 24th and 9th in 2006 to 22nd and 8th in 2014, respectively. The GDP of Chongqing and Sichuan also increased from 349 billion Yuan and 864 billion Yuan to 1278 billion Yuan and 2639 billion Yuan in 2014, respectively. The GDP of Yunnan also increased from 401 billion Yuan to 1183 billion Yuan in 2014, but its ranking decreased from 23rd to 24th. Guizhou and Tibet increased GDP with no ranking change (26th and 31st respectively). The GDP of Guizhou and Tibet in 2006 was 228 billion Yuan and 29 billion Yuan and 809 billion Yuan and 82 billion Yuan in 2014, in respective order. Tibet is always the last province in the list.

The rankings of provinces in Northwest China in 2014 were almost the same as in 2006. The rankings of Gansu, Qinghai, Ningxia and Xinjiang remained at 27th, 30th, 29th and 25th in 2014, respectively. However, the GDP of these four provinces increased from 228 billion Yuan, 64 billion Yuan, 71 billion Yuan and 305 billion Yuan in 2006 to 633 billion Yuan, 212 billion Yuan, 258 billion Yuan and 844 billion Yuan in 2014, in that order. Shanxi was the only province with a lower ranking in Northwest China. The ranking of Shanxi fell from 20th in 2006 to 23rd in 2014 with an increased GDP from 452 billion Yuan to 1621 billion Yuan in 2014.

Table 3 GDP and rankings of 31 provinces in 2006 and 2014

Province	**2006(billion Yuan)**	**Ranking**	**2014(billion Yuan)**	**Ranking**
North China				
Beijing	787.03	10	2133.08	13 (-)
Tianjin	435.90	21	1572.69	17 (+)
Hebei	1166.04	6	2942.12	6
Shanxi	475.25	20	1276.15	16 (+)
Inner Mongolia	479.15	17	1691.65	15 (+)
Northeast China				

Liaoning	925.12	8	2721.32	7 (+)
Jilin	427.51	22	1304.64	21 (+)
Heilongjiang	618.89	14	1445.50	18 (-)
East China				
Shanghai	1036.64	7	2181.82	12 (-)
Jiangsu	2164.51	3	5975.34	2 (+)
Zhejiang	1574.25	4	3775.66	4
Anhui	614.87	15	1922.95	14 (+)
Fujian	761.46	11	2186.85	11
Jiangxi	467.05	19	1441.02	20 (-)
Shandong	2207.74	2	5523.03	3 (-)
South China				
Henan	1249.60	5	3219.13	5
Hubei	758.13	12	2479.18	6 (+)
Hunan	756.89	13	2462.17	10 (+)
Guangdong	2620.45	1	6247.48	1
Guangxi	482.85	16	1445.00	19 (-)
Hainan	105.29	28	317.76	28
Southwest China				
Chongqing	349.16	24	1278.33	22 (+)
Sichuan	863.78	9	2639.21	8 (+)
Guizhou	228.20	26	808.69	26
Yunnan	400.67	23	1183.23	24 (-)
Tibet	29.10	31	81.57	31
Northwest China				
Shanxi	452.38	20	1620.55	23 (-)
Gansu	227.67	27	633.07	27
Qinghai	64.16	30	212.21	30
Ningxia	71.08	29	257.76	29
Xinjiang	304.53	25	844.38	25

Source: National Bureau of Statistics of China (NBSC)

1.3. Research Question

How does TV viewing time affect the obesity of children in China?

1.4. Objectives

— General Objectives

To find out the effect of TV viewing time, socioeconomic-demographic factors and other behavioral risk factors on the obesity of children in China.

— Specific Objectives

① Investigate the relationship between TV viewing time and body mass index (BMI).

② Find out the effect of TV viewing time on waist circumference (WC).

③ To assess the impact of TV viewing time on waist-to-height ratio (WHtR).

④ Discover the effect of socioeconomic-demographic factors and other behavioral risk factors on BMI.

⑤ To see the relationship between socioeconomic-demographic factors and other behavioral risk factors and WC.

⑥ Investigate the effect of socioeconomic-demographic factors and other behavioral risk factors on WHtR.

1.5. Hypothesis

—More TV viewing time relates to higher BMI, WC and WHtR among children.

1.6. Scope

This study uses the 2006 China Health and Nutrition Survey (CHNS) to investigate the relationship between TV viewing and child obesity. The survey itself is longitudinal data being surveyed from 1989 to 2011. Nevertheless, only the 2006 survey was used in this research as it contains a complete set of data and variables that

are needed for the study. It covered 9 provinces from the north to the south of China. The survey covers about 4,400 households and 19,000 individuals in all years combined.

For the children survey, children were separated into two groups: children less than 7 years old and children more than and equal to 7 years old and less than 18 years old. So, there were separate questionnaires for the two groups of children since the former were preschool children. This research focused on children aged 7 to 18 years old and used the cross-sectional data from the year 2006, with a total sample of children with complete data of 847.

1.7. Possible Benefits

1) If TV watching time is significantly related to child obesity, the government can find an intervention to alter and reduce the TV watching time of children in order to control the trend of obesity.

2) If socioeconomic-demographic factors have a statistically significant effect on child obesity, the government can direct certain policy for a particular group of people.

3) If other behavioral risk factors have significant effect on child obesity, the government can come up with policies to alter the children's and their parents' behavior to control and reduce child obesity.

CHAPTER 2

LITERATURE REVIEW

In the literature review, the researcher separated the papers on China and from other countries, and divided the papers based on the variables used.

2.1. Studies on Other Countries (except China)

2.1.1 TV Viewing and Obesity

Jeffery and French (1998) investigated the relationship between TV watching, fast food intake and obesity. They recruited 1060 people – both high-income and low-income 20-45 year-old adults in the US. They used a binary logistic model and multivariate linear regression to identify the relationship between TV viewing time, fast food and BMI. They found that TV viewing time and fast food intake have a strong positive relationship with BMI and energy intake of women. More TV viewing time related to higher BMI especially for high-income women. Also, there was no significant relationship for men and low-income women.

Crespo, Smit, Troiano, Bartlett, Macera and Andersen (2001) did similar research to investigate the relationship between TV watching, energy intake and obesity of children in the U.S. Their sample covered 4069 children aged 8-16 years old in the U.S. They used the ordinary least square method with the dependent variable equal to BMI, and explanatory variables including TV watching time per day, energy intake, weekly physical activity times and other socio-economic demographic variables. They found higher TV watching time and less time spent engaged in physical activities per week could increase children's obesity, especially for girls.

Mendoza, Zimmerman and Christakis (2007) looked at how TV viewing time and computer usage time affected the obesity of preschool children in the U.S. They chose 1809 children aged 2 to 5 years old in the U.S and used BMI and skinfold thickness to define obesity. They used multivariate Poisson regression and multivariate linear regression to do the analysis. They found more obesity among children with more than 2 hours of TV watching time than children with less TV watching time. Furthermore, computer usage time also had a negative relationship with skinfold thicknesses.

2.1.2 TV Watching Time, Physical Activity and Obesity

Eisenmann, Joey C., R. Todd Bartee, and Min Qi Wang (2002) investigated the relationship between TV watching time, physical activity and the BMI of children. They employed 15,143 high-school students between 14 and 18 years old from America, and they used a logistic regression model to do the analysis. They found that children with more than 4 hours of TV viewing time per day were more likely to be obese compared to children with less than 1 hour TV watching time per day. Furthermore, more physical activity was related to a lower BMI.

2.1.3 Parents' Obesity, Sedentary Activity and Children's Obesity

Maffeis, Talamini and Tato (1998) investigated the effect of diet, physical activity and parents' obesity on child obesity in Italy. They conducted a longitudinal study that consisted of two rounds of data gathered four years apart. They chose 298 prepubertal Caucasian children in the first round, with 112 of them participating in the second round of the survey (after 4 years). These children had an age range of 7-10 years old. After using multiple regression analyses, they found that parents' obesity was positively related to their children's obesity. Furthermore, sedentary activities only had a positive effect in the first round of the survey.

2.1.4 TV in the Bedroom and Obesity

Adachi-Mejia, Longacre, Gibson, Beach, Titus-Ernstoff and Dalton(2007) investigated the relationship between TV in children's bedrooms and child obesity. They employed 2,343 children between the 4th and 6th grade from two primary schools in America. They used odd ratio with adjusted variables to see the distribution of BMI and TV watching time in different situations. They found that TV in the bedroom increased the probability of a child becoming obese whatever variables were controlled.

2.1.5 Eating Snacks when Watching TV and Obesity

Francis, Lee, and Birch (2003) did research about the effect of TV viewing time, snack intake when watching TV and snack intake on the BMI of girls. They conducted a longitudinal survey when the girls were 5, 7 and 9 years old. Their final samples comprised 173 cases from central Pennsylvania in the U.S. They did path analysis with multiple regression to analysis. They found that girls with more TV watching time tended to eat more snacks when watching TV, and they were more likely to have an increasing BMI as they grew up.

2.2. Studies on China

2.2.1 TV and Obesity

Wang, Xu, Zheng et al. (2012) tried to identify how TV watching time affected child and adolescent obesity in China. They used cross-sectional data from 4,708 children between 6-16 years old in Shenyang, Liaoning Province. In terms of methodology, they employed multivariate linear regression, stratified analysis and multivariate logistic regression to analysis the relationship between BMI, WC, WHtR and TV watching time. Their findings were as follows: 1) longer TV viewing time leads

to higher BMI, WC and WHtR; 2) Children in the longer TV watching time group have the probability of being obese 1.3 times that of the shorter TV watching time group.

Deng, Wang, Chen et al. (2015) looked at the relationship between TV watching and adult obesity in China. They chose a nationwide sample and cross-sectional data from the Chronic Non-communicable Disease & Risk Factor Surveillance in China (2010), which covered 98,398 participants aged 18 years old and above. They conducted analysis using linear regression and logistic regression. They found that there was a significant positive relationship between TV watching time and BMI, especially among women and people aged 65 years old and up.

2.2.2 Screen (TV, Computer, Mobile Phone) Time and Obesity

Liu (2013) looked at the relationship between screen time and child obesity. The researcher reviewed 19 papers addressing screen time, physical activity and the obesity of children to summarize a review article. There were four main findings as follows: (1) longer screen time reduces the physical activities of children; (2) being exposed to food advertisements on TV increased junk food consumption and reduced the consumption of healthy food by children; (3) screen time reduced the sleeping time of children; (4) having a TV located in the bedroom increased the probability of obesity.

Qian (2012) investigated the relationship between sedentary behavior and child obesity in Macau. Her sample comprised 1483 children in the 4^{th} to 6^{th} grades from primary school and separated into three groups depending on the habits of sedentary activities: (1) children often participating in one or less than one kind of sedentary activities; (2) children often participating in two kinds of sedentary activities; (3) children often participating in three or more than three kinds of sedentary activities. She found that the more the sedentary activities the child often participates in leads to a higher probability of being overweight.

2.2.3 Economic Variables and Obesity

Ji Cheng-Ye (2008) tried to identify children's prevalence of overweight and obesity in different socioeconomic areas in China. He employed children between 7 and 18 years old in 30 provinces in China (except Tibet). He separated the area children lived to good, normal and bad according to the economic situation, and also separated children to four groups: urban boys, urban girls, rural boys and rural girls. He found the order of both overweight and obesity prevalence is: urban boys > urban girls > rural boys > rural girls. He also found in each group of children, the prevalence of overweight and obesity in good economic area always be the highest and in the bad economic area are always be the lowest.

