THE IMPACT OF FAMILY STRUCTURE AND FAMILY INCOME ON CHILD PHYSICAL HEALTH IN CHINA

Mr. Baode Zhao

A Thesis Submitted in Partial Fulfillment of the Requirements

for the Degree of Master of Science in Health Economics and Health

Care Management

Common Course

FACULTY OF ECONOMICS

Chulalongkorn University

Academic Year 2019

ผลกระทบของโครงสร้างครอบครัวและรายได้ครัวเรือนต่อสุขภาพกายของเด็กในประเทศจีน

นายเบาเตอ จาว

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต

สาขาวิชาเศรษฐศาสตร์สาธารณสุขและการจัดการบริการสุขภาพ ไม่สังกัดภาควิชา/เทียบเท่า

คณะเศรษฐศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย

ปีการศึกษา 2562

Thesis Title	THE IMPACT OF FAMILY STRUCTURE AND FAMILY INCOME ON CHILD PHYSICAL HEALTH IN CHINA
By	Mr. Baode Zhao
Field of Study	Health Economics and Health Care Management
Thesis Advisor	Associate Professor KANNIKA DAMRONGPLASIT, Ph.D.

Accepted by the FACULTY OF ECONOMICS, Chulalongkorn University in Partial Fulfillment of the Requirement for the Master of Science

.... Dean of the FACULTY OF ECONOMICS
(Associate Professor SITTIDAJ PONGKIJVORASIN, Ph.D.)

THESIS COMMITTEE

.... Chairman
(Assistant Professor TOUCHANUN KOMONPAISARN, Ph.D.)

.... Thesis Advisor
(Associate Professor KANNIKA DAMRONGPLASIT, Ph.D.)

.... External Examiner
(Assistant Professor Dusanee Kesavayuth, Ph.D.)

เบาเตอ จาว : ผลกระทบของโครงสร้างครอบครัวและรายได้ครัวเรือนต่อสุขภาพกายของเด็กในประเทศจีน . (THE IMPACT OF FAMILY STRUCTURE AND FAMILY INCOME ON CHILD PHYSICAL HEALTH IN CHINA) อ.ที่ปรึกษาหลัก : กรรณิการ์ ดำรงค์พลาสิทธิ์

บทความนี้มีวัตถุประสงค์เพื่อศึกษาความสัมพันธ์ระหว่างสุขภาพของเด็กกับรายได้และโครงสร้างของครอบครัว โดยใช้ส่วนสูงตามเกณฑ์อายุ (HAZ) เป็นหลัก และการที่เด็กมีอาการป่วยหรือไม่ป่วยในช่วงเวลาสี่สัปดาห์ที่ผ่านมา (ILL) เป็นตัวบ่งชี้ในการวัดสุขภาพร่างกายของเด็กตัวแปรอธิบายหลัก คือ รายได้ของครอบครัวและโครงสร้างของครอบครัว ในส่วนของโครงสร้างครอบครัวเรามุ่งเน้นไปยังกลุ่มครอบครัวที่มีพ่อหรือแม่เลี้ยงเดี่ยวเป็นหลัก นอกจากนี้แล้วยังมีการสำรวจปัจจัยอื่น ๆ ที่มีผลต่อสุขภาพของเด็ก เช่น ปัจจัยทางประชากร ปัจจัยทางสังคมและปัจจัยทางเศรษฐศาสตร์ การวิจัยนี้เชื่อมโยงสุขภาพร่างกายของเด็กกับรายได้ครอบครัวและโครงสร้างของครอบครัว และพยายามที่จะศึกษาถึงปัจจัยที่ส่งผลต่อสุขภาพร่างกายของเด็กจากมุมมองของครอบครัวข้อมูลที่ใช้ในการวิจัยนี้เป็นข้อมูลทุติยภูมิ จากฐานข้อมูลแบบเปิดของมหาวิทยาลัยปักกิ่งที่มีชื่อว่า ข้อมูลตัดขวางทางยาวของครอบครัวในประเทศจีน China Family Panel Studies (CFPS) การวิจัยนี้ใช้ข้อมูลตัดขวางจาก CFPS2016 หลังจากการจัดการข้อมูลแล้ว จำนวนเด็กทั้งหมดในกลุ่มตัวอย่างคือ 4,513 คน งานวิจัยนี้ใช้แบบจำลองการวิเคราะห์ถดถอยเชิงเส้นแบบพหุคูณ (OLS) เพื่อศึกษาความสัมพันธ์ระหว่างสุขภาพร่างกายของเด็ก (ในระยะยาว) กับรายได้ครอบครัวและโครงสร้างของครอบครัว และใช้การวิเคราะห์แบบสมการถดถอยโลจิสติคเพื่อวิจัยความสัมพันธ์ระหว่างสุขภาพร่างกายของเด็ก (ในระยะสั้น) กับรายได้ครอบครัวและโครงสร้างของครอบครัว ในการวิจัยนี้มีการทดสอบสมมติฐานว่าแต่ละตัวแปรมีนัยสำคัญทางสถิติหรือไม่โดยใช้ค่า P ที่ระดับนัยสำคัญที่ 10% และค่าความเชื่อมั่นที่ 90%จากผลการวิจัยนี้ โครงสร้างครอบครัวมีผลต่อค่า HAZ อย่างมีนัยสำคัญ และพบว่าเด็กที่อยู่ในครอบครัวพ่อเลี้ยงเดี่ยวมีสุขภาพร่างกายที่ด้อยกว่าเด็กที่อยู่ในครอบครัวที่มีพ่อแม่ครบถ้วนอย่างมีนัยสำคัญ รายได้ของครอบครัวมีผลเชิงบวกต่อสุขภาพของเด็ก โดยพบว่ารายได้ของครอบครัวยิ่งสูงจะทำให้ค่า HAZ สูงขึ้นตามไปด้วย สุขภาพของเด็กในระยะสั้นไม่มีความสัมพันธ์อย่างมีนัยสำคัญกับโครงสร้างครอบครัวและรายได้ของครอบครัว ผลการวิจัยเหล่านี้สามารถให้ข้อมูลที่มีประโยชน์ที่เกี่ยวข้องกับสุขภาพร่างกายของเด็ก โดยเฉพาะอย่างยิ่งทำให้ตระหนักว่าครอบครัวบางประเภทควรที่จะได้รับความสนใจเป็นพิเศษเพื่อช่วยสร้างเสริมสุขภาพของเด็กให้ดีขึ้น

สาขาวิชา	เศรษฐศาสตร์สาธารณสุขและการจัดการบริการสุขภาพ	ลายมือชื่อนิสิต ....
ปีการศึกษา	2562	ลายมือชื่อ อ.ที่ปรึกษาหลัก ....

6284138429 : MAJOR HEALTH ECONOMICS AND HEALTH CARE MANAGEMENT
KEYWORD: Family Income, Family Structure, Child physical health, HAZ

The purpose of this article is to study the relationship between child health and family income and family structure. The main use of the Height-for-Age Z score (HAZ) indicator and whether the child has been sick in the past four weeks (Ill) is used as an indicator to measure children's physical health. The main explanatory variables are family income and family structure. In terms of family structure, we mainly focus on the special group of single-parent families. In addition, it also explores other factors that affect children's health, such as demographic factors, sociological factors, and economic factors. This research will link children's health with family income and family structure, trying to explore the influencing factors and paths of children's physical health from the perspective of family.

The data used in this research is secondary data from the Peking University Open Database. Its name is the China Family Panel Studies (CFPS). This study uses CFPS2016 cross-sectional data. After data clean, the sample comprised 4,513 children. Multiple linear regression models (OLS) are used to study the relationship between child health (long-term) and family income and family structure and the Binary logit regression is used to study the relationship between child health (short-term) and family income and family structure. The significance of variables was tested at a P-value of 10 percent and 90 percent Confidence interval.

The results of the study found that family structure has a significant effect on the HAZ value, and children from single-father parent families have significant disadvantages compared to children from the dual-parent family. The impact of family income on children's health is positive, the higher the family income, the greater the HAZ value. Short-term child health has no significant correlation with family structure and family income. The results can help to provide some useful information in particular special attention can be given to certain family types to improve the health of children.

Field of Study:	Health Economics and Health Care Management	Student's Signature ....
Academic Year:	2019	Advisor's Signature ....

ACKNOWLEDGEMENTS

Knowledge is wealth. Through a one-year study of Health Economics and Health Care Management at Chulalongkorn University's Faculty of Economics, I not only gained knowledge but also enhanced my learning ability. Time always slips away from your fingertips inadvertently, and in a blink of an eye I will graduate, and everything seems to have happened yesterday. This paper is shown to you as a result of my phased study, although it is not perfect.

First of all, I will give all the glory to God I trust. The fear of the Lord is the beginning of wisdom and thank him for the wisdom he has given me. At the same time, I would also like to thank my thesis advisor, professor Kannika Damrongplasit, for her careful guidance. She always helps me every time I encounter a problem that I cannot solve. Thanks to her patience, every discussion never stopped because of my lack of language communication skills. She always tried her best to use the simplest words to let me understand those difficult models. She always smiles at me; she always encourages me. Professor Kanika's guidance on my thesis and the step-by-step problem-solving process will become the most valuable asset and experience in my life.

Second, I would like to thank every member of my defense committee, and thank you for your valuable comments and suggestions for me. Thank you for taking the time to read my article, thank you very much for your contribution, and I will remember it in my heart. At the same time, I also want to thank every teacher in the health economics and health management project team for their teaching and help. This is very helpful to my study because they provide a theoretical basis for me to write this article.

Finally, I want to thank my parents and the teachers at the School of Health Management of Inner Mongolia Medical University. My parents provided financial support for my study, and the teachers at the School of Health Management provided me with the opportunity to study abroad. I would also like to thank Professor Chunni Zhang from the School of Social Sciences at Peking University and Professor Rong Zhu from the College of Business, Government, and Law Flinders University in Australia, both of whom are researchers in child health. Thank them for their answers to my questions.

I sincerely wish every teacher I met in my study career who helped and taught me is healthy and happy. Finally, I share a sentence to encourage everyone: rejoice in hope, to be patient in tribulation.

Baode Zhao

TABLE OF CONTENTS

Page

LIST OF TABLES

Page

LIST OF FIGURES

Page

ABBREVIATIONS

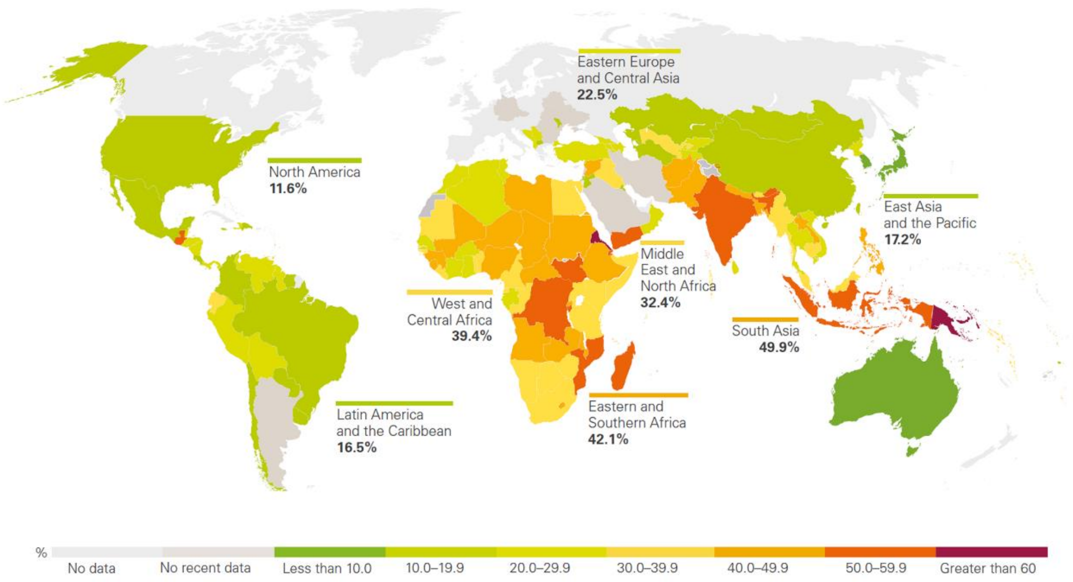
OLS	Ordinary Least Squares
CFPS	China Family Panel Studies
UNICEF	United Nations International Children's Emergency Fund
UN	United Nations
CDRF	China Development Research Foundation
WHO	World Health Organization
HAZ	Height-for-Age-Z score
GDP	Gross Domestic Product
GNP	Gross National Income
OECD	Organization for Economic Co-operation and Development

CHAPTER I. INTRODUCTION

1.1 Problem and Significance

Children are our future, and children are the hope of our entire human society. Children's health is one of the most important issues in the process of children's growth and development. However, as shown in Figure 1, by the end of 2019, one third of children under the age of five in the world are still suffering from nutrition problems, and they cannot get enough nutrition to ensure their healthy growth (UNICEF, 2019). Every five seconds around the world, a child under the age of 15 dies (UNICEF, 2019). Today in the 21st century, children's health problems are mainly manifested in growth retardation, lack of necessary vitamins and minerals (also known as "invisible hunger") and overweight; data shows that in 2018, nearly 200 million children under the age of five are stunted or emaciated, at least 340 million children under the age of five suffer from hidden hunger, and from 2000 to 2016, the proportion of overweight children aged 5-19 and young people increased from one tenth to one fifth (UNICEF, 2019). These statistics show that children's health problems greatly restrict their healthy growth, which not only affects the development of each individual child, but also affects the economic growth and development of each family, society, and country.

Figure 1 Prevalence of children under 5 who are not growing well (stunted, wasted, or overweight), 2018

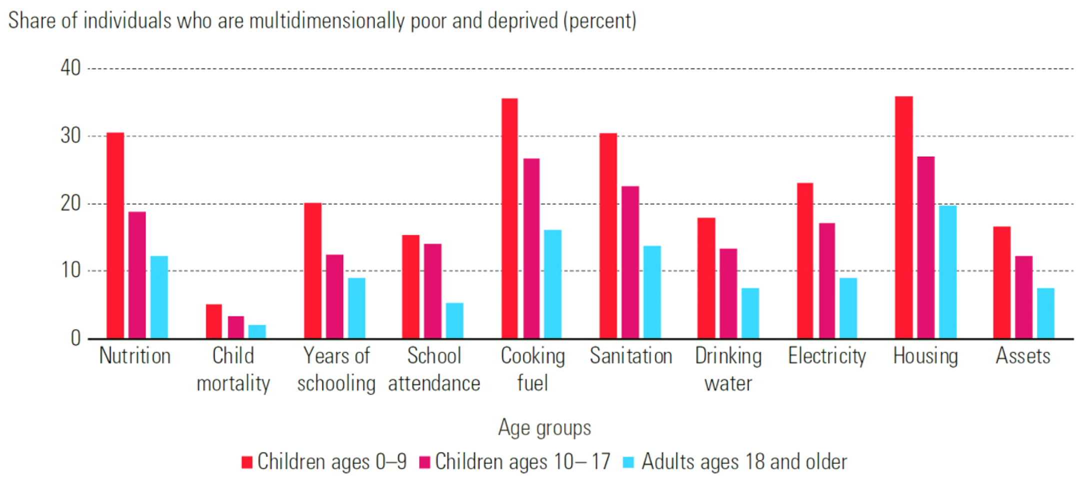


Note: Country data are the most recent available estimate between 2006 and 2018; where only data prior to 2000 are available, the dark grey color denoting no recent data is used. The designations employed in this publication and the presentation of the material do not imply on the part of the United Nations Children's Fund (UNICEF) the expression of any opinion whatsoever concerning the legal status of any country or territory, or of its authorities or the delimitations of its frontiers.
Source: UNICEF analysis of UNICEF/World Health Organization/World Bank Group Joint Malnutrition Estimates, 2019 edition. Levels and trends in child malnutrition: Key findings of the 2019 edition of the Joint Child Malnutrition Estimates.

Under nutrition of children will lead to growth retardation and low weight of children and increase the risk of chronic diseases of newborns in adulthood. However, hidden hunger will cause damage to both children's and women's health. For example, lack of iron will lead to the decline of children's learning ability, and iron deficiency anemia will increase the risk of maternal death during childbirth or after childbirth. Obesity in children leads to an increased risk of early onset type two diabetes, low self-esteem or depression (UNICEF, 2019). Because the impact of children's health problems is bad, we must pay the greatest attention to children's health problems and devote ourselves to the research of influencing factors related to children's health.

There are many reasons for these problems. With the prosperity and development of the world economy and the acceleration of urbanization and industrialization, more and more people have changed their original lifestyle and habits. A large number of processed foods with high calorie and low nutrition have been selected by people. These behaviors have led to the decline of people's health level, especially children; according to the data in the report "the state of the world's children 2019" released by the United Nations Children's fund, many school-age adolescents eat over processed products, 42% of them drink carbonated drinks at least once a day, 46% of them eat fast food at least once a week. Unhealthy food systems and risky health behaviors lead to obesity and overweight, while the causes of growth retardation and hidden hunger are poverty. As a result of poverty, children cannot get the normal growth environment and normal food intake. According to the report of "Global Multidimensional Poverty Index" (Alkire, Kanagaratnam, & Suppa, 2019) released by the United Nations Development Agency, in 2019, there are 1.3 billion people in the world in a "multidimensional poverty state". There are huge differences among countries and different regions within each country. The poverty phenomenon spreads all over the world, and children bear the biggest burden. Of the 1.3 billion poor people, about 663 million are under the age of 18—and 428 million of them (32.3 percent) are under age 10 (see Figure 2). In China, as of 2016, there are 43.35 million poor people in china, 20% of whom are children (0-15 years old) (CDRF, 2017).

Figure 2 A higher proportion of children than of adults are multidimensionally poor, and the youngest children bear the greatest burden



Note: Data are from surveys conducted between 2007 and 2018.
Source: Alkire, Kanagaratnam and Suppa (2019) based on Human Development Report Office and Oxford Poverty and Human Development Initiative calculations.

Human capital theory (Schultz, 1990) emphasizes that human capital consists of health, knowledge, skills and work experience. Human capital is an important part of social production, and children are an important part of human capital. Every adult has to go through the children's stage before becoming a social labor force. Health is an important part of human capital. Everyone has a certain amount of health stock from the beginning of birth. This stock is innate, and with the growth of age, the health stock will continue to decrease, but people can increase its stock through health investment (Grossman, 2017). Investing in the health of women, children and adolescents generates at least ten times the return on better academic performance, labor force participation and social contribution, generating a demographic dividend of at least $100 billion (Kuruvilla et al., 2016).

For every family, from the formation to the disintegration of the family, it has to go through a complete family life cycle (Glick, 1947). The healthy growth of children is the most important stage for every family (family with children) during the period of family expansion and stability. The core of family is children. Children's health is related to the development of the whole family, and the development of each family affects the development of society. In Chinese culture, family is one of the most important components. It is of practical significance to study the impact of family income and family structure on children's health. Through this research, we can find out whether different family income level and different family structure have different effects on children's health. Furthermore, we can also discover other socioeconomic and demographic factors also impact children’s health in China.

1.2 Research Question

How does family structure and family income affect child health in China?

1.3 Research Objectives

1. To study the effect of family structure on child health in China.
2. To assess the impact of family income on child health in China.
3. To find the impact of other child, parental and family characteristics on child health in China.

1.4 Hypothesis

1. High family income should have statistically positive effect on children’s health in China.

2. Single-parent family should lead to statistically worse child’s health than dual-parent family.
3. Children’s health in the single-father families and single-mother families should be significantly different.
4. Children’s health should be significantly different for those who receive additional care from other people.
5. Child’s Health in urban and rural should be significantly different.

1.5 Scope of the Study

This study uses the data of China's family tracking survey (CFPS) in 2016 and this is secondary data, which was officially started in 2010 by Peking University. The data sample covers 25 provinces (autonomous regions) representing 95% of China's population. Since 2010, in 2012, 2014 and 2016, three more follow-up surveys have been conducted on the samples. This study uses cross-sectional data from the 2016 survey. The 2016 survey data covered 8,427 children, 36,892 adults and 14,019 families.

For the children section, the object of the survey is children aged 0-15. In this research, our sample will also cover children aged under 15 years old. We divided children into three different age groups, 0-5 years old, 6-10 years old, and 11-15 years old. The child's physical health level Height-for-Age-Z score (HAZ) is used as a measure of child health. This study focused on child health and used CFPS 2016 cross-sectional data, with a total of 4,513 complete child samples.

1.6 Possible Benefits

This study focuses on the impact of children's family situation on children's health, mainly from the perspective of family income and family structure to explore the impact of family level factors on children's health. This study will reveal the relationship between family income and children's health, as well as the relationship between family structure and children's health. Especially in the aspect of family structure, this study will focus on the special group of "single parent family" and explore the impact of single parent family on children's health. It can also show whether different factors such as gender, age, nationality, and region have any influence on children's health, which extends the scope and depth of academic circles on the topic of factors affecting children's health.

Children's health has always been a topic of concern for the government and its relevant agencies. Policy makers will get some potential suggestions from this study, to help children develop healthily, improve children's health level, and pay more attention to special groups like single parent families that really need to be concerned. The government can then direct appropriate policy to certain family type or family with certain socioeconomic status in order to properly foster children's health.

CHAPTER II. BACKGROUND

2.1 General Information About China

China is the most populous country in the world. By the end of 2017, the total population of China was 1.386 billion, accounting for about one fifth of the world's population. In 1953, China's population was only 583 million. In the past 64 years, China's population has increased 1.38 times (Yearbook, 2017).

China is a unified multi-ethnic country. There are 56 ethnic groups in China, with the largest number of Han people, accounting for 91.5% of the total population, and other ethnic groups accounting for 8.5% of the total population (Yearbook, 2017).

China is divided into 23 provinces, 5 autonomous regions (Inner Mongolia, Guangxi, Ningxia, Xinjiang, Tibet), 4 municipalities (Beijing, Tianjin, Shanghai, Chongqing) and 2 special administrative regions (Hong Kong, Macao).

China is geographically divided into Eastern regions (11 provinces / municipalities directly under the central government, including Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan), Middle regions (8 provinces, including Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei and Hunan), Western regions (12 provinces / autonomous regions / municipalities directly under the central government, including Inner Mongolia , Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang) as show in Figure 3. It is worth noting that there are great differences in economy between the East, the middle, and the west, especially between the East and the West.

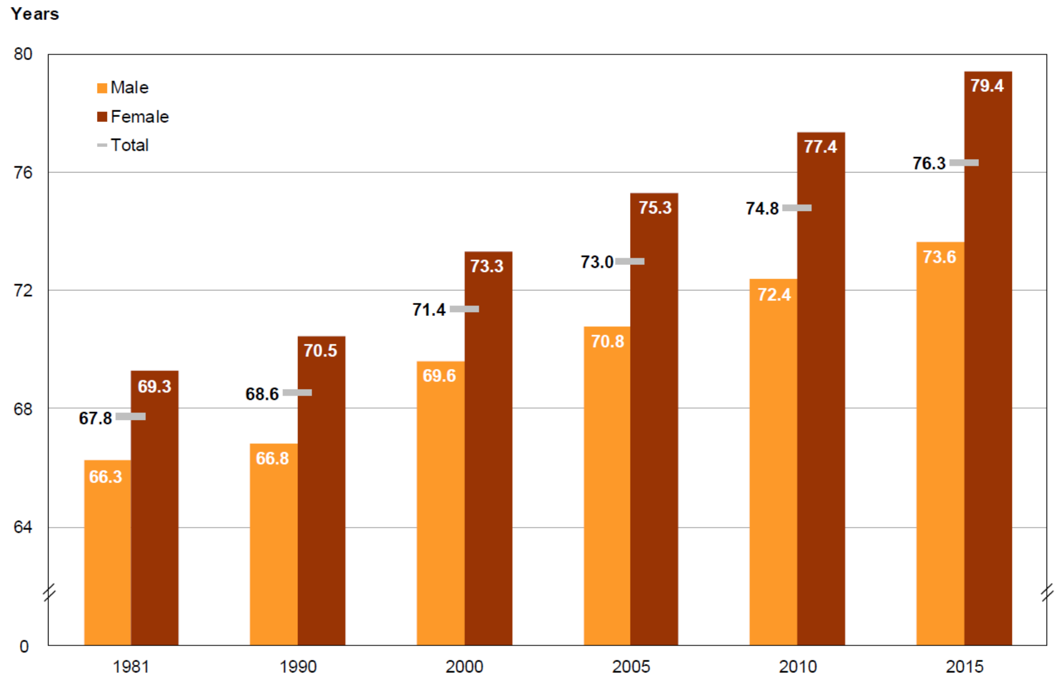
Figure 3 Geographic regions of China

Source: National Bureau of Statistics

According to the National Health Commission (formerly the Ministry of Health), the average life expectancy at birth was only 35 years in 1949, when the People's Republic of China was founded. By 2015, this had risen to 76 years. Figure 4 shows the life expectancy between 1981 and 2015, life expectancy increased by 10 years for men and

7 years for women. Average life expectancy at birth in China is higher than many other countries with a similar Gross National Income (GNI) per capita.

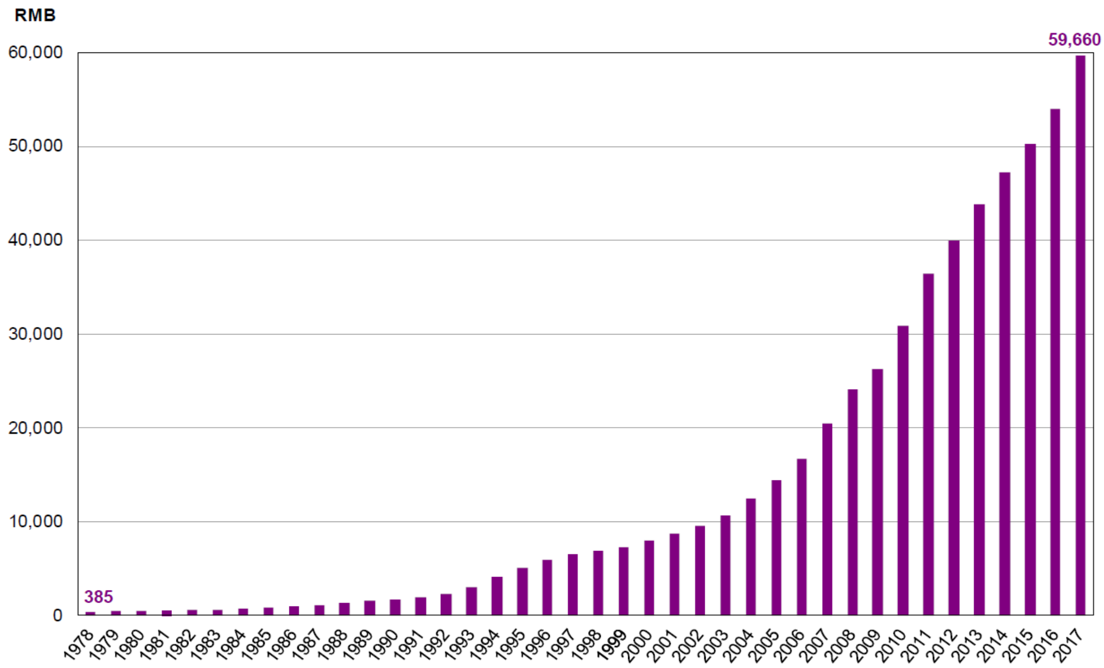
Figure 4 Life expectancy at birth in China, 1981–2015



Source: National Bureau of Statistics, 1982, 1990, 2000, and 2010 Tabulation on the Population Census of China (respectively published in 1985, 1993, 2002 and 2012); 2005 and 2015 Tabulation on the 1% National Population Sample Survey (respectively published in 2007 and 2016)

Since the implementation of "Economic Reform and open up" in 1978, China's economic development has been rapid. Figure 5 shows from the per capita GDP of 385 yuan (156 US dollars) in 1978 to 59,660 yuan (8830 US dollars) in 2017 (Yearbook, 2017) and the per capita GDP of 2019 has exceeded 10000 US dollars.

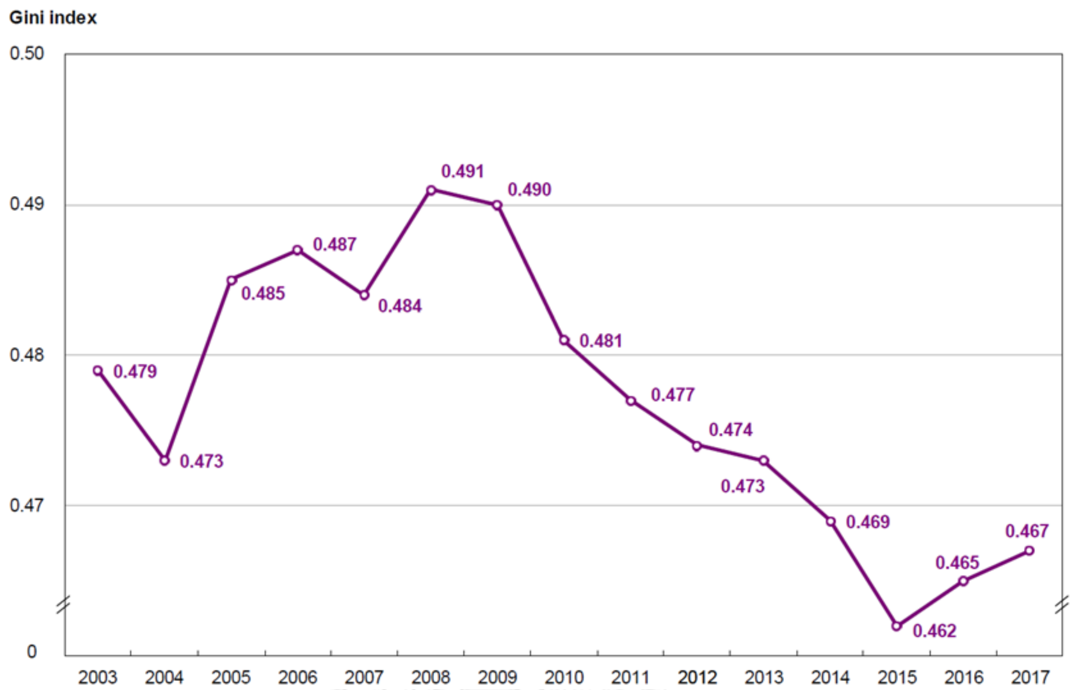
Figure 5 GDP per capita, 1978–2017



Source: National Bureau of Statistics, China Statistical Yearbook, 2018

With the rapid development of economy, there are also some problems. Due to the long-term implementation of the household registration system of urban and rural separate management in China, the urban-rural dual structure has been formed. This also makes the urban and rural areas show unbalanced development in the process of economic development. Although the government has cancelled the distinction between agricultural and non-agricultural households in 2014 and established a unified urban and rural household registration system, the difference still exists. As show in Figure 6, According to the statistics released by the National Bureau of statistics in 2017, from 2008 to 2017, China's Gini coefficient is between 0.462 and 0.491.

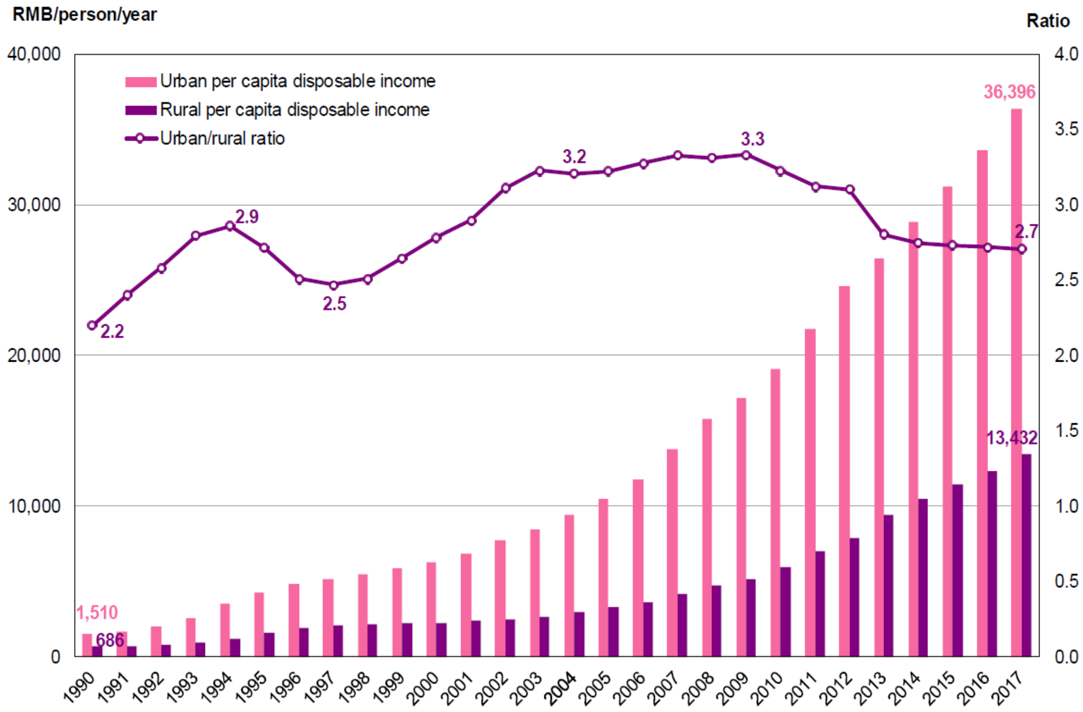
Figure 6 **National Gini index, 2003–2017**



Note: The Gini coefficient is usually used to measure the gap between the rich and the poor. If the Gini coefficient is equal to 0, it means that the income distribution is completely equal. If the Gini coefficient is equal to 1, it means that the income distribution is completely unequal.
Source: National Bureau of Statistics, China Yearbook of Household Survey, 2018

The Figure 7 shows between 1990 and 2009, the difference between the per capita disposable income of urban residents and the disposable income of rural residents increased from 2.2 to 3.3. After 2010, the income growth of rural residents exceeded that of urban residents, but until 2017, the difference between them was still 2.7 times (Yearbook, 2017).

Figure 7 Per capita disposable income, by urban-rural, 1990-2017



Source: National Bureau of Statistics, China Statistical Abstract, 2018

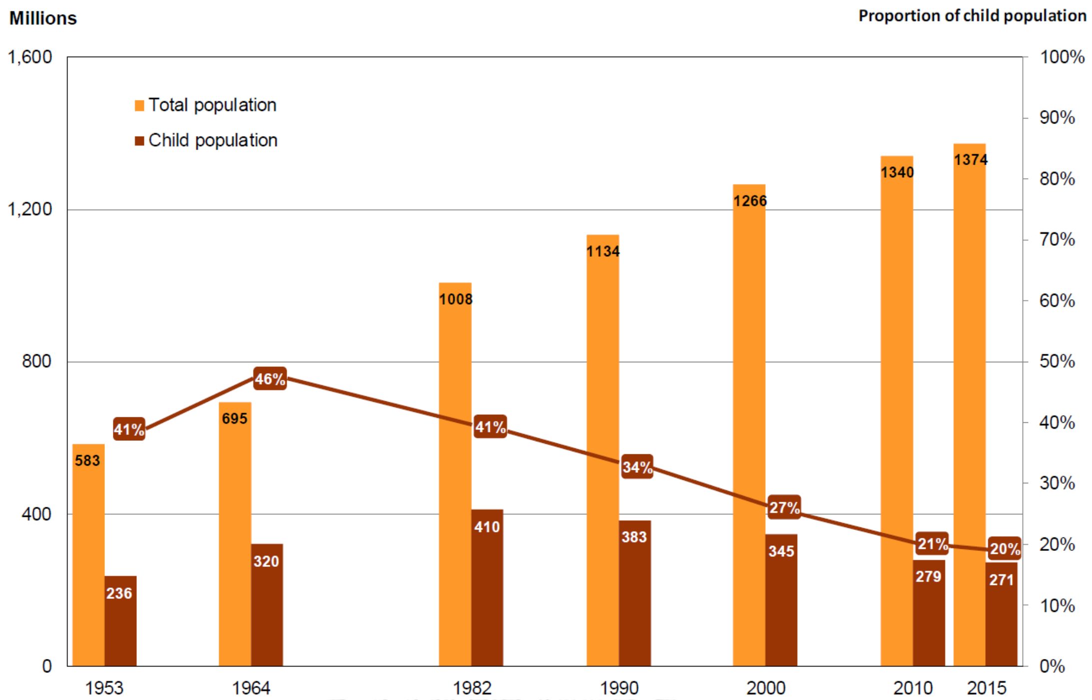
The per capita disposable income of urban population is higher than that of rural population. The per capita disposable income of urban and rural population in the eastern region is higher than that in the central and western regions. However, the per capita income of the population in the western region is still very different from that in the eastern region.

Poverty is an important cause of children's health problems, and income is an important indicator to measure poverty. According to the relevant data released by the National Bureau of statistics in 2017, although the incidence of poverty in China's rural areas is decreasing year by year, by the end of 2017, the incidence of poverty in China's rural areas is 3.1%, while 53.6% of the poor are concentrated in the western region of China. Among the population living in poverty-stricken areas, the incidence of poverty among children aged 0-17 is 3.9%, which shows that the incidence of children's poverty is higher than that of adults, and poverty has a greater impact on children. Many gaps in human development begin in childhood, and the deprivation and deprivation experienced in childhood may continue to affect the whole life. Therefore, the health problems caused by children's economic poverty are worthy of our study and discussion.

2.2 Children's Health Development in China

The Figure 8 shows the total population of 0-17 years old children in China is 271 million in 2015, of which 147 million are boys, accounting for 54% of the total, and 124 million are girls, accounting for 46% of the total. Children account for 20% of China's total population and 13% of the world's total. The number of children in China is affected by national policy. Since the implementation of the "family planning" policy in 1980, a couple has been allowed to have only one child, which led to a decrease in the fertility rate of pregnant women between 1980 and 2015. However, the total child population remained relatively stable from 2010 to 2015. In order to promote the balanced development of the population, the Chinese government officially implemented the "two child policy" in 2015. A couple was recommended to have two children.