2.3 Conclusions from the Literature Review

From the literature review, the results can be summarized as follows:

1) More time spent watching TV by children always significantly relates to higher body mass index, waist-to-height ratio and waist of children.

2) Physical activity is negatively related to the BMI of children.

3) Eating more fast food always relates to higher BMI.

4) Children with TVs in their bedroom always have higher BMIs compared to those without.

5) Eating snacks when watching TV could increase the probability of becoming obese.

6) Children in urban and richer area have higher prevalence of obese.

2.4 Gap in the Literature

1) The existing studies [Wang et al. (2012) & Deng et al. (2015)] do not typically include a comprehensive set of explanatory variables.

2) According to the essay by Jin (2001), obesity among the Chinese tends to be that of abdominal obesity (fat is more distributed in the belly and buttock than in the arms and legs), so BMI is not adequate in measuring the obesity of the Chinese. Waist–to–height ratio is a better variable for measurement.

3) According to Schneider et al. (2010), WhtR is the most accurate index to ascertain the fat distribution of people and to predict cardiovascular disease (higher WHtR means more fat distributed at the belly), but existing studies in China tend not to use WHtR.

2.5 Contributions of this Study

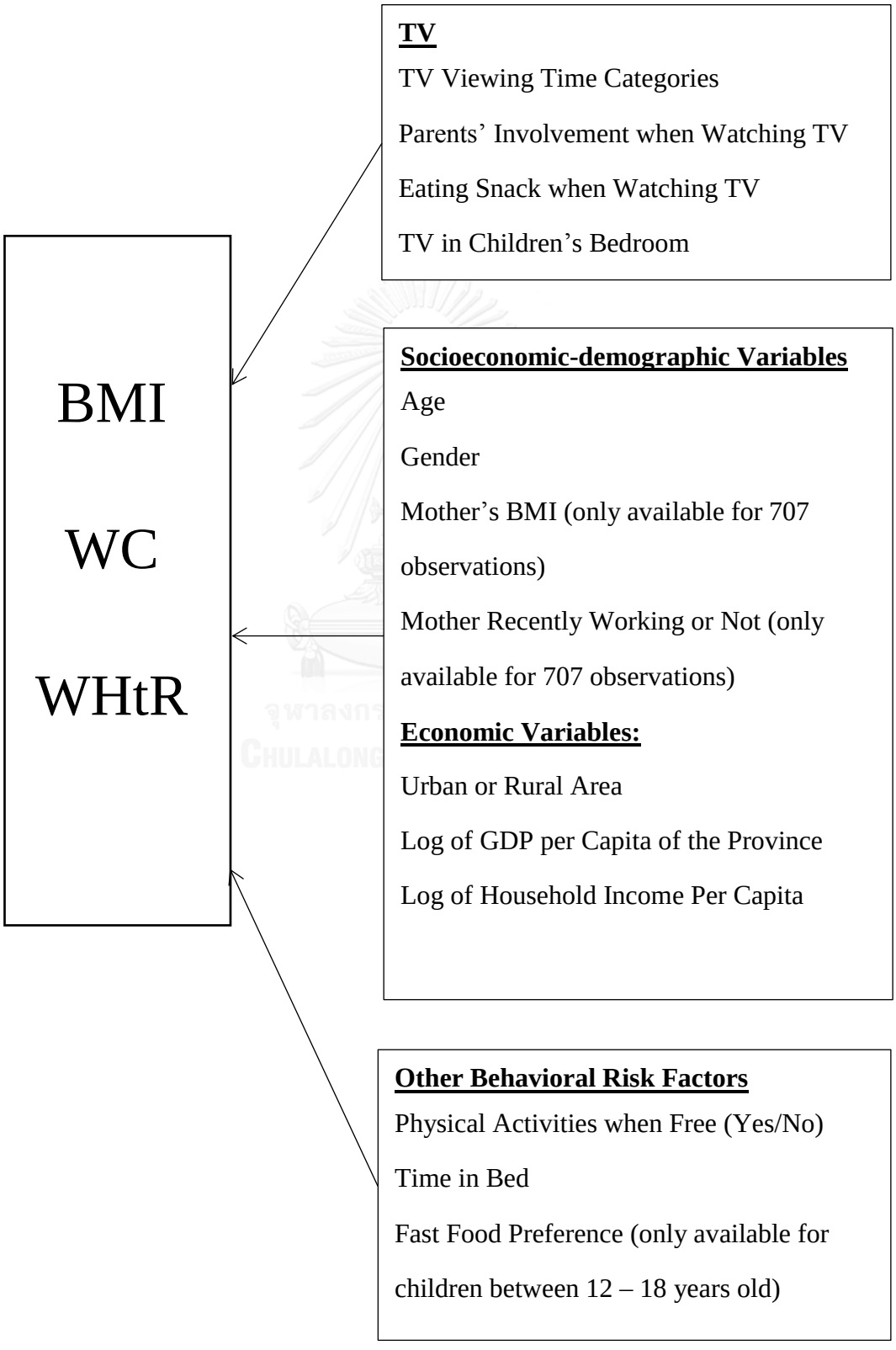
1) This study included a sample of children between 7 and 18 years in age, which covers a larger range of children's age in comparison with other existing studies.

2) The sampled provinces almost cover the whole country and cover both urban and rural areas, so this research will be more nationally representative than existing studies.

3) This research employs a more comprehensive set of variables in the analysis.

CHAPTER 3

CONCEPTUAL FRAMEWORK



The variables are expected to have certain impacts on the obesity of children.

For the TV viewing time categories, these are expected to be positively related to child obesity because more TV watching time can make children sit more and become more obese. For the parents' involvement when watching TV, this may reduce the probability of becoming obese, because parents always tell their children healthy food is a good thing. Eating snacks when watching TV should increase the risk of obese, because children will pay more attention to the TV rather than to how much they eat. Both TV in children's bedroom and the number of TVs should increase the risk of becoming obese because as the TV is highly accessible this simply means they spend more time watching it.

Regarding the relationship between age and obesity, this should depend on the dependent variable. Waist should increase as children grow up. However, for BMI and WHtR, age should relate to them in a negative way because children become taller faster than they become fatter as they grow up. Hence, the sign should be negative. The relationship between gender and obesity is difficult to predict – it could be positive or negative. The children living in urban areas are expected to have a higher risk of becoming obese because children in rural area have less money to buy food and have a healthier diet. GDP per capita is also expected to be positive because when people have a lot of money, they may pay for food with high calories or spend their money on drinking and smoking. The mother's BMI is expected to be positive because a fatter mother most likely will have a diet of high calories and an unhealthy lifestyle. This can therefore make children become fatter too. A mother presently working should have a positive impact on obesity because mothers with a job have less time to control their children's diet and this makes it easier for them to become obese.

Besides, physical activity is expected to have a negative effect on obesity because children who do physical activities are always in better shape. For the fast food preference, children who like eating fast food are more likely to be fatter as eating more fast food can make children more obese.

CHAPTER 4

METHODOLOGY

4.1. Variables

4.1.1 Dependent Variables

Three dependent variables were considered in this research. The three outcomes were waist circumference (WC), body mass index (BMI) and waist-to-height ratio (WHtR) as shown in Table 4 below.

Table 4 Details of Dependent Variables

Name	**Variable**	**Description**
BMI	Body mass index (kg/m^2)	Body mass index of children calculated by weight (kg) / height (m) ^{2}.
WC	Waist circumference (cm)	Waist circumference of children (only available for 842 children between 7-18 years old).
WHtR	Waist-to-height ratio (free unit)	Waist-to-height ratio of children calculated by waist (cm)/height (cm).

4.1.2 Independent Variables

Table 5 shows the details of the explanatory variables used in this study. It shows the name and description of every explanatory variable. The expected sign of effect on the dependent variables and the reasons are also shown in the table below. The last three variables are economic variables to show the economic status of children's home province or the children's families.

Table 5 Details of Independent Variables

Name	Variable	Description	Expected Sign	Reason
TVcat1	TV watching time per day	The amount of time children watch TV in a typical day in hours with three categories: Tvcat1 =1 if TV watching time per day less than 1 hour (omitted category); Tvcat2 =1 if TV watching time per day more than and equal to 1 hour, less than 3 hours; TVcat3 =1 if TV watching time per day more than and equal to 3 hours.	+	More TV watching time makes children sit more.
TVcat2				
TVcat3				
age	Age	Age of children (years old).	+/-	Waist of children keep growing with them grow up, so the sign should be positive. For BMI and WHtR defined obesity, children become taller faster than they become fatter as they grow up. So the sign should be negative.
Female	Gender of children.	Female = 1 if a child is a girl and female = 0 if a child is a boy.	+/-	Females may be fatter than males or maybe males are fatter.
activity	Physical activity	Children usually engage in physical activity or not when they are free: activity = 1 if a child does physical activity or 0 if not.	-	Children who physically exercise are more in shape.
bedtime	Time in bed	The average time children spend on the bed per day whether asleep or lying down in hours.	+/-	Time in bed can reduce or increase BMI
involve	Parents' involvement when	Parents tell children something on TV is true or not when watching TV: involve = 1 if yes or	-	Parents' involvement can provide children with better knowledge about

	watching TV	0 if not.		health.
snack	Eating snacks when watching TV	Children eat snacks when watching TV or not: Snack = 1 if yes or 0 if not.	+	When watching TV, people pay less attention to the amount of snacks they eat.
fastfood	Fast food preference	Does the child like fast food or not: fastfood = 1 if a child likes fast food or 0 if not.	+	Eating more fast food leads to a higher likelihood of obesity
BMIMO	Mother's BMI	Body mass index of child's mother (kg/m^2).	+	A fat mother always has a high calorie diet, and it will affect the child's diet
TVroom	TV in bedroom	There are working televisions in the children's bedroom or not: TVroom = 1 if a child has a TV in the bedroom or 0 if not.	+	A TV in a child's bedroom makes TV very easy to access and makes children spend more time watching TV.
workmo	Mother's work	The child's mother is presently working or not: workmo = 1 if yes or 0 if not.	+	Mothers with a job have less time to control their children's diet which makes it easier for them to be obese.
Explanatory Variables about Economics				
rural	Location	Location of children: rural = 1 if a child lives in a rural area, and rural = 0 if a child lives in an urban area.	-	Children in rural areas have less money to buy food and have a healthier diet.
lngdppc	Log of GDP per capita of the province	The gross domestic product per person of the province is measured in Yuan. In this study, we take the logarithm function of GDP per capita.	+	Richer areas always have more fast food restaurants, which makes it easier for children to access food with high calories and become fat.
lninc	Log of household income per capita	The household income per capita is measured in Yuan. In this study, we take the logarithm function of household income per capita.	+	When people have a lot of money, they may pay for food with high calories or spend more on drinking and smoking.

The researcher also attempted to see the relationship between seaside provinces and child obesity as there are different lifestyles and economic statuses between people living and not living in seaside provinces in China. Table 6 shows the rankings of nine provinces by GDP per capita in 2006 used in the dataset.

We can see that the province with the highest GDP per capita is Jiangsu with 28,685 Yuan per person which is a seaside province. Shandong is ranked second with 23,546 Yuan GDP per capita. Shandong is also located by the seaside. The following province is Liaoning, another coastal province. The GDP of Liaoning is 21,802 Yuan per capita. The fourth to seventh provinces in the list are inland provinces. The fourth province is Shandong with 16,268 Yuan GDP per capita. Next is Henan province with 13,279 Yuan GDP per capita. With 13,150 Yuan GDP per capita Hubei comes sixth in the list. Hunan is seventh with a GDP per capita of 11,830 Yuan. The eighth province Guangxi is a seaside province with a GDP per capita of 10,240 Yuan. The last province is Guizhou, an inland province, with only 5,750 Yuan GDP per capita.