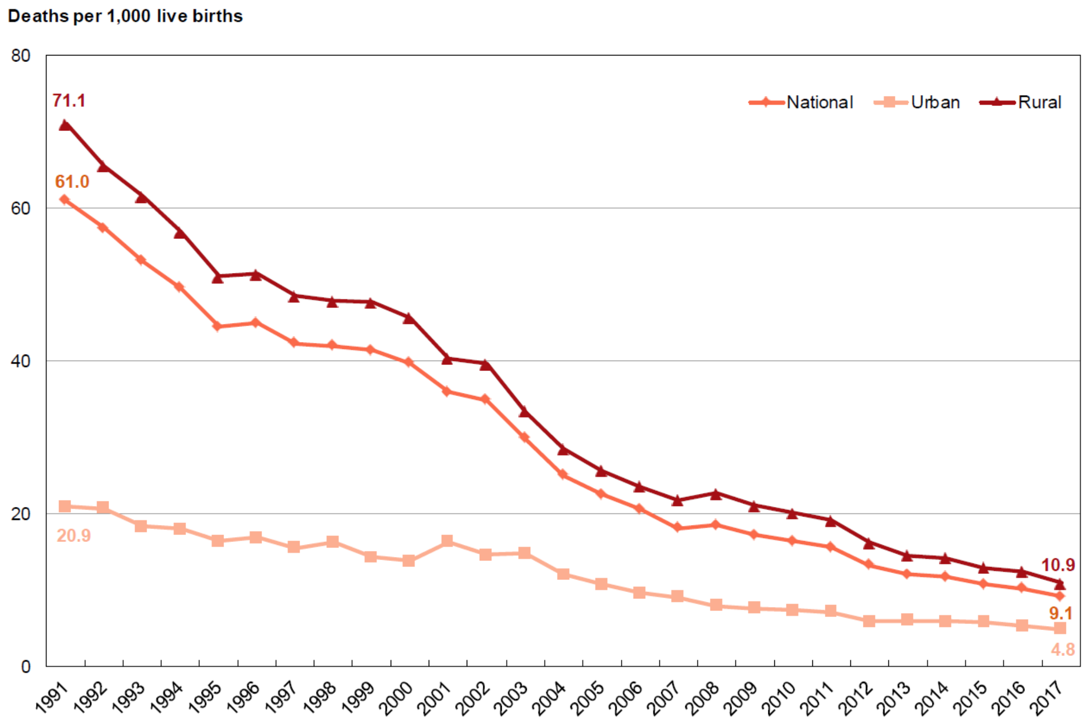
Figure 8 Total population and child population, 1953–2015



Source: National Bureau of Statistics, 1953, 1964, 1982, 1990, 2000 and 2010 Tabulation on the Population Census of China (respectively published in 1955, 1966, 1985, 1993, 2002 and 2012); Tabulation on the 2015 1% National Population Sample Survey, 2016

Due to the progress of science and technology and the vigorous development of economy, the mortality rate of children under five years old in China has been greatly reduced, from 61 ‰ in 1991 to 9.1 ‰ in 2017 (see Figure 9), with an average annual decrease of 7.1 ‰. However, the mortality rate of children under five years old in different regions is still different. The mortality rate of children under five years old in the Middle East with better economic situation is lower than that in the west, and higher in the rural areas than that in the urban areas. In 2017, the mortality rate of children under five years old in the rural areas is 2.3 times of that in the urban areas, close to the income gap between urban and rural areas. There are also gender differences in under five mortality rates, with boys (4.8 per 1000) having a higher mortality rate than girls (4.1 per 1000) (Commission, 2018a).

Figure 9 Under-five mortality rate, 1991–2017



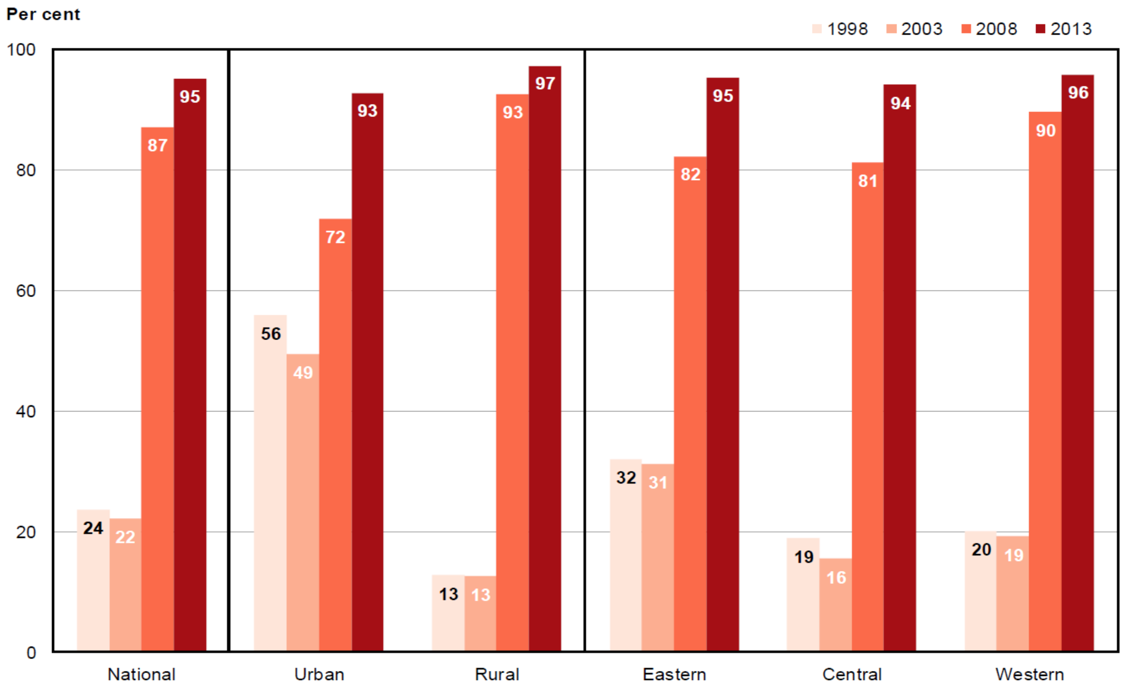
Source: National Health Commission, China Health Statistical Yearbook, 2018

China's children's poverty is the main cause of children's health problems. The Chinese government is actively carrying out poverty alleviation work. However, according to the data released by China Development Research Foundation in 2017, 16.7% of Chinese children (0-15 years old) are below the relative poverty line, with a population of about 40.08 million, including 10.08 million children in absolute income poverty These poor children are mainly distributed in the central and western regions of China. There are about 20 million children aged 0-6, accounting for about 10% of the population in poor areas. The 20 million people are mainly left behind children in rural areas, poor children, and children from single parent families. Most of these families are more likely to fall into the poverty trap and encounter intergenerational transmission of poverty due to the lack of normal parenting, nutrition, and education opportunities (CDRF, 2017).

In 2009, the Chinese government began to carry out the national basic public health service project to improve the health level of the Chinese people. The per capita basic public health service subsidy standard in China has increased from 15 yuan in 2011 to 50 yuan in 2017. The service items included in the basic public health service have also been expanded from the original 9 items to 14 categories (including children's health management, pregnant women's health management and prevention) And so on. However, due to China's large population base, unbalanced urban and rural development, accessibility of health services, fairness and quality of health services are particularly prominent in poor areas. Especially for the vulnerable groups (the elderly, women and children) in some poverty-stricken areas, it is relatively difficult for them to access and enjoy health care services and the quality of health care services they receive is not high (Commission, 2017).

The Figure 10 shows, the coverage rate of new rural cooperative medical assistance and medical insurance for urban and rural residents implemented in China has been increasing. As of 2017, the coverage rate of the two kinds of insurance has reached 95%.

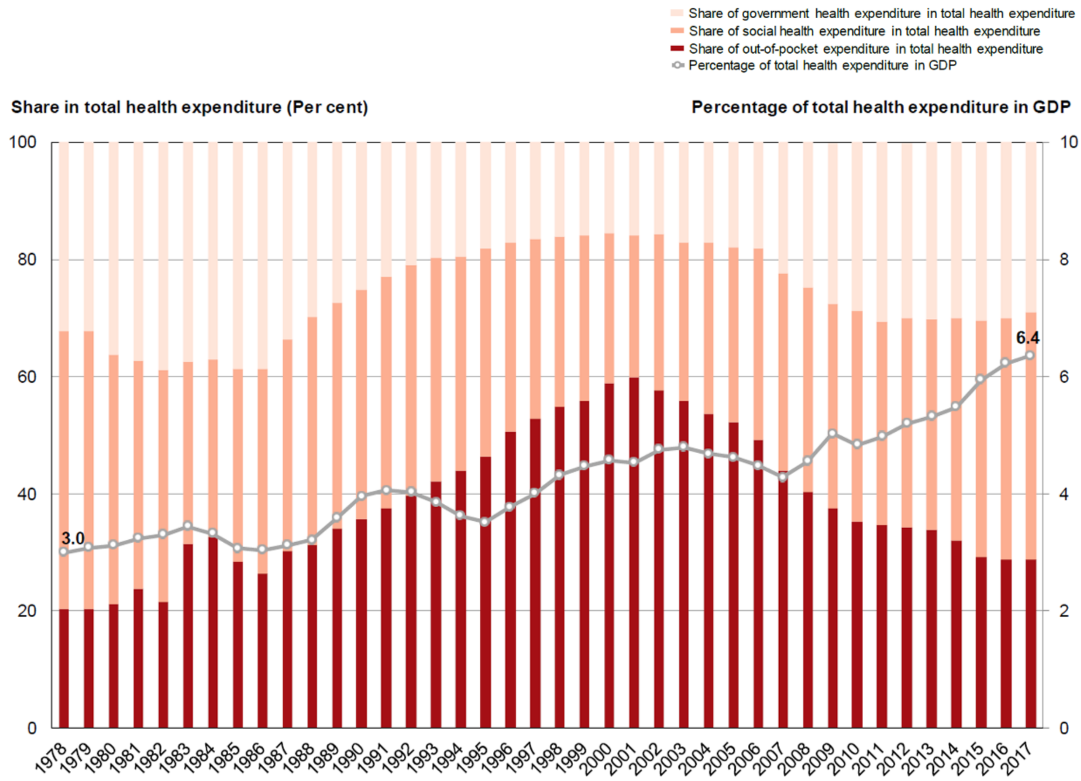
Figure 10 Health insurance coverage, 1998, 2003, 2008 and 2013



Sources: National Health Commission (formerly the National Health and Family Planning Commission), National Health Services Survey, 1998, 2003, 2008 and 2013

However, as show in Figure 11 due to the continuous increase of total health expenses, China's health expenditure as a percentage of GDP rose from 3.0% to 6.4% in 2017. The proportion of individual self-payment has decreased year by year, but as of 2017, the proportion of individual self-payment has still reached 28.8%, which is far more than the WHO recommendation the proportion of self-payment is controlled between 15% and 20%. Due to the large proportion of personal self-payment, the burden of family medical expenses for serious illness increases. Many families who have been out of poverty may return to poverty again because of the burden of medical expenses. Compared with adult children, the insurance coverage rate is lower. According to the results of the Fifth National Health Service Survey in 2013, the insurance coverage rate of newborns in China is only 22%, and that of infants aged 1-11 months is 60.7%. It is these children who are at greater risk of death.

Figure 11 Government, social and out-of-pocket expenditure on health, 1978–2017



Source: National Health Commission, China Health Statistical Yearbook, 2018

In terms of children's nutrition, the main problem facing Chinese children is the double burden of malnutrition and overweight and obesity. In 2017, 22% of the world's children (under five years old) had growth retardation. In China, the growth retardation rate of children under five years old dropped from 33.1% in 1990 to 8.1% in 2013. However, the growth retardation rate of children in poor areas reached 18.7%, 2.3 times of the national average. In addition, the problem of overweight and obesity is also very prominent. As children's energy intake from food exceeds the energy required for normal growth and development, the rate of overweight and obesity in Chinese children has increased year by year. From 2002 to 2012, the overweight rate of children under 6 years old has increased from 6.5% to 8.4%, and the obesity rate has increased from 2.7% to 3.4%. From 2002 to 2012, the overweight rate of boys aged 7-17 increased from 5.1% to 10.9%, and the obesity rate increased from 2.5% to 7.5%. The overweight rate of girls increased from 3.9% to 8%, and the obesity rate increased from 1.7% to 4.6%.

In terms of safeguarding children's rights and healthy development, the Chinese government has been making efforts to formulate and improve a series of policies on children's healthy development. Comply with all contents and provisions of the Convention on the rights of the child (UNICEF, 1989), and formulate a series of laws and plans to guarantee the rights and healthy development of children, including the law on the protection of minors, the law on compulsory education, the law on the prevention of juvenile delinquency, etc. The national vaccine plan, China's children's development program, China's 0-6-year-old children's survival and development strategy and other relevant policies and project plans are designed to ensure the normal growth of children, improve their health level and protect their rights.

2.3 Status of Family Structure in China

Family is the basic unit of the whole society. The health and development of each family member is closely related to the whole family. Children are one of the important members of the family. Healthy and normal family can perform the function of family, play the role of family and promote the development of society and economy. On the contrary, it will bring some bad problems and troubles and hinder the development of society and economy.

With the rapid economic development and social changes, the family structure has also changed a lot. Chinese family has gradually changed from traditional family structure to modern family structure. This change is mainly reflected in family size, family intergenerational structure and family relations. The first is the gradual reduction of family size. The table 1 shows, in 1953, the average size of Chinese families was 4.3, down to 3.00 in 2014, down by 1.3.

Table 1 Average size of Chinese households， 1953-2018

Year	Average family size (number of persons)
1953	4.30
1964	4.29
1982	4.43
1990	3.96
2000	3.44
2010	3.10
2018	3.00

Note： The data for 2018 comes from the China Statistical Yearbook 2019, and the rest comes from the data of the first six censuses. The Chinese census has been conducted six times so far, and every ten years since 1990.
Source: National Bureau of Statistics

The second is the family intergenerational structure and family relations. More and more families present the family structure of one generation (only one generation in the family) and the core family (married couple or family type composed of married couple and children), accounting for about 60% of the total families in China. The number of urban residents (average size of 2.63) is lower than that of rural residents (average size of 2.76), and the proportion of urban family structure core is higher than that of rural areas. Generally speaking, Chinese families show the characteristics of family size miniaturization and family structure core (CFDR, 2016).

In China, the traditional support for children and the elderly is entirely dependent on the family. Although with the continuous development of the society and the improvement of the welfare system, the care function of some families for children and the elderly has been transferred to the society, the data of the 2016 China family development report shows that the family still bears the main care responsibility, 90% of the families have different care needs, and 40% of the families are faced with dual care needs (taking care of both children and the elderly). Faced with the reality that " above are the elderly, below are the young ". At the same time, it is still a common social phenomenon that children are cared for by their grandparents, and there are regional differences in this phenomenon. According to statistics, 0-year-old babies are mainly taken care of by their mothers. 52.1% of children aged 1-5 are mainly taken care of by their mothers or both parents (taken care of by their grandparents). The proportion of fathers participating in children's daily care is relatively low. This problem is particularly prominent among left behind children. Especially in the left behind families where both parents are away, the proportion of alternative care is as high as 96.6% (CFDR, 2016).

The main cause of this problem is population flow. In the 1980s, China began a large-scale population flow. By 2017, the number of floating populations in China increased to 244 million. Although the population flow has made a great contribution to China's economic and social development (it is conducive to increasing the income of rural residents (because most of the floating population comes from rural areas), and narrowing the gap between urban and rural areas), it has a negative impact on the upbringing of children. In 2015, more than one third of China's children were unable to live with their parents for different reasons, with about 95.6 million people (including 40.51 million left behind children in rural areas, 28.26 million left behind children in urban areas, and 18.84 million other children who could not live with their parents). More than a quarter of 0-2-year-olds in the country are cared for by people other than their mothers (China, 2018; Lv, Yan, Duan, & Cheng, 2018; UNICEF, 2016). The lack of parental care, especially the lack of maternal care, is the key factor leading to children's cognitive lag, which is not conducive to children's health and development.

As a special family type, the single-parent family has attracted people's attention. In the international level, some western countries divorce rate rising first and down, as shown in table 2, but in some Asia country like Korea and Japan still have a trend of rising.

Table 2 Compare of Some Countries Divorce Rate

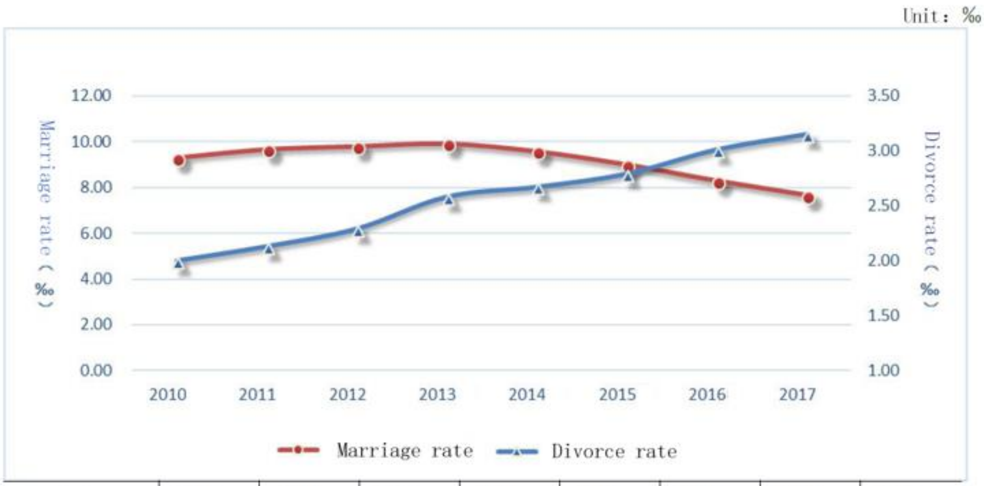
Country	1970	1995	2017	Trend
United States	3.48	4.39	2.90	
United Kingdom	1.00	2.90	1.80	
France		2.10	1.90	
Germany	1.30	2.10	1.90	
Australia	0.98	2.80	2.00	
Korea	0.40	1.50	2.10	
Japan	0.93	1.60	1.70	

Note: This divorce rate is the crude divorce rate (CDR), defined as the number of divorces during the year per 1000 people.

Source: OECD Family Database, Social Policy Division, Directorate of Employment, Labour and Social Affairs

According to the data of 2019 China's child development indicator atlas, among the 95.6 million children who cannot live with their parents, 8 million children from single-parent families account for about 8%. The main reason for single-parent children is the divorce of both parents. Since 2003, the divorce rate in China has continued to rise. In 2017, there were 10.631 million people who went through marriage registration according to law, a decrease of 7% over the previous year. There were 4.374 million people who went through divorce procedures according to law, an increase of 3.2% over the previous year (see Figure 12). The dissolution of the marriage between parents has a great impact on children, especially in terms of health (Yearbook, 2018).

Figure 12 Marriage and divorce rates in China, 2010-2017



Index	2010	2011	2012	2013	2014	2015	2016	2017
Marriage rate	9. 3	9. 7	9. 8	9. 9	9. 6	9. 0	8. 3	7. 7
Divorce rate	2. 0	2. 1	2. 3	2. 6	2. 7	2. 8	3. 0	3. 2

Source: Statistical Communiqué on Social Service Development 2017, Ministry of Civil Affairs of China

CHAPTER III. LITERATURE REVIEW

3.1 Child Health

3.1.1 Health

When it comes to health, we have to mention disease. In ancient times, people attributed health and disease to the gift and punishment of gods due to the limited cognition. After the occurrence of the disease, people will not seek medical and health care, but rely on the treatment of the disease to eliminate the "God of plague", which is the earliest knowledge about health (Kun, 2018). After entering the slavery society, with the continuous improvement of human's understanding of nature, people gradually try to explain diseases with the materials and phenomena of nature, and gradually form the natural philosophy medical mode (medical mode is a logic thinking mode of people for health, disease, death and other medical problems). Thanks to the review of literature and art and the industrial revolution in Europe, scientific progress has been promoted. At the same time, people's concept of health and disease has changed. People think that human is a special machine. The cause of the disease is that the parts inside the machine have problems. As long as the parts in question are replaced, the machine can be restored to normal, then to a healthy state. This theory is called mechanistic medical model. This theory introduces empirical medicine into experimental medicine, but it ignores the social and biological attributes of human beings. We need to know that machinery has no emotion. The biggest difference between human beings and animals is that they can make and use tools (Howard, Howard, & King, 1988) and have deeper emotional and social attributes. After that, basic disciplines such as anatomy, physiology and pathology developed continuously, and gradually formed a biomedical model. Health is the balance between human body, environment and etiology. Once the balance is broken, people will enter the disease state (Tavakoli, 2009) people have solved many diseases with this view, but this view still only focuses on human physical health and ignores mental health and social health. Simply solving human physical health problems cannot solve all disease problems. Some diseases are caused by psychological and social aspects.

With the continuous development of psychology, people pay more and more attention to mental health and social health, and the bio psychosocial medical model has been proposed (Engel, 1977). The World Health Organization defines health as: health is not only a state without disease and weakness, but also a comprehensive performance of physical, mental and social health, including physical, mental and social health (Organization, 1995).

3.1.2 Measure of Child Health

In 1989, the United Nations promulgated the Convention on the rights of the child. In the first part of the Convention on the rights of the child, Article 1 clearly states that a child refers to anyone under the age of 18. According to Article 2 of Chapter I of the law of the people's Republic of China on the protection of minors, minors refer to citizens under the age of 18. Article 240 and 241 of the criminal law of the people's Republic of China stipulate that children refer to people under the age of 14, among which those under the age of one are infants, and those over the age of one and under the age of six are preschool (the Supreme People's Court of the people's Republic of China, 2017). The second article of "China's regulations on the protection of children's personal information network" points out that the children referred to in the regulations are minors under the age of 14.

In past studies on children's health, children were aged 0-15 years (Currie, Shields, & Price, 2007; Shuangyue, 2018) and 0-18 years (Apouey & Geoffard, 2013; Goode, Mavromaras, & zhu, 2014; Khanam, Nghiem, & Connelly, 2009; Ma Zhe, 2016; Reinhold & Jürges, 2012; Sun Yu, 2014; F. Wang, 2010). There are also some scholars who cut off children in the 0-3 age group in the research process and take children aged 4-17 as the research object, because children in the 0-3 age group cannot prove the relationship between income and health due to a variety of complex factors. However, to sum up, the age of children is mainly limited by the data used (because most scholars use secondary data) and specific research content. The secondary data used in this paper is from the 2016 family tracking survey (CFPS, 2016) of Peking University. Due to the data limitation, the subjects are children aged 0-15 years old.

How to measure and evaluate children's health is a matter worthy of our discussion. According to the WHO definition of health, health is divided into three parts: physical health, mental health and social health. Height (Li Chen, 2010; Xinxin Zhang, 2015; Zaiyu, 2009; H. Zhang, 2013), Weight (Gao et al., 2010; H. Zhang, 2013), overweight or obesity rate (De Brauw, 2011; Gao et al., 2010; H. Zhang, 2013), body mass index (BMI) (Qiang Li, 2011; Zhongshuai Li, 2014), four week prevalence (Qiang Li, 2011; Zhongshuai Li, 2014), self-reported health (Mao & Zhao, 2012; Wen, 2015) and child growth and development standards (WHO, 2008) were used as indicators to measure children's health. Children's growth and development indicators will be introduced and discussed in detail later. The methods of measuring children 's physical health can be divided into two categories: subjective evaluation and objective measurement.

Objective measurement is to measure children's health according to their height, weight, and other anthropometric indicators. Subjective evaluation is children's self-reported health, generally divided into 3-5 levels. But sometimes it is exiting bias (Goode et al., 2014).

In terms of mental health, some mental health scales are used to measure children's mental health status. The commonly used indicators are depression, loneliness, social anxiety, self-esteem and personality questionnaire and mental health test as the main indicators (Hao Zhou, 2011; He et al., 2012; Hu, Lu, & Huang, 2014; Jing Wang, 2016; Miaomiao Zhao, 2012).According to the sum of each part of the questionnaire, the final score of each research object is obtained, and whether children have mental health problems is judged according to the standard.

The measurement method of social health is similar to that of mental health, but the main indicators of children's social health are children's learning ability test, social ability test and life ability test, Infant-Junior High School Student Social Capacity Scale and Achenbach Child Behavior Checklist (CBCL). The middle school students' social adaptability scale and children's behavior scale are commonly used measurement methods (Miaomiao Zhao, 2012; Xu, 2008).

The use of child growth and development criteria to measure child health is the most widely used method in current research (Goode et al., 2014; Ma Zhe, 2016; Shuangyue, 2018; F. Wang, 2010; Yang, 2018; N. Zhang, 2012). However, before 2006, there was no uniform standard for children's growth and development in the world. Through the research and analysis of children's development in some countries, a variety of growth maps adapted to the monitoring of children's growth and development in their own countries have been developed, such as the standard "CDC Growth Charts, 2000" developed by the Centers for Disease Control and Prevention of the United States and the standard "NCHS" developed by the National Center for Health Statistics of the United States and Children's growth map developed in the UK in 1990. It is worth mentioning that according to the research of the World Health Organization, children with good nutrition have very similar growth track in the world, so the World Health Organization issued the "child growth standard" in 2007. This standard includes four measurement indicators, namely Height-for-age, Weight-for-age, Weight-for-length, Weight-for-height, and Body mass index-for-age.

There are three main growth standards for children in the Chinese Ministry of Health. One is the standard provided by the National Center for Health Statistics from 1977. The latest version is currently released in 2000, referred to as 2000 CDC Growth Charts. The second is the child growth standards provided by the World Health Organization, the growth standards for children aged 0-5 years issued in 2006 and the growth standards for children aged 6-18 years issued in 2007, and the third is the children under 7 years old issued by the Ministry of Health in 2009 Growth standards. The three indicators are not much different, but the standards set by the Chinese Ministry of Health are higher than those of the National Center for Health Statistics and the standards issued by the World Health Organization (Linjiang Wang, 2011; Ping Yuan, 2008; Yuying Wang, 2007).

In order to compare the results of the research, the child growth indicators published by WHO in 2006 and 2007 are widely accepted by researchers who study the topic of child health in china. In most of the existing literature studies, WHO published the indicators are used as standards (Goode et al., 2014; Linjiang Wang, 2011; Liu, 2019; Yang, 2018; N. Zhang, 2012).

Compared with other indicators, using HAZ (Height-for-Age-Z score) as a measure of children's health has more advantages and comparability. Because BMI (Body Mass

Index) and BAZ (Body mass index-for-Age-Z-score) are suitable for children over 2 years old, WHZ (weight for height Z-score) is more suitable for children under 2 years old (Liu, 2019).

So, according to the literature, the commonly used indicators for studying children's health are shown in the following table 3:

Table 3 Research commonly used child health measurement indicators

Child Health	Type	Index
Child Physical Health	Nutrition and growth	HAZ, BMI, Height, Weight
	Disease condition/ Prevalence	Mortality, prevalence in the past four weeks
	Status of self-assessment of health	Self-report
Child Mental Health	Loneliness, anxiety, depression, self-blame, terror, etc.	Mental health diagnostic test (MHT) Children's self-awareness scale Children Loneliness Scale Children's Social Anxiety Scale
Child Social Health	Learning ability, social behavior ability, social communication ability, social life ability	Middle school students' social adaptability scale Infant-Junior High School Student Social Capacity Scale Achenbach Child Behavior Checklist

To sum up, in this study, ‘HAZ’ and ‘Any illness in the past four weeks’ were selected as indicators of children's health. There are three main reasons for choosing HAZ as an indicator of children's health. First, compared with other indicators, HAZ is more comprehensive. It can well reflect the health status of children of different ages and different periods, making the health status of children of different ages and different genders comparable. Second, HAZ has been widely accepted and used as an indicator of children's health in the academic community. Thirdly, HAZ is an authoritative standard index of children's growth issued by WHO. To a certain extent, HAZ reflects the long-term state of children 's health, and whether they are sick or injured in the past four weeks reflects the short-term state of children 's health.

3.2 Family Structure

Family is the cell of Chinese society, and it is the most basic way of life of Chinese people (Xiaotong, 1992). Family plays a very important role in Chinese culture. The relationship between parents and their children is a kind of "social capital", which is one of the important factors affecting the development of children's human capital (Coleman, 1988). The lack of family function will have a negative impact on children's healthy growth. Due to the rising divorce rate, more and more children will lack the care and care of their parents. Due to the lack of care and upbringing of the father or mother, the child 's healthy development is incomplete or even deformed.

Strictly speaking, family as a sociological concept refers to the group formed by husband and wife and their unmarried children. So from this point of view, the Chinese family can be divided into four types in terms of structure: (1) Incomplete core family, one of the original spouses of the family dies or leaves, or unmarried children in the family with only two parents dead. (2) A nuclear family, it is a living unit composed of a couple and their unmarried children. This type of family is also called "small family" in China. (3) The family composed of a nuclear family and other members, in this type of family, in addition to the nuclear family members, there are other members. These members are people who cannot live alone, most of them are widowers or widows who live with their married children after the death of their spouses, and some of them are distant relatives or even people without kinship. (4) United Family: this kind of family refers to the core family where children continue to live in the same unit with their parents after they get married, also known as two generations of overlapping. If the brothers don't start their own families after they get married, they will become the core family unit of their compatriots. This family type is also known as "extended family" in China (Xiaotong, 1992).

The content of the family structure includes the marriage, blood relationship, parent-child and intergenerational relationship of family members and the number of family members. A family household refers to a basic unit of a society composed of people living in a marriage, blood relationship or adoption relationship, and living together, as well as very few non-relative members. Therefore, the characteristics of family households can be divided into nine categories: (1) One-person households. (2) A couple of households. (3) Nuclear family household (4) Intergenerational household. (5) Three-generation direct family households. (6) Direct family households of four generations or more. (7) Second generation joint family households. (8) Three generations of joint family households. (9) Four generations or more combined family households (Yi Zeng, 1992).

The family structure can be divided into the following five categories based on family algebra and the number of couples and referring to the blood lineage of family members: (1) Nuclear family, a family composed of parents and unmarried children. (2) The main stem Family, it is a family consisting of parents and a pair of married children. (3) A joint family, a family consisting of parents and two or more pairs of married children, or a family where siblings do not separate after marriage. (4) Single-parent families, that is families that have lost their father or mother in the nuclear family due to widowhood or divorce. (5) Other families, that is, families other than the above types, such as intergenerational families, that is, families composed of grandchildren and grandchildren (Sun, 2004).

In a study on contemporary Chinese family structure, the basic family structure includes nuclear family, direct family, compound family, single-family, disabled family and other six categories. (1) Nuclear family refers to a family composed of two couples, or a couple (or a couple) and unmarried children. (2) Immediate family, which refers to a family consisting of a couple (or parents, one parent) and a married child and grandchild. (3) A compound family refers to a family consisting of a couple (or parents, one parent) and two or more married children. (4) Single household, it refers to a family consisting of one person. (5) Incomplete family refers to a family of unmarried siblings. (6) Other families (Chunhua Ma, 2011; Y. Wang, 2015).

According to the actual living conditions of parents and children, the family structure is divided into four categories. (1) Dual parent family, which refers to the normal maintenance of the marriage relationship between father and mother, and the children live with their parents. (2) Single mother family, which means that the marriage between the father and the mother is broken, the parents have divorced, or the father death, and the child lives with the mother. (3) Single father family, which refers to the broken marriage between father and mothers, or the death of the mother lead to the child lives with father. (4) The family of both parents are missing (Yuxiao Wu, 2018).

In summary, the classification of family structure is mainly based on family intergenerational relationships, the number of couples combined with the size of family households. This study mainly focuses on the comparative study of single-parent families and nuclear families, so this study focuses on family structure Divided into three categories, (1) Nuclear family (dual parent family), which refers to a family composed of parents and unmarried children, also called a dual-parent family or a normal family. (2) Single-mother family, it is referring to a family formed by divorced or widowed single mother and children and living together. (3) Single-father family, it is referring to a family formed by divorced or widowed single-parent dads and children and living together.

3.3 Impact of Family Structure on Child Health

According to the theory of family resources, family structure will have an impact on children's human capital accumulation, and then affect their economic status in adulthood (Becker & Tomes, 1986).

According to the theory of socialization, every family is a structural system and the most important institution of children's socialization. Each member has a unique function. Parents' living together and raising children are the most favorable means for children's healthy development, while the absence of the role of father and mother will have a negative impact on children's development (Parsons, 1949).

According to the theory of social capital, the social capital within the family (referring to the relationship between parents and children, mainly reflected in the interaction, commitment and trust between parents and children) is the main way to transform the economic capital of the family and the human capital of parents into the human capital of children. Social capital outside the family (referring to the social relationship between parents and other members of the community and the relationship between parents and social institutions) is an important channel to cultivate children's interpersonal skills and general trust level (McLanahan & Sandefur, 1994).

To sum up, the reason why family structure affects children's health level is that different family structures lead to differences in family resources, social capital and parental care structure.

The impact of family structure on children's health is mainly reflected in that children in rural areas are more likely to live in families where one or both parents are absent.

The lower the professional status of parents, the greater the possibility of parent-child separation. The education gap of single mother family is the smallest compared with that of double parent family. The level of social and psychological development of children from dual parent families is significantly higher than that of other three families (Yuxiao Wu, 2018).

Children from single parent families are more likely to be affected by bad emotions, and to form personality tendencies such as fear, anxiety and neuroticism (X. Wang, 2013). Moreover, in single parent families, due to the lack of education and care from both parents, children tend to form self-abasement, depression and coldness, which are not conducive to the healthy development of children (Z. Wang, 2018).

3.4 Impact of Other Factors on Child Health

3.4.1 Family Income

The relationship between economic factors and health has always been one of the hot topics in economics, sociology and medical research. Whether the economic level affects health or health affects the economy is a very controversial topic. As one of the important components of economic factors, family income is of course also an important factor affecting children's health. According to current research, the role of family income in affecting children's health is indirect, because "money does not cure diseases." Family income affects children's health status and levels indirectly by affecting some factors related to children's health, such as family purchasing power, children's nutrition supply, access to quality medical services, and a safe living environment (N. Zhang, 2012).

In China, more and more evidence show that the impact of income on children's health is positively related. Children's health level will change with changes in income. The higher the income, the higher the child's health level (Goode et al., 2014; Yang, 2018; N. Zhang, 2012). However, some studies have shown that the impact of family income on children 's health is positively related only to children over the age of 3, that is to say, the impact of family income on children 's health is significant between 4-17 years of age. For children in the age group of 0-3 years old the effect is not significant or is not statistically different (Goode et al., 2014).

In other countries, the relationship between family income and child health is also positively correlated. The percentage of children with better health in the United States increases with household income, and 10 indicators of access to and use of medical services are related to household income (Larson & Halfon, 2010). The relationship between child health and family income in Australia is positively correlated and the relationship between socioeconomic status and child health is more prominent in older children (Khanam et al., 2009). A study from the United Kingdom shows that there is a significant difference between family income and child health, but this difference is not relevant for children aged 0-1, and the impact of income on child health may be transmitted in the intergenerational transmission of socioeconomic status make a difference (Apouey & Geoffard, 2013). Unlike American children, there is a big difference between German children's family income and children's health, but there is insufficient evidence to show that the adverse factors for children's health in German low-income families will accumulate as children age. However, there has been evidence that children from high-income families can cope well with the adverse consequences of chronic diseases (Reinhold & Jürges, 2012).

In summary, the relationship between family income and children 's health is positively related, but there may be some differences in children of different ages.

3.4.2 Child Characteristics

Gender differences will lead to differences in children's health quality (Skoufias, 1998). Due to differences in the physiological structure of boys and girls, there are differences in the health status of children of different genders. In China, there is a significant gender difference in the mortality rate of children under five years of age. The risk of death of boys is higher than that of girls, both in urban and rural areas (Commission, 2018b). In rural China, girls' health is worse than boys' (F. Wang, 2010; N. Zhang, 2012). In Chinese cities, girls are in better health than boys (Yang, 2018). In summary, gender affects children 's health.

Age is also one of the factors that affect children 's health. The younger the child, the higher the dependence on parents and family. As children age, their self-care ability will increase, which will affect their health. Some studies have shown that there are statistical differences in the health status of children of different ages (Bai, 2019; Goode et al., 2014; Yang, 2018).

Childbirth weight has a significant impact on children 's health (Goode et al., 2014; Khanam et al., 2009), child mortality and risk of low birth weight (birth weight less than 2,500 grams) are higher than normal children. Due to the immature development of low birth weight children 's body organs, they have an adverse impact on children's health.

For nationalities, as we all know, China has 56 nationalities, of which the Han nationality is the largest ethnic group. Studies have shown that there are significant differences ($P<0.05$) in the health of children of ethnic minorities and Hans. The health status of Han children is better than that of minority children (Sun Yu, 2014).

Children's health risk behaviors, specifically manifested in smoking and drinking, will also affect children's health. The proportion of children smoking and drinking in ethnic minorities is more than that of Han children, which affects children's physical health to a certain extent. As children grow up and develop, their body organs are not fully developed and mature. It is obvious that the health risk behaviors of smoking and drinking have certain risks to children's health (Sun Yu, 2014).

3.4.3 Parental Characteristics

Due to the influence of genetic factors on the physiological characteristics of parents, scholars usually include the physiological characteristics of their parents in the analysis of children 's health when excluding the influence of genetic factors on children's health. Most studies used the age of the parents (Apouey & Geoffard, 2013; Currie et al., 2007; Goode et al., 2014; Khanam et al., 2009; Ma Zhe, 2016; N. Zhang, 2012), height and weight (Ma Zhe, 2016; F. Wang, 2010; N. Zhang, 2012) as explanatory variables.

Parents' education level is also one of the factors that affect children's health. There is a large amount of research evidence that parents' education level is positively correlated with children's health, and families with high parents' education level have higher children's health than those with low education level. Children's health level (Currie et al., 2007; Goode et al., 2014; Shuangyue, 2018; Sun Yu, 2014; F. Wang, 2010; Yang, 2018; N. Zhang, 2012). Especially the education level of the mother, has a greater impact on children's health (Miaomiao Zhao, 2012).

Parents' health risk behaviors also have a certain impact on children's health levels, specifically by smoking and drinking. A study from Germany showed that parents drinking alcohol during pregnancy has a significant ($P<0.05$) impact on children's health (Reinhold & Jürges, 2012). A study from China showed that smoking by mothers will significantly hinder the health of rural left-behind children (N. Zhang, 2012). In fact, the inclusion of indicators such as whether parents are smoking or drinking is just to describe certain family characteristics from the side. Studies have shown that parents smoking at home can increase the risk of children suffering from respiratory diseases (Hu et al., 2014). Drinking alcohol may cause traffic injuries or domestic violence, which will have a certain impact on children's health.

3.4.4 Family Characteristics

Family size, family size is also one of the factors that affect children's health. After World War II, Gary S. Becker, an economics professor at the University of Chicago in the United States, extended the theory of "consumer demand" in western economics to the family, analyzed the family 's needs for children, and proposed classic children Quality and quantity substitution theory (Becker & Tomes, 1986). This theory explains the relationship between family size and children's quality. If parents' demand for children's quality exceeds the demand for children, parents will reduce the number of children. Thereby improving the quality of children. Of course, this quality also includes the level of health. Because more children will take away family resources (Chun Luo, 1991). Although China's family planning policy limits the size of the family to a great extent, the substitution relationship between the quantity and quality of children still exists in China. Studies have shown that the relationship between family size and children's health is significant ($P<0.01$) and negatively correlated. The more children there are in a family, the worse the health of children in that family (Goode et al., 2014; F. Wang, 2010).

The geographical location of the family, due to the unbalanced development of the Chinese economy, has led to significant differences in urban and rural development. There are also significant differences between the eastern region and the central and western regions, especially in terms of economy. Due to the imbalance of development, the medical level, economic status and education level of different regions are very different. The eastern region is better than the central and western regions, and the cities are better than rural areas. Studies have shown that the health status of urban children is better than that of rural children (Yang, 2018). The health status of children in different geographic locations differs significantly ($P<0.01$) (Goode et al., 2014; F. Wang, 2010).

The level of family welfare also has a certain impact on children's health. The specific manifestations are whether the family has purchased health insurance for children, whether there is a TV set, and whether there is running water and toilets to reflect or describe the level of family welfare. Studies have shown that the relationship between child health insurance and child health is positively related and significant (P<0.01). The relationship between the use of toilets and tap water and children's health is also positively correlated and significant (P<0.01) (Goode et al., 2014). This means that families using tap water, flush toilets and children with children 's health insurance have higher levels of health than those of other families.

3.5 Methodology Used in Existing Literature

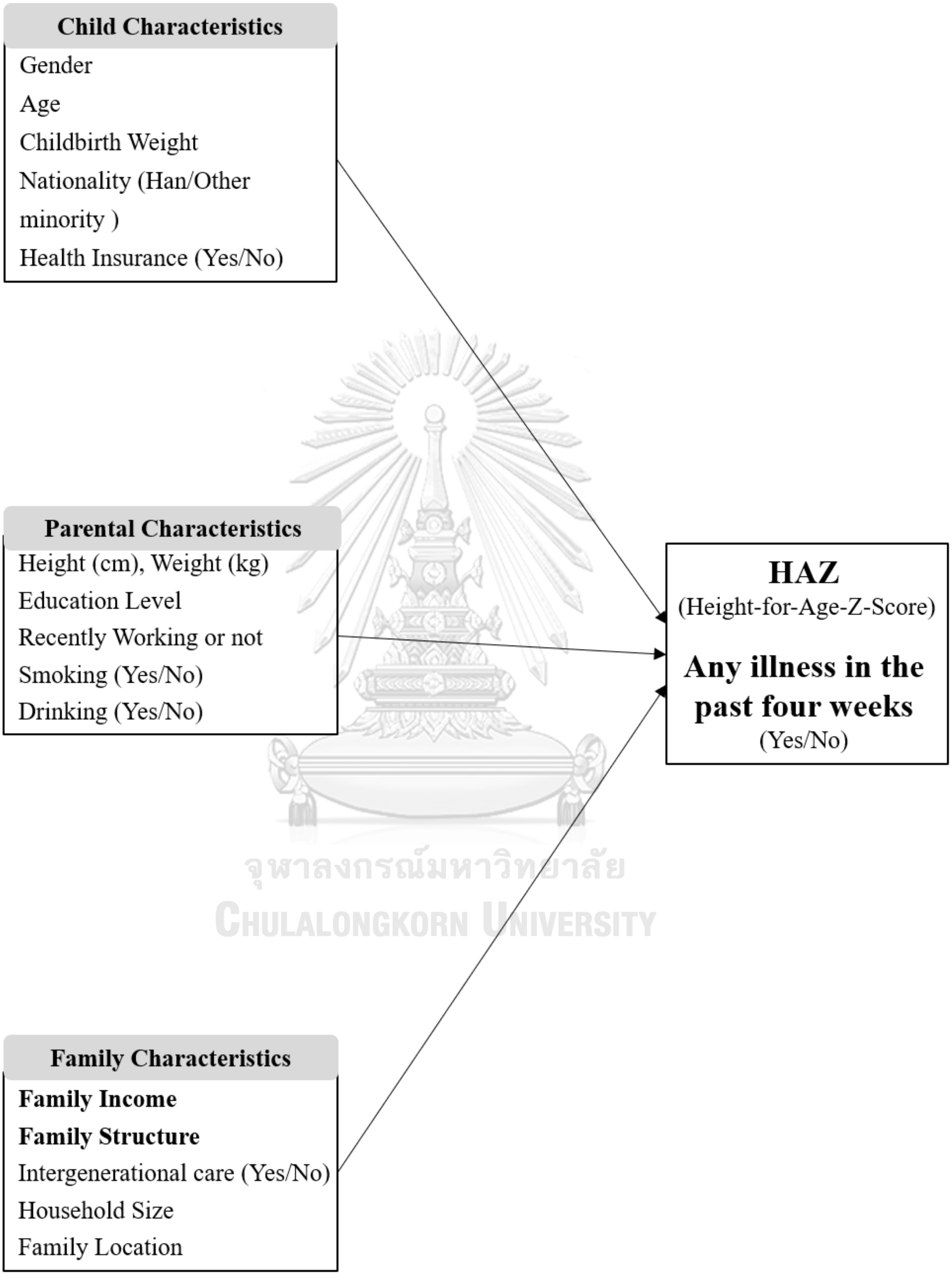
In quantitative research, in order to prove the correctness of the hypothesis related to the research topic, we usually construct an econometric model for empirical research. Since children's health mainly includes three aspects: physical health, mental health, and social health, the econometric models used are also different due to the different emphasis on children's health research. Which econometric model to use depends on the characteristics of the dependent variable. If the dependent variable is a categorical variable, the econometric model is a Logit model or Probit model (Apouey & Geoffard, 2013; Currie et al., 2007; Khanam et al., 2009; Larson & Halfon, 2010; Reinhold & Jürges, 2012). If the dependent variable is a continuous variable, a multiple linear regression model is used (Goode et al., 2014; Ma Zhe, 2016; Shuangyue, 2018; F. Wang, 2010; Z. Wang, 2018; Yang, 2018; N. Zhang, 2012). For the HAZ index of measured child physical health to say, using the multiple linear regression model OLS is the most.

3.6 Gap in the Literature and Contribution of this Research

To sum up, the existing literature research focuses on children left-behind, rural children, migrant children, and urban low-income children in terms of child health, but does not focus on the special group of Child physical health with different family structures. Studying the health problems of children of varying family structure is a supplement and extension to existing research.

This study uses data from Peking University's 2016 China Family Panel Studies. The target sample includes children aged 0-15 years. The sample data comes from a sample survey of 25 provinces/autonomous regions across the country. Coverage is greater than existing research. And the data in 2016 is the latest version of the data, which can more truly represent the health status of Chinese children.

CHAPTER IV. CONCEPTUAL FRAMEWORK



The variables are expected to have certain impacts on the health of child. This study focuses on the physical health of children, using HAZ published by the World Health

Organization in 2006 and 2007 as the main measure of children's health. HAZ can well reflect the long-term situation of children's health and any illness in the past four weeks as a secondary measure can well reflect the short-term health of children.

This research mainly divides the factors that may affect children's health into three aspects: children's characteristics, parents' characteristics and family characteristics. The first is the child itself. As the child grows, changes in age will bring about changes in the child 's health. As age increases, the degree of dependence on the parent or family will decrease. Due to differences in the innate physiological structure of boys and girls, this leads to differences in health status. Health Insurance as one of the risk transfer methods, will also have a certain impact on children's health, because insurance will reduce the risks brought by diseases such as the reduction of family income. Since China is a unified multi-ethnic country, we have 56 ethnic groups, and the majority of these ethnic groups are the Han nationality. The main settlement areas of ethnic minorities are remote areas or underdeveloped areas, so nationality differences will affect the health of children to a certain extent.

The second is the characteristics of the parents. The educational level of the parents will affect the health of the children. The higher the educational level of the parents, the more their health literacy will increase. Parents' height and weight as genetic factors can also affect children's health. In addition, whether the parents work will also have a certain impact on the children's health, because if both parents go to work, the time to take care of the children will be reduced. Similarly, the health risk behavior of parents (health risk behavior here refers to smoking and drinking) may also affect children's health, because second-hand smoke is still very harmful to health, and drinking will cause emotional instability and increase the risk of domestic violence.

The third is the characteristics of the family. Different family structures may cause some adverse effects on children's health. This is also one of the main explanatory variables in the study of the factors affecting children's health in this article. The other is family income. Children in dual-parent families differ greatly from those in single-parent families in terms of family resources and family income. The influence of parents caring in childhood on children's health is very important. The lack of any party will have an adverse impact on children's health. The gap in income between single-parent families and normal families is also obvious. For children in single-parent families, their health status is still at a disadvantage compared to normal families. As the imbalance of China's economic development leads to the imbalance of urban and rural development, this imbalance is not only reflected in income but also has an impact on health-related factors such as education and medical treatment. In addition, the size of the household may also affect children's health. If the number of children in the family is greater, then the average family resources will be less for each child. This will indirectly affect children's health human capital stock.

CHAPTER V. METHODOLOGY

5.1 Variables

5.1.1 Dependent Variables

In this study, two dependent variables were considered. The two outcomes were Height-for-age Z score (HAZ) and any illness in the past four weeks as show in Table 4 below.

Table 4 **Details of Dependent Variables**

Name	Variables	Description
HAZ	Height-for-age Z score	Measure long-term Child Health, Continuous variable
ILL	Any illness in the past four weeks	Measure short-term Child Health, Binary Variable (Yes/No)

5.1.2 Explanatory Variables

Table 5 shows some detailed information of explanatory variables used in this research. It shows the name and description of each variable. The expected sign of effect on the dependent variables and the reasons are also shown in this table. The main explanatory variables in this study are family income and family structure.

Table 5 Details of Independent Variables

Name	Variable	Description	Expected Sign (+/-)	Reason
dual_p single_m single_f	Family Structure	The family structure divide into three type. Dual parent family (Omitted) =1 if a child family type is dual parent family. Single mother family =1 if a child family type is single mother family. Single father family =1 if a child family type is single father family.	-	Comparing to dual-parent family, single-parent families have not enough resources to supplement and help their child grow healthy.
finc	Family Income	Total annual family income. This is a continuous variable.	+	Poverty is one of the main causes of children 's health problems. Income is one of the indicators to measure poverty. The higher the family income, the better the child's health status, and vice versa.
c_age	Child age	Age of children (years old). This is a continuous variable.	+	With the natural growth of age, the degree of growth and development of children continues to mature. So, the sign should be positive.
Boy	Child gender	Boy=1 if a child is a boy. Boy=0 if a child is a girl.	+/-	The different physiological structure of boys and girls may lead to some differences in their health conditions.

Lowbw	Childbirth weight	Low childbirth weight=1 if a child birthweight<2500g, the other=0	-	Children with low birth weight may have a higher risk of illness (Low birthweight refer to <2500g).
Min	Child Nationality	Minority nationality=1, Han=0	-	The health status of minority children may be lower than that of Han children.
HI	Health Insurance	Child have Health Insurance=1 otherwise=0	+	Children with health insurance may be in better health than children without health insurance.
Pw	P_weight_kg	Average Weight(kg) of the parent (note: dual-parent family=Average weight of the parent, single-father parent family=father's weight, single-mother parent family=mother's weight). This is a continuous variable.	+/-	Considering the influence of genetic factors on children's physical health.
Ph	P_height_cm	Average Height(cm) of the parent (note: dual-parent family=Average height of the parent, single-father parent family=father's height, single-mother parent family=mother's height). This is a continuous variable.	+/-	
P_edu	Parent education level	This is a continuous variable and refers to the number of years of parental	+	The relationship between parent's education level and children 's health may be positive,

		education (note: dual-parent family=parent's average of schooling, single-father parent family=father's schooling, single-mother parent family=mother's schooling).		because of the higher the education level, the stronger the health literacy and health concept.
p_working	parental working	Dual-parent family=mother's presently working or not, work=1 if yes, otherwise=0. Single-father parent family=father's presently working or not, work=1 if yes, otherwise=0. Single-mother parent family=mother's presently working or not, work=1 if yes, otherwise=0.	-	Mother's with a job have less time to care them child.
p_smoke	parent smoking	Dual-parent family=either parent smokes, Smoke=1, No=0. Single-father parent family=father smoke or not, Smoke=1, No=0. Single-mother parent family=mother smoke or not, Smoke=1, No=0.	-	If parent smoke at home or near children, second-hand smoke also has a negative impact on children 's health.
p_drink	parent drinking	Dual-parent family=either parent drinks alcohol 3 times per week, Yes=1, No=0.	-	The impact of mother drinking on children 's health may be is negative.

		Single-father parent family=father drink alcohol 3 times per week, Yes=1, No=0. Single-mother parent family=mother drink alcohol 3 times per week, Yes=1, No=0.		
Hsize	Household size	This is a continuous variable.	-	If the household size is larger, the investment in children 's health will be reduced.
Rural	Family Location	Rural=1, Urban=0	-	Due to the differences between urban and rural areas, the health of children in rural areas is worse than that of urban children.
Interca	Intergenerational care	Whether the child is under intergenerational care: Yes=1, No=0	+/-	Whether intergenerational care has an impact on children 's health is uncertain. However, the phenomenon of intergenerational care is more common in China, so this study had to include this variable.

5.2 Details of Variables

5.2.1 Child Health Outcome

In this research, two variables were used to measure child physical health: Height-for-age Z score (HAZ) and any illness in the past four weeks.

Height-for-age Z score (HAZ) is calculated according to the following formula:

$$HAZ = \frac{Height\ of\ child - \ Median\ height\ of\ that\ age(WHO, Standard)}{Standard\ deviation(WHO, Standard)}$$

In calculating HAZ, we use the median, not mean. HAZ is a continuous variable in this study, similar approach used by other Chinese studies, the physical health indicators of Chinese children were compared with each subject using the standard provided by WHO to calculate HAZ (Bai, 2019; Goode et al., 2014; F. Wang, 2010; Yang, 2018; N. Zhang, 2012). For detailed information on how to calculate HAZ, see Appendix I.

Compared with other indicators, HAZ is a suitable indicator to define the long-term health of children. The data used in this study does not directly give HAZ, so we need to calculate the HAZ value of each sampled child based on the child's height and the age calculated on a monthly basis. Because the WHO child HAZ standard about child age is the basic month. So, we need to transform this from year to month.

The data already contains the child's birth year and month and the year and month information at the time of the survey, so we only need to do subtraction to get accurate child age information calculated by month. Similarly, in the children ’s health section of the CFPS2016 survey data, the height of the child (cm) has been given, so we compare the growth standards for children under 19 years old published by the World Health Organization, the HAZ value of each sample child can be calculated.

Any illness in the past four weeks is measured for child health in short-term. The question in the survey is “Whether the child was ever sick last month?” The answer was separated into Yes (yes=0) and No (no=1).

5.2.2 Family Structure

According to Sample code of parents in the survey that is pid_m and pid_f, and the parents' marital status at the time of the survey, we can define the type of family structure. Each child is identified into dual-parent families, single father families or single mother families based on two questions. The first question used is “Sample code of parents in the survey” whether there is both pid_m and pid_f or either one is missing. The second question used is “Current marital status” of father and mother. For the detail information on how family structure is created, please check the Appendix II.

5.2.3 Family Income

In this study, family income refers to the total annual family income and in regression log (family income) will be used. The unit is yuan. The question in the survey is “Family's total income in past 12 months (yuan)” This is a continuous variable.

5.2.4 Child Characteristics

A. Age

The age of the children. Due to data limitations, children here range in age from 0-15 years old.

B. Gender

A child is boy or girl where, 1 is for boy, 0 is for girl.

C. Childbirth Weight

The weight of a child at birth, the unit is grams. If the weight at birth is less than 2500g, this child is a low-weight child. The question in the survey is “Child's weight at birth (unit is “jin”, 1 jin= 0.5kg)” Because the unit of measure in the data is “jin” we need to convert the unit, the formula is as follows:

$$1_{jin} = 0.5_{kg} = 500_{g}$$

D. Child Nationality

Child nationality=1, if a child nationality is minority, Child nationality=0 if a child nationality is Han. Because the Han nationality accounts for 91.5% of the total population, and the population of 55 ethnic minorities accounts for 8.5%, we include this variable in the study (National Bureau of Statistics, China Statistical Yearbook, 2013).

E. Health Insurance

The question in the survey is “Type of medical insurance”. So, we transform the answer to having insurance=1, and not having insurance =0.

5.2.5 Parental Characteristics

A. Parental Weight(kg)

The question in the survey is “Current weight jin”. Because the unit of measurement in the data is “jin”, we need to convert the unit. The formula is as follows:

$$1_{jin} = 0.5_{kg} = 500_{g}$$

For the dual-parent families in this study, we use parents’ average weight(kg). For single-parent families, the weight(kg) of either father or mother that is presented in the family is used.

B. Parental Height(cm)

The question in the survey is “Current height cm”. For the dual-parent families in this study, we use parents’ average height(cm). For single-parent families, the weight(cm) of either father or mother is used. This is similar approach used by other scholars (Lin & van der Meulen Rodgers, 2018; Ma Zhe, 2016; Shuangyue, 2018).

C. Parental education level

The question in the survey is “Highest educational degree in CFPS2016”. The people answer is Illiteracy=0, Primary school=1, Junior high school=2, Senior high school=3, 3-year college=4, 4-year college=5, Master's degree=6, Doctoral degree=7. Because we need to compare dual parent family and single parent family. so, we transform the education level to years of schooling. This is primary school=6 years, Junior high school=9 years, Senior high school=12 years, 3-year college=15 years, 4-year college=16 years, Master's degree=18 years and Doctoral degree=21 years. For the dual-parent families in this study, we use parents' average years of education. For single-parent families, the years of education of either father or mother that is presented in the family is used.

D. Parental working

The question in the survey is "Current employment status", working=1, otherwise=0. For the dual-parent families in this study to say, we create a variable whether the mother works or not. For single-parent families, the dummy variable for working captures either father or mother that is presented in the family. Because some studies have shown that, especially for younger children, the impact of lack of mother 's care is greater than lack of father 's care (Shuangyue, 2018; Zhongshuai Li, 2014). So, in this study we use the variable whether the mother works if the data allows.

E. Parent smoking

The question asked is "Whether smoked cigarettes last month". Yes=1, No=0. For the dual-parent families in this study, if either parent smokes, the answer to this question is 1. For single-parent families, smoking status of either father or mother who is presented in the family is used.

F. Parent drinking

The question asked is "Whether drank alcohol 3 times per week last month". Yes=1, No=0. For the dual-parent families in this study, if either parent drinks, the answer to this question is 1. For single-parent families, drinking status of either father or mother who is presented in the family is used.

5.2.6 Family Characteristics

A. Family location

The location of the family is in an urban or rural area. Rural=1, Urban=0.

B. Household Size

The question in the survey is "Household size 2016".

C. Intergenerational care

The intergenerational care refers to the grandparent helps child-parent take care of them, children. The question in the survey is “Person who mainly took care of child at daytime” and “Person who mainly took care of child at night” if the answer is Child's paternal grandparents or Child's maternal grandparents then the variable is equal to 1, otherwise equal to 0.

5.3 Econometrics Model

5.3.1 Multivariate Linear Regression (OLS)

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

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

Model 1: $HAZ_i = \beta_0 + single\_m\beta_1 + single\_f\beta_2 + \log\_finc\beta_3 + c\_age\beta_4 + Boy\beta_5 + Min\beta_6 + Pw\beta_7 + Ph\beta_8 + p\_edu\beta_9 + HSize\beta_{10} + Rural\beta_{11} + \varepsilon_i$

Model 2: $HAZ_i = \beta_0 + single\_m\beta_1 + single\_f\beta_2 + \log\_finc\beta_3 + c\_age\beta_4 + Boy\beta_5 + Min\beta_6 + Pw\beta_7 + Ph\beta_8 + p\_edu\beta_9 + HSize\beta_{10} + Rural\beta_{11} + p\_work\beta_{12} + p\_smoke\beta_{13} + p\_drink\beta_{14} + \varepsilon_i$

Model 3: $HAZ_i = \beta_0 + single\_m\beta_1 + single\_f\beta_2 + \log\_finc\beta_3 + c\_age\beta_4 + Boy\beta_5 + Min\beta_6 + Pw\beta_7 + Ph\beta_8 + p\_edu\beta_9 + HSize\beta_{10} + Rural\beta_{11} + p\_work\beta_{12} + p\_smoke\beta_{13} + p\_drink\beta_{14} + HI\beta_{15} + \varepsilon_i$

Model 4: $HAZ_i = \beta_0 + single\_m\beta_1 + single\_f\beta_2 + \log\ \_finc\beta_3 + c\_age\beta_4 + Boy\beta_5 + Min\beta_6 + Pw\beta_7 + Ph\beta_8 + p\_edu\beta_9 + HSize\beta_{10} + Rural\beta_{11} + p\_work\beta_{12} + p\_smoke\beta_{13} + p\_drink\beta_{14} + Icare\beta_{15} + \varepsilon_i$

Model 5: $HAZ_i = \beta_0 + single\_m\beta_1 + single\_f\beta_2 + \log\ \_finc\beta_3 + c\_age\beta_4 + Boy\beta_5 + Min\beta_6 + Pw\beta_7 + Ph\beta_8 + p\_edu\beta_9 + HSize\beta_{10} + Rural\beta_{11} + p\_work\beta_{12} + p\_smoke\beta_{13} + p\_drink\beta_{14} + Icare\beta_{15} + +Lowbw\beta_{16} + \varepsilon_i$

5.3.2 Binary Logit Regression

For “Any illness in the past four weeks” defined child health in the short-term, this research used binary logit regression to analyze the effect of each factor on child health.

For the data analysis of “Any illness in the past four weeks” the model should be represented like this:

$$Y_i = \begin{cases} 0, if\ a\ child\ got\ illness\ in\ the\ past\ four\ weeks \\ 1, otherwise \end{cases}$$

$$Y_{1i}^* = X_i'\beta + \varepsilon_i$$

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:

$$L = \prod \left[\frac{exp^{a_0+\beta_0 x}}{1 + exp^{a_0+\beta_0 x}}\right]^{Y_i} \left[\frac{1}{1 + exp^{a_0+\beta_0 x}}\right]^{1-Y_i}$$

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

Six 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 child health in short-term.

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

CHAPTER VI. DATA

6.1 China Family Panel Studies (CFPS)

China Family Panel Studies (CFPS) is a national longitudinal general social survey project. By collecting data at three levels (i.e., individual, family, community), the project aims to document changes in Chinese society, economy, population, education, and health, so as to provide data for academic research and public policy analysis (Xie, 2013).

CFPS focuses on both the economic and non-economic well-being of the Chinese people, covering substantive areas such as economic activities, educational attainment, family relationships and dynamics, population migration, and physical and mental health.

Since 2010, a follow-up survey has been conducted every two years. So far, five surveys have been conducted, but the data has already published in 2010, 2012, 2014, and 2016. The data for 2016 is the latest data currently available.

The data used in this study is CFPS2016. It is cross-sectional data. Although CFPS itself is panel data, in this study I only use CFPS2016 cross-sectional data. Because the main content of my research is the impact of family income and family structure on children 's health. For family structure, the change in children's family state has not change much (C. Zhang, 2019) as shown in table 6, so the panel data may not be applicable.

Table 6 Proportion of children living in various types of households in the CPFS survey

	CFPS 2010	CFPS 2012	CFPS 2014	CFPS 2016
Dual parent family	98.47%	98.43%	98.12%	98.28%
Single parent family	1.53%	1.57%	1.88%	1.72%

Source: CFPS

6.2 Sampling Method of CFPS Data

The sample of CFPS is drawn from 25 provinces/cities/autonomous regions in China excluding Hong Kong, Macao, Taiwan, Xinjiang, Xizang, Qinghai, Inner Mongolia, Ningxia, and Hainan. The population of these 25 provinces/cities/autonomous regions in China (excluding Hong Kong, Macao, and Taiwan) includes 95% of the Chinese total population. Thus, CPFS can be regarded as a nationally representative sample.

The original target sample size was 16,000 households. Half of the sample (8,000) was generated by oversampling with five independent sampling frames (called large provinces) of Shanghai, Liaoning, Henan, Gansu, and Guangdong, as show in figure 13. Each of the subsamples had 1,600 households. The other 8,000 households were from an independent sampling frame composed of 20 provinces (called small provinces). The large provinces were representative of the regional level, which could contribute to provincial population inferences and cross-region comparisons. With second-stage sampling, the five large provinces, together with the small provinces, made up the overall sampling frame representative of the national population.

Figure 13 The Sources of CFPS Samples at the Provincial Level

Source: China Family Panel Studies User's Manual

Taking the regional differences in Chinese society and the reduction of survey processing costs into consideration, CFPS implemented Probability-Proportional-to-Size Sampling (PPS) with implicit stratification. Administrative units and socioeconomic status (SES) were used as the main stratification variables. Within the administrative unit, local GDP per capita was used as the ordering index for SES. If the GDP per capita in the administrative unit is not available, the proportion of nonagricultural population or population density is used.

Table 7 CFPS Target Sample Size

Category	Provinces/Cities/Autonomous Regions	Target Households	Oversampling Rate
"Large Provinces"	Shanghai	1600	10.28
	Liaoning	1600	4.45
	Henan	1600	2.04
	Gansu	1600	7.30
	Guangdong	1600	2.02
"Small Provinces"	Jiangsu, Zhejiang, Fujian, Jiangxi, Anhui, Shandong, Hebei, Shanxi, Jilin, Heilongjiang, Guangxi, Hubei, Hunan, Sichuan, Guizhou, Yunnan, Tianjin, Beijing, Chongqing, Shaanxi.	8000	1.00

Source: China Family Panel Studies User's Manual

All the sub-sampling frames of CFPS were obtained through three stages: the Primary Sampling Unit (PSU) consisted of administrative districts/counties, the Second-stage Sampling Unit (SSU) consisted of administrative villages/neighborhood communities, and the third stage (Ultimate) Sampling Unit (TSU) consisted of households.

Table 8 Three Stages of CFPS Sampling

Stages	Guangdong, Gansu, Liaoning, Henan: 4 "Large Provinces"	Shanghai: "Large Province"	"Small Provinces"	Total
Primary	4×16 Counties=64 Counties	32 Streets (Towns)	80 Counties	144 Sampled Counties+32 Sampled Streets (Towns)
Second-stage	64×4 Communities =256 Communities	32×2 Communities =64 Communities	80×4 Communities =320 Communities	640 Communitie s
Third-stage	640×[28, 42] Households			19986 Households

Source: China Family Panel Studies User's Manual

In the first and second stages, CFPS used official administrative divisions for the sample selection. The third sampling stage was a systematic selection of housing units from street listing with a random starting point and equal probability method. For the consideration of response rate, the 2010 CFPS survey used the estimated response rates from 2008 and 2009 pilot studies as a reference and enlarged the sample size proportionately. A total of 19,986 households were selected according to systematic sampling principles, which ensured the expected sample size for the survey.

Table 9 Terminal Sample Size of CFPS 2010 Baseline Survey

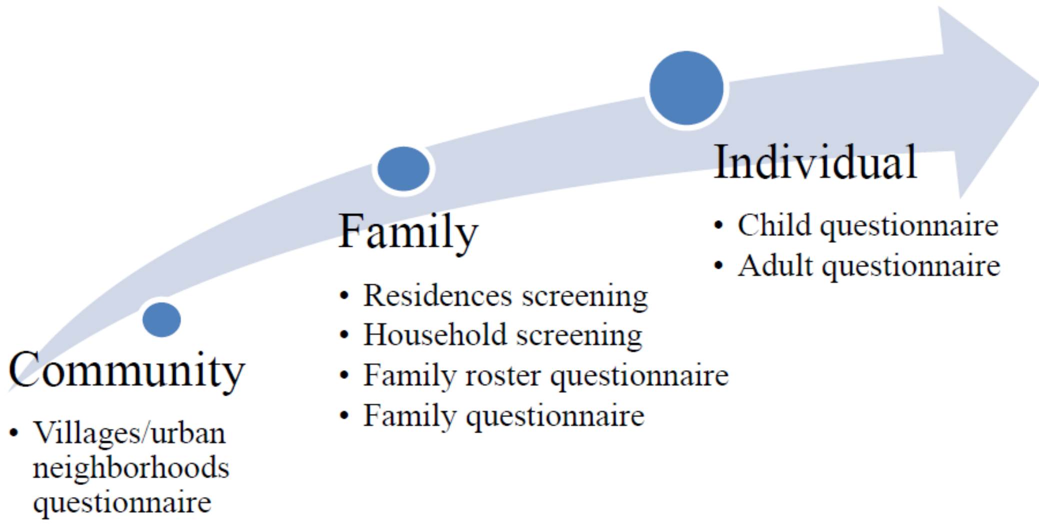
Region	Category	Expected Response Rate	Contacted Sample Size
Low Response Rate	Neighborhood committee (urban area and village in urban fringe)	60%	42
	Other village	70%	36
Intermediate Response Rate	Neighborhood committee (urban area and village in urban fringe)	70%	36
	Other village	80%	32
High Response Rate	Neighborhood committee	80%	32
	Village	90%	28

Source: China Family Panel Studies User's Manual

It is important to note that CFPS sampled the Chinese population as a whole instead of using traditional sampling methods which sampled urban and rural areas separately. The reason behind this is that the official rural-urban division can hardly reflect the reality of China's rapid urbanization. At the community level, this survey collected information regarding whether the sampled communities were urban neighborhoods or villages. At the household and individual level, this survey identified the "hukou" type and whether the household engaged in non-agricultural work or not. Users of such data may decide for themselves whether the community is rural or urban using such information rather than relying on administrative divisions.

Five major questionnaires were designed in the CFPS: the community questionnaire, the family roster questionnaire, the family questionnaire, the child questionnaire and the adult questionnaire. Surveys were conducted at three levels. At the community level, CFPS did an overall interview of the sampled villages/urban communities using the community questionnaire, mainly focusing on the infrastructure, population structure, policy implementation, economy, and social service, etc. At the family level, one member of each eligible household filled out two questionnaires, one on the family members basic information and members relationships, and the other on the basic information of the whole family. At the individual level, eligible individuals were surveyed, with children under 16 answering child questionnaires and family members older than 16 answering adult questionnaires. The child questionnaire was divided into two parts: proxy questionnaires answered by the child's guardian for children aged between 0 to 15, and a self-report for those aged 10 to 15.

Figure 14 The Levels of the Major Questionnaires in CFPS



Source: China Family Panel Studies User's Manual

6.3 Sampled Size

The data used in the analysis of this study is the cross-sectional data of CFPS2016 published by Peking University and all children aged 0-15 years because it is the latest available data and contains the most complete set of variables. After omitting the missing data, the total sample included 4,513 children. Among them, the total sample size of children in single-parent families is 237, including 149 in single-mother families, and 88 in single-father families. The total sample size of dual-parent families is 4,276. The detailed data cleaning process is shown in appendix II.

CHAPTER VII. RESULTS AND DISCUSSION

7.1 Summary Statistics

In this study, there are a total of 4,513 children samples. We use age as a sub-sample grouping. There are 1,589 children aged 0-5 (accounting for 35.21% of the total sample size), 1,545 children aged 6-10 (accounting for 34.23% of the total sample size), and 1,379 children aged 11-15 (accounting for 30.56% of the total sample size). The details are shown in the table 10：

Table 10 Summary Statistics of the Child Age Distribution in this study

Child Age	Freq.	Percent	Cum.
0-5	1,589	35.21	35.21
6-10	1,545	34.23	69.44
11-15	1,379	30.56	100.00

This research mainly focuses on the impact of family structure on children's health. Because children's health may be varying cross different age group, in this study sub-sample analysis is conducted. So, Table 11 below provides distribution of the family structure by child age group. And table 11 also shows us the Chi2 test result. The type of family structure is the dual-parent family of 1,465 children aged between 0-5, 1,492 children aged between 6-10 and 1,319 children aged between 11-15. There are 4276 children in the dual-parent family for all age groups. For the single-mother parent family in this research, there are 80 children aged 0-5, 39 children aged 6-10 and 30 children aged 11-15. There are total of 149 children in a single mother parent family. The type of family structure is the single-father parent family of 44 children aged between 0-5, 14 children aged between 6-10 and 30 children aged between 11-15. There are altogether 88 children in the dual-parent family. The distribution of different age groups in different family types is significantly different.

Table 11 Chi2 test to show different distribution of family types

	0-5 years old	**6-10 years old**	**11-15 years old**	**Total**
Dual parent	1,465 (34.26%)	1,492 (34.89%)	1,319 (34.85%)	4,276 (94.75%)
Single mother	80 (53.69%)	39 (26.17%)	30 (20.14%)	149 (3.30%)
Single father	44 (50%)	14 (15.90%)	30 (34.10%)	88 (1.95%)
			Pearson chi2(4) = 38.7897	Pr = 0.000

In this research, the necessary information of all the data and all the content of the variables already shown in Table 12. In the complete 4,513 samples, the mean of HAZ is -0.311, the minimum is -4.996, and the maximum is 4.948. According to the standards provided by the WHO, this value shows that the overall physiological health level of the children in the sample data is 0.3 standard deviations lower than the reference value. Still, it cannot say that the children in the sample are unhealthy; this only reflects a general situation in this study.

The variable of the ill mean is 0.719 because this variable is a dummy variable, the 0 means this child have sick in the past four weeks, the 1 means this child did not get sick in the past four weeks. In this sample size, we have 1,268 (28.1%) of children who got the sick in the past four weeks, 3,245 (71.9%) of children who did not get sick in the past four weeks. The family income means is 66,459 (unit yuan). It is about over $10,000 (according to the exchange rate between yuan and US dollar in 2016 that is 1$=6.6423 yuan), which means our sample size has a higher family income level in 2016. Because log (family income) is a more similar normal distribution compare with family income, so in this study, we use the transform variable of family income that is log (family income) in the regression model. In a simple statistical description, according to the distribution of Family income, quartiles of their family income is only used in our study to investigate the simple relationship between family income level and child physical health.

According to the literature review, we divided family structure into three categories, the dual-parent family, the single mother family, and the single father family. We introduce categorical variables to capture family structure. The average child age in this study is 7.677, the minimum is 0, and the maximum is 15 years old. We have a 2,408 number of boys, accounting for 53.36% in the total sample size. We have a 2,105 number of girls, accounting for 46.64% in the full sample size. The number of children with Han nationality is 4,038, accounting for 89.47% in the total sample size. The number of minorities is 475, accounting for 10.53% in the full sample size (4,513).

In this research, we have 4,126 number of data about the child birthweight, 387 missing data. So, we only have 170 observations is low birthweight (<2,500g), accounting for 4.12% in the total sample size (4,513). Only have 13.23% (597) of children who have no health insurance. The average parent years of education are 8.258, the minimum is 0, and the maximum is 21. For the parent weight(kg) and height(cm), the average value is 63.41kg, and the minimum is 32.5kg; the maximum is 110kg, the average height of the parent is 164.7cm, and the minimum is 127cm, the maximum is 190cm. In this sample size, we have 76.8% of parental recently work status is working, 23.2% of the parental is not working. Only have 28.1% of the parent drinking and over half(57.94%) parent smoking. The household size is a continuous variable, the mean is 5.316, the minimum is two, and the maximum is 14. We have 56.2% of the children live in rural areas; 43.8 % of children live in an urban area. There are 27.1% of children that are taken care by their parents in grand this sample (0-15 years old). we named this situation is intergeneration care.

In this study, we used a sub-sample analysis method to divide the age of children into three groups, 0-5 years old, 6-10 years old, 11-15 years old. We also analyze sample of 0-10-year-old children. The variables used in the sub-sample study are the same as shown in Table 12. The summary statistics for the subsamples are also quite similar to those presented in Table 12. The summary statistics for each subsample can be found on Table 13 to 16. Their variables information and essential characteristics of data are shown in the following table 13 to 16.