In conclusion, four provinces are located at the seaside, and three are listed in the top three for GDP per capita. So, the seaside actually captures similar effect as lnGDPPC. Furthermore, when the seaside is added to models, the contradictory outcome is that the sign of the seaside's coefficients differ with lnGDPPC. At the same time, TV categories become insignificant. In conclusion, the seaside is not a suitable explanatory variable for use.

Table 6 Rankings of nine provinces in the dataset by GDP per capita in 2006

No.	PROVINCE	GDP per capita(Yuan)	Seaside
1	Jiangsu	28,685	Yes
2	Shandong	23,546	Yes
3	Liaoning	21,802	Yes
4	Heilongjiang	16,268	No
5	Henan	13,279	No
6	Hubei	13,150	No
7	Hunan	11,830	No
8	Guangxi	10,240	Yes
9	Guizhou	5,750	No

Source: National Bureau of Statistics of China (NBSC)

4.2. Details of Variables

4.2.1 Obesity of Children

In this research, three variables were used to measure child obesity: Body Mass Index (BMI), Waist Circumference (WC, cm) and Waist-to-Height Ratio (WHtR).

— Body Mass Index (BMI) is calculated according to the following formula:

BMI = Weight/Height2 (kg/m2)

BMI is an appropriate index to define the obesity status of an individual. According to the standard of Ji Chengye (2004) in Table 7, there are different cutoff values for a specific age and gender. Children with BMI more than that cutoff value are defined as obese. For example, if a seven-year-old girl's BMI is 18 (>17.2), she is obese. However, if an eight-year-old girl has the same BMI as that girl above, she is not obese (18<18.1).

Table 7 Cutoff values of BMI

Age	Male	Female
7~	17.4	17.2
8~	18.1	18.1
9~	18.9	19.0
10~	19.6	20.0
11~	20.3	21.1
12~	21.0	21.9
13~	21.9	22.6
14~	22.6	23.0
15~	23.1	23.4
16~	23.5	23.7
17~	23.8	23.8

— Waist Circumference (WC) is measured in centimeters.

— Waist-to-Height Ratio (WHtR): Waist (cm)/Height (cm) is unit free.

4.2.2 TV

A. TV Watching Time per Week

The question in the survey is "How much time do you spend on watching TV in a typical day?" The answers were separated into weekdays and weekends. This research also created a new variable of average TV watching time per week. This research used it as categorical variable with three categories:

Tvcat1 =1 if TV watching time per day is less than 1 hour (omitted category);

Tvcat2 =1 if TV watching time per day is more than and equal to 1 hours, less than 3 hours;

Tvcat3 =1 if TV watching time per day is more than and equal to 3 hours.

B. Parents' Involvement

There is a question in the survey about parents' involvement when children watch TV. "How often do your parents tell you something on TV is not real?" The answer was graded by 0 to 4 representing "never" to "very often". This research used 0 as "No" and combined 1, 2, 3 and 4 to 1 as "Yes".

C. Eating Snacks when Watching TV

The question asked is “Do you eat snacks when watching TV?” People answered this question from “0” to “4”, from “never” to “very often”. In this paper, we used 0 as “No” and combined 1, 2, 3 and 4 to 1 as “Yes”.

D. TV in the Bedroom

Is there a working TV in the children’s bedroom? 1 is “Yes” and 0 if “No”.

4.2.3 Socioeconomic-demographic Variables

A. Age

The age of the children.

B. Gender

A child is male or female. 1 is “female” and 0 if not.

C. Log of GDP per capita

The gross domestic product per person of the province is measured by Yuan. In this study, we take the logarithm function of GDP per capita.

D. Log of Household Income per capita

The household income per capita is measured in Yuan. This research takes the logarithm function of household income per capita for analysis.

E. Urban or Rural Area

The location of the household is in an urban or rural area. 1 is a “rural area” or 0 if not.

F. Mothers’ BMI

The body mass index of the children’s mother in kg/m^2.

4.2.4 Other Behavioral Risk Factors

A. Physical Activities When Free

The question is “Do you participate in any physical exercises before or after school or on the weekend, including relatively intense physical exercises, such as volleyball, soccer, badminton, and long distance running?” The answer is “Yes” or “No”. 1 is scored for “Yes” and 0 if not.

B. Bedtime

The question is “How much time each day do you usually spend in bed either sleeping or lying, including the night time (in hours)?” The answer is the average hours of bedtime per day. Bedtime is not only the time spent on sleep, but also the time spent on reading, listening to music or other sedentary activities while lying on the bed.

The next variable is only available for children aged 12-18 years old. Thus, children aged less than 12 years old do not provide this information.

C. Fast Food Preference

The question is “How much do you like fast food?” The answers are measured by 0 to 4 – from “dislike” to “like very much”. This research used 0 as “dislike” and combined other answers for 1 as “like”.

Fast food in China is not only western fast food like hamburgers and French fries, but also includes China’s own fast food. From the report of Li Chengcheng (2013), Chinese fast food includes fried rice, topped rice, fried dishes, snacks, a variety of noodles and many soups.

4.3. Study Design

This research uses WC, Body Mass Index (BMI) and Waist-to-Height Ratio (WHtR) to define the obesity of children.

a. BMI

The standard comes from the research of Ji Chengye (2004). If a child's BMI is more than or equal to this cutoff value for a specific age and gender, we define the child as obese.

b. WHtR

In this research, 0.5 is defined as the cutoff value of abdominal obesity according to the research of Browning, Hsieh, & Ashwell (2010). Thus, if a child's WHtR is greater or equal to 0.5, he or she is grouped into the obese category.

c. WC

WC is considered a continuous variable in defining obesity.

4.4. Models

4.4.1 Multivariate Linear Regression (OLS)

This research chose OLS multivariate linear regression for the first analysis. This research considered WC a continuous variable in the analysis.

There are nine specifications explored in this study. The F-test of incremental variables was conducted to find out which specification captured our data the best. Models were put into regression to identify the best set of explanatory variables to capture the dataset.

Model 1: $WC= \beta_0 + \beta_1 TVcat2 + \beta_2 TVcat3 + \beta_3 Age + \beta_4 Female + \beta_5 Rural + \beta_6 Lngdppc + \varepsilon_i$

Model 2: $WC= \beta_0 + \beta_1 TVcat2 + \beta_2 TVcat3 + \beta_3 Age + \beta_4 Female + \beta_5 Rural + \beta_6 Lngdppc + \beta_7 Activity + \varepsilon_i$

Model 3: $WC= \beta_0 + \beta_1 TVcat2 + \beta_2 TVcat3 + \beta_3 Age + \beta_4 Female + \beta_5 Rural + \beta_6 Lngdppc + \beta_7 Activity + \beta_8 Bedtime + \varepsilon_i$

Model 4: $WC= \beta_0 + \beta_1 TVcat2 + \beta_2 TVcat3 + \beta_3 Age + \beta_4 Female + \beta_5 Rural + \beta_6 Lngdppc + \beta_7 Activity + \beta_8 TVroom + \varepsilon_i$

Model 5: $WC= \beta_0 + \beta_1 TVcat2 + \beta_2 TVcat3 + \beta_3 Age + \beta_4 Female + \beta_5 Rural + \beta_6 Lngdppc + \beta_7 Activity + \beta_8 TVroom + \beta_9 BMIMO + \varepsilon_i$

Model 6: $WC= \beta_0 + \beta_1 TVcat2 + \beta_2 TVcat3 + \beta_3 Age + \beta_4 Female + \beta_5 Rural + \beta_6 Lngdppc + \beta_7 Activity + \beta_8 TVroom + \beta_9 BMIMO + \beta_{10} Involve + \varepsilon_i$

Model 7: $WC= \beta_0 + \beta_1 TVcat2 + \beta_2 TVcat3 + \beta_3 Age + \beta_4 Female + \beta_5 Rural + \beta_6 Lngdppc + \beta_7 Activity + \beta_8 Bedtime + \beta_9 TVroom + \beta_{10} BMIMO + \beta_{11} Involve + \beta_{12} Workmo + \beta_{13} Snack + \beta_{14} Fastfood + \beta_{15} Lninc + \varepsilon_i$

Model 8: $WC= \beta_0 + \beta_1 TVcat2 + \beta_2 TVcat3 + \beta_3 Age + \beta_4 Female + \beta_5 Rural + \beta_6 Lngdppc + \beta_7 Activity + \beta_8 Bedtime + \beta_9 TVroom + \beta_{10} BMIMO + \beta_{11} Involve + \beta_{12} Workmo + \beta_{13} Snack + \beta_{14} Fastfood + \beta_{15} Lninc + \beta_{16} TVcat2female + \beta_{17} TVcat3female + \beta_{18} TVcat2age + \beta_{19} TVcat3age + \varepsilon_i$

Model 9: $WC= \beta_0 + \beta_1 TVcat2 + \beta_2 TVcat3 + \beta_3 Age + \beta_4 Female + \beta_5 Rural + \beta_6 Lngdppc + \beta_7 Activity + \beta_8 Bedtime + \beta_9 TVroom + \beta_{10} BMIMO + \beta_{11} Involve + \beta_{12} Workmo + \beta_{13} Snack + \beta_{14} Fastfood + \beta_{15} Lninc + \beta_{16} TVcat2female + \beta_{17} TVcat3female + \beta_{18} TVcat2age + \beta_{19} TVcat3age + \beta_{20} Seaside + \varepsilon_i$

4.4.2 Binary Logit Regression

For BMI defined obesity and WHtR defined obesity, this research used binary logit regression to analyse the effect of each factor on these two outcomes.

For the data analysis of BMI and WHtR, the model should be represented like this:

$Y_i = 1 \rightarrow$ obese if $Y_i^* > 0$

$0 \rightarrow$ non-obese if $Y_i^* <= 0$

The expressions are:

$$\Pr(Y = 1) = \frac{exp^{a_0 + \beta_0 X}}{1 + exp^{a_0 + \beta_0 X}}$$

$$\Pr(Y = 0) = \frac{1}{1 + exp^{a_0 + \beta_0 X}}$$

The expression can be put into the likelihood function:

$$L = \pi[\frac{exp^{a_0+\beta_0 X}}{1+exp^{a_0+\beta_0 X}}]^{Y^i}[\frac{1}{1+exp^{a_0+\beta_0 X}}]^{1-Y^i}$$

The error term has a logistic distribution with mean 0 and variance $\pi^2/3$.

Eight different model specifications were also explored. The likelihood-ratio test was used to identify the model that captured the data the best.

Once the coefficient estimates were obtained and the best specification chosen, the marginal effect was calculated to investigate the effect of explanatory variables on the probability of obesity.

Marginal effect is defined as $\partial \Pr(Y=1)/\partial X$ when X is a continuous variable and $\Pr(Y=1 \mid X=1) - \Pr(Y=1 \mid X=0)$ for X that is a dummy variable.

This research separates the children into two samples depending on the age range of the children under study.

For children 12-18 years old:

The explanatory variables include TV, socioeconomic-demographic variables and other behavioral risk factors (complete set of independent variables) with 422 observations;

For children among 7-18 years old:

The explanatory variables include TV, socioeconomic-demographic variables and other behavioral risk factors except fast food preference with 847 observations.