Table 12 Summary of all variables for the total sample (0-15 years old)

VARIABLES	**N**	**Mean**	**Std.Dev**	**Min**	**Max**
HAZ	4,513	-0.311	1.740	-4.996	4.948
Ill	4,513	0.719	0.450	0	1
Family income	4,513	66,459	101,996	0	2.160e+06
Log (family income)	4,513	10.62	1.227	0	14.59
Family income quartile	4,513	2.405	1.097	1	4
Dual parent family	4,513	0.9474	0.223	0	1
Single mother family	4,513	0.0330	0.179	0	1
Single father family	4,513	0.0195	0.138	0	1
Child age	4,513	7.677	4.318	0	15
Boy	4,513	0.534	0.499	0	1
Girl	4,513	0.466	0.498	0	1
Han	4513	0.894	0.307	0	1
Minority	4,513	0.105	0.307	0	1
Child low birth weight	4,126	0.0413	0.199	0	1
No low birth weight	4,126	0.9587	0.199	0	1
Have health insurance	4,513	0.868	0.339	0	1
No have health insurance	4,513	0.132	0.339	0	1
Parent years of education	4,513	8.258	3.9146	0	21
Parent weight (kg)	4,513	63.41	8.222	32.50	110
Parent height (cm)	4,513	164.7	5.284	127	190
Parental working	4,513	0.768	0.422	0	1

No working	4,513	0.232	0.422	0	1
Parent smoking	4,513	0.579	0.494	0	1
No smoking	4,513	0.420	0.493	0	1
Parent drinking	4,513	0.281	0.450	0	1
No drinking	4,513	0.719	0.450	0	1
Household Size	4,513	5.316	1.921	2	14
Rural	4,513	0.562	0.496	0	1
Urban	4,513	0.438	0.496	0	1
Intergeneration care	4,513	0.271	0.445	0	1
No intergeneration care	4,513	0.729	0.445	0	1

Table 13 Summary of statistics for the sub-sample (0-5 years old)

VARIABLES	N	Mean	Std.Dev	Min	Max
HAZ	1,589	-0.423	1.908	-4.996	4.948
Ill	1,589	0.600	0.490	0	1
Family income	1,589	75,520	98,186	0	2.060e+06
Log (family income)	1,589	10.77	1.243	0	14.54
Family income quartile	1,589	2.587	1.105	1	4
Dual parent family	1,589	0.9220	0.268	0	1
Single mother family	1,589	0.0503	0.219	0	1
Single father family	1,589	0.0277	0.164	0	1
Child age	1,589	2.890	1.607	0	5
Boy	1,589	0.512	0.500	0	1
Girl	1,589	0.488	0.500	0	1
Han	1,589	0.9138	0.281	0	1
Minority	1,589	0.0862	0.281	0	1
Child low birth weight	1,531	0.0379	0.191	0	1
No low birth weight	1,531	0.9621	0.191	0	1
Have health insurance	1,589	0.792	0.406	0	1
No have health insurance	1,589	0.208	0.406	0	1
Parent years of education	1,589	9.715	3.729	0	21

Parent weight (kg)	1,589	63.31	8.209	39	100
Parent height (cm)	1,589	165.4	5.226	149	187
Parental working	1,589	0.641	0.480	0	1
No working	1,589	0.359	0.480	0	1
Parent smoking	1,589	0.571	0.495	0	1
No smoking	1,589	0.429	0.495	0	1
Parent drinking	1,589	0.245	0.430	0	1
No drinking	1,589	0.755	0.430	0	1
Household Size	1,589	5.504	2.052	2	14
Rural	1,589	0.518	0.500	0	1
Urban	1,589	0.482	0.500	0	1
Intergeneration care	1,589	0.362	0.481	0	1
No intergeneration care	1,589	0.638	0.481	0	1

Table 14 Summary of statistics for the sub-sample (6-10 years old)

VARIABLES	**N**	**Mean**	**Std.Dev**	**Min**	**Max**
HAZ	1,545	-0.342	1.847	-4.952	4.904
Ill	1,545	0.734	0.442	0	1
Family income	1,545	64,384	104,178	0	2.160e+06
Log (family income)	1,545	10.59	1.188	0	14.59
Family income quartile	1,545	2.346	1.092	1	4
Dual parent family	1,545	0.9657	0.182	0	1
Single mother family	1,545	0.0252	0.157	0	1
Single father family	1,545	0.00906	0.0948	0	1
Child age	1,545	7.925	1.392	6	10
Boy	1,545	0.537	0.499	0	1
Girl	1,545	0.463	0.499	0	1
Han	1,545	0.885	0.319	0	1
Minority	1,545	0.115	0.319	0	1
Child low birth weight	1,402	0.0328	0.178	0	1
No low birth weight	1,402	0.9672	0.178	0	1

Have health insurance	1,545	0.917	0.276	0	1
No have health insurance	1,545	0.083	0.276	0	1
Parent years of education	1,545	7.862	3.687	0	18
Parent weight (kg)	1,545	63.55	7.997	43	110
Parent height (cm)	1,545	164.6	5.055	130	187
Parental working	1,545	0.803	0.398	0	1
No working	1,545	0.197	0.398	0	1
Parent smoking	1,545	0.587	0.493	0	1
No smoking	1,545	0.413	0.493	0	1
Parent drinking	1,545	0.302	0.459	0	1
No drinking	1,545	0.698	0.459	0	1
Household Size	1,545	5.465	1.944	2	14
Rural	1,545	0.588	0.492	0	1
Urban	1,545	0.412	0.492	0	1
Intergeneration care	1,545	0.304	0.460	0	1
No intergeneration care	1,545	0.696	0.460	0	1

Table 15 Summary of statistics for the sub-sample (0-10 years old)

VARIABLES	N	Mean	Std.Dev	Min	Max
HAZ	3,134	-0.383	1.878	-4.996	4.948
Ill	3,134	0.666	0.472	0	1
Family income	3,134	70,030	101,321	0	2.160e+06
Log (family income)	3,134	10.68	1.219	0	14.59
Family income quartile	3,134	2.468	1.105	1	4
Dual parent family	3,134	0.944	0.231	0	1
Single mother family	3,134	0.0380	0.191	0	1
Single father family	3,134	0.0185	0.135	0	1
Child age	3,134	5.372	2.933	0	10
Boy	3,134	0.524	0.499	0	1
Girl	3,134	0.476	0.499	0	1
Han	3,134	0.899	0.301	0	1
Minority	3,134	0.101	0.301	0	1

Child low birth weight	2,933	0.0355	0.185	0	1
No low birth weight	2,933	0.9645	0.185	0	1
Have health insurance	3,134	0.854	0.354	0	1
No have health insurance	3,134	0.146	0.354	0	1
Parent years of education	3,134	8.801	3.822	0	21
Parent weight (kg)	3,134	63.43	8.105	39	110
Parent height (cm)	3,134	165.0	5.157	130	187
Parental working	3,134	0.279	0.449	0	1
No working	3,134	0.721	0.449	0	1
Parent smoking	3,134	0.579	0.494	0	1
No smoking	3,134	0.421	0.494	0	1
Parent drinking	3,134	0.273	0.446	0	1
No drinking	3,134	0.727	0.446	0	1
Household Size	3,134	5.485	1.999	2	14
Rural	3,134	0.553	0.497	0	1
Urban	3,134	0.447	0.497	0	1
Intergeneration care	3,134	0.333	0.472	0	1
No intergeneration care	3,134	0.667	0.472	0	1

Table 16 Summary of statistics for the sub-sample (11-15 years old)

VARIABLES	N	Mean	Std.Dev	Min	Max
HAZ	1,379	-0.147	1.362	-4.937	4.205
Ill	1,379	0.839	0.368	0	1
Family income	1,379	58,342	103,093	0	2.000e+06
Log (family income)	1,379	10.50	1.237	0	14.51
Family income quartile	1,379	2.261	1.065	1	4
Dual parent family	1,379	0.956	0.204	0	1
Single mother family	1,379	0.0218	0.146	0	1
Single father family	1,379	0.0218	0.146	0	1
Child age	1,379	12.92	1.393	11	15

Boy	1,379	0.555	0.497	0	1
Girl	1,379	0.445	0.497	0	1
Han	1,379	0.884	0.320	0	1
Minority	1,379	0.116	0.320	0	1
Child low birth weight	1,193	0.0553	0.229	0	1
No low birth weight	1,193	0.9447	0.229	0	1
Have health insurance	1,379	0.900	0.300	0	1
No have health insurance	1,379	0.100	0.300	0	1
Parent years of education	1,379	7.024	3.844	0	16.50
Parent weight (kg)	1,379	63.37	8.484	32.50	110
Parent height (cm)	1,379	164.0	5.501	127	190
Parental working	1,379	0.875	0.331	0	1
No working	1,379	0.125	0.331	0	1
Parent smoking	1,379	0.581	0.494	0	1
No smoking	1,379	0.419	0.494	0	1
Parent drinking	1,379	0.299	0.458	0	1
No drinking	1,379	0.299	0.458	0	1
Household Size	1,379	4.933	1.666	2	13
Rural	1,379	0.582	0.493	0	1
Urban	1,379	0.418	0.493	0	1
Intergeneration care	1,379	0.129	0.335	0	1
No intergeneration care	1,379	0.871	0.335	0	1

7.2 Cross-tabulation Between Child Physical Health and Family Income, Family Structure

Before performing regression, we use some simple data feature analysis to get some basic sample data features about family structure and family income and children's health that are the main content of this research. As shown in Table 17 below, it mainly indicates some cross-tabulation information between children's physical health indicators HAZ, family income, and family structure. First of all, in Table 17, we can see that different family structure children's physical health indicators HAZ, and family income are different. Compared with the dual-parent family and the single-father family, the child's physiological health indicator HAZ value is the lowest (-0.7632503), which shows that the child's physical health status in the single-father family is lower than that of the single-mother family and the dual-parent f family. But what is interesting is that the children's physiological health index value HAZ is the highest for children in single-mother family among the three family structure classifications (-0.154039).

For family income, it is different among different family structures. Among the three categories of family structure, the family income of the single-mother family is the lowest (49428.81 yuan), followed by the single-father family (59864.15 yuan). The family income of the dual-parent family is the highest (67187.86 yuan). This data feature is reasonable, because generally speaking, the family income of the single-parent family is inevitably lower than that of the family and the single-mother as a socially disadvantaged group; in most cases, their family income is low.

Table 17 Simple Cross-tabulation between Child Physical Health and Family Income, Family Structure

Family Structure	Observations	Variables	Mean
Dual parent family	4,276 (94.75%)	HAZ	-.3072036
		Family Income	67187.86
Single- mother family	149 (3.30%)	HAZ	-.154039
		Family Income	49428.81
Single-Father Family	88 (1.95%)	HAZ	-.7632503
		Family Income	59864.15

Note: The unit of family income is yuan.

To explore the strength of the relationship between different household income levels and children's physiological health indicators HAZ values, we use the quartiles to preliminary analyze the family income and child health indicators HAZ values in different age groups. Since household income and HAZ are continuous variables, and approximately follow a normal distribution, we use the simple correlation analyses to test their correlation strength. The results are shown in Table 18 below.

From Table 18, we can see that the HAZ value shows the following characteristics in different income gradients: First, the HAZ value with the lowest income is also the shortest. The HAZ value with the highest income is even higher, and the HAZ ranges from low to the high-income range also shows an increasing trend from low to high, and the results are the same in different age groups. Second, in the first income range with the most insufficient income, the HAZ value of children aged 11-15 is the highest (-0.523). The HAZ value of children aged 6-10 is the lowest (-0.828), which may indicate that the income in the lowest group, the health of children aged 6-10 is weaker than the other two groups. In the middle-income group, which is the second income gradient, the HAZ value of children aged 11-15 is the highest (-0.204), and the HAZ value of children aged 0-5 and children 6-10 is almost equal (-0.448, -0.445). In the third income gradient, the HAZ value of children aged 11-15 is the highest (0.062), and the HAZ value of children aged 0-5 is the lowest (-0.435). Among the highest-income families, it is the fourth income in the gradient, the HAZ index value of children aged 11-15 was the highest (0.344), and the HAZ value of children aged 0-5 was the lowest (-0.237).

Besides, Table 18 also shows the pairwise correlation coefficients (ρ) between log (family income) and HAZ in different age groups. The correlation coefficients are all statistically significant and positive. This relationship is the strongest among children aged 6-10, and the weaker the relationship between family income and children's physical health HAZ value among children aged 0-5.

Table 18 Child HAZ and Family income quartile

		0-5	6-10	0-10	11-15	0-15
Family income quartile	First	-0.633	-0.828	-0.742	-0.523	-0.664
	Second	-0.448	-0.445	-0.447	-0.204	-0.370
	Third	-0.435	0.052	-0.216	0.062	-0.131
	Fourth	-0.237	0.085	-0.101	0.344	0.004
ρ(Log(family income), HAZ)		0.072^{***}	0.173^{***}	0.118^{***}	0.164^{***}	0.123^{***}

Note: HAZ is the mean value of different age groups. *** p<0.01, The numbers displayed in the table are retained three decimal places

According to the criteria provided by WHO to measure HAZ, if the HAZ value is less than -2, then the child's health status is defined as growth retardation. Table 19 shows the distribution of different samples in the four income gradients and the number of children facing growth retardation problems by varying age groups, in this study (the ratio is calculated using growth retardation of different ages the number of children divided by the number of children at different gradients of income). We found that children with lower incomes face higher risks of growth retardation and vice versa. Children under the age of ten are most likely to face growth retardation, and children under the age of ten in low-income families are most likely to face growth retardation. Overall, of the 4513 sample children in this study, 711 children had growth retardation, accounting for 15.73% of the total sample. Although less than one-fifth, this child health problem still deserves our inquiry and attention.

Table 19 Accounting for each Family income quartile of Child HAZ<-2(Growth retardation)

Family income quartile	Sample	0-5	6-10	0-10	11-15	0-15
First	1,141	77 (6.75%)	113 (9.90%)	190 (16.65%)	63 (5.53%)	253 (22.17%)
Second	1,435	110 (7.67%)	90 (6.27%)	200 (13.94%)	31 (2.16%)	231 (16.10%)
Third	906	55 (6.07%)	32 (3.52%)	87 (9.60%)	11 (1.21%)	98 (10.81%)

Fourth	1,031	79 (7.66%)	39 (3.78%)	118 (11.44%)	11 (1.07%)	129 (12.51%)
Total	4,513	321 (7.11%)	274 (6.06%)	595 (13.17%)	116 (2.56%)	711 (15.73%)

Note: The numbers displayed in the table are retained two decimal places.

As shown in Table 20, the average HAZ value of children with different family structures by age groups is already showing us. We can find from Table 20 that among children aged 6-10, the HAZ value of the child in the single-mother family is the highest. Still, in any age group, the HAZ value of the child in the single-father family is The lowest, compared with a single mother family and a dual-parent family. We used a one-way analysis of variance to test whether the mean HAZ of children in different family structures differed. The specific test method used is the Bonferroni method. The results show that for children aged 0-5 years and 11-15 years, the mean value of HAZ is not significantly different in different family structures. Still, for children of other age groups, the mean value of HAZ is significant in different families, especially for children aged 6-10.

Table 20 Child HAZ and Family structure

		0-5	6-10	0-10	11-15	0-15
Family Structure	Dual parent	-0.430	-0.339	-0.384	-0.135	-0.307
	Single mother	-0.248	0.088	-0.138	-0.218	-0.154
	Single father	-0.503	-1.905	-0.841	-0.613	-0.763
Anova (Family structure, HAZ)		0.681	0.002***	0.065*	0.158	0.028**

Note: * p<0.1, ** p<0.05, *** p<0.01; The numbers displayed in the table are retained three decimal places

Table 21 shows the distribution of children with growth retardation (HAZ<-2) in different family structures and the corresponding proportions. We can see that 15.73% of the 4513 children in the total sample are facing growth retardation. In different family structures, only dual parents' family have the same proportion of children with growth retardation as the overall sample. The ratio of children in single-parent families with growth retardation problems is greater than the incidence of growth retardation in the overall sample, with children from single-father families having the highest proportion (22.73%).

Table 21 The Simple Summary about the Number of Child HAZ<-2 in Different Family Structure by Age Group

Family Structure	Sample	0-5	6-10	0-10	11-15	0-15
Dual parent	4,276	293 (6.85%)	262 (6.13%)	555 (12.98%)	110 (2.57%)	665 (15.55%)
Single parent	237	28 (11.81%)	12 (5.06%)	40 (16.87%)	6 (2.53%)	46 (19.40%)
Single mother	149	19 (12.75%)	6 (4.03%)	25 (16.78%)	1 (0.67%)	26 (17.45%)
Single father	88	9 (10.23%)	6 (6.82%)	15 (17.05%)	5 (5.68%)	20 (22.73%)
Total	4,513	321 (7.11%)	274 (6.06%)	595 (13.17%)	116 (2.56%)	711 (15.73%)

Note: The numbers displayed in the table are retained two decimal places

In summary, we found that there is a strong relationship between the family structure and family income and the child health index HAZ. Children with different family structures have significant differences in HAZ values. This difference is mainly reflected in single-parent families and dual-parent families. In particular, single-father families is associated with lowest HAZ. There are also substantial differences in the HAZ value of children with different family incomes. This difference is mainly reflected in families with low and high-income gradients. Since single-parent families usually have lower incomes than dual-parent families, especially single-mother parent families. Family income is positively related to HAZ value. The higher the family income, the greater the HAZ value. Generally speaking, if the HAZ value is less than -2, we think that the child has a problem of growth retardation in the process of growth and development. Through the above superficial statistical characteristics, we find that children with growth retardation are mainly distributed in low-income families and single parents In the family, especially the single-father parent family, this shows that the physical health of the children of the single-parent family is in a particular disadvantage compared with the dual-parent family, especially the low-income single-father parent family.

7.3 Regression Result

7.3.1 OLS Regression Result

In this study, we first use the OLS model in the multiple linear regression model to explore the impact of family income and family structure on children's health. Because our explanatory variables include not only family income and family structure, but also many factors that may have a particular impact on children's health, such as genetic factors of parents-the specific variables related to genetic characteristics of parents in this study are height and weight, the geographic location of the family, the parent's health behavior-specifically smoking and drinking, and some of the child's factors-age, gender, ethnicity, insurance, etc.. To simplify our model and eliminate some irrelevant factors, we conducted an F-test of incremental parameters before determining the final regression result. This method can help us to identify which variables should be included in our model. Because we conduct subsample analysis by children's ages, we also did F-test of incremental parameters for different age groups. For example, children aged 0-15, I first test Model 1 against Model 2. I find the test favors Model2. Second, I test Model 3 against Model 2, I find the test favors Model 2. Third, I test Model 4 against Model 2, I find the test favors Model 4. Then, I test Model 5 against Model 5, I find the test favors Model5. Finally, it is found that Model 5 is most suitable for the data. The method for other age groups is similar to that for children aged 0-15. Tables 22, 23, 24, 25, and 26 show us the regression results and test results of children aged 0-15, 0-5, 5-10, 0-10, 11-15, and the results show that the Models 5 are the best for children aged 0-15 years, 0-5 years, 6-10 years, and 0-10 years, while model 2 is better for children 11-15 years old.

Table 22 Five Regressions with Different List of Variables for HAZ (0-15 years old)

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5
single_m	0.425***	0.492***	0.489***	0.513***	0.624***
	(0.139)	(0.142)	(0.142)	(0.143)	(0.152)
single_f	-0.627***	-0.594***	-0.605***	-0.574***	-0.598***
	(0.177)	(0.177)	(0.177)	(0.178)	(0.184)
log_finc	0.0694***	0.0723***	0.0719***	0.0733***	0.0786***
	(0.0213)	(0.0213)	(0.0213)	(0.0213)	(0.0225)
c_age	0.0421***	0.0465***	0.0478***	0.0444***	0.0471***
	(0.00604)	(0.00625)	(0.00632)	(0.00634)	(0.00654)
Boy	0.0553	0.0652	0.0651	0.0649	0.0562
	(0.0489)	(0.0489)	(0.0489)	(0.0489)	(0.0508)
Min	-0.459***	-0.441***	-0.440***	-0.448***	-0.342***
	(0.0812)	(0.0815)	(0.0815)	(0.0816)	(0.0874)
Pw	0.0311***	0.0310***	0.0310***	0.0308***	0.0297***
	(0.00329)	(0.00329)	(0.00329)	(0.00329)	(0.00343)
Ph	0.0422***	0.0428***	0.0428***	0.0435***	0.0423***
	(0.00515)	(0.00515)	(0.00515)	(0.00516)	(0.00555)
p_edu	0.0525***	0.0554***	0.0551***	0.0565***	0.0513***
	(0.00754)	(0.00756)	(0.00756)	(0.00758)	(0.00797)
HSize	-0.0401***	-0.0424***	-0.0412***	-0.0401***	-0.0420***
	(0.0134)	(0.0134)	(0.0134)	(0.0134)	(0.0139)
Rural	-0.168***	-0.155***	-0.154***	-0.152***	-0.159***
	(0.0543)	(0.0544)	(0.0544)	(0.0544)	(0.0561)
p_work		-0.176***	-0.176***	-0.157**	-0.148**
		(0.0604)	(0.0604)	(0.0612)	(0.0629)
p_smoke		0.0812	0.0810	0.0853*	0.0808
		(0.0511)	(0.0511)	(0.0511)	(0.0531)
p_drink		0.137**	0.136**	0.135**	0.144**
		(0.0551)	(0.0551)	(0.0551)	(0.0571)
HI			-0.0942		
			(0.0732)		
Icare				-0.108*	-0.0876
				(0.0577)	(0.0596)
Lowbw					-0.452***
					(0.128)
Constant	-10.40***	-10.53***	-10.47***	-10.65***	-10.39***
	(0.820)	(0.819)	(0.820)	(0.821)	(0.883)

Observations	4,513	4,513	4,513	4,513	4,126
R-squared	0.121	0.124	0.125	0.125	0.118

F-test of incremental variables

	Model 1	Model 2	Model 3	Model 4	Model 5
H_0		Model 1	Model 2	Model 2	Model 4
H_1		Model 2	Model 3	Model 4	Model 5
F-statistic		6.42***	1.66	3.49**	12.56***

Note: The above models have passed the multicollinearity test and heteroscedasticity test. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 23 Five Regressions with Different List of Variables for HAZ (0-5 years old)

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5
single_m	0.480**	0.577**	0.577**	0.573**	0.592**
	(0.221)	(0.229)	(0.229)	(0.229)	(0.239)
single_f	-0.392	-0.368	-0.369	-0.373	-0.368
	(0.289)	(0.290)	(0.291)	(0.291)	(0.289)
log_finc	0.0540	0.0553	0.0552	0.0547	0.0764*
	(0.0397)	(0.0399)	(0.0400)	(0.0400)	(0.0409)
c_age	-0.0464	-0.0425	-0.0391	-0.0429	-0.0466
	(0.0294)	(0.0301)	(0.0320)	(0.0302)	(0.0304)
Boy	-0.0572	-0.0552	-0.0555	-0.0565	-0.0230
	(0.0932)	(0.0932)	(0.0932)	(0.0933)	(0.0944)
Min	-0.270	-0.250	-0.248	-0.246	-0.226
	(0.170)	(0.171)	(0.171)	(0.171)	(0.173)
Pw	0.0261***	0.0261***	0.0261***	0.0262***	0.0257***
	(0.00632)	(0.00633)	(0.00633)	(0.00634)	(0.00645)
Ph	0.0437***	0.0435***	0.0436***	0.0433***	0.0410***
	(0.0100)	(0.0101)	(0.0101)	(0.0101)	(0.0103)
p_edu	0.0446***	0.0497***	0.0497***	0.0491***	0.0444***
	(0.0145)	(0.0147)	(0.0147)	(0.0148)	(0.0150)
HSize	-0.0211	-0.0225	-0.0223	-0.0228	-0.0369
	(0.0243)	(0.0243)	(0.0243)	(0.0243)	(0.0246)
Rural	0.0528	0.0537	0.0532	0.0532	0.0341
	(0.102)	(0.102)	(0.102)	(0.102)	(0.103)
p_work		-0.0870	-0.0889	-0.0954	-0.0845
		(0.102)	(0.102)	(0.105)	(0.106)
p_smoke		0.141	0.141	0.139	0.132
		(0.100)	(0.100)	(0.100)	(0.101)
p_drink		0.117	0.117	0.118	0.110
		(0.112)	(0.112)	(0.112)	(0.112)
HI			-0.0375		

			(0.122)		
Icare				0.0368	0.0492
				(0.102)	(0.103)
Lowbw					-0.577**
					(0.248)
Constant	-10.05***	-10.16***	-10.15***	-10.12***	-9.812***
	(1.597)	(1.599)	(1.600)	(1.603)	(1.631)
Observations	1,589	1,589	1,589	1,589	1,531
R-squared	0.064	0.066	0.066	0.066	0.071

F-test of incremental variables

	Model 1	Model 2	Model 3	Model 4	Model 5
H_0		Model 1	Model 2	Model 2	Model 4
H_1		Model 2	Model 3	Model 4	Model 5
F-statistic		1.58	0.09	0.13	5.43**

Note: The above models have passed the multicollinearity test and heteroscedasticity test. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 24 Five Regressions with Different List of Variables for HAZ (6-10 years old)

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5
single_m	0.443	0.481*	0.478*	0.536*	0.840***
	(0.279)	(0.284)	(0.284)	(0.285)	(0.310)
single_f	-1.608***	-1.556***	-1.562***	-1.529***	-1.654***
	(0.461)	(0.460)	(0.460)	(0.460)	(0.510)
log_finc	0.104***	0.108***	0.109***	0.110***	0.0916**
	(0.0395)	(0.0394)	(0.0394)	(0.0394)	(0.0424)
c_age	0.0324	0.0400	0.0398	0.0380	0.0438
	(0.0315)	(0.0316)	(0.0316)	(0.0315)	(0.0326)
Boy	0.0291	0.0475	0.0496	0.0463	0.0150
	(0.0875)	(0.0875)	(0.0875)	(0.0874)	(0.0904)
Min	-0.589***	-0.570***	-0.568***	-0.583***	-0.387**
	(0.139)	(0.140)	(0.140)	(0.140)	(0.152)
Pw	0.0342***	0.0343***	0.0343***	0.0342***	0.0322***
	(0.00594)	(0.00593)	(0.00593)	(0.00593)	(0.00616)
Ph	0.0420***	0.0430***	0.0431***	0.0443***	0.0478***
	(0.00935)	(0.00934)	(0.00934)	(0.00935)	(0.0100)
p_edu	0.0559***	0.0575***	0.0572***	0.0592***	0.0524***
	(0.0135)	(0.0135)	(0.0135)	(0.0135)	(0.0142)
HSize	-0.0783***	-0.0809***	-0.0797***	-0.0762***	-0.0672***
	(0.0232)	(0.0232)	(0.0233)	(0.0233)	(0.0242)
Rural	-0.366***	-0.339***	-0.337***	-0.326***	-0.309***
	(0.0965)	(0.0970)	(0.0971)	(0.0971)	(0.0992)

p_work		-0.294***	-0.294***	-0.267**	-0.257**
		(0.111)	(0.111)	(0.111)	(0.113)
p_smoke		-0.000885	-0.00354	0.0106	-0.00603
		(0.0906)	(0.0906)	(0.0906)	(0.0933)
p_drink		0.181*	0.181*	0.176*	0.176*
		(0.0956)	(0.0957)	(0.0956)	(0.0983)
HI			-0.131		
			(0.158)		
Icare				-0.194**	-0.203**
				(0.0964)	(0.0998)
Lowbw					-0.573**
					(0.252)
Constant	-10.53***	-10.65***	-10.55***	-10.87***	-11.13***
	(1.521)	(1.517)	(1.522)	(1.519)	(1.633)
Observations	1,545	1,545	1,545	1,545	1,402
R-squared	0.157	0.163	0.164	0.165	0.146

F-test of incremental variables

	Model 1	Model 2	Model 3	Model 4	Model 5
H_0		Model 1	Model 2	Model 2	Model 4
H_1		Model 2	Model 3	Model 4	Model 5
F-statistic		1.58	0.09	0.13	5.43**

Note: The above models have passed the multicollinearity test and heteroscedasticity test. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 25 Five Regressions with Different List of Variables for HAZ (0-10 years old)

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5
single_m	0.454***	0.509***	0.508***	0.529***	0.652***
	(0.171)	(0.176)	(0.176)	(0.176)	(0.186)
single_f	-0.651***	-0.593**	-0.601**	-0.580**	-0.551**
	(0.240)	(0.240)	(0.240)	(0.241)	(0.245)
log_finc	0.0859***	0.0895***	0.0894***	0.0908***	0.0892***
	(0.0281)	(0.0281)	(0.0281)	(0.0281)	(0.0295)
c_age	0.0316***	0.0384***	0.0423***	0.0377***	0.0428***
	(0.0114)	(0.0118)	(0.0122)	(0.0118)	(0.0120)
Boy	-0.00589	0.00436	0.00473	0.00563	-0.00128
	(0.0641)	(0.0641)	(0.0641)	(0.0641)	(0.0655)
Min	-0.452***	-0.430***	-0.427***	-0.438***	-0.295**
	(0.109)	(0.109)	(0.109)	(0.109)	(0.115)
Pw	0.0314***	0.0313***	0.0311***	0.0311***	0.0297***
	(0.00435)	(0.00434)	(0.00434)	(0.00434)	(0.00447)
Ph	0.0410***	0.0418***	0.0419***	0.0425***	0.0428***

	(0.00688)	(0.00689)	(0.00689)	(0.00690)	(0.00721)
p_edu	0.0498***	0.0536***	0.0535***	0.0550***	0.0496***
	(0.00995)	(0.00999)	(0.00999)	(0.0100)	(0.0104)
HSize	-0.0451***	-0.0474***	-0.0465***	-0.0457***	-0.0481***
	(0.0168)	(0.0168)	(0.0168)	(0.0168)	(0.0172)
Rural	-0.154**	-0.142**	-0.142**	-0.138*	-0.136*
	(0.0705)	(0.0707)	(0.0707)	(0.0707)	(0.0719)
p_work		-0.198***	-0.201***	-0.178**	-0.165**
		(0.0747)	(0.0747)	(0.0760)	(0.0772)
p_smoke		0.0625	0.0621	0.0682	0.0567
		(0.0676)	(0.0676)	(0.0677)	(0.0692)
p_drink		0.153**	0.153**	0.150**	0.145*
		(0.0733)	(0.0733)	(0.0733)	(0.0746)
HI			-0.123		
			(0.0936)		
Icare				-0.103	-0.0895
				(0.0703)	(0.0718)
Lowbw					-0.608***
					(0.177)
Constant	-10.29***	-10.46***	-10.39***	-10.57***	-10.47***
	(1.098)	(1.097)	(1.098)	(1.100)	(1.149)
Observations	3,134	3,134	3,134	3,134	2,933
R-squared	0.097	0.101	0.101	0.101	0.096

F-test of incremental variables

	Model 1	Model 2	Model 3	Model 4	Model 5
H_0		Model 1	Model 2	Model 2	Model 4
H_1		Model 2	Model 3	Model 4	Model 5
F-statistic		4.58^{***}	1.73	2.16	11.80^{***}

Note: Compared with model 2 and model 5, model 5 is better. The above models have passed the multicollinearity test and heteroscedasticity test. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 26 Five Regressions with Different List of Variables for HAZ (11-15 years old)

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5
single_m	0.321	0.407*	0.408*	0.431*	0.478*
	(0.227)	(0.231)	(0.231)	(0.233)	(0.252)
single_f	-0.575**	-0.569**	-0.568**	-0.540**	-0.690***
	(0.225)	(0.225)	(0.226)	(0.228)	(0.242)
log_finc	0.0335	0.0336	0.0337	0.0341	0.0553*
	(0.0283)	(0.0284)	(0.0284)	(0.0284)	(0.0301)
c_age	-0.0312	-0.0279	-0.0279	-0.0310	-0.0191

	(0.0236)	(0.0236)	(0.0236)	(0.0238)	(0.0255)
Boy	0.192***	0.199***	0.199***	0.196***	0.198***
	(0.0660)	(0.0661)	(0.0662)	(0.0662)	(0.0704)
Min	-0.476***	-0.468***	-0.468***	-0.471***	-0.432***
	(0.105)	(0.105)	(0.105)	(0.105)	(0.115)
Pw	0.0310***	0.0311***	0.0311***	0.0310***	0.0303***
	(0.00438)	(0.00439)	(0.00439)	(0.00439)	(0.00467)
Ph	0.0428***	0.0429***	0.0429***	0.0436***	0.0389***
	(0.00667)	(0.00668)	(0.00668)	(0.00672)	(0.00760)
p_edu	0.0575***	0.0594***	0.0594***	0.0599***	0.0559***
	(0.0101)	(0.0102)	(0.0102)	(0.0102)	(0.0110)
HSize	-0.0192	-0.0219	-0.0219	-0.0191	-0.0188
	(0.0204)	(0.0204)	(0.0206)	(0.0207)	(0.0219)
Rural	-0.188**	-0.173**	-0.173**	-0.175**	-0.195**
	(0.0751)	(0.0756)	(0.0756)	(0.0757)	(0.0794)
p_work		-0.0886	-0.0886	-0.0847	-0.120
		(0.0996)	(0.0997)	(0.0997)	(0.104)
p_smoke		0.109	0.109	0.109	0.120*
		(0.0678)	(0.0678)	(0.0678)	(0.0720)
p_drink		0.105	0.105	0.106	0.134*
		(0.0721)	(0.0722)	(0.0721)	(0.0763)
HI			0.00413		
			(0.110)		
Icare				-0.0917	-0.0400
				(0.102)	(0.109)
Lowbw					-0.200
					(0.153)
Constant	-9.316***	-9.426***	-9.431***	-9.499***	-8.994***
	(1.108)	(1.110)	(1.116)	(1.113)	(1.251)
Observations	1,379	1,379	1,379	1,379	1,193
R-squared	0.219	0.223	0.223	0.223	0.211

F-test of incremental variables

	Model 1	Model 2	Model 3	Model 4	Model 5
H_0		Model 1	Model 2	Model 2	Model 4
H_1		Model 2	Model 3	Model 4	Model 5
F-statistic		2.01^{*}	0.00	0.81	1.71

Note: The above models have passed the multicollinearity test and heteroscedasticity test. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 27 below shows us the results of OLS regression for each age group, and the table also shows the results of the sub-sample analysis. In general, for all children (0-15 years old), including sub-sample children of different age groups, the effect of family structure on child physical health-HAZ is significant. That means the family structure of a single mother has a significant impact on child physical health-HAZ. This effect is positive. However, their significance levels and impact coefficients are different, and this effect will be greater and more significant (the coefficient β of 0.840) for children aged 6-10 years (significance level $P<0.01$). For children aged 11-15 years, relatively weaker coefficient is found (the coefficient β of 0.407), but still significant (significance level $P<0.1$). For example, for 0-10-year-old child, the family structure of a single mother has a significant impact on HAZ. This effect is positive, with a coefficient β of 0.840—that means, if the child is in a single mother family, the HAZ value will increase by 0.840, and it is statistically significant at 1%. In this case, different from our expected results, we expect that single-parent families are at a disadvantage in terms of children's physical health compared with dual-parent families. But this situation can also be said. First, it is a fact that mothers are better than fathers in raising children. Single-mother knowing that her children lack the father, she may want to compensate her children by taking care of them really well. She may spend more resources on her children and thus result in better child health outcome than dual-parent family. On the other hand, the sample size of this study is small, so it is also possible that the relationship between the sample size caused this unexpected deviation.

For children with a single-father family structure, this significant direction of influence is reversed, which is a negative impact compared to dual-parent families. Through sub-sample analysis, we found that for different age groups, the coefficient β of this effect is negative, but for children aged 0-5 years, this effect is not significant, for children aged 6-10 years old and 11-15 years old, this effect is significant. The significance level is $P<0.05$. For example, for 0-10-year-old child, the family structure of a single father has a significant impact on HAZ. This effect is negative, with a coefficient β of -0.551—

that means, if the child is in a single father family, the HAZ value will decrease by -0.551, with a significance level of P<0.05.

Family income is also one of the factors that affect children's health, and there is a significant positive correlation between family income and HAZ. In children aged 0-15, family income has a significant effect on the HAZ value. The value of the correlation coefficient β is 0.0786, which means that family income increases by 1%, the index value of children's physical health HAZ increases by 0.000786%, the significance level is P<0.01. But after analyzing the sub-samples of different age groups, we found that the impact of family income on children aged 0-5 years is relatively weak (correlation coefficient β equals 0.0764, P<0.1), It also has no significant impact on children aged 11-15 years old.

Besides, we also found that age is also one of the factors that affect the child's physiological health index value HAZ, but it is not significant in some subsamples, but in general, as the age increases, the child's health level also increases. In the total sample, gender has no significant effect on the HAZ value, which shows that there is no significant difference in the HAZ value or physiological health level between boys and girls. However, among children aged 11-15, gender had a significant positive effect on HAZ, the coefficient β was equal to 0.199, and the significance level was P<0.01. This means that if a child is a boy aged 11-15 on average will have HAZ higher than girl by 0.199. Similarly, the HAZ values of ethnic minority children and Han children have a significant difference, and the relationship between them is negatively correlated, that is, if the child is a minority child, its HAZ value will decrease on average by 0.342 in the overall sample, which means that minority children have weaker physical health than Han children. But this situation is not significant among children aged 0-5 years old. The height and weight of parents have a significant positive effect on the children's physiological health index value HAZ (P<0.01), which is similar in all samples. This result matches our prior expectation. The height and weight of parents as a form of genetic factors are considered in this study because HAZ uses the child's height as the primary calculation basis. The education level of parents is also one of the factors that affect the HAZ value. In this study, the education level of parents is a continuous variable measured in years. In all age groups, the influence of the education level of parents on the HAZ value is a significant positive correlation ($P<0.01$). For example, for 0-15 years old child, the parent's education level has a significant impact on HAZ. This effect is positive, with a coefficient β of 0.0513—that means, if the parent's education level increases by 1 year, the HAZ value will increase on average by 0.0513, with a significance level of $P<0.01$.

Similarly, household size is also one of the factors that affect children's physical health index HAZ. We can draw some conclusions based on the research results shown in Table 27. First, for different age groups, the effect of household size on HAZ is negative, the larger the household size cause the smaller the HAZ value. However, this effect is not significant for children aged 0-5 years old and children aged 11-15 years old. For children aged 6-10 years, the impact of household size on the HAZ value is significant, with a coefficient β of -0.0672—that means, if the household size increase 1 unit, the HAZ value will decrease by -0.0672, with a significance level of $P<0.01$. The geographical location of the family is also an essential factor that affects the child's physiological health index HAZ. The results of the study show that children in rural areas show a disadvantage compared to children in urban. But in the group of children aged 0-5 years, this weakness is not statistically significant. For example, for 6-10 years old child, geographical location of the family has a significant impact on HAZ. This effect is negative, with a coefficient β of -0.309—that means, if a child geographical location of the family is rural, the HAZ value will decrease by -0.309 comparing for those living in urban area, with a significance level of $P<0.01$.

The mother's work will also have a specific effect on the HAZ value. This effect is negative. The results of this study show that for children aged 0-15, 6-10, and 0-10, the impact of the mother's work on the child's physical health index HAZ is significant. Still, for children aged 0-5 for younger children and older children aged 11-15 years old, although this effect is negative, it is not statistically significant. For example, for 6-10 years old child, the mother's work has a significant impact on HAZ. This effect is negative, with a coefficient β of -0.257—that means, if the mother of a child goes out to work, the HAZ value will decrease by -0.257, with a significance level of $P<0.05$.

In addition, the parents' health risk behavior will also have a certain impact on the child's physical health index HAZ, but smoking behavior has no significant impact on children's physical health, which is true in all age groups. It is interesting that the health behavior of drinking has a significant effect on the HAZ value of children in certain age groups (such as children groups 0-15, 6-10, 0-10 years old), and this effect is positive. The significance level is $P<0.1$. In our study, there is no specific unit of measurement for the variable of drinking, such as how many milliliters of drinking per day, this variable is only for the problem of drinking more than three times in the last month. The answer, so we cannot judge the specific situation of each sample. If a sample only drinks alcohol every day, but only a little at a time, there will not be some consequences of health risk behaviors, but it will promote health. Therefore, we still think that this result in this study is correct and can be explained.

Finally, the child's natural condition, whether it is a low-weight child or not, will also affect the child's physiological health indicator HAZ value. This effect is significant for children under ten years of age, and this effect is negative because When analyzing a sub-sample of 11-15 years old children, our best model does not include this variable, so we do not know the situation of 11-15 years old children. For example, for 0-10 years old child, low birthweight has a significant impact on HAZ. This effect is negative, with a coefficient β of -0.608—that means, if a child is low birthweight, the HAZ value will decrease by -0.608, with a significance level of P<0.01.

Table 27 The Summary of The Result for OLS Regression For HAZ

VARIABLES	0-15 Model 5	0-5 Model 5	6-10 Model 5	0-10 Model 2	11-15 Model 5
single_m	0.624***	0.592**	0.840***	0.652***	0.407*
	(0.152)	(0.239)	(0.310)	(0.186)	(0.231)
single_f	-0.598***	-0.368	-1.654***	-0.551**	-0.569**
	(0.184)	(0.289)	(0.510)	(0.245)	(0.225)
log_finc	0.0786***	0.0764*	0.0916**	0.0892***	0.0336
	(0.0225)	(0.0409)	(0.0424)	(0.0295)	(0.0284)
c_age	0.0471***	-0.0466	0.0438	0.0428***	-0.0279
	(0.00654)	(0.0304)	(0.0326)	(0.0120)	(0.0236)
Boy	0.0562	-0.0230	0.0150	-0.00128	0.199***
	(0.0508)	(0.0944)	(0.0904)	(0.0655)	(0.0661)
Min	-0.342***	-0.226	-0.387**	-0.295**	-0.468***
	(0.0874)	(0.173)	(0.152)	(0.115)	(0.105)
Pw	0.0297***	0.0257***	0.0322***	0.0297***	0.0311***
	(0.00343)	(0.00645)	(0.00616)	(0.00447)	(0.00439)
Ph	0.0423***	0.0410***	0.0478***	0.0428***	0.0429***
	(0.00555)	(0.0103)	(0.0100)	(0.00721)	(0.00668)
p_edu	0.0513***	0.0444***	0.0524***	0.0496***	0.0594***
	(0.00797)	(0.0150)	(0.0142)	(0.0104)	(0.0102)
HSize	-0.0420***	-0.0369	-0.0672***	-0.0481***	-0.0219
	(0.0139)	(0.0246)	(0.0242)	(0.0172)	(0.0204)
Rural	-0.159***	0.0341	-0.309***	-0.136*	-0.173**
	(0.0561)	(0.103)	(0.0992)	(0.0719)	(0.0756)
p_work	-0.148**	-0.0845	-0.257**	-0.165**	-0.0886
	(0.0629)	(0.106)	(0.113)	(0.0772)	(0.0996)
p_smoke	0.0808	0.132	-0.00603	0.0567	0.109
	(0.0531)	(0.101)	(0.0933)	(0.0692)	(0.0678)
p_drink	0.144**	0.110	0.176*	0.145*	0.105
	(0.0571)	(0.112)	(0.0983)	(0.0746)	(0.0721)
Icare	-0.0876	0.0492	-0.203**	-0.0895	
	(0.0596)	(0.103)	(0.0998)	(0.0718)	
Lowbw	-0.452***	-0.577**	-0.573**	-0.608***	
	(0.128)	(0.248)	(0.252)	(0.177)	
Constant	-10.39***	-9.812***	-11.13***	-10.47***	-9.426***
	(0.883)	(1.631)	(1.633)	(1.149)	(1.110)

Observations	4,126	1,531	1,402	2,933	1,379
R-squared	0.118	0.071	0.146	0.096	0.223

Note: The above models have passed the multicollinearity test and heteroscedasticity test. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

7.3.2 Binary Logistic Regression for ILL

Table 28 below shows us the prevalence of illness for children in all age groups in this study over the past four weeks. In the total sample, that is, children aged 0-15 years, 28.10% of children have been sick in the past four weeks. 33.38% of children aged 0-10 years have been ill in the past four weeks. 39.96% of children aged 0-5 have been sick in the past four weeks. 26.60% of children aged 6-10 who have been ill in the past four weeks. But only 16.10% of children aged 11-15 have been sick in the past four weeks. The groups with a high prevalence of illness in the past four weeks are those younger children. That is to say, and as the age increases, the majority will experience decline in illness the past four weeks.

Table 28 Cross-tabulation of age groups and Situation of illness in the Past Four Weeks

	0-15	0-10	0-5	6-10	11-15
Get sick	1,268 (28.10%)	1,046 (33.38%)	635 (39.96%)	411 (26.60%)	222 (16.10%)
No	3,245 (71.90%)	2,088 (66.62%)	954 (60.04%)	1,134 (73.40 %)	1,157 (83.90%)

As with OLS regression, we use the same explanatory variables in the binary regression, but the dependent variable is whether or not the disease has occurred in the past four weeks. In this model, we use Likelihood-ratio test to test which model should be selected for different age groups. The following table shows our regression and test results. Tables 29, 30, 31, 32, and 33 show us the coefficient estimates and test results of children aged 0-15, 0-10, 0-5, 6-10, 11-15, and the results show that the Models 3 are the best for children aged 0-15 years old, 0-10 years old, 0-5 years old and 11-15 years old. while model 1 is better for children aged 6-10 years old.

Table 29 Binary Logit Regressions with Different List of Variables for ILL (0-15 years old)

VARIABLES	Model A	Model 1	Model 2	Model 3	Model 4	Model 5
single_m	-0.250	-0.159	-0.256	-0.257	-0.247	-0.247
	(0.204)	(0.197)	(0.203)	(0.203)	(0.204)	(0.204)
single_f	0.155	0.176	0.166	0.150	0.171	0.171
	(0.265)	(0.263)	(0.264)	(0.264)	(0.264)	(0.264)
log_finc	-0.0129	-0.0117	-0.0124	-0.0133	-0.0119	-0.0119
	(0.0319)	(0.0318)	(0.0319)	(0.0319)	(0.0319)	(0.0319)
c_age	0.118***	0.116***	0.114***	0.118***	0.114***	0.114***
	(0.00978)	(0.00909)	(0.00942)	(0.00965)	(0.00953)	(0.00953)
Boy	-0.0210	-0.0157	-0.0206	-0.0211	-0.0205	-0.0205
	(0.0712)	(0.0710)	(0.0712)	(0.0712)	(0.0712)	(0.0712)
Min	0.268**	0.277**	0.269**	0.270**	0.265**	0.265**
	(0.129)	(0.128)	(0.129)	(0.129)	(0.129)	(0.129)
Pw	0.00101	0.00123	0.00110	0.00106	0.00101	0.00102
	(0.00483)	(0.00481)	(0.00482)	(0.00482)	(0.00482)	(0.00482)
Ph	0.00438	0.00390	0.00406	0.00412	0.00437	0.00439
	(0.00780)	(0.00775)	(0.00777)	(0.00777)	(0.00779)	(0.00780)
p_edu	-0.00640	-0.00316	-0.00621	-0.00680	-0.00572	-0.00570
	(0.0113)	(0.0111)	(0.0112)	(0.0112)	(0.0113)	(0.0113)
HSize	-0.00920	-0.0135	-0.0117	-0.00989	-0.0108	-0.0108
	(0.0191)	(0.0190)	(0.0190)	(0.0191)	(0.0191)	(0.0191)
Rural	-0.111	-0.108	-0.112	-0.111	-0.111	-0.111
	(0.0786)	(0.0782)	(0.0786)	(0.0786)	(0.0786)	(0.0786)
p_work	0.0782		0.0726	0.0714	0.0812	0.0814
	(0.0856)		(0.0840)	(0.0840)	(0.0855)	(0.0855)

p_smoke	-0.133*		-0.134*	-0.134*	-0.133*	-0.133*
	(0.0753)		(0.0752)	(0.0752)	(0.0753)	(0.0753)
p_drink	-0.109		-0.107	-0.108	-0.109	-0.108
	(0.0799)		(0.0798)	(0.0799)	(0.0799)	(0.0799)
HI	-0.210**			-0.213**		
	(0.107)			(0.106)		
Icare	-0.0341				-0.0445	-0.0445
	(0.0814)				(0.0812)	(0.0812)
Lowbw	0.0109					0.0113
	(0.183)					(0.183)
Constant	-0.159	-0.354	-0.269	-0.113	-0.320	-0.324
	(1.244)	(1.233)	(1.236)	(1.239)	(1.239)	(1.241)
Observations	4,126	4,126	4,126	4,126	4,126	4,126

Likelihood-ratio test

	Model A	Model 1	Model 2	Model 3	Model 4	Model 5
H0		Model A	Model A	Model A	Model A	Model A
H1		Model 1	Model 2	Model 3	Model 4	Model 5
Likelihood-ratio statistic		11.01*	4.26	0.18	3.96	3.96

Note: The above table only shows the comparison between models 1 to 5 and Model A. Due to space limitations, the comparison between models 1-5 is not shown in the table. For children aged 0-15, model 3 is finally selected for use in this study. The above models have passed the multicollinearity test and heteroscedasticity test.

Standard errors in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 30 Binary Logit Regressions with Different List of Variables for ILL (0-10 years old)

VARIABLES	Model A	Model 1	Model 2	Model 3	Model 4	Model 5
single_m	-0.163	-0.106	-0.172	-0.167	-0.167	-0.166
	(0.220)	(0.213)	(0.220)	(0.220)	(0.220)	(0.220)
single_f	0.0813	0.117	0.0888	0.0793	0.0918	0.0923
	(0.296)	(0.294)	(0.295)	(0.296)	(0.295)	(0.295)
log_finc	-0.0226	-0.0180	-0.0218	-0.0227	-0.0215	-0.0216
	(0.0361)	(0.0358)	(0.0360)	(0.0360)	(0.0360)	(0.0360)
c_age	0.0994***	0.0942***	0.0887***	0.0995***	0.0886***	0.0886***
	(0.0153)	(0.0142)	(0.0146)	(0.0153)	(0.0146)	(0.0146)
Boy	-0.0798	-0.0734	-0.0793	-0.0800	-0.0791	-0.0791
	(0.0795)	(0.0792)	(0.0794)	(0.0795)	(0.0794)	(0.0794)
Min	0.354**	0.370**	0.347**	0.356**	0.344**	0.343**
	(0.147)	(0.146)	(0.147)	(0.147)	(0.147)	(0.147)
Pw	0.00340	0.00385	0.00363	0.00343	0.00357	0.00358
	(0.00543)	(0.00541)	(0.00541)	(0.00542)	(0.00542)	(0.00542)
Ph	-0.00214	-0.00240	-0.00254	-0.00237	-0.00236	-0.00222
	(0.00874)	(0.00868)	(0.00871)	(0.00872)	(0.00872)	(0.00874)
p_edu	-0.0101	-0.00619	-0.00986	-0.0103	-0.00953	-0.00947
	(0.0127)	(0.0124)	(0.0126)	(0.0126)	(0.0126)	(0.0126)
HSize	-0.00806	-0.0116	-0.00995	-0.00827	-0.00947	-0.00951
	(0.0208)	(0.0207)	(0.0207)	(0.0207)	(0.0208)	(0.0208)
Rural	-0.111	-0.105	-0.112	-0.112	-0.112	-0.112
	(0.0873)	(0.0868)	(0.0872)	(0.0872)	(0.0872)	(0.0872)
p_work	0.139		0.140	0.135	0.146	0.147
	(0.0923)		(0.0902)	(0.0903)	(0.0920)	(0.0921)

p_smoke	-0.123		-0.125	-0.124	-0.123	-0.123
	(0.0844)		(0.0842)	(0.0842)	(0.0843)	(0.0843)
p_drink	-0.0379		-0.0355	-0.0377	-0.0366	-0.0361
	(0.0906)		(0.0904)	(0.0905)	(0.0905)	(0.0905)
HI	-0.306***			-0.307***		
	(0.118)			(0.118)		
Icare	-0.0142				-0.0276	-0.0275
	(0.0870)				(0.0867)	(0.0867)
Lowbw	0.0733					0.0732
	(0.217)					(0.217)
Constant	0.998	0.715	0.843	1.043	0.812	0.784
	(1.398)	(1.386)	(1.389)	(1.392)	(1.392)	(1.395)
Observations	2,933	2,933	2,933	2,933	2,933	2,933

Likelihood-ratio test

	Model A	Model 1	Model 2	Model 3	Model 4	Model 5
H0		Model A	Model A	Model A	Model A	Model A
H1		Model 1	Model 2	Model 3	Model 4	Model 5
Likelihood-ratio statistic		12.42*	7.08*	0.14	0.10	6.78***

Note: The above table only shows the comparison between models 1 to 5 and Model A. Due to space limitations, the comparison between models 1-5 is not shown in the table. For children aged 0-10, model 3 is finally selected for use in this study. The above models have passed the multicollinearity test and heteroscedasticity test.

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 31 Binary Logit Regressions with Different List of Variables for ILL (0-5 years old)

VARIABLES	Model A	Model 1	Model 2	Model 3	Model 4	Model 5
single_m	-0.244	-0.196	-0.262	-0.250	-0.252	-0.254
	(0.265)	(0.254)	(0.263)	(0.264)	(0.264)	(0.264)
single_f	0.325	0.362	0.320	0.317	0.331	0.331
	(0.340)	(0.336)	(0.338)	(0.340)	(0.339)	(0.339)
log_finc	-0.0301	-0.0261	-0.0309	-0.0311	-0.0296	-0.0295
	(0.0468)	(0.0463)	(0.0467)	(0.0468)	(0.0467)	(0.0467)
c_age	0.0528	0.0290	0.0195	0.0525	0.0205	0.0206
	(0.0365)	(0.0331)	(0.0340)	(0.0365)	(0.0341)	(0.0341)
Boy	-0.184*	-0.176*	-0.180*	-0.187*	-0.178*	-0.177*
	(0.106)	(0.105)	(0.106)	(0.106)	(0.106)	(0.106)
Min	0.497**	0.512**	0.479**	0.502**	0.472**	0.473**
	(0.205)	(0.203)	(0.204)	(0.205)	(0.205)	(0.205)
Pw	0.00918	0.00966	0.00957	0.00933	0.00939	0.00936
	(0.00725)	(0.00721)	(0.00723)	(0.00725)	(0.00723)	(0.00724)
Ph	-0.0224*	-0.0224*	-0.0226*	-0.0225*	-0.0222*	-0.0224*
	(0.0116)	(0.0115)	(0.0115)	(0.0116)	(0.0116)	(0.0116)
p_edu	0.0132	0.0175	0.0116	0.0123	0.0128	0.0128
	(0.0170)	(0.0165)	(0.0168)	(0.0169)	(0.0169)	(0.0169)
HSize	0.00820	0.00497	0.00612	0.00763	0.00693	0.00689
	(0.0277)	(0.0275)	(0.0276)	(0.0277)	(0.0276)	(0.0276)
Rural	-0.0768	-0.0651	-0.0727	-0.0771	-0.0720	-0.0723
	(0.116)	(0.115)	(0.116)	(0.116)	(0.116)	(0.116)
p_work	0.154		0.160	0.142	0.178	0.175
	(0.119)		(0.115)	(0.116)	(0.118)	(0.119)

p_smoke	-0.117		-0.123	-0.119	-0.119	-0.120
	(0.114)		(0.114)	(0.114)	(0.114)	(0.114)
p_drink	-0.0616		-0.0560	-0.0602	-0.0581	-0.0581
	(0.125)		(0.125)	(0.125)	(0.125)	(0.125)
HI	-0.362**			-0.367***		
	(0.142)			(0.142)		
Icare	-0.0575				-0.0762	-0.0766
	(0.116)				(0.115)	(0.115)
Lowbw	-0.0603					-0.0737
	(0.277)					(0.276)
Constant	3.927**	3.589**	3.756**	3.954**	3.681**	3.718**
	(1.843)	(1.823)	(1.830)	(1.834)	(1.833)	(1.838)
Observations	1,531	1,531	1,531	1,531	1,531	1,531

Likelihood-ratio test

	Model A	Model 1	Model 2	Model 3	Model 4	Model 5
H0		Model A	Model A	Model A	Model A	Model A
H1		Model 1	Model 2	Model 3	Model 4	Model 5
Likelihood-ratio statistic		10.96*	7.13*	0.29	6.69**	6.62**

Note: The above table only shows the comparison between models 1 to 5 and Model A. Due to space limitations, the comparison between models 1-5 is not shown in the table. For children aged 0-5, model 3 is finally selected for use in this study. The above models have passed the multicollinearity test and heteroscedasticity test. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 32 Binary Logit Regressions with Different List of Variables for ILL (6-10 years old)

VARIABLES	Model A	Model 1	Model 2	Model 3	Model 4	Model 5
single_m	0.159	0.208	0.170	0.170	0.150	0.159
	(0.430)	(0.420)	(0.428)	(0.428)	(0.430)	(0.430)
single_f	-1.045*	-1.048*	-1.049*	-1.051*	-1.052*	-1.043*
	(0.620)	(0.617)	(0.619)	(0.619)	(0.619)	(0.619)
log_finc	-0.00588	-0.00357	-0.00530	-0.00525	-0.00587	-0.00593
	(0.0577)	(0.0575)	(0.0578)	(0.0578)	(0.0578)	(0.0577)
c_age	0.0983**	0.102**	0.0988**	0.0988**	0.0993**	0.0982**
	(0.0444)	(0.0442)	(0.0444)	(0.0444)	(0.0444)	(0.0444)
Boy	0.0591	0.0618	0.0568	0.0564	0.0574	0.0595
	(0.122)	(0.122)	(0.122)	(0.122)	(0.122)	(0.122)
Min	0.170	0.192	0.173	0.173	0.178	0.170
	(0.212)	(0.210)	(0.211)	(0.211)	(0.212)	(0.212)
Pw	-0.00646	-0.00599	-0.00642	-0.00643	-0.00635	-0.00645
	(0.00834)	(0.00831)	(0.00834)	(0.00834)	(0.00834)	(0.00834)
Ph	0.0289**	0.0289**	0.0288**	0.0288**	0.0284**	0.0288**
	(0.0136)	(0.0135)	(0.0135)	(0.0135)	(0.0136)	(0.0136)
p_edu	-0.0390**	-0.0381**	-0.0394**	-0.0393**	-0.0397**	-0.0391**
	(0.0194)	(0.0193)	(0.0194)	(0.0194)	(0.0194)	(0.0194)
HSize	-0.0387	-0.0386	-0.0362	-0.0363	-0.0377	-0.0385
	(0.0320)	(0.0318)	(0.0318)	(0.0318)	(0.0319)	(0.0319)
Rural	-0.174	-0.156	-0.165	-0.166	-0.170	-0.173
	(0.135)	(0.133)	(0.135)	(0.135)	(0.135)	(0.135)
p_work	0.126		0.132	0.132	0.123	0.126
	(0.151)		(0.149)	(0.149)	(0.151)	(0.151)

p_smoke	-0.0920		-0.0873	-0.0869	-0.0907	-0.0925
	(0.127)		(0.127)	(0.127)	(0.127)	(0.127)
p_drink	0.0188		0.0125	0.0127	0.0152	0.0186
	(0.133)		(0.133)	(0.133)	(0.133)	(0.133)
HI	0.0274			0.0215		
	(0.227)			(0.226)		
Icare	0.0609				0.0610	0.0610
	(0.135)				(0.135)	(0.135)
Lowbw	0.314					0.313
	(0.367)					(0.367)
Constant	-3.583	-3.603	-3.551	-3.573	-3.490	-3.553
	(2.217)	(2.195)	(2.198)	(2.212)	(2.203)	(2.204)
Observations	1,402	1,402	1,402	1,402	1,402	1,402
Likelihood-ratio test						
	Model A	Model 1	Model 2	Model 3	Model 4	Model 5
H0		Model A	Model A	Model A	Model A	Model A
H1		Model 1	Model 2	Model 3	Model 4	Model 5
Likelihood-ratio statistic		2.27	0.98	0.97	0.78	0.01

Note: The above table only shows the comparison between models 1 to 5 and Model A. Due to space limitations, the comparison between models 1-5 is not shown in the table. For children aged 6-10, model 1 is finally selected for use in this study. The above models have passed the multicollinearity test and heteroscedasticity test.

Standard errors in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 33 Binary Logit Regressions with Different List of Variables for ILL (11-15 years old)

VARIABLES	Model A	Model 1	Model 2	Model 3	Model 4	Model 5
single_m	-0.720	-0.540	-0.786	-0.729	-0.776	-0.777
	(0.512)	(0.493)	(0.506)	(0.507)	(0.510)	(0.510)
single_f	0.245	0.251	0.185	0.221	0.193	0.211
	(0.635)	(0.628)	(0.631)	(0.631)	(0.634)	(0.635)
log_finc	0.0302	0.0170	0.0253	0.0315	0.0257	0.0242
	(0.0680)	(0.0683)	(0.0676)	(0.0678)	(0.0677)	(0.0678)
c_age	0.178***	0.180***	0.176***	0.178***	0.175***	0.175***
	(0.0602)	(0.0594)	(0.0597)	(0.0598)	(0.0602)	(0.0602)
Boy	0.226	0.219	0.227	0.229	0.226	0.224
	(0.163)	(0.161)	(0.162)	(0.163)	(0.162)	(0.162)
Min	0.00983	-0.0528	-0.0185	0.0101	-0.0193	-0.0192
	(0.265)	(0.261)	(0.263)	(0.265)	(0.264)	(0.264)
Pw	-0.0121	-0.0113	-0.0111	-0.0118	-0.0111	-0.0114
	(0.0109)	(0.0108)	(0.0108)	(0.0108)	(0.0108)	(0.0108)
Ph	0.0304*	0.0296*	0.0297*	0.0302*	0.0299*	0.0299*
	(0.0176)	(0.0172)	(0.0174)	(0.0175)	(0.0175)	(0.0175)
p_edu	0.00673	0.00907	0.00538	0.00728	0.00557	0.00485
	(0.0259)	(0.0254)	(0.0257)	(0.0258)	(0.0258)	(0.0258)
HSize	-0.0167	-0.0146	-0.00979	-0.0173	-0.00870	-0.00903
	(0.0500)	(0.0491)	(0.0489)	(0.0492)	(0.0496)	(0.0497)
Rural	-0.0945	-0.0925	-0.0890	-0.0953	-0.0901	-0.0884
	(0.186)	(0.183)	(0.185)	(0.185)	(0.185)	(0.185)
p_work	-0.267		-0.267	-0.267	-0.266	-0.266
	(0.256)		(0.256)	(0.256)	(0.256)	(0.256)

p_smoke	-0.194		-0.197	-0.195	-0.197	-0.196
	(0.171)		(0.171)	(0.171)	(0.171)	(0.171)
p_drink	-0.332*		-0.340**	-0.331*	-0.340**	-0.341**
	(0.171)		(0.171)	(0.171)	(0.171)	(0.171)
HI	0.439*			0.437*		
	(0.248)			(0.248)		
Icare	-0.0264				-0.0336	-0.0321
	(0.246)				(0.246)	(0.246)
Lowbw	-0.167					-0.159
	(0.337)					(0.337)
Constant	-5.069*	-4.987*	-4.584	-5.086*	-4.620	-4.569
	(2.876)	(2.823)	(2.841)	(2.863)	(2.852)	(2.855)
Observations	1,193	1,193	1,193	1,193	1,193	1,193
Likelihood-ratio test						
	Model A	Model 1	Model 2	Model 3	Model 4	Model 5
H0		Model A	Model A	Model A	Model A	Model A
H1		Model 1	Model 2	Model 3	Model 4	Model 5
Likelihood-ratio statistic		9.71	3.18	0.25	3.16	2.94*

Note: The above table only shows the comparison between models 1 to 5 and Model A. Due to space limitations, the comparison between models 1-5 is not shown in the table. For children aged 11-15, model 3 is finally selected for use in this study. The above models have passed the multicollinearity test and heteroscedasticity test.

Standard errors in parentheses   *** p<0.01, ** p<0.05, * p<0.1

Table 34 below shows us the final results of Binary Logit regression, and the table also shows the results of the sub-sample analysis. We found that the impact of family structure and household income on the whether or not get sick in the past four weeks is not significant, and it is the same in all age groups. The age of children has a significant impact on whether or not they have been sick in the past four weeks. This effect is the same in all age groups except for children aged 0-5 years. The significance level is $P<0.05$. For children aged 0-5 years, gender has a significant impact on whether they have been sick in the past four weeks, and the significance level is $P<0.1$. That is, a boy is more likely to be ill comparing to a girl. Except for children aged 6-10 years, there is a significant difference between the minority and Han nationality about whether or not to get sick in the past four weeks, the significance level is $P<0.1$. In particular, minority child are less likely to be sick. The height of parents as a part of genetic factors has a significant impact on whether children aged 0-5 and 6-10 years have been sick in the past four weeks, with significance levels of $P<0.1$, $P<0.05$. For children aged 6-10 years, the education level of the parents has a significant impact on whether they have been sick in the past four weeks, the significance level is $P<0.05$. In addition to the above variables, the relationship between other variables and whether they have been sick in the past four weeks is not statistically significant.

Table 34 The Summary of The Result for Binary Logit Regression For ILL

VARIABLES	0-15 (Model 3)	0-5 (Model 3)	6-10 (Model 1)	0-10 (Model 3)	11-15 (Model 3)
single_m	-0.257	-0.250	0.208	-0.167	-0.729
	(0.203)	(0.264)	(0.420)	(0.220)	(0.507)
single_f	0.150	0.317	-1.048*	0.0793	0.221
	(0.264)	(0.340)	(0.617)	(0.296)	(0.631)
log_finc	-0.0133	-0.0311	-0.00357	-0.0227	0.0315
	(0.0319)	(0.0468)	(0.0575)	(0.0360)	(0.0678)
c_age	0.118***	0.0525	0.102**	0.0995***	0.178***
	(0.00965)	(0.0365)	(0.0442)	(0.0153)	(0.0598)
Boy	-0.0211	-0.187*	0.0618	-0.0800	0.229
	(0.0712)	(0.106)	(0.122)	(0.0795)	(0.163)

Min	0.270**	0.502**	0.192	0.356**	0.0101
	(0.129)	(0.205)	(0.210)	(0.147)	(0.265)
Pw	0.00106	0.00933	-0.00599	0.00343	-0.0118
	(0.00482)	(0.00725)	(0.00831)	(0.00542)	(0.0108)
Ph	0.00412	-0.0225*	0.0289**	-0.00237	0.0302*
	(0.00777)	(0.0116)	(0.0135)	(0.00872)	(0.0175)
p_edu	-0.00680	0.0123	-0.0381**	-0.0103	0.00728
	(0.0112)	(0.0169)	(0.0193)	(0.0126)	(0.0258)
HSize	-0.00989	0.00763	-0.0386	-0.00827	-0.0173
	(0.0191)	(0.0277)	(0.0318)	(0.0207)	(0.0492)
Rural	-0.111	-0.0771	-0.156	-0.112	-0.0953
	(0.0786)	(0.116)	(0.133)	(0.0872)	(0.185)
p_work	0.0714	0.142		0.135	-0.267
	(0.0840)	(0.116)		(0.0903)	(0.256)
p_smoke	-0.134*	-0.119		-0.124	-0.195
	(0.0752)	(0.114)		(0.0842)	(0.171)
p_drink	-0.108	-0.0602		-0.0377	-0.331*
	(0.0799)	(0.125)		(0.0905)	(0.171)
HI	-0.213**	-0.367***		-0.307***	0.437*
	(0.106)	(0.142)		(0.118)	(0.248)
Constant	-0.113	3.954**	-3.603	1.043	-5.086*
	(1.239)	(1.834)	(2.195)	(1.392)	(2.863)
Observations	4,126	1,531	1,402	2,933	1,193

Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The marginal effects of the final list of variables of children aged 0-15 based on Model 3 are shown in Table 35. We can see that the family structure and family income have no significant effect on whether the child has been ill in the past four weeks. For the age of the child, if the child age increases 1year, the probability of the child not getting sick in the past four weeks will increase by 2.4%, P<0.01. For the minority variable, if a child is minority, then it will have a 5.4% higher probability of the child not getting sick in the past four weeks than a child is Han, P<0.05.

Table 35 Marginal effects of variables on the ILL of children based on model 3, 0-15 years old

	dy/dx	Std.Err.	z	P>z	[95%Conf.	Interval]
single_m	-0.051	0.040	-1.260	0.206	-0.130	0.028
single_f	0.030	0.053	0.570	0.570	-0.073	0.133

log_finc	-0.003	0.006	-0.420	0.676	-0.015	0.010
c_age	0.024***	0.002	12.510	0.000	0.020	0.027
Boy	-0.004	0.014	-0.300	0.767	-0.032	0.024
Min	0.054**	0.026	2.100	0.036	0.004	0.104
Pw	0.000	0.001	0.220	0.825	-0.002	0.002
Ph	0.001	0.002	0.530	0.596	-0.002	0.004
p_edu	-0.001	0.002	-0.600	0.545	-0.006	0.003
HSize	-0.002	0.004	-0.520	0.604	-0.009	0.005
Rural	-0.022	0.016	-1.420	0.157	-0.053	0.008
p_work	0.014	0.017	0.850	0.396	-0.019	0.047
p_smoke	-0.027*	0.015	-1.780	0.075	-0.056	0.003
p_drink	-0.022	0.016	-1.360	0.175	-0.053	0.010
HI	-0.042**	0.021	-2.000	0.045	-0.084	-0.001

Note: *** p<0.01, ** p<0.05, * p<0.1

The marginal effects of the final list of variables of children aged 0-5 based on Model 3 are shown in Table 36. We can see that the family structure and family income have no significant effect on whether the child has been ill in the past four weeks. The coefficient of boy is -0.045 that means if the child is a boy, then he will have a 4.5% lower probability of the child not getting sick in the past four weeks than a girl on average, P<0.1. For minority variable, if a child is minority, then it will have a 12.0% higher probability of not getting sick in the past four weeks than a child is Han, P<0.05.

Table 36 Marginal effects of variables on the ILL of children based on model 3, 0-5 years old

	dy/dx	Std.Err.	z	P>z	[95%Conf.	Interval]
single_m	-0.060	0.063	-0.950	0.344	-0.184	0.064
single_f	0.076	0.081	0.930	0.351	-0.083	0.235
log_finc	-0.007	0.011	-0.670	0.506	-0.029	0.014
c_age	0.013	0.009	1.440	0.150	-0.005	0.030
Boy	-0.045*	0.025	-1.760	0.078	-0.094	0.005
Min	0.120**	0.049	2.450	0.014	0.024	0.216
Pw	0.002	0.002	1.290	0.198	-0.001	0.006
Ph	-0.005*	0.003	-1.950	0.052	-0.011	0.000
p_edu	0.003	0.004	0.730	0.467	-0.005	0.011
HSize	0.002	0.007	0.280	0.783	-0.011	0.015
Rural	-0.018	0.028	-0.670	0.506	-0.073	0.036
m_work	0.034	0.028	1.220	0.221	-0.020	0.088

p_smoke	-0.029	0.027	-1.050	0.295	-0.082	0.025
p_drink	-0.014	0.030	-0.480	0.631	-0.073	0.044
HI	-0.088***	0.034	-2.590	0.010	-0.154	-0.021

Note: *** p<0.01, ** p<0.05, * p<0.1

The marginal effects of the final list of variables of children aged 6-10 based on Model 1 are shown in Table 37. We can see that the family structure and family income have no significant effect on whether the child has been ill in the past four weeks. But for single father family, the coefficient is -0.207 that means if the child is single father family, then he will have a 20.7% lower probability of the child not got sick in the past four weeks than dual-parent parent family on average, P<0.1. For the age of the child, if the child age increases 1year, the probability of the child not got sick in the past four weeks will increase by 2.0%, P<0.05. For the parent's education level, if the parent's education level increases by 1year, the probability of the child not got sick in the past four weeks will decrease by 0.8%, P<0.05.

Table 37 Marginal effects of variables on the ILL of children based on Model 1, 6-10 years old

	dy/dx	Std.Err.	z	P>z	[95%Conf.	Interval]
single_m	0.041	0.083	0.500	0.620	-0.121	0.203
single_f	-0.207*	0.122	-1.700	0.089	-0.445	0.032
log_finc	-0.001	0.011	-0.060	0.950	-0.023	0.022
c_age	0.020**	0.009	2.320	0.020	0.003	0.037
Boy	0.012	0.024	0.510	0.612	-0.035	0.059
Min	0.038	0.041	0.910	0.361	-0.043	0.119
Pw	-0.001	0.002	-0.720	0.471	-0.004	0.002
Ph	0.006**	0.003	2.140	0.032	0.000	0.011
p_edu	-0.008**	0.004	-1.980	0.048	-0.015	-0.000
HSize	-0.008	0.006	-1.220	0.224	-0.020	0.005
Rural	-0.031	0.026	-1.170	0.243	-0.082	0.021

Note: *** p<0.01, ** p<0.05, * p<0.1

The marginal effects of the final list of variables of children aged 0-10 based on Model 3 are shown in Table 38. We can see that the family structure and family income have no significant effect on whether the child has been ill in the past four weeks. For the age of the child, if the child age increases 1year, the probability of the child not getting sick in the past four weeks will increase by 2.2%, P<0.01. For minority variable, if a child is minority, then it will have a 7.9% higher probability of the child not got sick in the past four weeks than a child is Han, P<0.05.

Table 38 Marginal effects of variables on the ILL of children based on model 3, 0-10 years old

	dy/dx	Std.Err.	z	P>z	[95%Conf.	Interval]
single_m	-0.037	0.049	-0.760	0.448	-0.133	0.059
single_f	0.018	0.066	0.270	0.789	-0.111	0.147
log_finc	-0.005	0.008	-0.630	0.528	-0.021	0.011
c_age	0.022***	0.003	6.540	0.000	0.016	0.029
Boy	-0.018	0.018	-1.010	0.314	-0.052	0.017
Min	0.079**	0.033	2.420	0.015	0.015	0.143
Pw	0.001	0.001	0.630	0.528	-0.002	0.003
Ph	-0.001	0.002	-0.270	0.785	-0.004	0.003
p_edu	-0.002	0.003	-0.820	0.414	-0.008	0.003
HSize	-0.002	0.005	-0.400	0.690	-0.011	0.007
Rural	-0.025	0.019	-1.280	0.200	-0.063	0.013
p_work	0.030	0.020	1.490	0.136	-0.009	0.069
p_smoke	-0.028	0.019	-1.470	0.141	-0.064	0.009
p_drink	-0.008	0.020	-0.420	0.677	-0.048	0.031
HI	-0.068***	0.026	-2.610	0.009	-0.120	-0.017

Note: *** p<0.01, ** p<0.05, * p<0.1

The marginal effects of the final list of variables of children aged 11-15 based on Model 3 are shown in Table 39. We can see that the family structure and family income have no significant effect on whether the child has been ill in the past four weeks. For the age of the child, if the child age increases by 1year, the probability of the child not getting sick in the past four weeks will increase by 2.3%, P<0.01. For the variable parents drinking, if parents drinking, then it will have a 4.2% lower probability of the child not getting sick in the past four weeks than a parent not drinking, P<0.1.

Table 39 Marginal effects of variables on the ILL of children based on model 3, 11-15 years old

	dy/dx	Std.Err.	z	P>z	[95%Conf.	Interval]
single_m	-0.093	0.065	-1.440	0.149	-0.220	0.033

single_f	0.028	0.081	0.350	0.727	-0.130	0.186
log_finc	0.004	0.009	0.460	0.643	-0.013	0.021
c_age	0.023***	0.008	3.020	0.003	0.008	0.038
Boy	0.029	0.021	1.420	0.157	-0.011	0.070
Min	0.001	0.034	0.040	0.970	-0.065	0.068
Pw	-0.002	0.001	-1.090	0.274	-0.004	0.001
Ph	0.004*	0.002	1.740	0.083	-0.000	0.008
p_edu	0.001	0.003	0.280	0.778	-0.006	0.007
HSize	-0.002	0.006	-0.350	0.725	-0.015	0.010
Rural	-0.012	0.024	-0.510	0.607	-0.059	0.034
p_work	-0.034	0.033	-1.040	0.297	-0.098	0.030
p_smoke	-0.025	0.022	-1.140	0.254	-0.068	0.018
p_drink	-0.042*	0.022	-1.950	0.052	-0.085	0.000
HI	0.056	0.032	1.770	0.077	-0.006	0.118

Note: *** p<0.01, ** p<0.05, * p<0.1

CHAPTER VIII. CONCLUSION AND POLICY SUGGESTIONS

8.1 Conclusion

This study focuses on the impact of family structure and household income on children's physical health and attempts to find other factors that affect children's physical health. In terms of family structure, it mainly includes three types of family structure, dual-parent family, single-mother family, and single-father family. In measuring children's physical health, we are mainly divided into two parts, long-term and short-term. In terms of long-term health, we mainly use the child growth index HAZ released by the World Health Organization to measure children's physical health. If the HAZ value is less than -2, then we consider that the child has growth retardation. In this study, we use the HAZ value as a continuous variable. Generally speaking, the larger the HAZ value, the better. In the short-term aspect of children's health, we use the binary variable of "have you been sick in the past four weeks" to measure the short-term physical health of children.

In the long-term aspect of children's physical health, our research uses the OLS model. First, the overall sample of 4513 0-15 years old was analyzed. Then we took the age of children as a grouping basis and divided it into four sub-samples for sub-sample analysis. The four sub-samples were 0-5 years old children, 6-10 years old children, 0-10 years old children, and 11-15 years old children. Through research, we found that family structure has a significant effect on HAZ values, and there are substantial differences between children of single-parent families and children of dual-parent families. Compared with other families, the average HAZ value of children in single-mother families is higher, which also shows that in some aspects, the mother's upbringing has a significant impact on the healthy growth of children, especially for children under ten years of age. This effect is more significant for younger children. But the dual-parent family is the best way of rearing (Liu, 2019; Xiaotong, 1992). Because in the group of children with growth retardation, the rate of children with single-parent families with growth retardation problems is higher than the dual-parent family children and the overall average of the sample. Children in single-father families are particularly worthy of our attention, because children in single-father families perform the worst in this study, and their average HAZ value is the lowest, which shows that children in single-father families are disadvantaged to some extent. They need more attention and help from policy makers.

The above results prove that hypothesis 3 (i.e. Children's health in the single-father families and single-mother families should be significantly different) is correct. In the long-term indicator of children's health, HAZ, children from single-father families and single-mother families compare with dual-parent family have significant differences. But for Hypothesis 2 is partially correct (i.e. Single-parent family should lead to statistically worse child's health than dual-parent family), we can only say that the HAZ value of children of single-father families is weaker than that of dual-parent families. Still, we cannot say that the HAZ value of children of single-mother families is weaker than that of dual-parent families, because the average HAZ value of children of single-mother families is the highest in this study.

Family income also has a significant impact on children's long-term physical health. In the families of children with growth retardation problems, their family income is mostly distributed in the first gradient and the second gradient, which means that children in low-income families are more prone to growth retardation problems. Moreover, family income has the most significant impact on children's health among children aged 6-10. In this study, family income has a significant effect on children aged 0-5 years old, and there is a specific difference between previous studies on the impact of family income on children aged 0-3 years old (Apouey & Geoffard, 2013; Currie et al., 2007; Goode et al., 2014). The possible reason is that the sample size is different. The included age range is diverse, but it can be concluded that the long-term physiological health of children in the 0-5 age range is relatively weakly affected by family income, although this effect is statistically significant. At the same time, this result also confirmed our hypothesis, indicating that our hypothesis 1 (i.e. High family income should have statistically positive effect on children's health in China) is correct. The relationship between the HAZ value and family income is positive, and the HAZ value will continue to increase with the increase in family income.

In addition to the above factors, this study also found that the factors that affect children's long-term physical health include age, gender, ethnicity, father's height and weight, parents' education level, parents' health risk behavior, family size, and family geographic location, Whether it is under intergenerational care (whether it is under the care of grandparents), and whether it is a low-weight child. It is particularly worth mentioning whether intergenerational care is taken from grandparents. The research results show that the intergenerational care only has a significant impact on children 6-10 years old, with a significance level of $P<0.1$, but for other age groups the coefficient of intergenerational care is not significant, so, hypothesis 4(i.e. Children's health should be significantly different for those who receive additional care from other people) is partially correct. Because only children aged 6-10 years old is significant. For other children to say, there is insufficient evidence to prove that children receiving intergenerational care are significantly different in terms of physical health. Also, the geographical location of the family is one of the essential factors that affect children's physical health. Through the data shown in the research results, we can conclude that hypothesis 5 (i.e. Child's Health in urban and rural should be significant different) is correct. Due to the imbalance of urban and rural development in China, there is a significant difference in the physical health of urban children and rural children. The physical health of urban children is higher than that of rural children. The difference is grouped at every age.

For short-term children's health, we use "have you been sick in the past four weeks" as a measurement standard and use a binary Logistic regression model. We found that for short-term children's health "whether they have been sick in the past four weeks", family structure and family income have no significant effect on it, and their relationship is not very strong. In other words, in the long-term child health, family structure, and family income will have a certain impact on children's physical health, but in the short term, there is no significant relationship between them. Of course, age is an important factor that affects the health of short-term children. With the increase of age, especially for children, the risk of getting ill usually decreases, which matches our prior expectation.

Besides, among children aged 0-5, the health status of boys seems to be weaker than girls in the short term. Another notable phenomenon is that the children of ethnic minorities are weaker than the Han children in the long-term health status, but in the short-term health conditions, the probability of the minority nationality getting sick is lower than that of the Han children.

8.2 Recommendations

The object of this study is children aged 0-15 in China. According to the research results, the following three suggestions are mainly proposed, which are aimed at family, society, and country. The first is the family. As we know, the family is a basic unit of society. The development of human society is inseparable from the family. The family has many functions. Through the family, each individual can be connected. The family assumes many responsibilities. However, in the family, children are an indispensable part of the family. Due to the rapid development of China's economy and social and cultural changes, the size of the family has gradually shrunk. However, in Western countries, their definition of family is just a married couple. The structure composed of a couple and children. According to the health capital theory, we can know that everyone's human capital is a certain amount. The normal growth and development of childhood have a significant impact on future health capital stock. As a special family structure, the number of single-parent families is increasing year by year. What I want to say is that the policymaker should pay more attention to the single-parent family especially the single-father family. Because the child's health outcome is worst in the single-father family.

Second is the society. The traditional culture of Chinese society has led the Chinese to pay special attention to the family and have special feelings for it. To a certain extent, single-parent families are not complete families. Children of single-parent families are in a disadvantaged position in society, and society should pay more attention to them. Starting from each community, children of single-parent families in the community are regularly provided with financial subsidies or nutritional items. Call on more social organizations to pay attention to children's health, especially children in single-father families. The China Children's Foundation has continued to carry out a project called the "Spring Bud Project", which aims to help girls in poverty-stricken areas to obtain equal opportunities for education. So, I hope that more social organizations and foundations can carry out similar projects, focusing on helping children from single-parent families.