CHAPTER 5

DATA

5.1. China Health and Nutrition Survey (CHNS)

The China Health and Nutrition Survey (CHNS) is a program of Carolina Population Center at the University of North Carolina at Chapel Hill and the National Institute for Nutrition and Health (NINH, former National Institute of Nutrition and Food Safety) at the Chinese Center for Disease Control and Prevention (CCDC).

This survey has two objectives:

a. To evaluate the policies and programs of local government and national government concerned health, nutrition, and family planning.

b. Chinese society and economy has changed a lot from the start of the survey (1989) to the latest survey (2011). So, the researchers of the program have attempted to find out how the kinds of changes affect the health of the Chinese people.

This survey was designed by an international research group, and the backgrounds of these researchers include nutrition, public health, economics, sociology, Chinese studies, and demography.

5.2. Data Sampling

Nine provinces were covered by the survey: Guangxi, Guizhou, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Liaoning, and Shandong. Also, these nine provinces vary substantially in terms of geography, economic development, public resources, and health indicators.

In choosing the four counties for each province, the researchers used a multistage, random cluster process. First, they stratified all the counties in each province into low-income county, middle-income county and high-income county, and then they used a

weighted sampling scheme to randomly select four counties in each province. Also, the villages and towns in each county were selected randomly.

5.3. Sample Size

This research used the cross-sectional data of 2006 with all of the children aged 7-18 years old in the analysis since it is the latest published available data and contains the most complete set of variables. After omitting missing data, 847 children were included in the total sample.

CHAPTER 6

RESULTS AND DISSCUSION

6.1. Overview of the Dataset

In this research, two samples were used according to the targeted group of the questionnaire: the total sample of children between 7-18 years old and the sub-sample of children between 12-18 years old. There were 847 children in the total sample and 422 children in the sub-sample. This part shows the distribution of variables.

6.1.1 Summary of the Statistics for the Total Sample

Table 8 shows the summary of the statistics for the total sample. For the sample, the mean for waist circumference was 62.12cm with a minimum of 15cm and maximum of 105cm. The mean of BMI was 18.38kg/m^2, which is a normal value. The mean of the waist-to-height ratio was even less than the cutoff value of WHtR (0.43 < 0.5).

The mean of three categories of TV watching time shows most of children fell into the second category: less than 3 hours and more than or equal to 1 hour (63%). Also, the smallest group of children watches TV more than 3 hours per day at only 9%. There were 28% of children who watched TV for less than 1 hour per day.

The average age of a child was about 11 years old, and there were slightly more boys (54%) than girls (46%) in the whole sample. Most of the children in the sample lived in rural areas (69%). The mean of the log of GDP per capita was about 9.5 with the lowest at 8.66 and highest at 10.26, and the mean log of household income per capita at 8.2 with the lowest of no income and highest of 11. In the sample, 64% of children do not like to engage in physical activity. The average time children spend on their beds is about 9 hours per day, and most children do not have a television in their bedroom (86%). More than half of the children have parents involved when they watch TV

(55%). Of the total children 65% do not like eating snacks when watching TV. The mean of the mothers' BMI was about 22.9kg/m2. Finally, 74% of children's mothers have a job at the time of the survey.

Table 8 Summary of all variables for the total sample

Variable	Obs.	Mean	Std.Dev.	Min	Max
WC	847	62.12	11.07	15	105.2
BMI	847	18.38	4.64	10.27	66.00
WHtR	847	0.43	0.06	0.12	0.68
TVcat1	847	0.28	0.45	0	1
TVcat2	847	0.63	0.48	0	1
TVcat3	847	0.09	0.29	0	1
Age	847	11.76	3.13	7	17
Male	847	0.54	0.50	0	1
Female	847	0.46	0.50	0	1
Urban	847	0.31	0.46	0	1
Rural	847	0.69	0.46	0	1
Lngdppc	847	9.47	0.48	8.66	10.26
Lninc	847	8.20	1.44	0	11.00
Activity	847	0.36	0.48	0	1
No activity	847	0.64	0.48	0	1
Bedtime	847	8.94	1.01	6	14
TVroom	847	0.14	0.35	0	1
No TVroom	847	0.86	0.35	0	1
No involve	847	0.45	0.50	0	1
Involve	847	0.55	0.50	0	1
Snack	847	0.35	0.48	0	1
No snack	847	0.65	0.48	0	1
BMIMO	707	22.93	4.88	9.64	89.41
Workmo	707	0.74	0.44	0	1
No workmo	847	0.26	0.41	0	1

6.1.2 Summary of Statistics for the Sub-sample (12-18 years old)

The following is a summary of the statistics for the sub-sample of children between 12 and 18 years old. The means for WC and BMI are all higher than the total sample (68cm> 62cm, 19.49 kg/m2> 18.38 kg/m2). However, WHtR is almost the same as the total sample. Compared to the total sample, the situation regarding the obesity of the sub-sample is more serious.

In the sub--sample, the largest and smallest groups are still in TV category 2 and TV category 3 which account for 54% and 10%, respectively. However children in category 2 with a TV watching time of between 1 and 3 hours are less than the total sample (54%< 63%). Children in TV category 1 with a TV watching time of less than 1 hour are more than the total sample (36%> 28%). It appears that the habits of TV watching among children aged between 12 and 18 years old are better than the total sample.

The percentages of males (55%) and females (45%) are similar to the total sample. Also, the percentage of children in rural (65%) and urban areas (35%) are almost the same as the total sample too. The means of lngdppc (9.49> 9.47) and lninc (8.31>8.20) were almost the same for the total sample, but a little bit higher. Children in the sub-sample appeared to be slightly richer than the total sample.

For physical activity, the mean of children engaged in physical activities was higher than the total sample (41%> 36%). Also, older children were more likely to do physical activities. Slightly more children like eating fast food than those who do not (0.53 > 0.47). Less children had a mother in a job in the sub-sample than the total sample (71 %< 74%). Besides, the mean of the other variables were almost the same as the total sample.

Table 9 Summary of statistics for the sub-sample (12-18 years old)

Variable	Obs.	Mean	Std.Dev.	Min	Max
WC	422	68.10	9.49	22	105.2
BMI	422	19.49	4.06	10.27	46.24
WHtR	422	0.43	0.05	0.13	0.64
TVcat1	422	0.36	0.48	0	1
TVcat2	422	0.54	0.50	0	1
TVcat3	422	0.10	0.30	0	1
Age	422	14.47	1.72	12	17
Male	422	0.55	0.50	0	1
Female	422	0.45	0.50	0	1
Urban	422	0.35	0.48	0	1
Rural	422	0.65	0.48	0	1
lngdppc	422	9.49	0.44	8.66	10.26
Lninc	422	8.31	1.29	0	10.82
Activity	422	0.41	0.49	0	1
No activity	422	0.59	0.49	0	1
Bedtime	422	8.58	1.05	6	14
TVroom	422	0.14	0.34	0	1
No TVroom	422	0.86	0.34	0	1
Involve	422	0.44	0.50	0	1
No involve	422	0.56	0.50	0	1
Fastfood	422	0.53	0.50	0	1
No fastfood	422	0.47	0.50	0	1
Snack	422	0.34	0.47	0	1
No snack	422	0.66	0.47	0	1
BMIMO	351	22.90	3.35	15.72	45.44
Workmo	351	0.71	0.46	0	1
No workmo	422	0.29	0.43	0	1

6.2 Descriptive Statistics for Several Variables

This part shows the descriptive statistics for several selected variables of the total sample. For BMI defined obesity, 15.23% (N=129) of children were in the obese group, which is slightly higher than WHtR defined obesity (10.27%, N=87).

For TV watching time, there were 238 children watching TV for less than 1 hour per day, accounting for 28.1%. The largest of the three categories was 62.69% of children watching TV between 1 and 3 hours per day (N=531). Only 78 children watched TV for 3 hours or more a day (9.21%).

Table 10 shows there were more boys than girls in the sample. The percentages of males and females were 53.84% (N=456) and 46.16% (N=391), respectively. Regarding the location of the children, 585 (69.07%) were living in rural areas in contrast to 262 living in urban areas (30.93%). 542 children did not do any physical activities (63.99%), which is a lot more than those who did (36.01%, N=305).

In our sample, 122 children had a working TV in their bedroom, which only stood at 14.4%. 85.6% of children did not have a TV in their bedroom (N=725). Most children did not eat snacks when watching TV (64.7%, N=548) – this was almost two times those always eating snacks when watching TV (35.3%, N=299). The percentages of children who like fast food and those who do not were almost the same (52.61% and 47.39%). Almost three quarters of children's mothers were employed at the time of the survey (73.69%, N=521), and 186 mothers in the sample did not have a job at that time (26.31%).

Table 10 Descriptive statistics of selected variables

Characteristics	Frequency	Percentage (%)
BMI defined obesity		
Obese	129	15.23
Non-obese	718	84.77
WHtR defined obesity		
Obese	87	10.27
Non-obese	760	89.73
TV watching time		
TV time(<1hour)	238	28.1
TV time(>=1hour,<3hours)	531	62.69
TV time(>3hours)	78	9.21
Gender		
Male	456	53.84
Female	391	46.16
Location		
Urban	262	30.93
Rural	585	69.07
Physical activity		
Yes	305	36.01
No	542	63.99
TV in bedroom		
Yes	122	14.40
No	725	85.60
Parents involve		
Yes	377	44.51
No	470	55.49
Eat snack when watching TV		
Yes	299	35.30
No	548	64.70
Like fast food		
Yes	222	52.61
No	200	47.39
Mother presently working		
Yes	521	73.69
No	186	26.31

6.3 Cross-tabulation between BMI defined Obesity, WHtR defined Obesity and Explanatory Variables

Before regression, the cross-tabulation of selected explanatory variables and BMI, WHtR defined obesity will be shown in this part. From the cross-tabulations, a preliminary assessment of the relationship between explanatory variables and dependent variables will follow.

Table 11 shows the percentage of obese and non-obese children in each TV category. There were 718 children not obese, and 129 obese. Of the children watching TV for less than 1 hour per day, 15.13% of children were obese. In TV category 2, 15.25% of the children fell into the obese group. Of the children watching TV more than 3 hours per day, 15.38% were obese. For the chi-square test, probability was equal to 0.998, which was more than 0.05. This means that the H_0 was not rejected and thus the TV categories and BMI are independent of each other.

Table 11 Cross-tabulation between BMI defined obesity and average TV watching time per day

BMI defined obesity	**TVcat1 (< 1hour)**	**TVcat2 (1-3hours)**	**TVcat3 (>=3hours)**	**Total**
Non-obese	202	450	66	718
	84.87%	84.75%	84.62%	
Obese	36	81	12	129
	15.13%	15.25%	15.38%	
Total				847
Pearson chi2(2) = 0.0037 Pr = 0.998				

Table 12 shows the percentage of children in the WHtR defined obese and non-obese group. There were 760 children in the non-obese group and 87 in the obese group. In TV category 1, only 8.82% of children were obese. In TV category 2, 10.36% of children were obese. For children watching TV more than 3 hours per day, 14.1% were

obese. The p-value of the chi-square test was 0.409, which was more than 0.05, so the TV categories and WHtR were independent of each other.

Tables 11 and 12 show the same trend: more TV watching time was associated with greater obesity.