Finally, the country. In the development of Chinese society, the imbalance in social development has led to a dual urban-rural structure. The direct consequence of this structure is the inequality of income between urban and rural areas and the widening income gap. The results of this study show that the impact of income on children's health is significant and positive. The Chinese government has always been committed to helping those poor areas get rid of poverty. Although some results have been achieved, poverty still exists. Children are the future of a country and a nationality. Paying attention to children's growth will protect them from poverty because poverty has a greater impact on children. Therefore, we must continue to do the work of poverty alleviation, targeted poverty alleviation, help every family struggling under the poverty line, and give them corresponding subsidies, especially for single-mother family whose income tends to be the lowest.

The Chinese government attaches great importance to the development of children. Since the reform and opening up, especially since the 18th National Congress of the Communist Party of China, China has adhered to the principle of (Children First), accelerated the construction of the rule of law, and strengthened the government's responsibility. The development of children has made great achievements. From the conclusions of this study, we know that the relationship between family income and children's health is positively correlated. Poverty is a currency expression of household income, and China is also continuing to implement many policies to escape poverty. The 13th Five-Year Plan for Poverty Alleviation is one of the most important documents. This document further clarifies the key areas of early childhood development in poor areas. First, speed up the improvement of the public service system for preschool education in poverty-stricken areas. Second, comprehensively implement child nutrition improvement projects in impoverished areas. Implement rehabilitation and assistance projects for disabled children aged 0-6 years old and provide basic assistive devices. Third, the treatment of serious and chronic diseases of the rural poor. Starting in 2017, intensive treatment has been carried out for poor families suffering from childhood acute lymphoblastic leukemia, children with congenital heart atrial septal defect, and other diseases. Fourth, improve the service system for left-behind personnel, organize and carry out the investigation of left-behind children, left-behind women, and left-behind elderly in rural areas. Provide care services for left-behind people, strengthen care service facilities and team construction for left-behind children, and establish a rescue and protection mechanism for left-behind children and a care service network. Table 40 below shows some of the poverty alleviation policies for children in China.

Table 40 Policies related to child development in China

Major Policies	Year of implementation	Support object	Main content
Tow Exemptions and One Subsidy Project.	2001	Poverty-stricken areas	Free of tuition and free of books, subsidize the living expenses of residence student
New Rural Cooperation Medical Project	2003	Rural areas	Establish a new rural cooperative medical system with serious illness as main part
Nutrition Improvement program Project	2011	Poverty-stricken areas	Improve the nutrition of rural compulsory education students
Nutrition package project	2012	Poverty-stricken areas	Provide free nutritional package for infants aged 6

			to 24 months, improve the level of child caregivers and scientific feeding knowledge.
Integrated Early Childhood Development Pilot Project	2014	Pilot poverty-stricken areas	Promote the early comprehensive development of children aged 0 to 3 years.

Source: China Development Research Foundation

These policies are all policies implemented by children in poverty-stricken areas, which are helpful to the development of children's nutrition, but there is no relevant special policy care for special family structures. Therefore, it is recommended that policy makers should formulate policies to help poor children. Children from single-parent families, especially children from single-father families, are considered separately as a special group.

8.3 Limitations

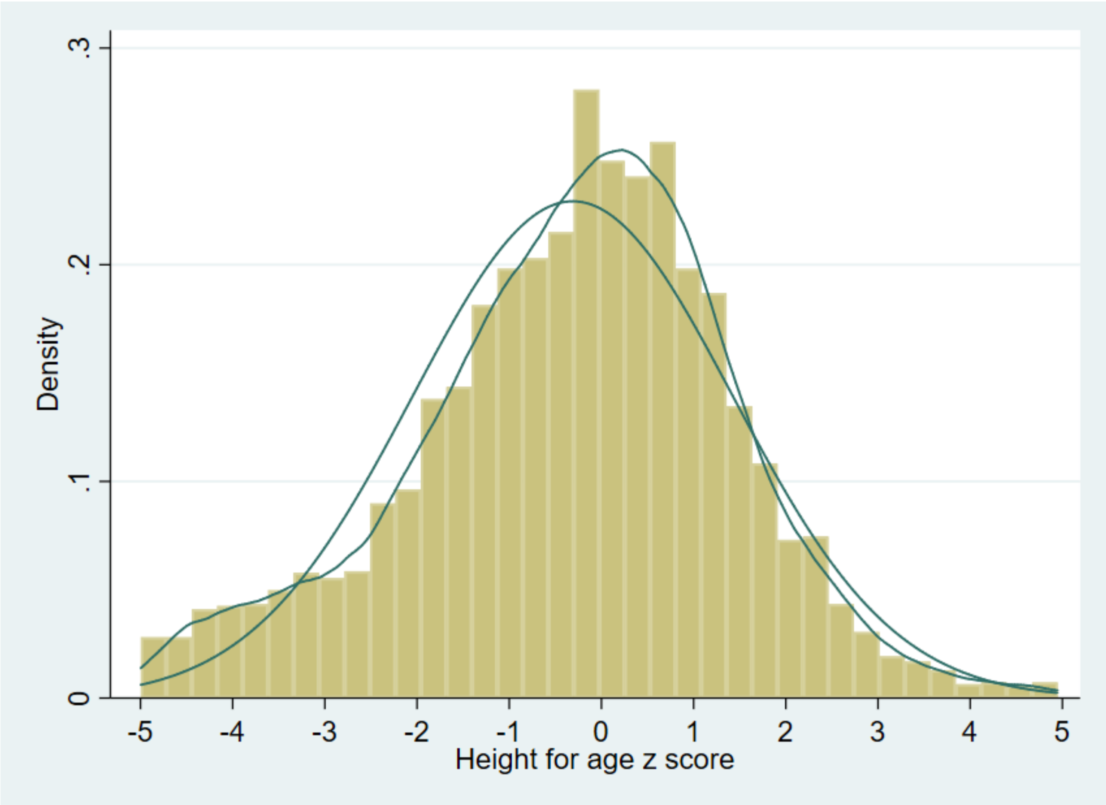
This study has the following shortcomings and limitations. The first is about the data set. This study uses secondary data released by the Peking University open data platform. The data set only includes children aged 0-15 years old, so this study lacks a sample of children aged 16-18 years old.

The second is about the econometric model. This study does not consider the endogenous problem. The study uses the OLS model, does not explore whether there is an endogenous problem between family income and child health, and uses instrumental variables to solve it.

APPENDIX I

Appendix I introduces the detailed process of calculating HAZ. In this research, the distribution of HAZ is shown in figure below, which is approximately normal distribution, so we use the following formula to calculate the HAZ value:

$$HAZ = \frac{Height\ of\ child - \ Median\ height\ of\ that\ age(WHO, Standard)}{Standard\ deviation(WHO, Standard)}$$



After calculating the HAZ value according to the child growth standard provided by WHO, we can determine whether the child has growth retardation by comparison. The specific judgment is based on the following table:

HAZ	Above 3	Above 2	Above 1	Median 0	Below -1	Below -2	Below -3
Status	See note	No definition				Stunted	Severely stunted

Source: WHO child growth standards: training course on child growth assessment

Note: A child in this range is very tall. Tallness is rarely a problem unless it is so excessive that it may indicate an endocrine disorder such as a growth-hormone-producing tumor. Refer a child in this range for assessment if you suspect an endocrine disorder (e.g. if parents of normal height have a child who is excessively tall for his or her age. But in this study, we don't consider this problem) (WHO, 2008).

Generally speaking, we think that the higher the HAZ value, the better. According to WHO's recommendation, we only keep the HAZ value in the range of -5 to 5 after calculating the HAZ value (Liu, 2019; WHO, 2008).

For example, we already have some child basic information as shown in below:

Child 'pid'	Child gender	Child height(cm)	Child year: month	Median (WHO)	Standard deviation (WHO)
01	girl	110	4:11	108.8948	4.7195
02	girl	66	0:7	67.2873	2.3154
03	boy	110	4:8	107.7697	4.4886

According to this information about child, we can calculate HAZ, the detail as shown in below:

$$HAZ_{01} = \frac{110 - 108.8948}{4.7195} = 0.234177$$

$$HAZ_{02} = \frac{66 - 67.2873}{2.3154} = -0.555973$$

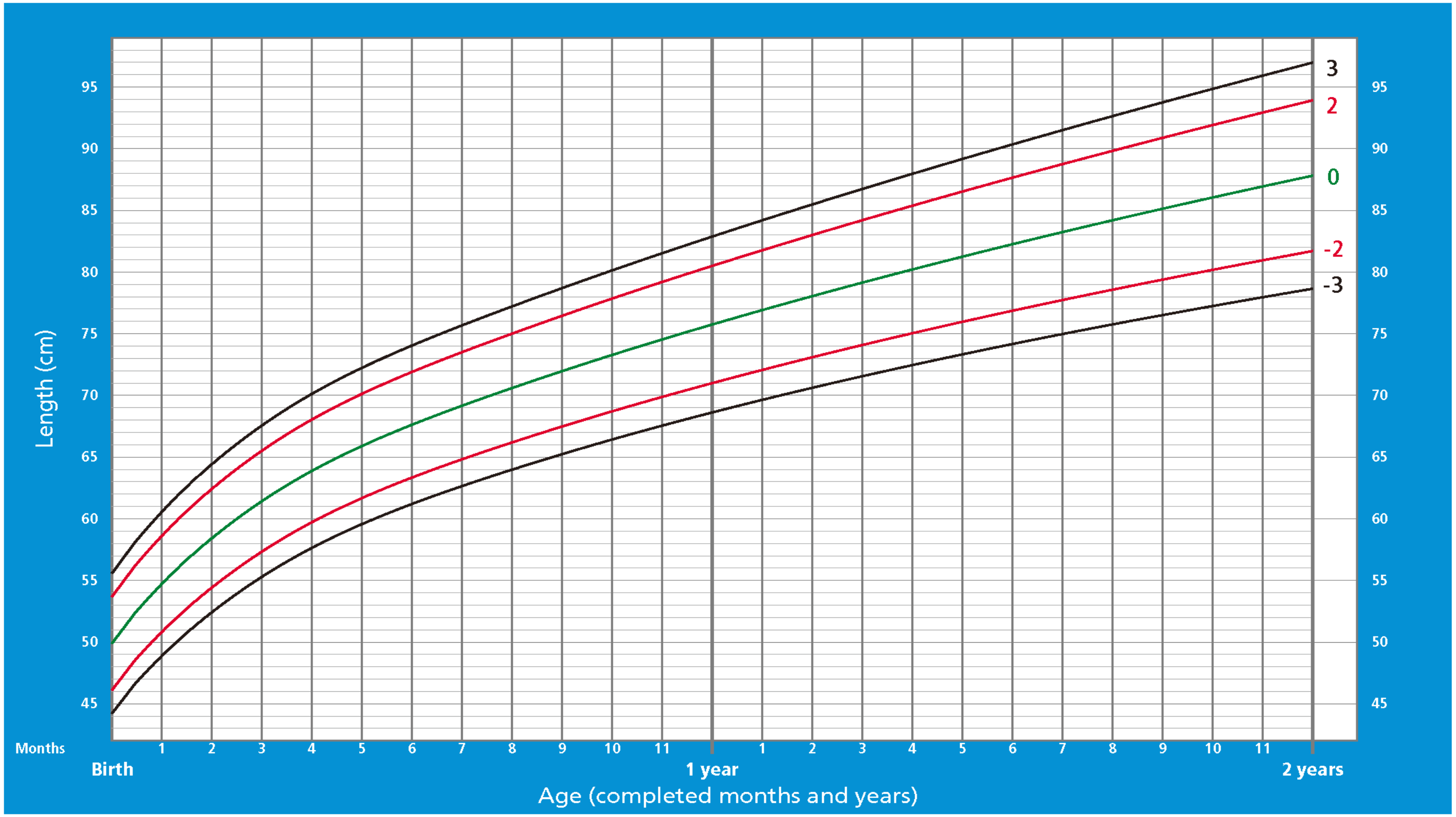
$$HAZ_{03} = \frac{110 - 107.7697}{4.4886} = 0.496880$$

For example, $HAZ_{01} = 0.234177$ which means this Chinese child is about 0.23177 standard deviations higher than WHO child reference standard in the same reference group with the same gender and age (measured in months). $HAZ_{01} = -0.555973$ which means this Chinese child is about 0.555973 standard deviations shorter than WHO child reference standard in the same reference group with the same gender and age (measured in months). HAZ is a continuous variable in this study, similar approach used by other Chinese studies, the physical health indicators of Chinese children were compared with each subject using the standard provided by WHO to calculate HAZ (Bai, 2019; Goode et al., 2014; F. Wang, 2010; Yang, 2018; N. Zhang, 2012).

The child growth reference about HAZ table and chart released by WHO are as follows:

Length-for-age BOYS

Birth to 2 years (z-scores)

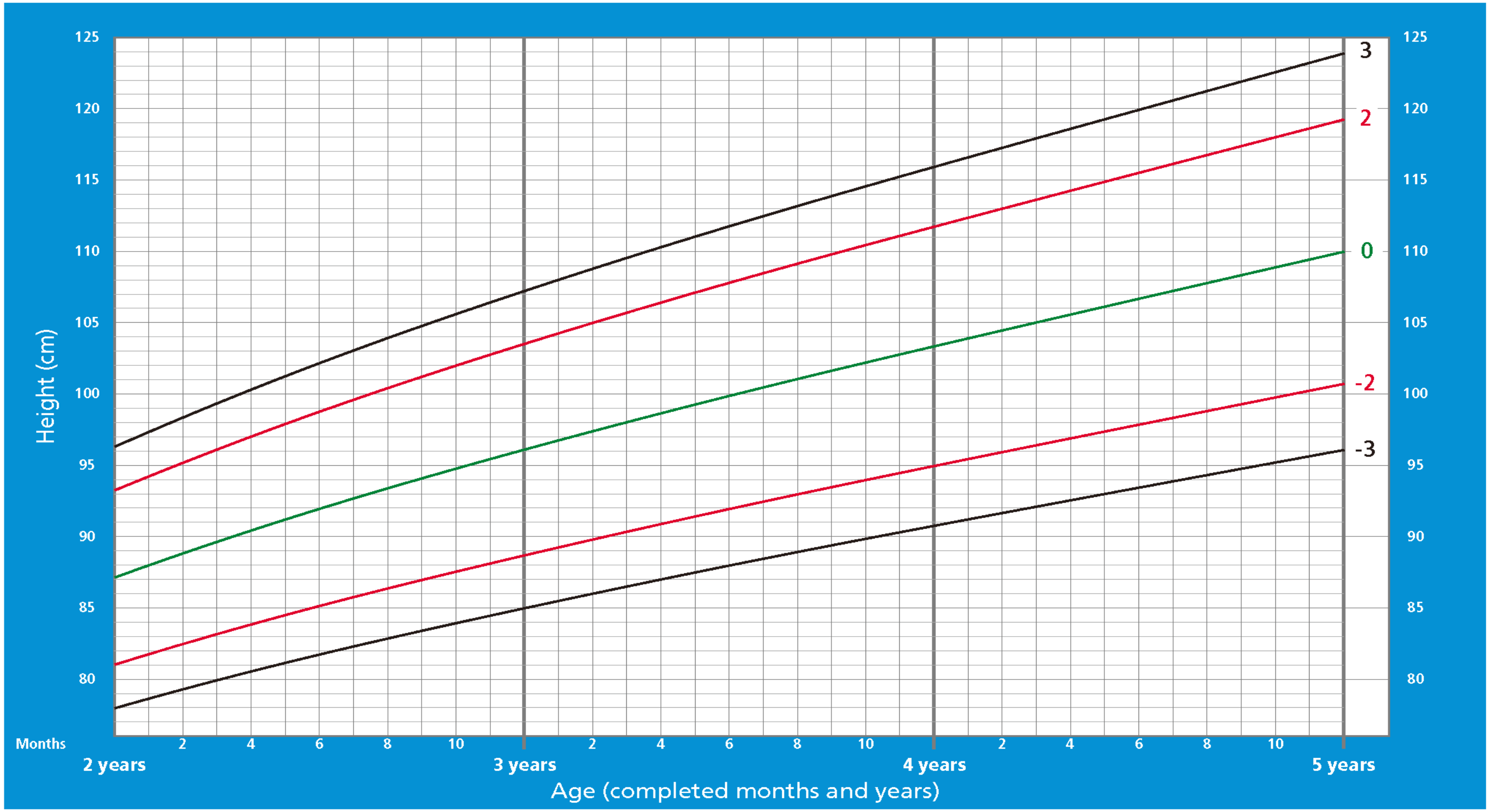


WHO Child Growth Standards

Source: WHO, Child Growth Reference, https://www.who.int/childgrowth/standards/cht_lfa_boys_z_0_2.pdf?ua=1

Height-for-age BOYS

2 to 5 years (z-scores)



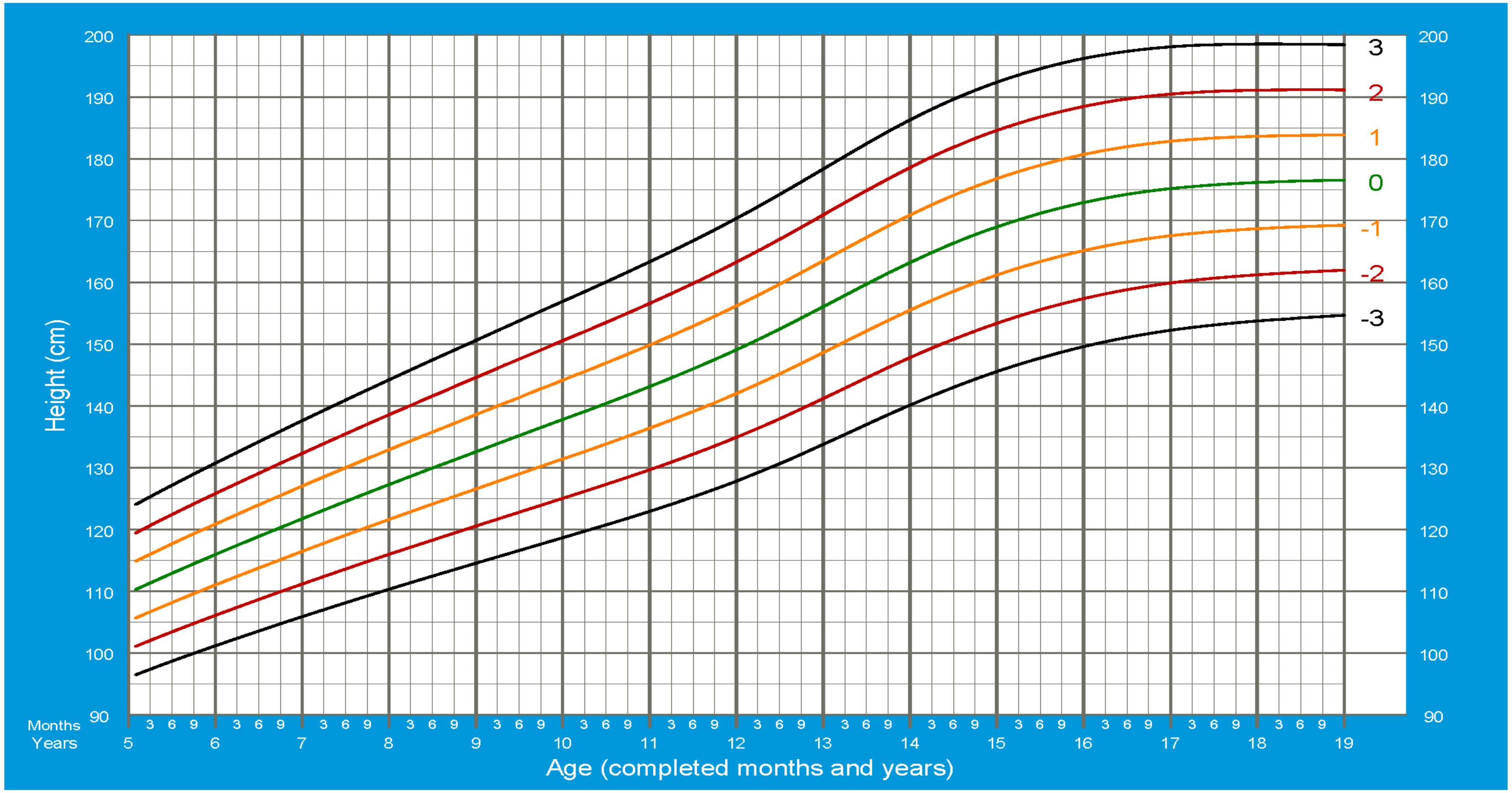
WHO Child Growth Standards

Source: WHO, Child Growth Reference, https://www.who.int/childgrowth/standards/cht_hfa_boys_z_2_5.pdf?ua=1

Height-for-age BOYS

5 to 19 years (z-scores)

World Health Organization



2007 WHO Reference

Source: WHO, Child Growth Reference, https://www.who.int/growthref/cht_hfa_boys_z_5_19years.pdf?ua=1

Length-for-age BOYS

Birth to 2 years (z-scores)

World Health Organization

Year: Month	Month	L	M	S	SD	Z-scores (length in cm)						
						-3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
0: 0	0	1	49.8842	0.03795	1.8931	44.2	46.1	48.0	49.9	51.8	53.7	55.6
0: 1	1	1	54.7244	0.03557	1.9465	48.9	50.8	52.8	54.7	56.7	58.6	60.6
0: 2	2	1	58.4249	0.03424	2.0005	52.4	54.4	56.4	58.4	60.4	62.4	64.4
0: 3	3	1	61.4292	0.03328	2.0444	55.3	57.3	59.4	61.4	63.5	65.5	67.6
0: 4	4	1	63.8860	0.03257	2.0808	57.6	59.7	61.8	63.9	66.0	68.0	70.1
0: 5	5	1	65.9026	0.03204	2.1115	59.6	61.7	63.8	65.9	68.0	70.1	72.2
0: 6	6	1	67.6236	0.03165	2.1403	61.2	63.3	65.5	67.6	69.8	71.9	74.0
0: 7	7	1	69.1645	0.03139	2.1711	62.7	64.8	67.0	69.2	71.3	73.5	75.7
0: 8	8	1	70.5994	0.03124	2.2055	64.0	66.2	68.4	70.6	72.8	75.0	77.2
0: 9	9	1	71.9687	0.03117	2.2433	65.2	67.5	69.7	72.0	74.2	76.5	78.7
0:10	10	1	73.2812	0.03118	2.2849	66.4	68.7	71.0	73.3	75.6	77.9	80.1
0:11	11	1	74.5388	0.03125	2.3293	67.6	69.9	72.2	74.5	76.9	79.2	81.5
1: 0	12	1	75.7488	0.03137	2.3762	68.6	71.0	73.4	75.7	78.1	80.5	82.9
1: 1	13	1	76.9186	0.03154	2.4260	69.6	72.1	74.5	76.9	79.3	81.8	84.2
1: 2	14	1	78.0497	0.03174	2.4773	70.6	73.1	75.6	78.0	80.5	83.0	85.5
1: 3	15	1	79.1458	0.03197	2.5303	71.6	74.1	76.6	79.1	81.7	84.2	86.7
1: 4	16	1	80.2113	0.03222	2.5844	72.5	75.0	77.6	80.2	82.8	85.4	88.0
1: 5	17	1	81.2487	0.03250	2.6406	73.3	76.0	78.6	81.2	83.9	86.5	89.2
1: 6	18	1	82.2587	0.03279	2.6973	74.2	76.9	79.6	82.3	85.0	87.7	90.4
1: 7	19	1	83.2418	0.03310	2.7553	75.0	77.7	80.5	83.2	86.0	88.8	91.5
1: 8	20	1	84.1996	0.03342	2.8140	75.8	78.6	81.4	84.2	87.0	89.8	92.6
1: 9	21	1	85.1348	0.03376	2.8742	76.5	79.4	82.3	85.1	88.0	90.9	93.8
1:10	22	1	86.0477	0.03410	2.9342	77.2	80.2	83.1	86.0	89.0	91.9	94.9
1:11	23	1	86.9410	0.03445	2.9951	78.0	81.0	83.9	86.9	89.9	92.9	95.9
2: 0	24	1	87.8161	0.03479	3.0551	78.7	81.7	84.8	87.8	90.9	93.9	97.0

WHO Child Growth Standards

Source: WHO, Child Growth Reference, https://www.who.int/childgrowth/standards/LFA_boys_0_2_zscores.pdf?ua=1

Height-for-age BOYS

2 to 5 years (z-scores)

World Health Organization

						Z-scores (height in cm)						
Year: Month	Month	L	M	S	SD	-3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
2: 0	**24**	1	87.1161	0.03507	3.0551	78.0	81.0	84.1	87.1	90.2	93.2	96.3
2: 1	**25**	1	87.9720	0.03542	3.1160	78.6	81.7	84.9	88.0	91.1	94.2	97.3
2: 2	**26**	1	88.8065	0.03576	3.1757	79.3	82.5	85.6	88.8	92.0	95.2	98.3
2: 3	**27**	1	89.6197	0.03610	3.2353	79.9	83.1	86.4	89.6	92.9	96.1	99.3
2: 4	**28**	1	90.4120	0.03642	3.2928	80.5	83.8	87.1	90.4	93.7	97.0	100.3
2: 5	**29**	1	91.1828	0.03674	3.3501	81.1	84.5	87.8	91.2	94.5	97.9	101.2
2: 6	**30**	1	91.9327	0.03704	3.4052	81.7	85.1	88.5	91.9	95.3	98.7	102.1
2: 7	**31**	1	92.6631	0.03733	3.4591	82.3	85.7	89.2	92.7	96.1	99.6	103.0
2: 8	**32**	1	93.3753	0.03761	3.5118	82.8	86.4	89.9	93.4	96.9	100.4	103.9
2: 9	**33**	1	94.0711	0.03787	3.5625	83.4	86.9	90.5	94.1	97.6	101.2	104.8
2:10	**34**	1	94.7532	0.03812	3.6120	83.9	87.5	91.1	94.8	98.4	102.0	105.6
2:11	**35**	1	95.4236	0.03836	3.6604	84.4	88.1	91.8	95.4	99.1	102.7	106.4
3: 0	**36**	1	96.0835	0.03858	3.7069	85.0	88.7	92.4	96.1	99.8	103.5	107.2
3: 1	**37**	1	96.7337	0.03879	3.7523	85.5	89.2	93.0	96.7	100.5	104.2	108.0
3: 2	**38**	1	97.3749	0.03900	3.7976	86.0	89.8	93.6	97.4	101.2	105.0	108.8
3: 3	**39**	1	98.0073	0.03919	3.8409	86.5	90.3	94.2	98.0	101.8	105.7	109.5
3: 4	**40**	1	98.6310	0.03937	3.8831	87.0	90.9	94.7	98.6	102.5	106.4	110.3
3: 5	**41**	1	99.2459	0.03954	3.9242	87.5	91.4	95.3	99.2	103.2	107.1	111.0
3: 6	**42**	1	99.8515	0.03971	3.9651	88.0	91.9	95.9	99.9	103.8	107.8	111.7
3: 7	**43**	1	100.4485	0.03986	4.0039	88.4	92.4	96.4	100.4	104.5	108.5	112.5
3: 8	**44**	1	101.0374	0.04002	4.0435	88.9	93.0	97.0	101.0	105.1	109.1	113.2
3: 9	**45**	1	101.6186	0.04016	4.0810	89.4	93.5	97.5	101.6	105.7	109.8	113.9
3:10	**46**	1	102.1933	0.04031	4.1194	89.8	94.0	98.1	102.2	106.3	110.4	114.6
3:11	**47**	1	102.7625	0.04045	4.1567	90.3	94.4	98.6	102.8	106.9	111.1	115.2
4: 0	**48**	1	103.3273	0.04059	4.1941	90.7	94.9	99.1	103.3	107.5	111.7	115.9

WHO Child Growth Standards

Source: WHO, Child Growth Reference, https://www.who.int/childgrowth/standards/HFA_boys_2_5_zscores.pdf?ua=1

Height-for-age BOYS

2 to 5 years (z-scores)

World Health Organization

						Z-scores (height in cm)						
Year: Month	Month	L	M	S	SD	-3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
4: 1	**49**	1	103.8886	0.04073	4.2314	91.2	95.4	99.7	103.9	108.1	112.4	116.6
4: 2	**50**	1	104.4473	0.04086	4.2677	91.6	95.9	100.2	104.4	108.7	113.0	117.3
4: 3	**51**	1	105.0041	0.04100	4.3052	92.1	96.4	100.7	105.0	109.3	113.6	117.9
4: 4	**52**	1	105.5596	0.04113	4.3417	92.5	96.9	101.2	105.6	109.9	114.2	118.6
4: 5	**53**	1	106.1138	0.04126	4.3783	93.0	97.4	101.7	106.1	110.5	114.9	119.2
4: 6	**54**	1	106.6668	0.04139	4.4149	93.4	97.8	102.3	106.7	111.1	115.5	119.9
4: 7	**55**	1	107.2188	0.04152	4.4517	93.9	98.3	102.8	107.2	111.7	116.1	120.6
4: 8	**56**	1	107.7697	0.04165	4.4886	94.3	98.8	103.3	107.8	112.3	116.7	121.2
4: 9	**57**	1	108.3198	0.04177	4.5245	94.7	99.3	103.8	108.3	112.8	117.4	121.9
4:10	**58**	1	108.8689	0.04190	4.5616	95.2	99.7	104.3	108.9	113.4	118.0	122.6
4:11	**59**	1	109.4170	0.04202	4.5977	95.6	100.2	104.8	109.4	114.0	118.6	123.2
5: 0	**60**	1	109.9638	0.04214	4.6339	96.1	100.7	105.3	110.0	114.6	119.2	123.9

WHO Child Growth Standards

Source: WHO, Child Growth Reference, https://www.who.int/childgrowth/standards/HFA_boys_2_5_zscores.pdf?ua=1

Height-for-age BOYS

5 to 19 years (z-scores)

World Health Organization

Year: Month	Month	L	M	S	SD	Z-scores (height in cm) -3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
5: 1	61	1	110.2647	0.04164	4.5914	96.5	101.1	105.7	110.3	114.9	119.4	124.0
5: 2	62	1	110.8006	0.04172	4.6226	96.9	101.6	106.2	110.8	115.4	120.0	124.7
5: 3	63	1	111.3338	0.04180	4.6538	97.4	102.0	106.7	111.3	116.0	120.6	125.3
5: 4	64	1	111.8636	0.04187	4.6837	97.8	102.5	107.2	111.9	116.5	121.2	125.9
5: 5	65	1	112.3895	0.04195	4.7147	98.2	103.0	107.7	112.4	117.1	121.8	126.5
5: 6	66	1	112.9110	0.04203	4.7456	98.7	103.4	108.2	112.9	117.7	122.4	127.1
5: 7	67	1	113.4280	0.04211	4.7765	99.1	103.9	108.7	113.4	118.2	123.0	127.8
5: 8	68	1	113.9410	0.04218	4.8060	99.5	104.3	109.1	113.9	118.7	123.6	128.4
5: 9	69	1	114.4500	0.04226	4.8367	99.9	104.8	109.6	114.5	119.3	124.1	129.0
5:10	70	1	114.9547	0.04234	4.8672	100.4	105.2	110.1	115.0	119.8	124.7	129.6
5:11	71	1	115.4549	0.04241	4.8964	100.8	105.7	110.6	115.5	120.4	125.2	130.1
6: 0	72	1	115.9509	0.04249	4.9268	101.2	106.1	111.0	116.0	120.9	125.8	130.7
6: 1	73	1	116.4432	0.04257	4.9570	101.6	106.5	111.5	116.4	121.4	126.4	131.3
6: 2	74	1	116.9325	0.04264	4.9860	102.0	107.0	111.9	116.9	121.9	126.9	131.9
6: 3	75	1	117.4196	0.04272	5.0162	102.4	107.4	112.4	117.4	122.4	127.5	132.5
6: 4	76	1	117.9046	0.04280	5.0463	102.8	107.8	112.9	117.9	123.0	128.0	133.0
6: 5	77	1	118.3880	0.04287	5.0753	103.2	108.2	113.3	118.4	123.5	128.5	133.6
6: 6	78	1	118.8700	0.04295	5.1055	103.6	108.7	113.8	118.9	124.0	129.1	134.2
6: 7	79	1	119.3508	0.04303	5.1357	103.9	109.1	114.2	119.4	124.5	129.6	134.8
6: 8	80	1	119.8303	0.04311	5.1659	104.3	109.5	114.7	119.8	125.0	130.2	135.3
6: 9	81	1	120.3085	0.04318	5.1949	104.7	109.9	115.1	120.3	125.5	130.7	135.9
6:10	82	1	120.7853	0.04326	5.2252	105.1	110.3	115.6	120.8	126.0	131.2	136.5
6:11	83	1	121.2604	0.04334	5.2554	105.5	110.8	116.0	121.3	126.5	131.8	137.0
7: 0	84	1	121.7338	0.04342	5.2857	105.9	111.2	116.4	121.7	127.0	132.3	137.6
7: 1	85	1	122.2053	0.04350	5.3159	106.3	111.6	116.9	122.2	127.5	132.8	138.2
7: 2	86	1	122.6750	0.04358	5.3462	106.6	112.0	117.3	122.7	128.0	133.4	138.7

2007 WHO Reference

Source: WHO, Child Growth Reference, https://www.who.int/growthref/hfa_boys_5_19years_z.pdf?ua=1

Height-for-age BOYS

5 to 19 years (z-scores)

World Health Organization

Year: Month	Month	L	M	S	SD	Z-scores (height in cm)						
						-3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
7: 3	**87**	1	123.1429	0.04366	5.3764	107.0	112.4	117.8	123.1	128.5	133.9	139.3
7: 4	**88**	1	123.6092	0.04374	5.4067	107.4	112.8	118.2	123.6	129.0	134.4	139.8
7: 5	**89**	1	124.0736	0.04382	5.4369	107.8	113.2	118.6	124.1	129.5	134.9	140.4
7: 6	**90**	1	124.5361	0.04390	5.4671	108.1	113.6	119.1	124.5	130.0	135.5	140.9
7: 7	**91**	1	124.9964	0.04398	5.4973	108.5	114.0	119.5	125.0	130.5	136.0	141.5
7: 8	**92**	1	125.4545	0.04406	5.5275	108.9	114.4	119.9	125.5	131.0	136.5	142.0
7: 9	**93**	1	125.9104	0.04414	5.5577	109.2	114.8	120.4	125.9	131.5	137.0	142.6
7:10	**94**	1	126.3640	0.04422	5.5878	109.6	115.2	120.8	126.4	132.0	137.5	143.1
7:11	**95**	1	126.8156	0.04430	5.6179	110.0	115.6	121.2	126.8	132.4	138.1	143.7
8: 0	**96**	1	127.2651	0.04438	5.6480	110.3	116.0	121.6	127.3	132.9	138.6	144.2
8: 1	**97**	1	127.7129	0.04446	5.6781	110.7	116.4	122.0	127.7	133.4	139.1	144.7
8: 2	**98**	1	128.1590	0.04454	5.7082	111.0	116.7	122.5	128.2	133.9	139.6	145.3
8: 3	**99**	1	128.6034	0.04462	5.7383	111.4	117.1	122.9	128.6	134.3	140.1	145.8
8: 4	**100**	1	129.0466	0.04470	5.7684	111.7	117.5	123.3	129.0	134.8	140.6	146.4
8: 5	**101**	1	129.4887	0.04478	5.7985	112.1	117.9	123.7	129.5	135.3	141.1	146.9
8: 6	**102**	1	129.9300	0.04487	5.8300	112.4	118.3	124.1	129.9	135.8	141.6	147.4
8: 7	**103**	1	130.3705	0.04495	5.8602	112.8	118.7	124.5	130.4	136.2	142.1	148.0
8: 8	**104**	1	130.8103	0.04503	5.8904	113.1	119.0	124.9	130.8	136.7	142.6	148.5
8: 9	**105**	1	131.2495	0.04511	5.9207	113.5	119.4	125.3	131.3	137.2	143.1	149.0
8:10	**106**	1	131.6884	0.04519	5.9510	113.8	119.8	125.7	131.7	137.6	143.6	149.5
8:11	**107**	1	132.1269	0.04527	5.9814	114.2	120.2	126.1	132.1	138.1	144.1	150.1
9: 0	**108**	1	132.5652	0.04535	6.0118	114.5	120.5	126.6	132.6	138.6	144.6	150.6
9: 1	**109**	1	133.0031	0.04543	6.0423	114.9	120.9	127.0	133.0	139.0	145.1	151.1
9: 2	**110**	1	133.4404	0.04551	6.0729	115.2	121.3	127.4	133.4	139.5	145.6	151.7
9: 3	**111**	1	133.8770	0.04559	6.1035	115.6	121.7	127.8	133.9	140.0	146.1	152.2

2007 WHO Reference

Source: WHO, Child Growth Reference, https://www.who.int/growthref/hfa_boys_5_19years_z.pdf?ua=1

Height-for-age BOYS

5 to 19 years (z-scores)

						Z-scores (height in cm)						
Year: Month	**Month**	**L**	**M**	**S**	**SD**	**-3 SD**	**-2 SD**	**-1 SD**	**Median**	**1 SD**	**2 SD**	**3 SD**
9: 4	**112**	1	134.3130	0.04566	6.1327	115.9	122.0	128.2	134.3	140.4	146.6	152.7
9: 5	**113**	1	134.7483	0.04574	6.1634	116.3	122.4	128.6	134.7	140.9	147.1	153.2
9: 6	**114**	1	135.1829	0.04582	6.1941	116.6	122.8	129.0	135.2	141.4	147.6	153.8
9: 7	**115**	1	135.6168	0.04589	6.2235	116.9	123.2	129.4	135.6	141.8	148.1	154.3
9: 8	**116**	1	136.0501	0.04597	6.2542	117.3	123.5	129.8	136.1	142.3	148.6	154.8
9: 9	**117**	1	136.4829	0.04604	6.2837	117.6	123.9	130.2	136.5	142.8	149.1	155.3
9:10	**118**	1	136.9153	0.04612	6.3145	118.0	124.3	130.6	136.9	143.2	149.5	155.9
9:11	**119**	1	137.3474	0.04619	6.3441	118.3	124.7	131.0	137.3	143.7	150.0	156.4
10: 0	**120**	1	137.7795	0.04626	6.3737	118.7	125.0	131.4	137.8	144.2	150.5	156.9
10: 1	**121**	1	138.2119	0.04633	6.4034	119.0	125.4	131.8	138.2	144.6	151.0	157.4
10: 2	**122**	1	138.6452	0.04640	6.4331	119.3	125.8	132.2	138.6	145.1	151.5	157.9
10: 3	**123**	1	139.0797	0.04647	6.4630	119.7	126.2	132.6	139.1	145.5	152.0	158.5
10: 4	**124**	1	139.5158	0.04654	6.4931	120.0	126.5	133.0	139.5	146.0	152.5	159.0
10: 5	**125**	1	139.9540	0.04661	6.5233	120.4	126.9	133.4	140.0	146.5	153.0	159.5
10: 6	**126**	1	140.3948	0.04667	6.5522	120.7	127.3	133.8	140.4	146.9	153.5	160.1
10: 7	**127**	1	140.8387	0.04674	6.5828	121.1	127.7	134.3	140.8	147.4	154.0	160.6
10: 8	**128**	1	141.2859	0.04680	6.6122	121.4	128.1	134.7	141.3	147.9	154.5	161.1
10: 9	**129**	1	141.7368	0.04686	6.6418	121.8	128.5	135.1	141.7	148.4	155.0	161.7
10:10	**130**	1	142.1916	0.04692	6.6716	122.2	128.8	135.5	142.2	148.9	155.5	162.2
10:11	**131**	1	142.6501	0.04698	6.7017	122.5	129.2	135.9	142.7	149.4	156.1	162.8
11: 0	**132**	1	143.1126	0.04703	6.7306	122.9	129.7	136.4	143.1	149.8	156.6	163.3
11: 1	**133**	1	143.5795	0.04709	6.7612	123.3	130.1	136.8	143.6	150.3	157.1	163.9
11: 2	**134**	1	144.0511	0.04714	6.7906	123.7	130.5	137.3	144.1	150.8	157.6	164.4
11: 3	**135**	1	144.5276	0.04719	6.8203	124.1	130.9	137.7	144.5	151.3	158.2	165.0