Table 12 Cross-tabulation between WHtR defined obesity and average TV watching time per day

WHtR defined obesity	**TVcat1 (< 1hour)**	**TVcat2 (1-3hours)**	**TVcat3 (>=3hours)**	**Total**
Non-obese	217	476	67	760
	91.18%	89.64%	85.9%	
Obese	21	55	11	87
	8.82%	10.36%	14.1%	
Total				847
Pearson chi2(2) = 1.7878 Pr = 0.409				

Table 13 shows the observations and percentages for obese and non-obese children doing physical activity and not doing physical activity. As can be seen from Table 13, 14.58% of children were obese of those who do not do physical activity when they are free. Of the children who do physical activity, 16.39% were obese. The chi-square test shows physical activity and BMI were independent of each other (Pr=0.48>0.05).

Table 13 Cross-tabulation between BMI defined obesity and physical activity

BMI defined obesity	**No physical**	**Do physical**	**Total number**
Non-obese	463	255	718
	85.42%	83.61%	
Obese	79	50	129
	14.58%	16.39%	
Total			847
Pearson chi2(1) = 0.4995 Pr = 0.480			

Table 14 shows the percentages of children in the WHtR defined obese and non-obese groups of those engaging and not engaging in physical activity. It reveals the same trend as Table 13. Of those children not doing any physical activity when free, 8.86% were obese. In contrast, of those who did, 12.79% were obese. Because the p-value of the chi-square test (0.07) was more than 0.05 but less than 0.1, the independence of physical activity and WHtR were rejected at the 10% level but accepted at the 5% level, which means WHtR and physical activity were independent of each other at a 5% confidence level but not independent at a 10% confidence level.

Both Tables 13 and 14 show that more physical activity was related to greater obesity.

Table 14 Cross-tabulation between WHtR defined obesity and physical activity

WHtR defined obesity	**No physical activity**	**Do physical activity**	**Total number of observations**
Non-obese	494 91.14%	266 87.21%	760
Obese	48 8.86%	39 12.79%	87
Total			847
Pearson chi2(1) = 3.2720 Pr = 0.070			

Table 15 shows the percentages of children in the BMI defined obese and non-obese groups among children in urban and rural areas. Table 16 shows the same as Table 15 except the obese and non-obese groups are defined by WHtR. For Tables 15 and 16, both show there were less children from rural areas than from urban areas in the obese group (13.33% less than 19.47% and 9.57% less than 11.83%, respectively), even though most of the children in this sample were from rural areas. It would appear that children from rural areas were less likely to be obese. There is much existing literature that shows similar results. One of the reasons may be because fast food restaurants like KFC and McDonalds had become very popular in China since 2000,

and almost all of them were located in urban areas. The resulting high calorie diet makes children become fatter.

In Table 15, the p-value of the chi-square test was 0.022 which was less than 0.05, so BMI and location of children can be considered to be related to each other at a 5% confidence level. However, for the chi-square test of WHtR and location of children in Table 16 the p-value is 0.317, which was more than 0.1. Thus, location categories and WHtR categories of children were independent of each other.

Table 15 Cross-tabulation between BMI defined obesity and location

BMI defined obesity	**Urban area**	**Rural area**	**Total**
Non-obese	211	507	718
	80.53%	86.67%	
Obese	51	78	129
	19.47%	13.33%	
Total			847
Pearson chi2(1) = 5.2708 Pr = 0.022			

Table 16 Cross-tabulation between WHtR defined obesity and location

WHtR defined obesity	**Urban area**	**Rural area**	**Total**
Non-obese	231	529	760
	88.17%	90.43%	
Obese	31	56	87
	11.83%	9.57%	
Total			847
Pearson chi2(1) = 1.0023 Pr = 0.317			

Table 17 shows the t-test for the BMI dummy variable and log of GDP per capita. It shows the mean of GDP per capita in the obese group to be about 9.69 and 9.43 in the non-obese group. So, the children in the obese group had a higher average log of

GDP per capita than children in the non-obese group. The difference between the two means is -0.25. For the t-test, the t-statistic was -5.65 and the degree of freedom was 845. Pr(|T| > |t|) was smaller than 0.05 and even smaller than 0.01, so H_0 was rejected which means the mean difference of log of GDP per capita between the two BMI groups was significant at the 1% confidence level.

Table 17 Two-sample T-tests with equal variances of log of GDP per capita across two BMI groups

Group	**Obs**	**Mean**
0	718	9.43428
1	129	9.68719
Combined	847	9.472801
Diff		-.252907
diff = mean(0) - mean(1)		t = -5.6528
Ho: diff = 0	degree of freedom = 845	
Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = 0.0000	Pr(|T| > |t|) = 0.0000	Pr(T > t) = 1.0000

Table 18 shows the t-test for the WHtR dummy variable and log of GDP per capita. The mean of the log of GDP per capita in the obese group was 9.61 and in the non-obese group was 9.46 and the difference is negative. It appeared that children in the obese group had a higher log of GDP per capita of the province they live in. The t-test shows Pr(|T| > |t|) was smaller than 0.05 and also smaller than 0.01, so we also reject H_0 and accept H_1 which means that the mean of log of GDP per capita between the two WHtR categories was significantly different. Particularly, the obese group had higher log of GDP per capita. Table 18 shows the same trend as Table 17 that obese children had higher mean of log of GDP per capita.

Table 18 Two-sample T-tests with equal variances of log of GDP per capita across two WHtR groups

Group	Obs	Mean
0	760	9.45757
1	87	9.60586
Combined	847	9.4728
diff		-0.14829

diff = mean(0) - mean(1) t = -2.7613
Ho: diff = 0 degree of freedom = 845
Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.0029 Pr(|T| > |t|) = 0.0059 Pr(T > t) = 0.9971

Table 19 shows a two-sample t-test with equal variances of BMI and log of household income per capita. It shows the mean of log of household income per capita in obese group was slightly higher than the non-obese group (8.37>8.17). Also, the difference was negative (-0.20). The t-test shows Pr(|T| > |t|) was 0.1431 which was higher than 0.05 and H_0 was not rejected. So the mean difference of log of household income per capita between the two BMI groups was not significant. But one-tailed test showed that Pr(T < t) was less than 0.1 (0.0716<0.1) which implied the mean difference of log of household income per capita between the two BMI groups was significant at 10% one-tailed test.

Table 19 Two-sample T-tests with equal variances of log of household income per capita across two BMI groups

Group	Obs	Mean
0	718	8.16505
1	129	8.36722
Combined	847	8.19584
Diff		-.20218

diff = mean(0) - mean(1) t = -1.4657
Ho: diff = 0 degree of freedom = 845
Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.0716 Pr(|T| > |t|) = 0.1431 Pr(T > t) = 0.9284

Table 20 shows the t-test between WHtR and log of household income per capita. It shows the mean of log of household income per capita in the obese group was 8.05 and 8.21 in the non-obese group. The difference was 0.16 which was positive and showed the different sign with table 19. For the t-test, t-statistic was 0.9956 with the degree of freedom of 845. Pr(|T| > |t|) was 0.32, which was more than 0.05 and thus H_0 was not rejected. This implied that the mean difference of log of household income per capita between the two WHtR defined obesity groups was not significant at all.

Table 20 Two-sample T-test with equal variances of log of household income per capita across two WHtR groups

Group	Obs	Mean
0	718	8.21255
1	129	8.04990
Combined	847	8.19584
Diff		.162650
diff = mean(0) - mean(1)		t = 0.9956
Ho: diff = 0	degree of freedom = 845	
Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = 0.8401	Pr(|T| > |t|) = 0.3197	Pr(T > t) = 0.1599

Table 21 shows the average time children spend on the bed in the obese group and the non-obese group and the results of the t-test. It was found that the mean of the bedtime for the obese group was slightly higher than the non-obese group (8.97>8.93), and the difference was negative (-0.04). The t-statistic was -0.39 and the degree of freedom 845. Pr(|T| > |t|) was 0.7 which was higher than 0.05, so H_0 was not rejected. This implied that the mean difference of time in bed per day between the two BMI groups was not significant. So there was no mean difference of the average time children spend on the bed between obese and non-obese kids.

Table 21 Two-sample T-test with equal variances of time in bed per day across two BMI groups

Group	Obs	Mean
0	718	8.931755
1	129	8.968992
Combined	847	8.937426
Diff		-.0372374

diff = mean(0) - mean(1) t = -0.3852

Ho: diff = 0 degree of freedom = 845

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0

Pr(T < t) = 0.3501 Pr(|T| > |t|) = 0.7002 Pr(T > t) = 0.6499

Table 22 shows the mean of bedtime in the WHtR defined obese and non-obese groups and the results of the t-test. It shows the same trend as Table 21 which is that the average bedtime in the obese group was slightly higher than the non-obese group (9.03>0.93). Also, the difference was also negative (-0.11). The t-statistic was -0.095 and degree of freedom 845. For the t-test, p-value (0.35) was more than 0.05, so H_0 was not rejected. Thus, the difference in the mean of time in bed per day between the obese and non-obese group was not significant which showed the same trend with Table 21.

Table 22 Two-sample T-test with equal variances of time in bed per day across two WHtR groups

Group	Obs	Mean
0	760	8.926316
1	87	9.034483
Combined	847	8.937426
Diff		-.108167

diff = mean(0) - mean(1) t = -0.9458

Ho: diff = 0 degree of freedom = 845

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0

Pr(T < t) = 0.1723 Pr(|T| > |t|) = 0.3445 Pr(T > t) = 0.8277

Table 23 shows the relationship between the BMI of children and parents' involvement when watching TV. There were 18.3% children with parents' involvement

in the obese group; in contrast, 12.77% of children were obese who did not have parents' involvement. The p-value of the chi-square test was 0.026 less than 0.05, so the H_0 was rejected and H_1 was accepted which means that parents' involvement and the BMI of children were related with each other.

Table 23 Cross-tabulation between BMI defined obesity and parents' involvement

BMI defined obesity	**Not involved**	**Involved**	**Total**
Non-obese	410	308	718
	87.23%	81.7%	
Obese	60	69	129
	12.77%	18.3%	
Total			847
Pearson chi2(1) = 4.9667 Pr = 0.026			

Table 24 presents the cross-tabulation of parent's involvement and WHtR of children. It showed similar results to Table 23. Of the children without parents' involvement, 9.57% were obese, while 11.14% of children with parents' involvement were obese. It appeared that obese children tend to have greater parent's involvement. This may be because parents with a non-obese child may not think about how to prevent obesity, but parents with an obese child are involved more because they always notice the things that can make child become more obese. The p-value of the chi-square test was more than 0.05 (Pr=0.456), so H_0 was not rejected which means that WHtR and parents' involvement were independent of each other.

Table 24 Cross-tabulation between WHtR defined obesity and parents' involvement

WHtR defined obesity	**Not involved**	**Involved**	**Total**
Non-obese	425	335	760
	90.43%	88.86%	
Obese	45	42	87
	9.57%	11.14%	
Total			847
Pearson chi2(1) = 0.5567 Pr = 0.456			

Table 25 shows the relationship between snack preference when watching TV and the BMI of children. It was found that more children eat snacks when watching TV in the obese group (18.06% > 13.69%). For the results of the chi-square test of these two variables, the p-value was more than 0.05 but less than 0.1 (Pr=0.09), so the snack preference of children in BMI defined obese and non-obese group were independent of each other at a 5% confidence level but were related at a 10% confidence level.

Table 25 Cross-tabulation between BMI defined obesity and eating snacks when watching TV

BMI defined obesity	**No snack**	**Eat snack**	**Total**
Non-obese	473	245	718
	86.31%	81.94%	
Obese	75	54	129
	13.69%	18.06%	
Total			847
Pearson chi2(1) = 2.8668 Pr = 0.090			

The cross-tabulation of snack preferences when watching TV and the WHtR of children in Table 26 reveals the same trend as Table 25 (11.71% more than 9.49%), namely, that children eating snacks when watching TV have a larger percentage than children not eating snacks when watching TV in the obese group. So, from Tables 25 and 26, children with the habit of eating snacks when watching TV were more likely to be obese. The p-value of chi-square test of snack preference when watching TV and WHtR of children was 0.3 which was higher than 0.05, so H_0 was not rejected. It showed that snack preference and WHtR defined obese and non-obese group were independent of each other.

Table 26 Cross-tabulation between WHtR defined obesity and eating snacks when watching TV

WHtR defined obesity	No snack	Eat snack	Total
Non-obese	496	264	760
	90.51%	88.29%	
Obese	52	35	87
	9.49%	11.71%	
Total			847
Pearson chi2(1) = 1.0313 Pr = 0.310			

Table 27 shows the average BMI of children's mothers for the two groups of BMI defined obese and non-obese children, and the t-test was also used to test the independence of the two variables. The average BMI of mothers in the children's obese group was 23.70 kg/m^2, which was higher than 22.78 kg/m^2 in the non-obese group. Also, the difference was -0.92 kg/m^2. The t-statistic of the t-test was -1.84 and the degree of freedom was 705. For the p-values, Pr(|T| > |t|) was 0.07, which was less than 0.1 and H_1 was accepted at 10% level. This implied that the mean difference of mothers' BMI across the obese and non-obese children was significant at 10% level. But one-tailed test showed Pr(T < t) was 0.03, which was smaller than 0.05 implying that the mean difference was significant at 5% one-tailed test. In particular, our statistics showed that obese children tend to have mothers with larger BMI.

Table 27 Two-sample T-test with equal variances of mother's BMI across children's BMI groups

Group	Obs	Mean
0	594	22.7811
1	113	23.70247
Combined	707	22.92837
Diff		-.921364
diff = mean(0) - mean(1)		t = -1.8442
Ho: diff = 0		degree of freedom = 705
Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = 0.0328	Pr(|T| > |t|) = 0.0656	Pr(T > t) = 0.9672

Table 28 showed the mean of mothers' BMI for the two groups of WHtR defined obese and non-obese children with the results of the t-test. Table 28 showed the same trend as Table 27, namely, the average mothers' BMI in the obese group was higher than the non-obese group (24.09 kg/m^2 >22.79 kg/m^2). The difference was also negative (-1.29 kg/m^2). T-statistics was -2.17 with 705 degrees of freedom. Pr(|T| > |t|) was less than 0.05 (0.03<0.05), so the H_0 was rejected and H_1 was accepted which means that the mean difference of mothers' BMI across children's obesity group was significant at the 5% level.

Table 28 Two-sample T-test with equal variances of mother's BMI across children's WHtR groups

Group	**Obs**	**Mean**
0	633	22.79271
1	74	24.0888
Combined	707	22.92837
Diff		-1.29609

diff = mean(0) - mean(1) t = -2.1692

Ho: diff = 0 degree of freedom = 705

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0

Pr(T < t) = 0.0152 Pr(|T| > |t|) = 0.0304 Pr(T > t) = 0.9848

6.4 Factors Affecting BMI, WHtR and WC of children

In this part, nine regressions for WC and eight regressions for BMI and WHtR with different sets of explanatory variables were employed to find out which set of explanatory variables best capture the data. The F-test and likelihood-ratio tests were calculated to show the explanatory power of additional variables. The standard of a P-value less than 0.1 was applied to discover whether the coefficients of the incremental variables were significant.

For waist circumference, after the seven basic regressions, the interaction terms of TV categories with age and TV categories with females were also added as incremental variables in Model 8, and seaside was added in Model 9. Models 8 and 9 were used to test the explanatory power of the added variables.

For the binary logistic regression of BMI and WHtR, seaside was added in Model 8 and the explanatory power of the added variable was tested. Marginal effect was computed after the best list of variables was chosen.

6.4.1 OLS for Waist Circumference

From Table 29, Model 1 contains TV watching time, age, gender, location and log GDP per capita as the explanatory variables. Then, additional explanatory variables were added into each subsequent model. The TV watching time in these regressions was not significant, but the coefficients were positive. Rural area was also not significant. Age and female were always significant at the 1% level. The coefficients of age were around 2 and were positive. Furthermore, the coefficients of females were always between -3 and -4. With the adding of more and more variables, log GDP per capita and physical activity became less significant. When testing Model 2 against Model 1, the F-test showed that the additional variable (activity) in Model 2 was statistically significant. In the same way, Model 4 was chosen over Model 2. Thus, Model 5 was chosen to be the best list of variables with TV watching time, age, gender,

location, log GDP per capita, physical activities, TV in bedroom, BMI of mother and parents' involvement because of it having the most complete and significant variables included with the F-test significant at a 5% significance level. Besides, eating snacks when watching TV was significant at the 10% level in Model 7, and it was positively related to waist circumference.

The interaction terms of TV categories with age and TV categories with female as incremental variables were also added in Model 8, but neither the F-test nor P-value were shown to be statistically significant at all. Besides, we used seaside as the incremental variable in Model 9 to show the effect of seaside on waist. It was found that the F-test of Model 9 was not significant, and the seaside in Model 9 was also not significant. From Model 9, the coefficient of seaside was -0.386, but the coefficient of lngdppc was 3.203. As mentioned before in the Chapter 4, these two variables were similar but have opposite signs of coefficients. There was some contradiction, so seaside was not included in the final regression.

Table 29 Nine regressions with different lists of variables for WC

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model8	Model 9
TVcat2	0.202 [0.719]	0.360 [0.720]	0.387 [0.723]	0.319 [0.717]	0.440 [0.783]	0.378 [0.786]	0.418 [1.066]	4.784 [8.832]	4.978 [8.864]
TVcat3	0.608 [1.171]	0.937 [1.175]	0.996 [1.183]	0.724 [1.173]	1.198 [1.316]	1.152 [1.317]	0.774 [1.934]	8.766 [18.13]	9.305 [18.228]
Age	2.010 [0.100] ***	1.987 [0.100] ***	1.969 [0.107] ***	2.002 [0.100] ***	2.070 [0.110] ***	2.073 [0.110] ***	1.356 [0.297] ***	1.512 [0.494] ***	1.528 [0.497] ***
Female	-3.472 [0.612] ***	-3.179 [0.621] ***	-3.181 [0.622] ***	-3.204 [0.619] ***	-3.292 [0.691] ***	-3.346 [0.693] ***	-4.107 [1.010]** *	-2.962 [1.612]*	-3.041 [1.631] *
Rural	-0.298 [0.670]	-0.222 [0.669]	-0.200 [0.671]	-0.135 [0.667]	0.216 [0.728]	0.342 [0.739]	0.662 [1.050]	0.601 [1.056]	0.608 [1.058]
lngdppc	2.301 [0.656] ***	2.360 [0.655] ***	2.339 [0.657] ***	1.983 [0.667] ***	1.911 [0.785] **	1.813 [0.790] **	3.059 [1.221] **	3.03 [1.237] **	3.203 [1.344] **
Activity		1.617 [0.653] **	1.609 [0.653] **	1.592 [0.650] **	1.440 [0.723] **	1.373 [0.726] *	-0.204 [1.032]	-0.2 [1.047]	-0.254 [1.062]
Bedtime			-0.144 [0.333]				0.379 [0.478]	0.396 [0.482]	0.4 [0.483]
Tvroom				-2.364 [0.884] ***	-2.038 [0.987] **	1.995 [0.988] **	1.228 [1.455]	1.206 [1.468]	1.235 [1.473]
BMIMO					0.147 [0.070] **	0.142 [0.070] **	0.295 [0.148] **	0.288 [0.149]*	0.288 [0.149]*
Involve						0.716 [0.696]	-0.008 [0.982]	0.002 [0.994]	0.009 [0.995]
Workmo							-0.861 [1.071]	-0.862 [1.076]	-0.853 [1.078]

Snack							1.989 [1.026] *	2.009 [1.033] *	2.018 [1.035] *
Fastfood							-0.084 [1.016]	-0.06 [1.025]	-0.002 [1.042]
Ininc							-0.003 [0.363]	-0.008 [0.366]	-0.029 [0.372]
tvcat2female								-1.599 [2.037]	[2.043]
tvcat3female								-4.004 [3.698]	[3.707]
tvcat2age								-0.254 [0.615]	[0.618]
tvcat3age								-0.428 [1.180]	[1.188]
Seaside									-0.386 [1.168]
Constant	18.308 [6.492] ***	17.125 [6.490] ***	18.782 [7.543] **	22.543 [6.776] ***	18.812 [7.987] **	17.442 [7.771] **	10.889 [13.36]	8.516 [14.36]	6.93 [15.163]
F-test of incremental variables									
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**	**Model 9**
H_0		Model 1	Model 2	Model 2	Model 4	Model 5	Model 5	Model 7	Model 7
H_1		Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
F-statistic		6.14 **	0.19	7.15 ***	4.43 **	1.06	0.87	0.43	0.36
Observations	847	847	847	847	707	707	351	351	351
Standard errors in brackets									
*** significant at 10%; ** significant at 5%; *** significant at 1%**									

Based on Model 5 from Table 29, we can interpret the results as follows in Table 30.

TV watching time does not have a significant relationship with WC, but the coefficient is positive which is as expected before. This can be seen from the fact that TVcat2 and TVcat3 are both statistically insignificant. Age is significantly related to WC at the 1% level in a positive manner, and the coefficient is 2.07 with the confidence interval from 1.85 to 2.29. So, if a child grows by one year, his waist circumference on average will grow 2.07 cm. Female is significantly related to WC at the 1% level with a negative coefficient (-3.292). The confidence interval ranges from -4.65 to -1.93, so 0 is not located in the interval which means H_0 of coefficient being equal to 0 was rejected and the coefficient was statistically significant. This means if a child is a girl, her waist will be on average 3.292 cm less than a boy. Rural area is not significant with a positive coefficient and is the same as expected before.

Log GDP per capita is significant at the 5% significant level with a positive coefficient just as predicted in Chapter Four. The confidence interval ranges from 0.37 to 3.4, which does not include 0 implying that the coefficient was statistically significant. Thus, a 1% increase in GDP per capita will increase the waist of a child by on average 0.01912 cm (For OLS: When GDP per capita increases by 1%, the waist of a child will increase by $\beta/100$ cm). Both TV in bedroom and mother's BMI have a positive relationship with circumference and are significant at the 5% level, and they have the same sign as the prior prediction. This means if a child has a working TV in his bedroom, his waist will be on average 2.038 cm more than a child without. If the mother's BMI increases by 1 kg/m^2, her child's waist will increase by on average 0.147 cm. Physical activities is significant at the 10% level, which means a child engaged in physical activity will have a on average 1.44cm bigger waist than a child not engaged in physical activity.

Table 30 Final results of OLS for WC based on Model 5

Variables	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
TVcat2	0.44022	0.78327	0.56	0.574	-1.09762	1.97807
TVcat3	1.19764	1.31598	0.91	0.363	-1.38612	3.78140
Age	2.06980	0.11039	18.75	0.000	1.85307	2.28654
Female	-3.29195	0.69137	-4.76	0.000	-4.64936	-1.93454
Rural	0.21582	0.72849	0.30	0.767	-1.21447	1.64611
Lngdppc	1.91086	0.78457	2.44	0.015	0.37046	3.45125
Activity	1.43959	0.72272	1.99	0.047	0.02061	2.85857
TVroom	2.03839	0.98741	2.06	0.039	0.09974	3.97704
BMIMO	0.14652	0.06965	2.10	0.036	0.00978	0.28327
_cons	16.77362	7.74449	2.17	0.031	1.56829	31.97895

Regarding the unexpected correlation with physical activity, the reason could be the huge impact of age. Children's waists become bigger when they are growing. A cross-tabulation of age and physical activity can show the impact of age.