2007 WHO Reference

Source: WHO, Child Growth Reference, https://www.who.int/growthref/hfa_boys_5_19years_z.pdf?ua=1

Height-for-age BOYS

5 to 19 years (z-scores)

						Z-scores (height in cm)						
Year: Month	Month	L	M	S	SD	-3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
11: 4	**136**	1	145.0093	0.04723	6.8488	124.5	131.3	138.2	145.0	151.9	158.7	165.6
11: 5	**137**	1	145.4964	0.04728	6.8791	124.9	131.7	138.6	145.5	152.4	159.3	166.1
11: 6	**138**	1	145.9891	0.04732	6.9082	125.3	132.2	139.1	146.0	152.9	159.8	166.7
11: 7	**139**	1	146.4878	0.04736	6.9377	125.7	132.6	139.6	146.5	153.4	160.4	167.3
11: 8	**140**	1	146.9927	0.04740	6.9675	126.1	133.1	140.0	147.0	154.0	160.9	167.9
11: 9	**141**	1	147.5041	0.04744	6.9976	126.5	133.5	140.5	147.5	154.5	161.5	168.5
11:10	**142**	1	148.0224	0.04747	7.0266	126.9	134.0	141.0	148.0	155.0	162.1	169.1
11:11	**143**	1	148.5478	0.04750	7.0560	127.4	134.4	141.5	148.5	155.6	162.7	169.7
12: 0	**144**	1	149.0807	0.04753	7.0858	127.8	134.9	142.0	149.1	156.2	163.3	170.3
12: 1	**145**	1	149.6212	0.04755	7.1145	128.3	135.4	142.5	149.6	156.7	163.9	171.0
12: 2	**146**	1	150.1694	0.04758	7.1451	128.7	135.9	143.0	150.2	157.3	164.5	171.6
12: 3	**147**	1	150.7256	0.04759	7.1730	129.2	136.4	143.6	150.7	157.9	165.1	172.2
12: 4	**148**	1	151.2899	0.04761	7.2029	129.7	136.9	144.1	151.3	158.5	165.7	172.9
12: 5	**149**	1	151.8623	0.04762	7.2317	130.2	137.4	144.6	151.9	159.1	166.3	173.6
12: 6	**150**	1	152.4425	0.04763	7.2608	130.7	137.9	145.2	152.4	159.7	167.0	174.2
12: 7	**151**	1	153.0298	0.04763	7.2888	131.2	138.5	145.7	153.0	160.3	167.6	174.9
12: 8	**152**	1	153.6234	0.04764	7.3186	131.7	139.0	146.3	153.6	160.9	168.3	175.6
12: 9	**153**	1	154.2223	0.04763	7.3456	132.2	139.5	146.9	154.2	161.6	168.9	176.3
12:10	**154**	1	154.8258	0.04763	7.3744	132.7	140.1	147.5	154.8	162.2	169.6	176.9
12:11	**155**	1	155.4329	0.04762	7.4017	133.2	140.6	148.0	155.4	162.8	170.2	177.6
13: 0	**156**	1	156.0426	0.04760	7.4276	133.8	141.2	148.6	156.0	163.5	170.9	178.3
13: 1	**157**	1	156.6539	0.04758	7.4536	134.3	141.7	149.2	156.7	164.1	171.6	179.0
13: 2	**158**	1	157.2660	0.04756	7.4796	134.8	142.3	149.8	157.3	164.7	172.2	179.7
13: 3	**159**	1	157.8775	0.04754	7.5055	135.4	142.9	150.4	157.9	165.4	172.9	180.4

2007 WHO Reference

Source: WHO, Child Growth Reference, https://www.who.int/growthref/hfa_boys_5_19years_z.pdf?ua=1

Height-for-age BOYS

5 to 19 years (z-scores)

						Z-scores (height in cm)						
Year: Month	Month	L	M	S	SD	-3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
13: 4	**160**	1	158.4871	0.04751	7.5297	135.9	143.4	151.0	158.5	166.0	173.5	181.1
13: 5	**161**	1	159.0937	0.04747	7.5522	136.4	144.0	151.5	159.1	166.6	174.2	181.8
13: 6	**162**	1	159.6962	0.04744	7.5760	137.0	144.5	152.1	159.7	167.3	174.8	182.4
13: 7	**163**	1	160.2939	0.04740	7.5979	137.5	145.1	152.7	160.3	167.9	175.5	183.1
13: 8	**164**	1	160.8861	0.04735	7.6180	138.0	145.7	153.3	160.9	168.5	176.1	183.7
13: 9	**165**	1	161.4720	0.04730	7.6376	138.6	146.2	153.8	161.5	169.1	176.7	184.4
13:10	**166**	1	162.0505	0.04725	7.6569	139.1	146.7	154.4	162.1	169.7	177.4	185.0
13:11	**167**	1	162.6207	0.04720	7.6757	139.6	147.3	154.9	162.6	170.3	178.0	185.6
14: 0	**168**	1	163.1816	0.04714	7.6924	140.1	147.8	155.5	163.2	170.9	178.6	186.3
14: 1	**169**	1	163.7321	0.04707	7.7069	140.6	148.3	156.0	163.7	171.4	179.1	186.9
14: 2	**170**	1	164.2717	0.04701	7.7224	141.1	148.8	156.5	164.3	172.0	179.7	187.4
14: 3	**171**	1	164.7994	0.04694	7.7357	141.6	149.3	157.1	164.8	172.5	180.3	188.0
14: 4	**172**	1	165.3145	0.04687	7.7483	142.1	149.8	157.6	165.3	173.1	180.8	188.6
14: 5	**173**	1	165.8165	0.04679	7.7586	142.5	150.3	158.1	165.8	173.6	181.3	189.1
14: 6	**174**	1	166.3050	0.04671	7.7681	143.0	150.8	158.5	166.3	174.1	181.8	189.6
14: 7	**175**	1	166.7799	0.04663	7.7769	143.4	151.2	159.0	166.8	174.6	182.3	190.1
14: 8	**176**	1	167.2415	0.04655	7.7851	143.9	151.7	159.5	167.2	175.0	182.8	190.6
14: 9	**177**	1	167.6899	0.04646	7.7909	144.3	152.1	159.9	167.7	175.5	183.3	191.1
14:10	**178**	1	168.1255	0.04637	7.7960	144.7	152.5	160.3	168.1	175.9	183.7	191.5
14:11	**179**	1	168.5482	0.04628	7.8004	145.1	152.9	160.7	168.5	176.3	184.1	191.9
15: 0	**180**	1	168.9580	0.04619	7.8042	145.5	153.4	161.2	169.0	176.8	184.6	192.4
15: 1	**181**	1	169.3549	0.04609	7.8056	145.9	153.7	161.5	169.4	177.2	185.0	192.8
15: 2	**182**	1	169.7389	0.04599	7.8063	146.3	154.1	161.9	169.7	177.5	185.4	193.2
15: 3	**183**	1	170.1099	0.04589	7.8063	146.7	154.5	162.3	170.1	177.9	185.7	193.5

2007 WHO Reference

Source: WHO, Child Growth Reference, https://www.who.int/growthref/hfa_boys_5_19years_z.pdf?ua=1

Height-for-age BOYS

5 to 19 years (z-scores)

Year: Month	Month	L	M	S	SD	Z-scores (height in cm) -3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
15: 4	**184**	1	170.4680	0.04579	7.8057	147.1	154.9	162.7	170.5	178.3	186.1	193.9
15: 5	**185**	1	170.8136	0.04569	7.8045	147.4	155.2	163.0	170.8	178.6	186.4	194.2
15: 6	**186**	1	171.1468	0.04559	7.8026	147.7	155.5	163.3	171.1	178.9	186.8	194.6
15: 7	**187**	1	171.4680	0.04548	7.7984	148.1	155.9	163.7	171.5	179.3	187.1	194.9
15: 8	**188**	1	171.7773	0.04538	7.7953	148.4	156.2	164.0	171.8	179.6	187.4	195.2
15: 9	**189**	1	172.0748	0.04527	7.7898	148.7	156.5	164.3	172.1	179.9	187.7	195.4
15:10	**190**	1	172.3606	0.04516	7.7838	149.0	156.8	164.6	172.4	180.1	187.9	195.7
15:11	**191**	1	172.6345	0.04506	7.7789	149.3	157.1	164.9	172.6	180.4	188.2	196.0
16: 0	**192**	1	172.8967	0.04495	7.7717	149.6	157.4	165.1	172.9	180.7	188.4	196.2
16: 1	**193**	1	173.1470	0.04484	7.7639	149.9	157.6	165.4	173.1	180.9	188.7	196.4
16: 2	**194**	1	173.3856	0.04473	7.7555	150.1	157.9	165.6	173.4	181.1	188.9	196.7
16: 3	**195**	1	173.6126	0.04462	7.7466	150.4	158.1	165.9	173.6	181.4	189.1	196.9
16: 4	**196**	1	173.8280	0.04451	7.7371	150.6	158.4	166.1	173.8	181.6	189.3	197.0
16: 5	**197**	1	174.0321	0.04440	7.7270	150.9	158.6	166.3	174.0	181.8	189.5	197.2
16: 6	**198**	1	174.2251	0.04429	7.7164	151.1	158.8	166.5	174.2	181.9	189.7	197.4
16: 7	**199**	1	174.4071	0.04418	7.7053	151.3	159.0	166.7	174.4	182.1	189.8	197.5
16: 8	**200**	1	174.5784	0.04407	7.6937	151.5	159.2	166.9	174.6	182.3	190.0	197.7
16: 9	**201**	1	174.7392	0.04396	7.6815	151.7	159.4	167.1	174.7	182.4	190.1	197.8
16:10	**202**	1	174.8896	0.04385	7.6689	151.9	159.6	167.2	174.9	182.6	190.2	197.9
16:11	**203**	1	175.0301	0.04375	7.6576	152.1	159.7	167.4	175.0	182.7	190.3	198.0
17: 0	**204**	1	175.1609	0.04364	7.6440	152.2	159.9	167.5	175.2	182.8	190.4	198.1
17: 1	**205**	1	175.2824	0.04353	7.6300	152.4	160.0	167.7	175.3	182.9	190.5	198.2
17: 2	**206**	1	175.3951	0.04343	7.6174	152.5	160.2	167.8	175.4	183.0	190.6	198.2
17: 3	**207**	1	175.4995	0.04332	7.6026	152.7	160.3	167.9	175.5	183.1	190.7	198.3
2007 WHO Reference												

Source: WHO, Child Growth Reference, https://www.who.int/growthref/hfa_boys_5_19years_z.pdf?ua=1

Height-for-age BOYS

5 to 19 years (z-scores)

						Z-scores (height in cm)						
Year: Month	Month	L	M	S	SD	-3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
17: 4	**208**	1	175.5959	0.04322	7.5893	152.8	160.4	168.0	175.6	183.2	190.8	198.4
17: 5	**209**	1	175.6850	0.04311	7.5738	153.0	160.5	168.1	175.7	183.3	190.8	198.4
17: 6	**210**	1	175.7672	0.04301	7.5597	153.1	160.6	168.2	175.8	183.3	190.9	198.4
17: 7	**211**	1	175.8432	0.04291	7.5454	153.2	160.8	168.3	175.8	183.4	190.9	198.5
17: 8	**212**	1	175.9133	0.04281	7.5308	153.3	160.9	168.4	175.9	183.4	191.0	198.5
17: 9	**213**	1	175.9781	0.04271	7.5160	153.4	160.9	168.5	176.0	183.5	191.0	198.5
17:10	**214**	1	176.0380	0.04261	7.5010	153.5	161.0	168.5	176.0	183.5	191.0	198.5
17:11	**215**	1	176.0935	0.04251	7.4857	153.6	161.1	168.6	176.1	183.6	191.1	198.6
18: 0	**216**	1	176.1449	0.04241	7.4703	153.7	161.2	168.7	176.1	183.6	191.1	198.6
18: 1	**217**	1	176.1925	0.04232	7.4565	153.8	161.3	168.7	176.2	183.6	191.1	198.6
18: 2	**218**	1	176.2368	0.04222	7.4407	153.9	161.4	168.8	176.2	183.7	191.1	198.6
18: 3	**219**	1	176.2779	0.04213	7.4266	154.0	161.4	168.9	176.3	183.7	191.1	198.6
18: 4	**220**	1	176.3162	0.04204	7.4123	154.1	161.5	168.9	176.3	183.7	191.1	198.6
18: 5	**221**	1	176.3518	0.04195	7.3980	154.2	161.6	169.0	176.4	183.8	191.1	198.5
18: 6	**222**	1	176.3851	0.04185	7.3817	154.2	161.6	169.0	176.4	183.8	191.1	198.5
18: 7	**223**	1	176.4162	0.04177	7.3689	154.3	161.7	169.0	176.4	183.8	191.2	198.5
18: 8	**224**	1	176.4453	0.04168	7.3542	154.4	161.7	169.1	176.4	183.8	191.2	198.5
18: 9	**225**	1	176.4724	0.04159	7.3395	154.5	161.8	169.1	176.5	183.8	191.2	198.5
18:10	**226**	1	176.4976	0.04150	7.3247	154.5	161.8	169.2	176.5	183.8	191.1	198.5
18:11	**227**	1	176.5211	0.04142	7.3115	154.6	161.9	169.2	176.5	183.8	191.1	198.5
19: 0	**228**	1	176.5432	0.04134	7.2983	154.6	161.9	169.2	176.5	183.8	191.1	198.4

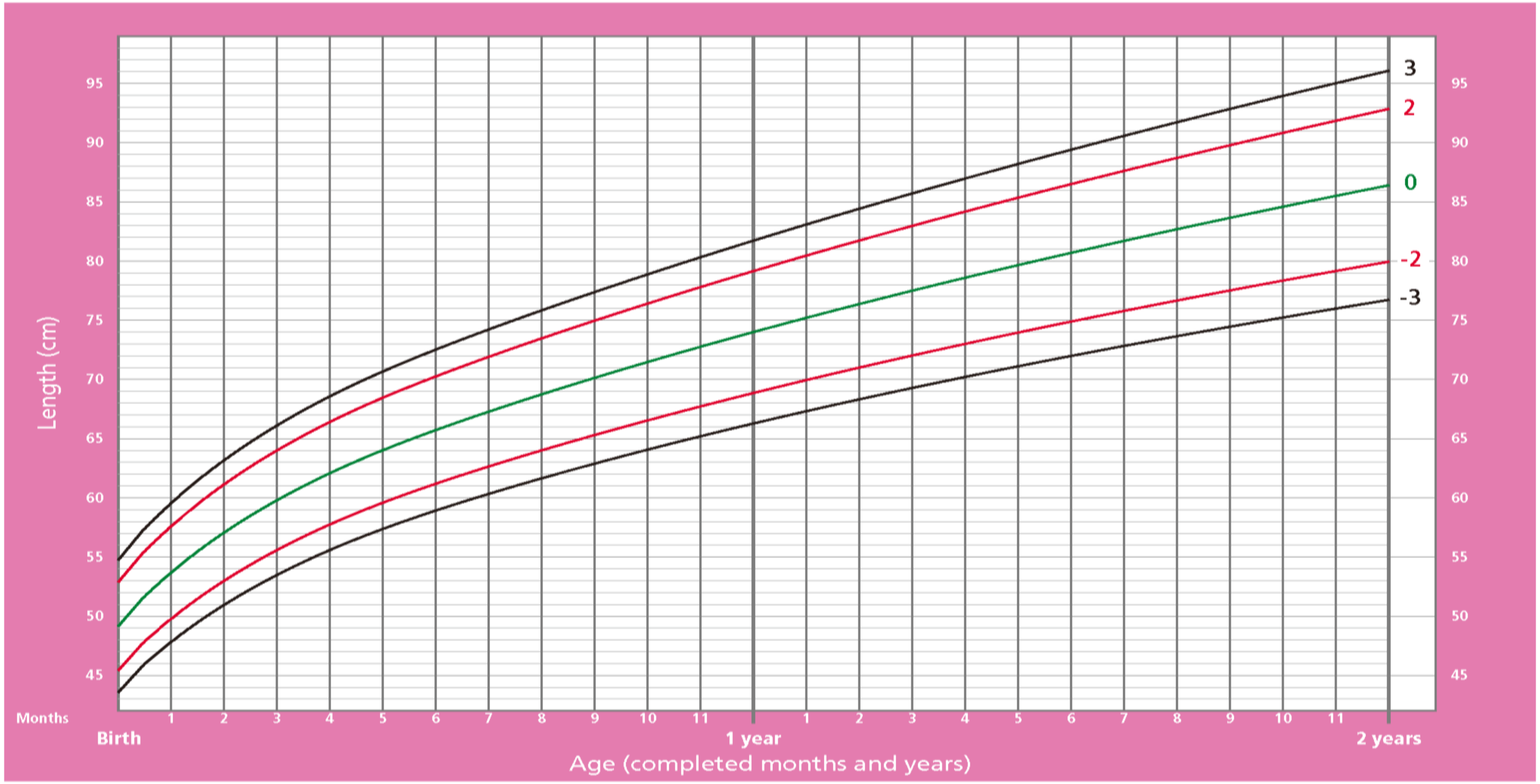
2007 WHO Reference

Source: WHO, Child Growth Reference, https://www.who.int/growthref/hfa_boys_5_19years_z.pdf?ua=1

Length-for-age GIRLS

Birth to 2 years (z-scores)

World Health Organization



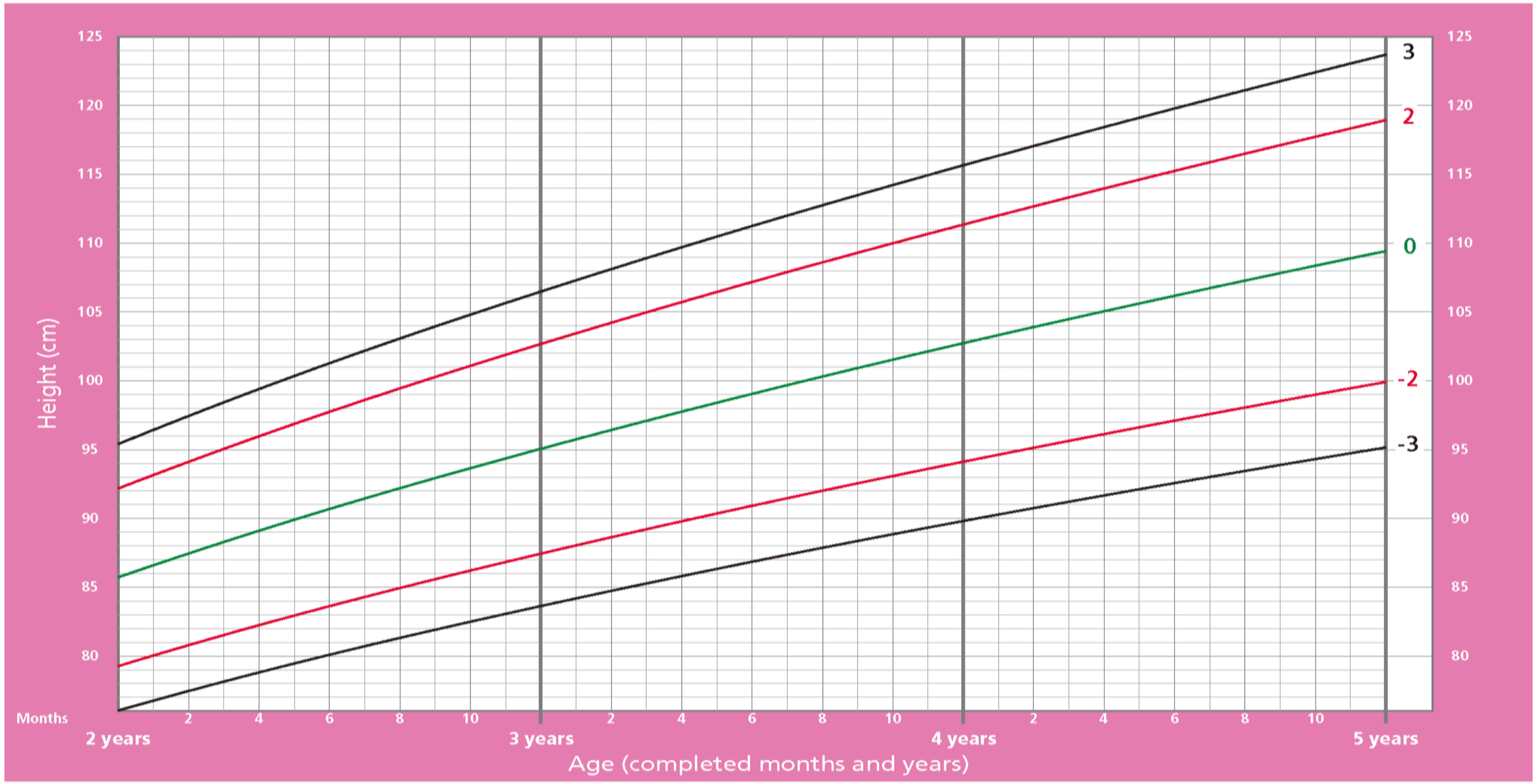
WHO Child Growth Standards

Source: WHO, Child Growth Reference, https://www.who.int/childgrowth/standards/cht_lfa_girls_z_0_2.pdf?ua=1

Height-for-age GIRLS

2 to 5 years (z-scores)

World Health Organization

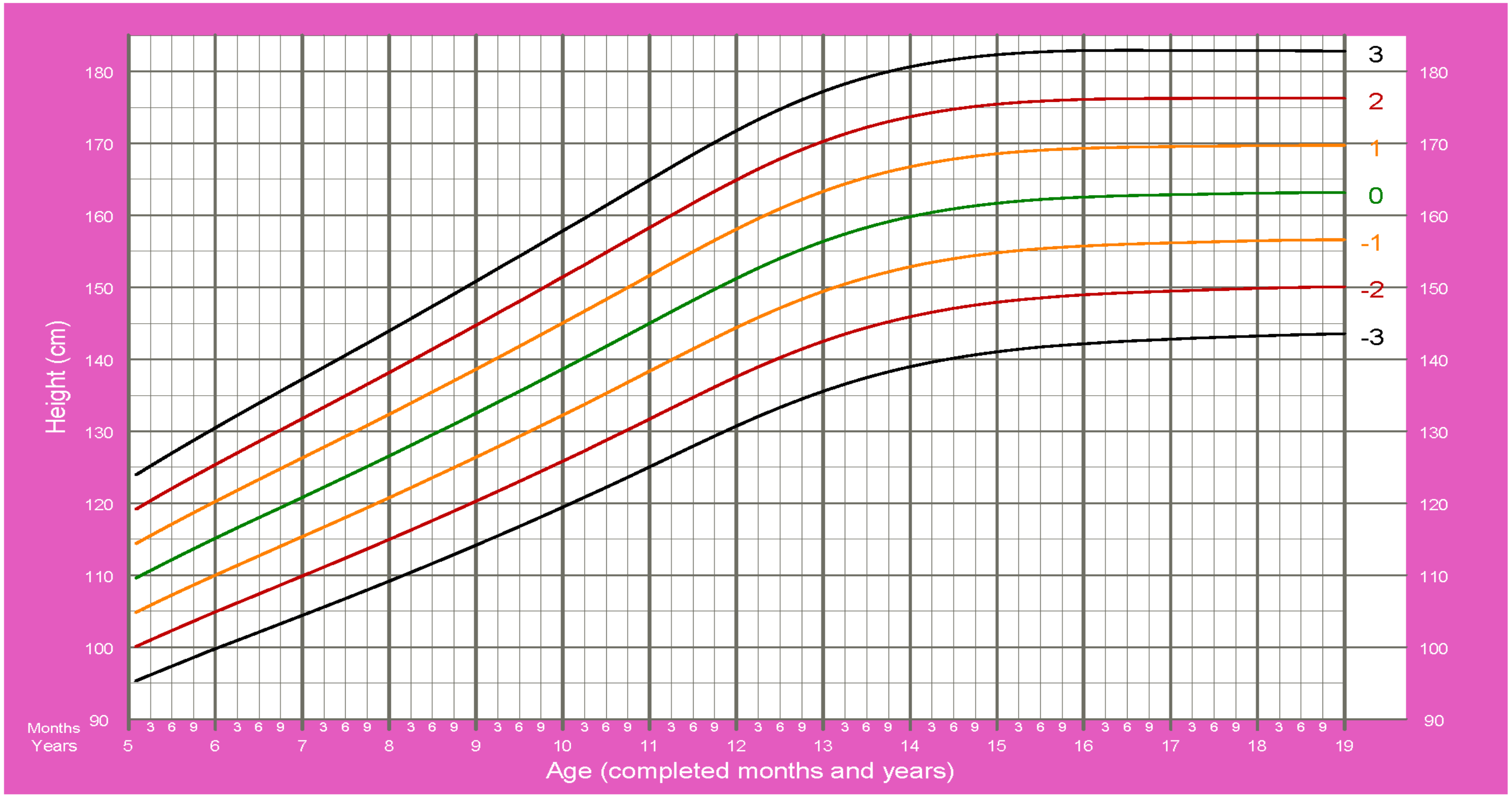


WHO Child Growth Standards

Source: WHO, Child Growth Reference, https://www.who.int/childgrowth/standards/cht_hfa_girls_z_2_5.pdf?ua=1

Height-for-age GIRLS

5 to 19 years (z-scores)



2007 WHO Reference

Source: WHO, Child Growth Reference, https://www.who.int/growthref/cht_hfa_girls_z_5_19years.pdf?ua=1

Length-for-age GIRLS

Birth to 2 years (z-scores)

World Health Organization

						Z-scores (length in cm)						
Year: Month	Month	L	M	S	SD	-3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
0: 0	0	1	49.1477	0.03790	1.8627	43.6	45.4	47.3	49.1	51.0	52.9	54.7
0: 1	1	1	53.6872	0.03640	1.9542	47.8	49.8	51.7	53.7	55.6	57.6	59.5
0: 2	2	1	57.0673	0.03568	2.0362	51.0	53.0	55.0	57.1	59.1	61.1	63.2
0: 3	3	1	59.8029	0.03520	2.1051	53.5	55.6	57.7	59.8	61.9	64.0	66.1
0: 4	4	1	62.0899	0.03486	2.1645	55.6	57.8	59.9	62.1	64.3	66.4	68.6
0: 5	5	1	64.0301	0.03463	2.2174	57.4	59.6	61.8	64.0	66.2	68.5	70.7
0: 6	6	1	65.7311	0.03448	2.2664	58.9	61.2	63.5	65.7	68.0	70.3	72.5
0: 7	7	1	67.2873	0.03441	2.3154	60.3	62.7	65.0	67.3	69.6	71.9	74.2
0: 8	8	1	68.7498	0.03440	2.3650	61.7	64.0	66.4	68.7	71.1	73.5	75.8
0: 9	9	1	70.1435	0.03444	2.4157	62.9	65.3	67.7	70.1	72.6	75.0	77.4
0:10	10	1	71.4818	0.03452	2.4676	64.1	66.5	69.0	71.5	73.9	76.4	78.9
0:11	11	1	72.7710	0.03464	2.5208	65.2	67.7	70.3	72.8	75.3	77.8	80.3
1: 0	12	1	74.0150	0.03479	2.5750	66.3	68.9	71.4	74.0	76.6	79.2	81.7
1: 1	13	1	75.2176	0.03496	2.6296	67.3	70.0	72.6	75.2	77.8	80.5	83.1
1: 2	14	1	76.3817	0.03514	2.6841	68.3	71.0	73.7	76.4	79.1	81.7	84.4
1: 3	15	1	77.5099	0.03534	2.7392	69.3	72.0	74.8	77.5	80.2	83.0	85.7
1: 4	16	1	78.6055	0.03555	2.7944	70.2	73.0	75.8	78.6	81.4	84.2	87.0
1: 5	17	1	79.6710	0.03576	2.8490	71.1	74.0	76.8	79.7	82.5	85.4	88.2
1: 6	18	1	80.7079	0.03598	2.9039	72.0	74.9	77.8	80.7	83.6	86.5	89.4
1: 7	19	1	81.7182	0.03620	2.9582	72.8	75.8	78.8	81.7	84.7	87.6	90.6
1: 8	20	1	82.7036	0.03643	3.0129	73.7	76.7	79.7	82.7	85.7	88.7	91.7
1: 9	21	1	83.6654	0.03666	3.0672	74.5	77.5	80.6	83.7	86.7	89.8	92.9
1:10	22	1	84.6040	0.03688	3.1202	75.2	78.4	81.5	84.6	87.7	90.8	94.0
1:11	23	1	85.5202	0.03711	3.1737	76.0	79.2	82.3	85.5	88.7	91.9	95.0
2: 0	24	1	86.4153	0.03734	3.2267	76.7	80.0	83.2	86.4	89.6	92.9	96.1

WHO Child Growth Standards

Source: WHO, Child Growth Reference, https://www.who.int/childgrowth/standards/LFA_girls_0_2_zscores.pdf?ua=1

Height-for-age GIRLS

2 to 5 years (z-scores)

World Health Organization

						Z-scores (height in cm)						
Year: Month	Month	L	M	S	SD	-3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
2: 0	**24**	1	85.7153	0.03764	3.2267	76.0	79.3	82.5	85.7	88.9	92.2	95.4
2: 1	**25**	1	86.5904	0.03786	3.2783	76.8	80.0	83.3	86.6	89.9	93.1	96.4
2: 2	**26**	1	87.4462	0.03808	3.3300	77.5	80.8	84.1	87.4	90.8	94.1	97.4
2: 3	**27**	1	88.2830	0.03830	3.3812	78.1	81.5	84.9	88.3	91.7	95.0	98.4
2: 4	**28**	1	89.1004	0.03851	3.4313	78.8	82.2	85.7	89.1	92.5	96.0	99.4
2: 5	**29**	1	89.8991	0.03872	3.4809	79.5	82.9	86.4	89.9	93.4	96.9	100.3
2: 6	**30**	1	90.6797	0.03893	3.5302	80.1	83.6	87.1	90.7	94.2	97.7	101.3
2: 7	**31**	1	91.4430	0.03913	3.5782	80.7	84.3	87.9	91.4	95.0	98.6	102.2
2: 8	**32**	1	92.1906	0.03933	3.6259	81.3	84.9	88.6	92.2	95.8	99.4	103.1
2: 9	**33**	1	92.9239	0.03952	3.6724	81.9	85.6	89.3	92.9	96.6	100.3	103.9
2:10	**34**	1	93.6444	0.03971	3.7186	82.5	86.2	89.9	93.6	97.4	101.1	104.8
2:11	**35**	1	94.3533	0.03989	3.7638	83.1	86.8	90.6	94.4	98.1	101.9	105.6
3: 0	**36**	1	95.0515	0.04006	3.8078	83.6	87.4	91.2	95.1	98.9	102.7	106.5
3: 1	**37**	1	95.7399	0.04024	3.8526	84.2	88.0	91.9	95.7	99.6	103.4	107.3
3: 2	**38**	1	96.4187	0.04041	3.8963	84.7	88.6	92.5	96.4	100.3	104.2	108.1
3: 3	**39**	1	97.0885	0.04057	3.9389	85.3	89.2	93.1	97.1	101.0	105.0	108.9
3: 4	**40**	1	97.7493	0.04073	3.9813	85.8	89.8	93.8	97.7	101.7	105.7	109.7
3: 5	**41**	1	98.4015	0.04089	4.0236	86.3	90.4	94.4	98.4	102.4	106.4	110.5
3: 6	**42**	1	99.0448	0.04105	4.0658	86.8	90.9	95.0	99.0	103.1	107.2	111.2
3: 7	**43**	1	99.6795	0.04120	4.1068	87.4	91.5	95.6	99.7	103.8	107.9	112.0
3: 8	**44**	1	100.3058	0.04135	4.1476	87.9	92.0	96.2	100.3	104.5	108.6	112.7
3: 9	**45**	1	100.9238	0.04150	4.1883	88.4	92.5	96.7	100.9	105.1	109.3	113.5
3:10	**46**	1	101.5337	0.04164	4.2279	88.9	93.1	97.3	101.5	105.8	110.0	114.2
3:11	**47**	1	102.1360	0.04179	4.2683	89.3	93.6	97.9	102.1	106.4	110.7	114.9
4: 0	**48**	1	102.7312	0.04193	4.3075	89.8	94.1	98.4	102.7	107.0	111.3	115.7

WHO Child Growth Standards

Source: WHO, Child Growth Reference, https://www.who.int/childgrowth/standards/HFA_girls_2_5_zscores.pdf?ua=1

Height-for-age GIRLS

2 to 5 years (z-scores)

World Health Organization

						Z-scores (height in cm)						
Year: Month	Month	L	M	S	SD	-3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
4: 1	**49**	1	103.3197	0.04206	4.3456	90.3	94.6	99.0	103.3	107.7	112.0	116.4
4: 2	**50**	1	103.9021	0.04220	4.3847	90.7	95.1	99.5	103.9	108.3	112.7	117.1
4: 3	**51**	1	104.4786	0.04233	4.4226	91.2	95.6	100.1	104.5	108.9	113.3	117.7
4: 4	**52**	1	105.0494	0.04246	4.4604	91.7	96.1	100.6	105.0	109.5	114.0	118.4
4: 5	**53**	1	105.6148	0.04259	4.4981	92.1	96.6	101.1	105.6	110.1	114.6	119.1
4: 6	**54**	1	106.1748	0.04272	4.5358	92.6	97.1	101.6	106.2	110.7	115.2	119.8
4: 7	**55**	1	106.7295	0.04285	4.5734	93.0	97.6	102.2	106.7	111.3	115.9	120.4
4: 8	**56**	1	107.2788	0.04298	4.6108	93.4	98.1	102.7	107.3	111.9	116.5	121.1
4: 9	**57**	1	107.8227	0.04310	4.6472	93.9	98.5	103.2	107.8	112.5	117.1	121.8
4:10	**58**	1	108.3613	0.04322	4.6834	94.3	99.0	103.7	108.4	113.0	117.7	122.4
4:11	**59**	1	108.8948	0.04334	4.7195	94.7	99.5	104.2	108.9	113.6	118.3	123.1
5: 0	**60**	1	109.4233	0.04347	4.7566	95.2	99.9	104.7	109.4	114.2	118.9	123.7

WHO Child Growth Standards

Source: WHO, Child Growth Reference, https://www.who.int/childgrowth/standards/HFA_girls_2_5_zscores.pdf?ua=1

Height-for-age GIRLS

5 to 19 years (z-scores)

World Health Organization

Year: Month	Month	L	M	S	SD	Z-scores (height in cm)						
						-3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
5: 1	61	1	109.6016	0.04355	4.7731	95.3	100.1	104.8	109.6	114.4	119.1	123.9
5: 2	62	1	110.1258	0.04364	4.8059	95.7	100.5	105.3	110.1	114.9	119.7	124.5
5: 3	63	1	110.6451	0.04373	4.8385	96.1	101.0	105.8	110.6	115.5	120.3	125.2
5: 4	64	1	111.1596	0.04382	4.8710	96.5	101.4	106.3	111.2	116.0	120.9	125.8
5: 5	65	1	111.6696	0.04390	4.9023	97.0	101.9	106.8	111.7	116.6	121.5	126.4
5: 6	66	1	112.1753	0.04399	4.9346	97.4	102.3	107.2	112.2	117.1	122.0	127.0
5: 7	67	1	112.6767	0.04407	4.9657	97.8	102.7	107.7	112.7	117.6	122.6	127.6
5: 8	68	1	113.1740	0.04415	4.9966	98.2	103.2	108.2	113.2	118.2	123.2	128.2
5: 9	69	1	113.6672	0.04423	5.0275	98.6	103.6	108.6	113.7	118.7	123.7	128.8
5:10	70	1	114.1565	0.04431	5.0583	99.0	104.0	109.1	114.2	119.2	124.3	129.3
5:11	71	1	114.6421	0.04439	5.0890	99.4	104.5	109.6	114.6	119.7	124.8	129.9
6: 0	72	1	115.1244	0.04447	5.1196	99.8	104.9	110.0	115.1	120.2	125.4	130.5
6: 1	73	1	115.6039	0.04454	5.1490	100.2	105.3	110.5	115.6	120.8	125.9	131.1
6: 2	74	1	116.0812	0.04461	5.1784	100.5	105.7	110.9	116.1	121.3	126.4	131.6
6: 3	75	1	116.5568	0.04469	5.2089	100.9	106.1	111.3	116.6	121.8	127.0	132.2
6: 4	76	1	117.0311	0.04475	5.2371	101.3	106.6	111.8	117.0	122.3	127.5	132.7
6: 5	77	1	117.5044	0.04482	5.2665	101.7	107.0	112.2	117.5	122.8	128.0	133.3
6: 6	78	1	117.9769	0.04489	5.2960	102.1	107.4	112.7	118.0	123.3	128.6	133.9
6: 7	79	1	118.4489	0.04495	5.3243	102.5	107.8	113.1	118.4	123.8	129.1	134.4
6: 8	80	1	118.9208	0.04502	5.3538	102.9	108.2	113.6	118.9	124.3	129.6	135.0
6: 9	81	1	119.3926	0.04508	5.3822	103.2	108.6	114.0	119.4	124.8	130.2	135.5
6:10	82	1	119.8648	0.04514	5.4107	103.6	109.0	114.5	119.9	125.3	130.7	136.1
6:11	83	1	120.3374	0.04520	5.4393	104.0	109.5	114.9	120.3	125.8	131.2	136.7
7: 0	84	1	120.8105	0.04525	5.4667	104.4	109.9	115.3	120.8	126.3	131.7	137.2
7: 1	85	1	121.2843	0.04531	5.4954	104.8	110.3	115.8	121.3	126.8	132.3	137.8
7: 2	86	1	121.7587	0.04536	5.5230	105.2	110.7	116.2	121.8	127.3	132.8	138.3

2007 WHO Reference

Source: WHO, Child Growth Reference, https://www.who.int/growthref/hfa_girls_5_19years_z.pdf?ua=1

Height-for-age GIRLS

5 to 19 years (z-scores)