As can be seen in Table 31, the average age in the group of children doing physical activity was slightly higher than the average for the group of children not doing any physical activity (12.213> 1.502). Children are more likely to do activities as they become older and children have bigger waists when they become older. So, the result for physical activity shows that more physical activity leads to a bigger waist circumference.

Table 31 Cross-tabulation of age and physical activity

	Mean	Freq.
No activity	11.502	542
Do activity	12.213	305
Total		847

According to the effect of each factor on WC, it was found that TVroom (2.04) was the greatest contributing factor followed by lngdppc (1.911) and BMIMO (0.147).

Being female also had substantial effect on WC; however, it is difficult for the government to target policy only at males.

6.4.2 Binary Logistic Regression for BMI

As evident in Table 32, the same basic list of variables as regression for WC was chosen with new variables continually being added. TV watching time was still insignificant, but they always have positive coefficients. Age is still very significant at the 1% level with negative coefficients at about -0.13. Female is significant at the 5% level in Models 1, 3, 4 and 5 and significant at 10% in other models. The coefficients of gender were about -0.43. Rural area was always significant at the 1% level but significant at the 5% level in Model 7 with coefficients of about -0.59. Log GDP per capita was always significant at the 1% level with coefficients of around 1.25. Besides, other incremental variables were totally insignificant.

For the binary logistic regression, a likelihood ratio test was used to find out which model best captured our data. Each model from 2 to 7 was tested against Model 1 and it turned out that the null hypothesis of Model 1 being valid is always not rejected. Therefore, Model 1 was considered to best capture the data with TV watching time, age, gender, location and log GDP per capita.

Besides, seaside was also added as an incremental variable in Model 8 to show how the seaside affects BMI. From Model 8, it was found that the likelihood-ratio test for Model 8 was not significant, however, seaside was significant with a negative coefficient (-0.48). In contrast, the coefficient of lngdppc in Model 8 was positive (1.82) . As mentioned in chapter 4, they actually represent a similar economic trend, but they have the opposite effect on BMI. Seaside was not used in the final model because of the contradiction.

Table 32 Eight regressions with different lists of variables for BMI

Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
TVcat2	0.201 [0.234]	0.215 [0.234]	0.213 [0.235]	0.2 [0.234]	0.186 [0.234]	0.153 [0.250]	0.132 [0.254]	0.117 [0.254]
TVcat3	0.408 [0.380]	0.431 [0.382]	0.431 [0.382]	0.404 [0.381]	0.395 [0.380]	0.46 [0.405]	0.449 [0.411]	0.396 [0.412]
Age	-0.127 [0.033] ***	-0.129 [0.033] ***	-0.135 [0.036] ***	-0.127 [0.033] ***	-0.126 [0.033] ***	-0.12 [0.036] ***	-0.122 [0.040] ***	-0.127 [0.041] ***
Female	-0.428 [0.204] **	-0.399 [0.208] *	-0.429 [0.204] **	-0.429 [0.204] **	-0.438 [0.205] **	-0.433 [0.222] *	-0.437 [0.228] *	-0.445 [0.228] *
Rural	-0.593 [0.210] ***	-0.587 [0.210] ***	-0.587 [0.210] ***	-0.592 [0.210] ***	-0.567 [0.211] ***	-0.646 [0.225] ***	-0.595 [0.232] **	-0.593 [0.231] **
Lngdppc	1.275 [0.232] ***	1.28 [0.233] ***	1.268 [0.233] ***	1.266 [0.238] ***	1.239 [0.235] ***	1.546 [0.273] ***	1.468 [0.285] ***	1.822 [0.370] ***
Activity		0.159 [0.211]					0.049 [0.233]	0.016 [0.233]
Bedtime			-0.066 [0.112]				-0.012 [0.123]	-0.017 [0.123]
TVroom				0.047 [0.265]			0.037 [0.289]	0.042 [0.289]
Involve					0.207 [0.203]		0.255 [0.226]	0.261 [0.226]
BMIMO						0.027 [0.018]	0.026 [0.018]	0.03 [0.018]
Workmo							0.015 [0.255]	0.057 [0.256]
Lninc							0.049 [0.079]	0.042 [0.080]
Snack							0.117 [0.226]	0.106 [0.226]
Seaside								-0.481 [0.284] *
Constant	-8.305 [1.976] ***	-8.337 [1.979] ***	-7.284 [2.258] ***	-8.029 [2.019] ***	-10.738 [2.317] ***	-8.149 [1.986] ***	-9.131 [2.737] ***	-18.194 [3.839] ***
Likelihood-ratio test								
H_0		Model 1	Model 1	Model 1	Model 1	Model 1	Model 1	Model 1
H_1		Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Likelihood-ratio statistic		0.57	0.35	0.03	1.04	2.02	4.35	7.34
Observations	847	847	847	847	847	707	707	707
Standard errors in bracket								
* significant at 10%; ** significant at 5%; *** significant at 1%								

Table 33 shows the marginal effects of the final list of variables based on Model 1 in Table 32.

For the TV watching time categories 2 and 3, there was no significant relationship with BMI but the marginal effects were positive with the same sign as expected before. Age has a strong negative relationship with the BMI of children which is significant at the 1% level, and there is a different result with the regression of WC. This means that for a child growing older by one year, the probability of the child being obese will decrease by 1.43% on average.

Female was significant at the 5% level, which means that if a child is a girl, she has a 4.81% lower probability of being obese than a boy. Rural area had a negative relationship with BMI and was significant at the 1% level which means a child living in a rural area has a 6.664% lower probability of being defined as obese by BMI than a child in an urban area on average. GDP per capita was strongly and significantly related to BMI defined obesity at the 1% level and in a positive manner. This means that as GDP per capita increases by 1%, the probability of being defined as obese by BMI increases by 0.143% (for binary logistic regression: 1% increase in GDP will increase the probability of being obese by dy/dx/100) on average. The direction of the effects on BMI of location and lngdppc were all the same as expected before.

Table 33 Marginal effects of variables on BMI of children based on Model 1

Variables	dy/dx	Std. Err.	z	P>z	[95% Conf.	Interval]
TVcat2	0.02256	0.02623	0.86	0.390	-0.02885	0.07398
TVcat3	0.04587	0.04262	1.08	0.282	-0.03766	0.12940
Age	-0.01428	0.00367	-3.90	0.000	-0.02146	-0.00710
Female	-0.04810	0.02277	-2.11	0.035	-0.09272	-0.00348
Rural	-0.06664	0.02341	-2.85	0.004	-0.11252	-0.02076
Lngdppc	0.14326	0.02456	5.83	0.000	0.09512	0.19140

From the result of factors affecting the probability of becoming obese, this study found that rural was the most meaningful variable (-6.7%). The second was GDP per capita (0.143%). Thus, the government could pay more attention to urban areas and richer areas. Age also greatly impacts BMI, but there is no need to pay attention to this variable as children become thinner as they grow up.

6.4.3 Binary Logistic Regression for WHtR

From Table 34, the same basic list of variables was chosen with more added.

In the seven models of binary logistic regression for WHtR, TV watching time more than 3 hours was significantly related to WHtR except for Model 7, and the coefficients varied among the models. Female was strongly related to WHtR in a negative manner with coefficients of around -0.8. Rural area was not significantly related to WHtR with negative coefficients. Log GDP per capita was significantly related to WHtR in a positive direction at the 1% level except for Model 7, and the coefficients were about 0.75. Besides, all of the incremental variables were not significant except for the BMI of the mother in Model 7.

Regarding the likelihood-ratio test, this showed the same results with the regression for BMI. Similarly, each model from 2 to 7 was tested against Model 1, but there was no likelihood ratio with any statistical significance. Thus, Model 1 was chosen to be the best model to capture our data with TV watching time, age, gender, location and log GDP per capita.

Besides, seaside was also added as an incremental variable in Model 8 to show how the seaside affects BMI. From Model 8, the likelihood-ratio test for Model 8 was found to be not significant, and seaside was also insignificant with a positive coefficient (0.37). Although the sign for seaside and lngdppc were all significant in Model 8 of the binary logistic regression of WHtR, seaside was not used in the final model because it could not capture the dataset very well.

Table 34 Eight regressions with different lists of variables for WHtR.

Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
TVcat2	0.319 [0.282]	0.355 [0.283]	0.299 [0.283]	0.311 [0.282]	0.314 [0.283]	0.402 [0.311]	0.307 [0.453]	0.354 [0.458]
TVcat3	0.732 [0.410] *	0.809 [0.414] *	0.69 [0.415] *	0.696 [0.412] *	0.727 [0.411] *	0.933 [0.443] **	0.302 [0.745]	0.34 [0.748]
Age	-0.042 [0.037]	-0.046 [0.038]	-0.032 [0.040]	-0.04 [0.038]	-0.042 [0.037]	-0.042 [0.041]	0.000 [0.116]	0.002 [0.116]
Female	-0.843 [0.250] ***	-0.78 [0.254] ***	-0.842 [0.250] ***	-0.851 [0.251] ***	-0.846 [0.251] ***	-0.94 [0.278] ***	-0.930 [0.439] **	-0.895 [0.442] **
Rural	-0.347 [0.246]	-0.332 [0.246]	-0.357 [0.246]	-0.333 [0.247]	-0.34 [0.247]	-0.402 [0.265]	0.494 [0.465]	0.513 [0.468]
Lngdppc	0.752 [0.257] ***	0.763 [0.258] ***	0.76 [0.257] ***	0.679 [0.263] ***	0.74 [0.261] ***	0.82 [0.298] ***	1.018 [0.534] *	0.794 [0.586]
Activity		0.356 [0.239]					0.197 [0.416]	0.234 [0.419]
Bedtime			0.089 [0.123]				0.122 [0.181]	0.119 [0.181]
TVroom				0.383 [0.294]			0.364 [0.521]	0.35 [0.522]
Involve					0.06 [0.236]		0.205 [0.396]	0.208 [0.397]
BMIMO						0.028 [0.018]	0.105 [0.049] **	0.103 [0.050] **
Workmo							-0.431 [0.427]	-0.44 [0.429]
Ininc							-0.015 [0.135]	-0.001 [0.135]
Snack							0.483 [0.404]	0.47 [0.404]
Fastfood							-0.013 [0.421]	-0.066 [0.427]
Seaside								0.365 [0.463]
Constant	-8.567 [2.577] ***	-8.834 [2.590] ***	-9.539 [2.910] ***	-7.964 [2.616] ***	-8.49 [2.594] ***	-9.914 [3.012] ***	-15.720 [5.876] ***	-13.86 [6.174] **
Likelihood-ratio test								
H_0		Model 1	Model 1	Model 1	Model 1	Model 1	Model 1	Model 1
H_1		Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Likelihood-ratio statistic	2.19	0.51	1.62	0.06	2.13	9.85	10.46	
Observations	847	847	847	847	847	707	351	351
Standard errors in brackets								
* significant at 10%; ** significant at 5%; *** significant at 1%								

Based on Model 1 from Table 34, the marginal effect was computed in Table 35. It shows that TV watching time more than 3 hours per day, female and log GDP per capita were significantly related to the WHtR of children. TV watching time more than 3 hours per day was related to WHtR in a positive manner with the coefficient equal to 0.126, which means that if a child is watching TV more than 3 hours per day, the probability of being obese will be 12.6% higher than a child with an average TV watching time of less than 1 hour per day. The signs of TVcat2 and TVcat3 were all positive – the same as expected before.

The coefficient of female was -0.0624 and female was significant at a 1% confidence level. If a child is a girl, then she will have a 6.24% lower probability of being WHtR defined obesity than a boy on average.

For log GDP per capita, if the GDP per capita of a child's province increases by a 1%, the probability of the child being WHtR defined obese will increase by 0.058% on average (for binary logistic regression: 1% increase in GDP will increase the probability of being obese by dy/dx/100). The positive sign of the coefficient was also the same as expected before.

Table 35 Marginal effects of variables on the WHtR of children based on Model 1

	dy/dx	Std. Err.	z	P>z	[95% Conf.	Interval]
TVcat2	0.043789	0.026656	1.64	0.100	-0.00846	0.096034
TVcat3	0.125974	0.0395257	3.19	0.001	0.048506	0.203443
Age	-0.02765	0.0032731	-8.45	0.000	-0.03406	-0.02123
Female	-0.0624	0.0214003	-2.92	0.004	-0.10434	-0.02045
Rural	-0.04655	0.0227702	-2.04	0.041	-0.09118	-0.00192
Ingdppc	0.058018	0.0232068	2.5	0.012	0.012533	0.103502

In decreasing order of the effect of each factor on the probability of being obese, it was found that TVcat3 was the greatest contributing factor (12.6%) followed by GDP per capita (0.058%). Female did not have much policy implications.

Table 36 shows the conclusion of the results in the three regressions above. The blank means there was no significant relationship between those two variables in the row and column of that blank. The sign denotes the direction of the effect on the dependent variables.

(1) TVcat2, bedtime, involve, workmo and fastfood had no significant relationship with any dependent variables at all. For the signs of coefficients, only TVcat2 had the same sign as expected, which was positive. The coefficients of bedtime could be considered the same as expected, because it always changed in different models and regressions just as the sign could not be predicted in Chapters 3 and 4. Most of the coefficients of involve were positive which was not as expected. The sign of workmo was only as expected in the binary logistic regression of BMI which was positive. The expected sign of fastfood was positive, but the result was negative. This may be because fast food in China is not the same as other countries as mentioned before in Chapter 4. Indeed, Chinese fast food may be healthier than other countries.

(2) Age, female and lngdppc were significant in all models and followed the same direction except for the impact of age on waist. So, children become less obese as they become older. Females are less likely to be obese. These results are all the same as expected.

(3) Activity, TVroom, Snack and BMIMO had positive impacts on the waists of children. BMIMO also had a positive relationship with children's WHtR. All of the signs were the same as expected except activity.

(4) For the economic variables, children living in rural areas had a negative relationship with children's BMI and WHtR. The lngdppc had a positive impact on

WC, BMI and WHtR. The log of household income per capita was not significant across all regression models in this research. All of these economic variables followed the same direction of effects on child obesity as we expected before, which shows that children in richer areas were more likely to be obese.

Table 36 Conclusion of results

Variables	WC	BMI	WHtR
TVcat2			
TVcat3			+
Age	+	-	-
Female	-	-	-
Rural		-	-
lngdppc	+	+	+
lninc			
Activity	+		
Bedtime			
TVroom	+		
Involve			
Snack	+		
BMIMO	+		+
Workmo			
Fastfood			

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

This research attempted to identify the relationship between TV viewing time, socioeconomic-demographic factors, other behavioral risk factors and the obesity of children in China. Following multiple linear regression and binary logistic regression, it was found that socioeconomic-demographic variables had very strong effects on the obesity of children.

For the variables related to TV, there was not as much significance as expected concerning the significant relations to all of the dependent variables. TV watching time only substantially affected WHtR defined obesity and only when the TV watching time was more than 3 hours per day compared to less than 1 hour per day. This result was similar to research by Mendoza, Zimmerman, and Christakis (2007) and Eisenmann, Joey C., R. Todd Bartee and Min Qi Wang (2002). The former research found that children with a TV watching time of more than 2 hours were more likely to be obese than children with less TV watching time; the latter found that children with more than 4 hours TV viewing time had a higher probability of being obese than children with less than 1 hour TV viewing time per day. Both of these groups were in the U.S. It appears that the situation in China is similar to that in the U.S.

Regarding parents' involvement when watching TV and eating snacks when watching TV, these are definitely not significant at all in all models, these two variables appear to not have any impact on child obesity. A TV in the bedroom can only strongly increase a child's waist. Also, the number of working TVs in the household also can only increase a child's waist.

The socioeconomic-demographic variables have more impacts on child obesity. The most interesting thing in this part is age, because it always shows a strong impact

but in different directions on different dependent variables. The reason could be that the waist of a child is always increasing as the child grows. So, when age is being considered in the model, waist is not good enough to explain the obesity of children. In this situation, the results of the impact on BMI and WHtR have more explanatory power: children will be less likely to be obese as they grow up. Gender is strongly related to child obesity as girls are shown to be less likely to be obese than boys. Children in rural areas are substantially shown to have lower BMI and WHtR than children in urban areas, while children in urban areas are more likely to be fat. Log GDP per capita shows the same thing: children in richer provinces tend to be fatter. Mothers' BMI shows that a fatter mother is more likely to have fatter children, but the relationship is only to a somewhat degree. Whether the mother has a job or not does not affect the child's obesity.

For other behavioral risk factors, there is only a slight impact on child obesity. Physical activity only has an impact on waist but not in an unexpected sign. This may be because of the huge impact of age on waist. Fast food preference is only significant in Model 7 of binary logistic regression for WHtR, and it can slightly increase the WHtR of children.

7.2 Recommendations

Following the conclusions of the study, some recommendations for reducing the prevalence of child obesity in China are given.

1) Adults should be taught to keep a child's TV watching time at less than 3 hours per day to reduce the probability of being obese. The government should convey this knowledge to adults by advertising on television, newspapers, the internet or other social media.

2) Reduce the chances of children having a TV in their bedroom. On the one hand, parents should be made aware of the risk of putting a television in a child's bedroom; On the other hand, this can also be solved by policies. For example, there could be a policy to control builders and estate companies to never put a TV line cable in the second bedroom.

3) The policy of the government should target urban areas and richer provinces. More advertisements and interventions should be made among the richer and those in urban areas to reduce the prevalence of child obesity.

7.3 Limitations

This study tried to investigate the effect of TV viewing and other factors on the obesity of children, but there are still some limitations on the research.

1) Dataset

First, society is changing year by year, but the latest dataset we could use is from 2006. The results would be more representative if data was used from more recent years. Second, after cleaning the missing data, only 847 observations were left. If there were more observations in the dataset, the results could be even more accurate.

2) Sleeping time is a very strong variable affecting child obesity, and there is prior research. However, the variable in this questionnaire is all of the time spent on bed per day, so it can not represent sleeping time.

3) The length of physical activity per day could affect child obesity substantially according to much existing literature. However, the question in this survey was only whether the child did or did not do any physical activity.

REFERENCES

Adachi-Mejia A M, Longacre M R, Gibson J J, et al. Children with a TV in their bedroom at higher risk for being overweight[J]. International journal of obesity, 2007, 31(4): 644-651.

Browning, L. M., Hsieh, S. D., & Ashwell, M. (2010). A systematic review of waist-to-height ratio as a screening tool for the prediction of cardiovascular disease and diabetes: 0· 5 could be a suitable global boundary value.Nutrition research reviews, 23(02), 247-269.

Crespo, C. J., Smit, E., Troiano, R. P., Bartlett, S. J., Macera, C. A., & Andersen, R. E. (2001). Television watching, energy intake, and obesity in US children: results from the third National Health and Nutrition Examination Survey, 1988-1994. Archives of pediatrics & adolescent medicine, 155(3), 360-365.

Deng Qian, Wang Limin, Chen Xiaorong, Wang Zhihui, Zhang Mei,... & Li Yichong et al.2015. Television viewing time of Chinese adults: associations with body mass index and obesity [J]. Chinese Journal of Frontier Medical Science (Electronic), 2015, 7(1): 46-50.

Dietz, W. H. (1998). Health consequences of obesity in youth: childhood predictors of adult disease. Pediatrics, 101(Supplement 2), 518-525.

Eisenmann J C, Bartee R T, Wang M Q. Physical activity, TV viewing, and weight in US youth: 1999 Youth Risk Behavior Survey[J]. Obesity research, 2002, 10(5): 379-385.

Francis L A, Lee Y, Birch L L. Parental weight status and girls' television viewing, snacking, and body mass indexes[J]. Obesity research, 2003, 11(1): 143-151.

Jeffery, R. W., & French, S. A. (1998). Epidemic obesity in the United States: are fast foods and television viewing contributing?. American journal of public health, 88(2), 277-280.

Jin Xin. "Chinese people have our own standard of obesity now". The Beijing News, 29.Jun.2001, A15

Ji Chengye. Body mass index reference norm for screening overweight and obesity in Chinese children and adolescents [J]. Chinese Journal of Epidemiology, 2004, 25(2): 97-102.

Ji Chengye. Prevalence of overweight and obesity in Chinese students and its socioeconomic difference [J]. Institute of Child and Adolescent Health , 2008, 29(2): 106-108.

Laurie Burkitt, 2014, As Obesity Rises, *Chinese Kids Are Almost as Fat as Americans*,.http://blogs.wsj.com/chinarealtime/2014/05/29/as-obesity-rises-chinese-kids-are-almost-as-fat-as-americans/

Liu Honghua. Screen time and obesity of children [J]. 2013. Chinese Journal of Practical Pediatrics, 28(12): 946-947.

Li Chengcheng. “Catering emerging body strength: the rapid expansion of Chinese fast food”. Entrepreneurs Daily, 02. Sep. 2013. 07

Maffeis, C., Talamini, G., & Tato, L. (1998). Influence of diet, physical activity and parents’ obesity on children’s adiposity: a four-year longitudinal study.International Journal of Obesity & Related Metabolic Disorders, 22(8).

Mendoza, J. A., Zimmerman, F. J., & Christakis, D. A. (2007). Television viewing, computer use, obesity, and adiposity in US preschool children.International Journal of Behavioral Nutrition and Physical Activity, 4(1), 44.

Ng, M., Fleming, T., Robinson, M., Thomson, B., Graetz, N., Margono, C., ... & Abraham, J. P. (2014). Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the Global Burden of Disease Study 2013. The Lancet, 384(9945), 766-781.

Qian Miaozhen. 2012. An analysis of sedentary behaviors (i.e. television viewing) and neighborhood factors in relation to overweight、obesity among 4-6th grade of primary students in Macau[D]. Guangzhou Sport University.

Schneider, H. J., Friedrich, N., Klotsche, J., Pieper, L., Nauck, M., John, U., ... & Silber, S. (2010). The predictive value of different measures of obesity for incident cardiovascular events and mortality. The Journal of Clinical Endocrinology & Metabolism, 95(4), 1777-1785.

Wang, N., Xu, F., Zheng, L. Q., Zhang, X. G., Li, Y., Sun, G. Z., ... & Sun, Y. X. (2012). Effects of television viewing on body fatness among Chinese children and adolescents. Chinese medical journal, 125(8), 1500-1503.

Wu Jian,2011,A report on the development of young people's physical fitness in China,Teachers Journal

Zhu Jianhong, “Chinese economy is the world's miracle”, *People's Daily Newspaper*, 21.Nov.2013.

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