World Health Organization

Year: Month	Month	L	M	S	SD	Z-scores (height in cm)						
						-3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
7: 3	**87**	1	122.2338	0.04542	5.5519	105.6	111.1	116.7	122.2	127.8	133.3	138.9
7: 4	**88**	1	122.7098	0.04547	5.5796	106.0	111.6	117.1	122.7	128.3	133.9	139.4
7: 5	**89**	1	123.1868	0.04551	5.6062	106.4	112.0	117.6	123.2	128.8	134.4	140.0
7: 6	**90**	1	123.6646	0.04556	5.6342	106.8	112.4	118.0	123.7	129.3	134.9	140.6
7: 7	**91**	1	124.1435	0.04561	5.6622	107.2	112.8	118.5	124.1	129.8	135.5	141.1
7: 8	**92**	1	124.6234	0.04565	5.6891	107.6	113.2	118.9	124.6	130.3	136.0	141.7
7: 9	**93**	1	125.1045	0.04569	5.7160	108.0	113.7	119.4	125.1	130.8	136.5	142.3
7:10	**94**	1	125.5869	0.04573	5.7431	108.4	114.1	119.8	125.6	131.3	137.1	142.8
7:11	**95**	1	126.0706	0.04577	5.7703	108.8	114.5	120.3	126.1	131.8	137.6	143.4
8: 0	**96**	1	126.5558	0.04581	5.7975	109.2	115.0	120.8	126.6	132.4	138.2	143.9
8: 1	**97**	1	127.0424	0.04585	5.8249	109.6	115.4	121.2	127.0	132.9	138.7	144.5
8: 2	**98**	1	127.5304	0.04588	5.8511	110.0	115.8	121.7	127.5	133.4	139.2	145.1
8: 3	**99**	1	128.0199	0.04591	5.8774	110.4	116.3	122.1	128.0	133.9	139.8	145.7
8: 4	**100**	1	128.5109	0.04594	5.9038	110.8	116.7	122.6	128.5	134.4	140.3	146.2
8: 5	**101**	1	129.0035	0.04597	5.9303	111.2	117.1	123.1	129.0	134.9	140.9	146.8
8: 6	**102**	1	129.4975	0.04600	5.9569	111.6	117.6	123.5	129.5	135.5	141.4	147.4
8: 7	**103**	1	129.9932	0.04602	5.9823	112.0	118.0	124.0	130.0	136.0	142.0	147.9
8: 8	**104**	1	130.4904	0.04604	6.0078	112.5	118.5	124.5	130.5	136.5	142.5	148.5
8: 9	**105**	1	130.9891	0.04607	6.0347	112.9	118.9	125.0	131.0	137.0	143.1	149.1
8:10	**106**	1	131.4895	0.04608	6.0590	113.3	119.4	125.4	131.5	137.5	143.6	149.7
8:11	**107**	1	131.9912	0.04610	6.0848	113.7	119.8	125.9	132.0	138.1	144.2	150.2
9: 0	**108**	1	132.4944	0.04612	6.1106	114.2	120.3	126.4	132.5	138.6	144.7	150.8
9: 1	**109**	1	132.9989	0.04613	6.1352	114.6	120.7	126.9	133.0	139.1	145.3	151.4
9: 2	**110**	1	133.5046	0.04614	6.1599	115.0	121.2	127.3	133.5	139.7	145.8	152.0
9: 3	**111**	1	134.0118	0.04615	6.1846	115.5	121.6	127.8	134.0	140.2	146.4	152.6

2007 WHO Reference

Source: WHO, Child Growth Reference, https://www.who.int/growthref/hfa_girls_5_19years_z.pdf?ua=1

Height-for-age GIRLS

5 to 19 years (z-scores)

Year: Month	Month	L	M	S	SD	Z-scores (height in cm)						
						-3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
9: 4	**112**	1	134.5202	0.04616	6.2095	115.9	122.1	128.3	134.5	140.7	146.9	153.1
9: 5	**113**	1	135.0299	0.04616	6.2330	116.3	122.6	128.8	135.0	141.3	147.5	153.7
9: 6	**114**	1	135.5410	0.04617	6.2579	116.8	123.0	129.3	135.5	141.8	148.1	154.3
9: 7	**115**	1	136.0533	0.04617	6.2816	117.2	123.5	129.8	136.1	142.3	148.6	154.9
9: 8	**116**	1	136.5670	0.04616	6.3039	117.7	124.0	130.3	136.6	142.9	149.2	155.5
9: 9	**117**	1	137.0821	0.04616	6.3277	118.1	124.4	130.8	137.1	143.4	149.7	156.1
9:10	**118**	1	137.5987	0.04616	6.3516	118.5	124.9	131.2	137.6	144.0	150.3	156.7
9:11	**119**	1	138.1167	0.04615	6.3741	119.0	125.4	131.7	138.1	144.5	150.9	157.2
10: 0	**120**	1	138.6363	0.04614	6.3967	119.4	125.8	132.2	138.6	145.0	151.4	157.8
10: 1	**121**	1	139.1575	0.04612	6.4179	119.9	126.3	132.7	139.2	145.6	152.0	158.4
10: 2	**122**	1	139.6803	0.04611	6.4407	120.4	126.8	133.2	139.7	146.1	152.6	159.0
10: 3	**123**	1	140.2049	0.04609	6.4620	120.8	127.3	133.7	140.2	146.7	153.1	159.6
10: 4	**124**	1	140.7313	0.04607	6.4835	121.3	127.8	134.2	140.7	147.2	153.7	160.2
10: 5	**125**	1	141.2594	0.04605	6.5050	121.7	128.2	134.8	141.3	147.8	154.3	160.8
10: 6	**126**	1	141.7892	0.04603	6.5266	122.2	128.7	135.3	141.8	148.3	154.8	161.4
10: 7	**127**	1	142.3206	0.04600	6.5467	122.7	129.2	135.8	142.3	148.9	155.4	162.0
10: 8	**128**	1	142.8534	0.04597	6.5670	123.2	129.7	136.3	142.9	149.4	156.0	162.6
10: 9	**129**	1	143.3874	0.04594	6.5872	123.6	130.2	136.8	143.4	150.0	156.6	163.1
10:10	**130**	1	143.9222	0.04591	6.6075	124.1	130.7	137.3	143.9	150.5	157.1	163.7
10:11	**131**	1	144.4575	0.04588	6.6277	124.6	131.2	137.8	144.5	151.1	157.7	164.3
11: 0	**132**	1	144.9929	0.04584	6.6465	125.1	131.7	138.3	145.0	151.6	158.3	164.9
11: 1	**133**	1	145.5280	0.04580	6.6652	125.5	132.2	138.9	145.5	152.2	158.9	165.5
11: 2	**134**	1	146.0622	0.04576	6.6838	126.0	132.7	139.4	146.1	152.7	159.4	166.1
11: 3	**135**	1	146.5951	0.04571	6.7009	126.5	133.2	139.9	146.6	153.3	160.0	166.7
2007 WHO Reference												

Source: WHO, Child Growth Reference, https://www.who.int/growthref/hfa_girls_5_19years_z.pdf?ua=1

Height-for-age GIRLS

5 to 19 years (z-scores)

Year: Month	Month	L	M	S	SD	Z-scores (height in cm) -3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
11: 4	**136**	1	147.1262	0.04567	6.7193	127.0	133.7	140.4	147.1	153.8	160.6	167.3
11: 5	**137**	1	147.6548	0.04562	6.7360	127.4	134.2	140.9	147.7	154.4	161.1	167.9
11: 6	**138**	1	148.1804	0.04557	6.7526	127.9	134.7	141.4	148.2	154.9	161.7	168.4
11: 7	**139**	1	148.7023	0.04552	6.7689	128.4	135.2	141.9	148.7	155.5	162.2	169.0
11: 8	**140**	1	149.2197	0.04546	6.7835	128.9	135.7	142.4	149.2	156.0	162.8	169.6
11: 9	**141**	1	149.7322	0.04541	6.7993	129.3	136.1	142.9	149.7	156.5	163.3	170.1
11:10	**142**	1	150.2390	0.04535	6.8133	129.8	136.6	143.4	150.2	157.1	163.9	170.7
11:11	**143**	1	150.7394	0.04529	6.8270	130.3	137.1	143.9	150.7	157.6	164.4	171.2
12: 0	**144**	1	151.2327	0.04523	6.8403	130.7	137.6	144.4	151.2	158.1	164.9	171.8
12: 1	**145**	1	151.7182	0.04516	6.8516	131.2	138.0	144.9	151.7	158.6	165.4	172.3
12: 2	**146**	1	152.1951	0.04510	6.8640	131.6	138.5	145.3	152.2	159.1	165.9	172.8
12: 3	**147**	1	152.6628	0.04503	6.8744	132.0	138.9	145.8	152.7	159.5	166.4	173.3
12: 4	**148**	1	153.1206	0.04497	6.8858	132.5	139.3	146.2	153.1	160.0	166.9	173.8
12: 5	**149**	1	153.5678	0.04490	6.8952	132.9	139.8	146.7	153.6	160.5	167.4	174.3
12: 6	**150**	1	154.0041	0.04483	6.9040	133.3	140.2	147.1	154.0	160.9	167.8	174.7
12: 7	**151**	1	154.4290	0.04476	6.9122	133.7	140.6	147.5	154.4	161.3	168.3	175.2
12: 8	**152**	1	154.8423	0.04468	6.9184	134.1	141.0	147.9	154.8	161.8	168.7	175.6
12: 9	**153**	1	155.2437	0.04461	6.9254	134.5	141.4	148.3	155.2	162.2	169.1	176.0
12:10	**154**	1	155.6330	0.04454	6.9319	134.8	141.8	148.7	155.6	162.6	169.5	176.4
12:11	**155**	1	156.0101	0.04446	6.9362	135.2	142.1	149.1	156.0	162.9	169.9	176.8
13: 0	**156**	1	156.3748	0.04439	6.9415	135.6	142.5	149.4	156.4	163.3	170.3	177.2
13: 1	**157**	1	156.7269	0.04431	6.9446	135.9	142.8	149.8	156.7	163.7	170.6	177.6
13: 2	**158**	1	157.0666	0.04423	6.9471	136.2	143.2	150.1	157.1	164.0	171.0	177.9
13: 3	**159**	1	157.3936	0.04415	6.9489	136.5	143.5	150.4	157.4	164.3	171.3	178.2

2007 WHO Reference

Source: WHO, Child Growth Reference, https://www.who.int/growthref/hfa_girls_5_19years_z.pdf?ua=1

Height-for-age GIRLS

5 to 19 years (z-scores)

Year: Month	Month	L	M	S	SD	Z-scores (height in cm) -3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
13: 4	**160**	1	157.7082	0.04408	6.9518	136.9	143.8	150.8	157.7	164.7	171.6	178.6
13: 5	**161**	1	158.0102	0.04400	6.9524	137.2	144.1	151.1	158.0	165.0	171.9	178.9
13: 6	**162**	1	158.2997	0.04392	6.9525	137.4	144.4	151.3	158.3	165.3	172.2	179.2
13: 7	**163**	1	158.5771	0.04384	6.9520	137.7	144.7	151.6	158.6	165.5	172.5	179.4
13: 8	**164**	1	158.8425	0.04376	6.9509	138.0	144.9	151.9	158.8	165.8	172.7	179.7
13: 9	**165**	1	159.0961	0.04369	6.9509	138.2	145.2	152.1	159.1	166.0	173.0	179.9
13:10	**166**	1	159.3382	0.04361	6.9487	138.5	145.4	152.4	159.3	166.3	173.2	180.2
13:11	**167**	1	159.5691	0.04353	6.9460	138.7	145.7	152.6	159.6	166.5	173.5	180.4
14: 0	**168**	1	159.7890	0.04345	6.9428	139.0	145.9	152.8	159.8	166.7	173.7	180.6
14: 1	**169**	1	159.9983	0.04337	6.9391	139.2	146.1	153.1	160.0	166.9	173.9	180.8
14: 2	**170**	1	160.1971	0.04330	6.9365	139.4	146.3	153.3	160.2	167.1	174.1	181.0
14: 3	**171**	1	160.3857	0.04322	6.9319	139.6	146.5	153.5	160.4	167.3	174.2	181.2
14: 4	**172**	1	160.5643	0.04314	6.9267	139.8	146.7	153.6	160.6	167.5	174.4	181.3
14: 5	**173**	1	160.7332	0.04307	6.9228	140.0	146.9	153.8	160.7	167.7	174.6	181.5
14: 6	**174**	1	160.8927	0.04299	6.9168	140.1	147.1	154.0	160.9	167.8	174.7	181.6
14: 7	**175**	1	161.0430	0.04292	6.9120	140.3	147.2	154.1	161.0	168.0	174.9	181.8
14: 8	**176**	1	161.1845	0.04284	6.9051	140.5	147.4	154.3	161.2	168.1	175.0	181.9
14: 9	**177**	1	161.3176	0.04277	6.8996	140.6	147.5	154.4	161.3	168.2	175.1	182.0
14:10	**178**	1	161.4425	0.04270	6.8936	140.8	147.7	154.5	161.4	168.3	175.2	182.1
14:11	**179**	1	161.5596	0.04263	6.8873	140.9	147.8	154.7	161.6	168.4	175.3	182.2
15: 0	**180**	1	161.6692	0.04255	6.8790	141.0	147.9	154.8	161.7	168.5	175.4	182.3
15: 1	**181**	1	161.7717	0.04248	6.8721	141.2	148.0	154.9	161.8	168.6	175.5	182.4
15: 2	**182**	1	161.8673	0.04241	6.8648	141.3	148.1	155.0	161.9	168.7	175.6	182.5
15: 3	**183**	1	161.9564	0.04235	6.8589	141.4	148.2	155.1	162.0	168.8	175.7	182.5

2007 WHO Reference

Source: WHO, Child Growth Reference, https://www.who.int/growthref/hfa_girls_5_19years_z.pdf?ua=1

Height-for-age GIRLS

5 to 19 years (z-scores)

						Z-scores (height in cm)						
Year: Month	Month	L	M	S	SD	-3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
15: 4	**184**	1	162.0393	0.04228	6.8510	141.5	148.3	155.2	162.0	168.9	175.7	182.6
15: 5	**185**	1	162.1164	0.04221	6.8429	141.6	148.4	155.3	162.1	169.0	175.8	182.6
15: 6	**186**	1	162.1880	0.04214	6.8346	141.7	148.5	155.4	162.2	169.0	175.9	182.7
15: 7	**187**	1	162.2542	0.04208	6.8277	141.8	148.6	155.4	162.3	169.1	175.9	182.7
15: 8	**188**	1	162.3154	0.04201	6.8189	141.9	148.7	155.5	162.3	169.1	176.0	182.8
15: 9	**189**	1	162.3719	0.04195	6.8115	141.9	148.7	155.6	162.4	169.2	176.0	182.8
15:10	**190**	1	162.4239	0.04189	6.8039	142.0	148.8	155.6	162.4	169.2	176.0	182.8
15:11	**191**	1	162.4717	0.04182	6.7946	142.1	148.9	155.7	162.5	169.3	176.1	182.9
16: 0	**192**	1	162.5156	0.04176	6.7867	142.2	148.9	155.7	162.5	169.3	176.1	182.9
16: 1	**193**	1	162.5560	0.04170	6.7786	142.2	149.0	155.8	162.6	169.3	176.1	182.9
16: 2	**194**	1	162.5933	0.04164	6.7704	142.3	149.1	155.8	162.6	169.4	176.1	182.9
16: 3	**195**	1	162.6276	0.04158	6.7621	142.3	149.1	155.9	162.6	169.4	176.2	182.9
16: 4	**196**	1	162.6594	0.04152	6.7536	142.4	149.2	155.9	162.7	169.4	176.2	182.9
16: 5	**197**	1	162.6890	0.04147	6.7467	142.4	149.2	155.9	162.7	169.4	176.2	182.9
16: 6	**198**	1	162.7165	0.04141	6.7381	142.5	149.2	156.0	162.7	169.5	176.2	182.9
16: 7	**199**	1	162.7425	0.04136	6.7310	142.5	149.3	156.0	162.7	169.5	176.2	182.9
16: 8	**200**	1	162.7670	0.04130	6.7223	142.6	149.3	156.0	162.8	169.5	176.2	182.9
16: 9	**201**	1	162.7904	0.04125	6.7151	142.6	149.4	156.1	162.8	169.5	176.2	182.9
16:10	**202**	1	162.8126	0.04119	6.7063	142.7	149.4	156.1	162.8	169.5	176.2	182.9
16:11	**203**	1	162.8340	0.04114	6.6990	142.7	149.4	156.1	162.8	169.5	176.2	182.9
17: 0	**204**	1	162.8545	0.04109	6.6917	142.8	149.5	156.2	162.9	169.5	176.2	182.9
17: 1	**205**	1	162.8743	0.04104	6.6844	142.8	149.5	156.2	162.9	169.6	176.2	182.9
17: 2	**206**	1	162.8935	0.04099	6.6770	142.9	149.5	156.2	162.9	169.6	176.2	182.9
17: 3	**207**	1	162.9120	0.04094	6.6696	142.9	149.6	156.2	162.9	169.6	176.3	182.9

2007 WHO Reference

Source: WHO, Child Growth Reference, https://www.who.int/growthref/hfa_girls_5_19years_z.pdf?ua=1

Height-for-age GIRLS

5 to 19 years (z-scores)

						Z-scores (height in cm)						
Year: Month	Month	L	M	S	SD	-3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
17: 4	**208**	1	162.9300	0.04089	6.6622	142.9	149.6	156.3	162.9	169.6	176.3	182.9
17: 5	**209**	1	162.9476	0.04084	6.6548	143.0	149.6	156.3	162.9	169.6	176.3	182.9
17: 6	**210**	1	162.9649	0.04080	6.6490	143.0	149.7	156.3	163.0	169.6	176.3	182.9
17: 7	**211**	1	162.9817	0.04075	6.6415	143.1	149.7	156.3	163.0	169.6	176.3	182.9
17: 8	**212**	1	162.9983	0.04071	6.6357	143.1	149.7	156.4	163.0	169.6	176.3	182.9
17: 9	**213**	1	163.0144	0.04066	6.6282	143.1	149.8	156.4	163.0	169.6	176.3	182.9
17:10	**214**	1	163.0300	0.04062	6.6223	143.2	149.8	156.4	163.0	169.7	176.3	182.9
17:11	**215**	1	163.0451	0.04058	6.6164	143.2	149.8	156.4	163.0	169.7	176.3	182.9
18: 0	**216**	1	163.0595	0.04053	6.6088	143.2	149.8	156.5	163.1	169.7	176.3	182.9
18: 1	**217**	1	163.0733	0.04049	6.6028	143.3	149.9	156.5	163.1	169.7	176.3	182.9
18: 2	**218**	1	163.0862	0.04045	6.5968	143.3	149.9	156.5	163.1	169.7	176.3	182.9
18: 3	**219**	1	163.0982	0.04041	6.5908	143.3	149.9	156.5	163.1	169.7	176.3	182.9
18: 4	**220**	1	163.1092	0.04037	6.5847	143.4	149.9	156.5	163.1	169.7	176.3	182.9
18: 5	**221**	1	163.1192	0.04034	6.5802	143.4	150.0	156.5	163.1	169.7	176.3	182.9
18: 6	**222**	1	163.1279	0.04030	6.5741	143.4	150.0	156.6	163.1	169.7	176.3	182.9
18: 7	**223**	1	163.1355	0.04026	6.5678	143.4	150.0	156.6	163.1	169.7	176.3	182.8
18: 8	**224**	1	163.1418	0.04023	6.5632	143.5	150.0	156.6	163.1	169.7	176.3	182.8
18: 9	**225**	1	163.1469	0.04019	6.5569	143.5	150.0	156.6	163.1	169.7	176.3	182.8
18:10	**226**	1	163.1508	0.04016	6.5521	143.5	150.0	156.6	163.2	169.7	176.3	182.8
18:11	**227**	1	163.1534	0.04012	6.5457	143.5	150.1	156.6	163.2	169.7	176.2	182.8
19: 0	**228**	1	163.1548	0.04009	6.5409	143.5	150.1	156.6	163.2	169.7	176.2	182.8

2007 WHO Reference

Source: WHO, Child Growth Reference, https://www.who.int/growthref/hfa_girls_5_19years_z.pdf?ua=1

APPENDIX II

Appendix II details the cleaning process of the data used in this study as well as how variables family structure is created:

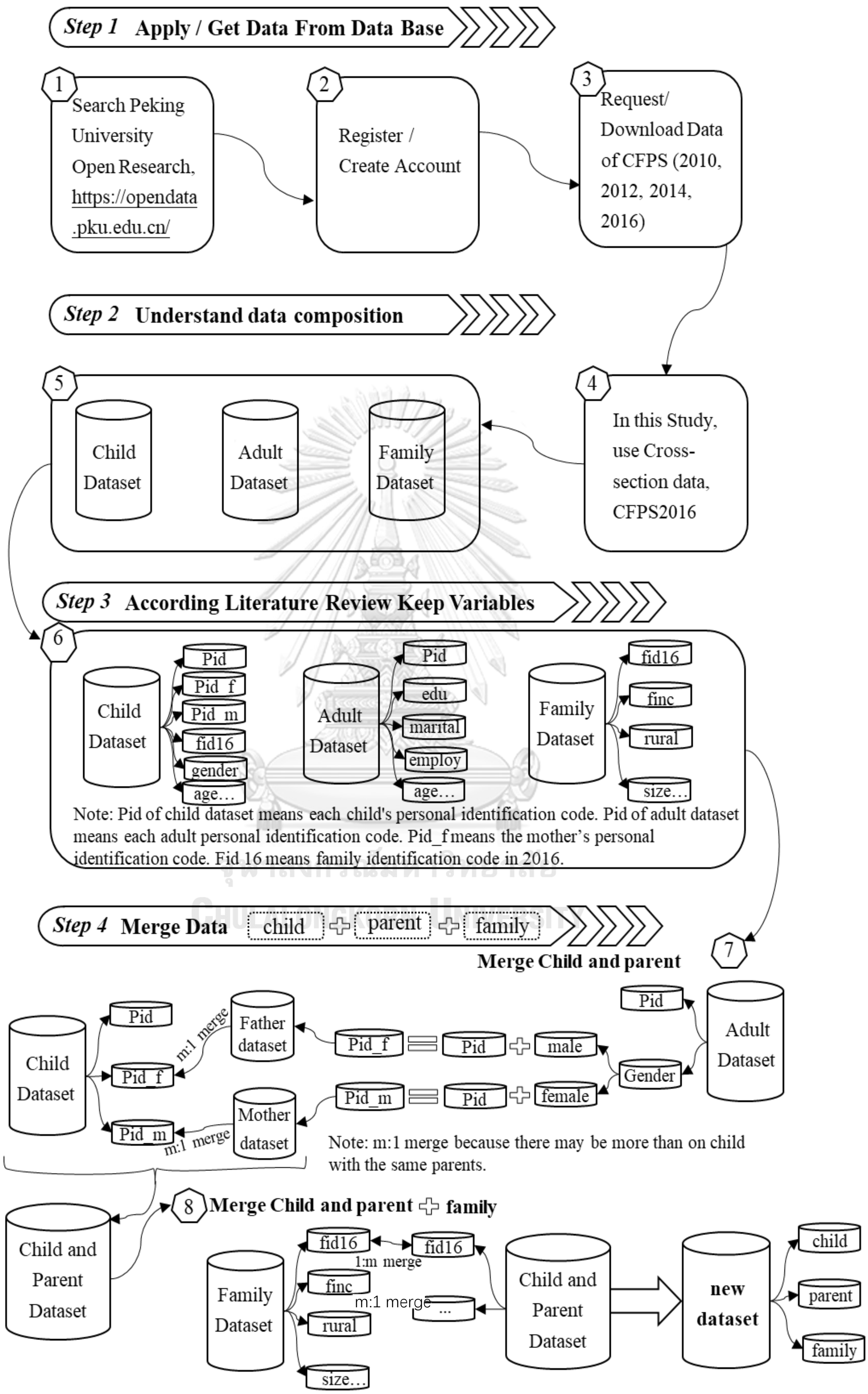
Here are a few things I would like to say about the data cleansing process. First of all, we need to know that before we clean up the data, we need the children's information, parents' information, and family information distributed in different data sets. Children's statement is in the children's data set, parents' story is in the adult data set, and family information is in the family data set. All we have to do is match them. Before matching them, we need to pre-clean each data set. Because the data set contains many variables, and we do not need most of them, it is easy to clean them, and we only need to delete the useless variables.

Because there are two variables in the children's data set, one is the father's code in the survey, which is pid_f, and the other is the mother's code in the survey, which is pid_m. These two variables are also the same as the adults' data in the survey. It corresponds to pid (personal ID). In other words, every father and mother code shown in the children's database can be found in the adult database. So, we can use this bond to match them. Because each child's code is unique in the children's database, there are some duplications in the code of the child's parents in the survey. This is because a pair of parents may have two or more children. Because each adult's code in the adult library is unique, we use "m:1" to match the children and their corresponding parent information.

The second is to match the information of the family corresponding to each child. Because the variable of family ID in the children database is likely to be repeated, because a family may have multiple children, but in the family data set, each family's ID are unique, so we also use "m:1" to match them together.

After matching the information of children, parents, and families, we currently have only one data set. The next step is to identify single-parent families. When the children and parents are matched, the main variables we use are the father's code "pid_f" in the sample and the mother's code "pid_m" in the sample, but some children's father or mother's code does not exist. Since no children were investigated and parents were not investigated in this survey, we can basically conclude that this type of child is a child of a single-parent family. To further verify our conclusion, we use the variable "marital status at the time of investigation" in the parent dataset. If it is divorced or widowed, then the child's family is a single-parent family, which makes sense. In addition, in this survey, we only consider single-parent families and not orphans.

After identifying the children of single-parent families, our job is to do some necessary data cleaning, such as deleting missing values, calculating HAZ, creating new dummy variables, etc., which will not be repeated here.



Step 1 Apply / Get Data From Data Base
1
Search Peking University Open Research, https://opendata.pku.edu.cn/
2
Register / Create Account
3
Request/ Download Data of CFPS (2010, 2012, 2014, 2016)
Step 2 Understand data composition
4
In this Study, use Cross-section data, CFPS2016
5
Child Dataset
Adult Dataset
Family Dataset
Step 3 According Literature Review Keep Variables
6
Child Dataset
Pid
Pid_f
Pid_m
fid16
gender
age…
Adult Dataset
Pid
edu
marital
employ
age…
Family Dataset
fid16
finc
rural
size…
Note: Pid of child dataset means each child's personal identification code. Pid of adult dataset means each adult personal identification code. Pid_f means the mother's personal identification code. Fid 16 means family identification code in 2016.
Step 4 Merge Data
child
parent
family
7
Merge Child and parent
Child Dataset
Pid
Pid_f
Pid_m
m:1 merge
Father dataset
Mother dataset
m:1 merge
Pid_f
Pid
male
Pid_m
Pid
female
Pid
Gender
Adult Dataset
Note: m:1 merge because there may be more than on child with the same parents.
Child and Parent Dataset
8
Merge Child and parent
family
Family Dataset
fid16
finc
rural
size…
fid16
1:m merge
m:1 merge
…
Child and Parent Dataset
new dataset
child
parent
family

Step 5 Define Single Parent Family

9

Using New Dataset, according to the index of 'pid_f' 'pid_m' 'parent marital state' pid_f and pid_m mean parent personal identify in this survey because this survey that basic on the family, so, if a child didn't have pid_f or pid_m, we can see this child is a single father family or single mother family. Then we use the index of parent marital state check it again for the define single-parent family is correct also. For example:

Child pid	pid_m	pid_f	Marital stata	Family Type
1	123	124	Marriage	Dual parent
2	223	null	Divorce	Single mother
3	null	324	Widowed	Single father
4	null	null	null	other

So, we divide into three type of the family. Because the other type family have a lot of data missing and this type family account for lowest in total sample. So, we drop this type family in this study only keep dual parent family, single mother family and single father family.

Step 6 Calculate Height-for-age Z score

10

We calculate HAZ as following this formula. And for the detail information in appendix II

$$HAZ = \frac{Height\ of\ child - Median\ height\ of\ that\ age(WHO, Standard)}{Standard\ deviation(WHO, Standard)}$$

REFERENCES

Alkire, S., Kanagaratnam, U., & Suppa, N. (2019). The global multidimensional poverty index (MPI) 2019.

Apouey, B., & Geoffard, P.-Y. (2013). Family income and child health in the UK. *Journal of Health Economics, 32*(4), 715-727.

Bai, Y. (2019). *A study on the health status of children in urban low-income families and school health promotion.* (Master Degree), Jiang Nan University, Available from Cnki

Becker, G. S., & Tomes, N. (1986). Human capital and the rise and fall of families. *Journal of labor economics, 4*(3, Part 2), S1-S39.

CDRF. (2017). *China Child Development Report 2017: Anti-Poverty and Early Childhood Development*. Beijing: China Development Press

CFDR. (2016). *China Family Developmet Report*.

China, N. B. o. S. o. (2018). *Statistical communiqué of the People's Republic of China on the Social Service Development, 2017*. National Bureau of Statistics of China

Chunhua Ma, J. S., Yinghe Li, Zhengyu Wang, Can Tang. (2011). Trends and latest discoveries of family changes in Chinese cities. *Sociological Studies, 25*(02), 182-216+246.

Coleman, J. S. (1988). Social capital in the creation of human capital. *American journal of sociology, 94*, S95-S120.

Commission, N. H. (2017). *China Health Statistics Yearbook 2017*. Beijing, China: China Union Medical College Press.

Commission, N. H. (2018a). China Health Statistics Yearbook 2018. *China Union Medical College Press: Beijing, China*.

Commission, N. H. (2018b). *China Health Statistics Yearbook 2018*. Beijing, China: China Union Medical College Press.

Currie, A., Shields, M. A., & Price, S. W. (2007). The child health/family income gradient: Evidence from England. *Journal of Health Economics, 26*(2), 213-232. doi:https://doi.org/10.1016/j.jhealeco.2006.08.003

De Brauw, A., Mu, Ren (2011). Migration and the overweight and underweight status of children in rural China. *Food Policy, 36*(1), 88-100.

Engel, G. L. (1977). The need for a new medical model: a challenge for biomedicine. *Science, 196*(4286), 129-136.

Gao, Y., Li, L. P., Kim, J. H., Congdon, N., Lau, J., & Griffiths, S. (2010). The impact of parental migration on health status and health behaviours among left behind adolescent school children in China. *BMC public health, 10*(1), 56.

Glick, P. C. (1947). The family cycle. *American sociological review, 12*(2), 164-174.

Goode, A., Mavromaras, K., & zhu, R. (2014). Family income and child health in China. *China Economic Review, 29*, 152-165. doi:https://doi.org/10.1016/j.chieco.2014.04.007

Grossman, M. (2017). *The demand for health: a theoretical and empirical investigation*: Columbia University Press.

Hao Zhou, S. R. (2011). A Summary of Studies on Floating Children in my country. *Population & Economics*(03), 94-103.

He, B., Fan, J., Liu, N., Li, H., Wang, Y., Williams, J., & Wong, K. (2012). Depression risk of 'left-behind children'in rural China. *Psychiatry research, 200*(2-3), 306-312.

Howard, M., Howard, M., & King, J. (1988). *The political economy of Marx*: NYU Press.

Hu, H., Lu, S., & Huang, C.-C. (2014). The psychological and behavioral outcomes of migrant and left-behind children in China. *Children Youth Services Review, 46*, 1-10.

Jing Wang, F. D., Changqing Suo. (2016). A Summary of Research on Mental Health of Migrant Children in China in the Last Ten Years. *Journal of Shaanxi Xueqian Normal University, 32*(01), 143-147.

Khanam, R., Nghiem, H. S., & Connelly, L. B. (2009). Child health and the income gradient: Evidence from Australia. *Journal of Health Economics, 28*(4), 805-817. doi:https://doi.org/10.1016/j.jhealeco.2009.05.001

Kun, Y. D. Y. (2018). Evolution of Medical Model and Discussion. *Chinese Medical Ethics, 31*(12), 1532-1535. doi:10 . 12026 /j . issn . 1001 − 8565 . 2018 . 12 . 07

Kuruvilla, S., Bustreo, F., Kuo, T., Mishra, C., Taylor, K., Fogstad, H., . . . Thomas, J. (2016). The Global strategy for women's, children's and adolescents' health (2016–2030): a roadmap based on evidence and country experience. *Bulletin of the World Health Organization, 94*(5), 398.

Larson, K., & Halfon, N. (2010). Family income gradients in the health and health care access of US children. *Maternal*
child health journal
14(3), 332-342.

Li Chen, X. W., Zhiyong Qu. (2010). An Analysis of the Growth and Nutritional Status of Migrant Children and Left-at-home Children. *Chinese Journal of Special Education*(08), 48-54.

Lin, C., & van der Meulen Rodgers, Y. (2018). Parental migration decisions and child health outcomes: Evidence from China.

Linjiang Wang, X. W., Fen Chang, Zengkang Xu, Ping Chen, Xiaoju Li. (2011). Applying two criteria to evaluate children's growth and development. *Modern Preventive Medicine, 38*(13), 2487-2488+2491.

Liu, J. (2019). Analysis of malnutrition of children in China. *Jiangsu Social Sciences*(01), 59-68.

Lv, L., Yan, F., Duan, C., & Cheng, M. (2018). Changing patterns and development challenges of child population in China. *Popul Res, 42*(3), 65-78.

Ma Zhe, Z. Z. (2016). Evolution of Children's Health Inequality and Related Social Economic Factors in China *Studies in Labor Economics, 4*(06), 22-41.

Mao, Z.-h., & Zhao, X.-d. (2012). The effects of social connections on self-rated physical and mental health among internal migrant and local adolescents in Shanghai, China. *BMC public health, 12*(1), 97.

McLanahan, S., & Sandefur, G. (1994). *Growing Up with a Single Parent. What Hurts, What Helps*: ERIC.

Miaomiao Zhao, H. L., Jun Li, Lingui Li, Cuili Wang, Stephen Nicholas , Qingyue Meng (2012). A Study on the Influence of Parents Working Outside on the Mental Health of Left-behind Children in Rural Areas. *Chinese Health Service Management, 29*(01), 60-63.

Organization, W. H. (1995). Constitution of the world health organization.

Parsons, T. (1949). The social structure of the family. 173-201.

Ping Yuan, X. W., Yan Wang. (2008). Comparison of three commonly used evaluation criteria for children's growth and development in China. *Chinese Journal of Child Health Care, 16*(06), 682-684.

Qiang Li, W. Z. (2011). Impact of parents' going out on the health of left-behind children. *China Economic Quarterly, 10*(01), 341-360.

Reinhold, S., & Jürges, H. (2012). Parental income and child health in Germany. *Health economics, 21*(5), 562-579.

Schultz, T. W. (1990). Human capital investment and urban competitiveness. *American Economic Review, 30*, 1-17.

Shuangyue, S. (2018). Mother's Migration and Children's Health, Evidence from CFPS Data *West Forum on Economy and Management, 29*(01), 63-71.

Skoufias, E. (1998). Determinants of child health during the economic transition in Romania. *World Development, 26*(11), 2045-2056.

Sun, L. (2004). Changes of Chinese Family Structure and Its Social Functions at the End of the 20th Century. *Northwest Population Journal*(05), 13-16.

Sun Yu, C. Q., Zhang rong, Chen Lu. (2014). Health related Behaviors in Children in Han and Minority Populations in China *Chinese General Practice, 17*(01), 64-66. doi:10. 3969 /j. issn. 1007-9572. 2014. 01. 020

Tavakoli, H. R. (2009). A closer evaluation of current methods in psychiatric assessments: a challenge for the biopsychosocial model. *Psychiatry, 6*(2), 25.

UNICEF. (1989). Convention on the Rights of the Child.

UNICEF. (2016). Population status of Children in China in 2015: Facts and Figures. In.

UNICEF. (2019). *The State of the World's Children 2019. Children, Food and Nutrition: Growing well in a changing world. UNICEF, New York.*

Wang, F. (2010). *The Analysis of Affect-factor of Chinese Children's Quanlity From Health and Education.* (Doctor degree), Nan Kai University, Available from Cnki

Wang, X. (2013). On the influence of family structure on the formation of children's personality *Cultural and educational information*(04), 122-123.

Wang, Y. (2015). Regional comparative analysis of contemporary family structure—Based on the 2010 census data. *Population & Economics*(01), 34-48.

Wang, Z. (2018). The influence of different family structures on children's personality. *Research on Transmission Competence, 2*(03), 123-124.

Wen, M. S., Shaobing Li, Xiaoming Lin, Danhua (2015). Positive youth development in rural China: The role of parental migration. *Social Science & Medicine, 132*, 261-269.

WHO. (2008). WHO child growth standards: training course on child growth assessment.

Xiaotong, F. (1992). From the soil: The foundations of Chinese society.

Xie, Y. (2013). Gender and family in contemporary China. *Population studies center research report*(13-808).

Xinxin Zhang, P. Z., Zhenxing Wang. (2015). Study on the health problems of "left-behind children" in the process of building a new socialist countryside in China, Take Ankang City in Shaanxi Province as an example. *Journal of Mudanjiang College of Education*(12), 56-58.

Xu, Z. (2008). Comparison of Children's Health Index System between China and Europe and America. *China Youth Study*(09), 52-57.

Yang, M. (2018). *FAMILY INCOME AND CHILDREN'S HEALTH IN RURAL AREAS: STUDY BASED ON CHNS DATA.* (Master Degree), Southeast University,

Yearbook, C. S. (2017). *National Bureau of Statistics of the People's Republic of China. 2017*. Retrieved from http://www. stats. gov. cn/tjsj/ndsj//indexch. htm

Yearbook, C. S. (2018). *National Bureau of Statistics of the People's Republic of China. 2018*. Retrieved from http://www. stats. gov. cn/tjsj/ndsj//indexch. htm

Yi Zeng, W. L., Zhiwu Liang. (1992). The current situation, regional differences and changing trends of Chinese family structure. *Chinese Journal of Population Science*(02), 1-12+22.

Yuxiao Wu, P. W., Sijia Du. (2018). The Changing Chinese Family Structure and Youth Development. *Social Sciences in China*(02), 98-120+206-207.

Yuying Wang, C. C., Wu He. (2007). An Analysis of the Changes of Chinese Children's Nutrition Status in 15 Years—Applying 2006 World Health Organization Child Growth Standards to Evaluate Chinese Children's Nutrition Status. *Journal of Hygiene Research*(02), 203-206.

Zaiyu, C. (2009). The health status of the left-behind children in rural China. *Chinese Journal of Population Science*(05), 95-102+112.

Zhang, C. (2019). *Children From Divorced Families in China*. Beijing: Social Science Academic Press

Zhang, H. (2013). Comparative Study on Physical Health of Children Migrating, Urban and Left-behind School-age Children. *Science & Technology Information*(23), 200-202+332.

Zhang, N. (2012). *Left-Behind Children's Health and Household Income Gradient: Evidence from Rural China.* (Master Dregee), Tianjin University, Available from Cnki

Zhongshuai Li, Q. S. (2014). Parents Working Outside and Left-behind Children's Health, Evidence from Rural China *Population & Economics*(03), 51-58.

VITA

NAME	Baode Zhao
DATE OF BIRTH	08 January 1998
PLACE OF BIRTH	Inner Mongolia, China
INSTITUTIONS ATTENDED	Bachelor degree of Marketing graduated in 2019, School of Health Management, Inner Mongolia Medical University, Hohhot, Inner Mongolia, China