# SOCIAL DETERMINANTS OF CHILD MALNUTRITION OUTCOMES, HEALTH HUMAN CAPITAL AND ECONOMIC GROWTH IN CHINA.

By

LI SA

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

**SOCIAL DETERMINANTS OF CHILD MALNUTRITION OUTCOMES, HEALTH HUMAN CAPITAL AND ECONOMIC GROWTH IN CHINA**

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**Chairman : Associate Professor Norashidah binti Mohamed Nor, PhD**
**School : Business and Economics**

Child malnutrition outcomes (CMOs) pose a threat to children's survival, development, and thriving worldwide, causing profoundly detrimental effects on health throughout their lives. Due to China's regional and urban-rural disparities in CMOs, this is still an enormous challenge for China to reach sustainable development goals (SDGs). This thesis aims to examine the social determinants of CMOs; the impact of CMOs on health human capital; the impact of health human capital and economic growth.

The first objective examines the social determinants of CMOs (measured by stunting, wasting and overweight) by employing fixed-effects (FE) models and using China Health and Nutrition Survey (CHNS) data from 1991 to 2015. The findings show that significant factors of child stunting (4012 observations) include whether the child is insured, maternal education level, maternal employment, and maternal working days, household income per capita, household assets, community urbanization, and living area. Meanwhile, the

significant factors of child wasting (4229 observations) are maternal employment, maternal working days, living regions and areas. For overweight (4429 observations), significant factors are maternal with low-middle school, maternal employment, maternal working days, household income per capita, maternal with medical insurance, and living regions.

The second objective examines the impact of CMOs on health human capital using the same period of CHNS. Based on FE models and logit models (1612 observations), the findings show the persistent impact of CMOs, including early-life and mid-to-late childhood, on health human capital in adulthood. CMOs measured by child stunting has been significantly influencing health human capital measured by height, BMI, self-rated health (SRH), and whether have been sick in the last four weeks (SH). CMOs measured by overweight significantly influences adult health human capital measured by body mass index (BMI), blood pressure (1165 observations), and perceived pressure (PP).

Finally, the third objective examines the impact of health human capital on economic growth using the 29 province-level data from 1990 to 2020 in China. By employing FE model, panel correction standard error (PCSE model), and feasible generalized least square (FGLS model) estimation method, findings consistently demonstrate a statistically significant positive relationship between health human capital and economic growth in China.

Overall, the study reveals significant social determinants influencing CMOs; its long-term impact on health human capital; and positive association of health

human capital on economic growth. To attain SDGs, the Chinese government can prioritize reducing the number of stunting and wasting among 5-year-olds in the western region by improving mothers' education and feeding knowledge, and providing financial subsidies. Meanwhile, emphasis should be placed on controlling overweight among children in the eastern region. By doing so can reduce the disease burden on the nation and increase the stock of health human capital for future population. Moreover, preventive healthcare and mental health intervention policies targeting young children should be explicitly drafted. At the macro-level, to narrow down the regional disparities, an explicit recommendation is to focus on health human capital, particularly increased health investment in the central and western region is highlighted.

**Keywords:** Child Malnutrition Outcomes, Economic Growth, Health Human Capital.

**SDG:** GOAL 2: Zero Hunger, GOAL 3: Good Health and Wellbeing, GOAL 8: Decent Work and Economic Growth.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**PENENTU SOSIAL HASIL MALNUTRISI KANAK-KANAK, MODAL IHSAN KESIHATAN, DAN PERTUMBUHAN EKONOMI DI CHINA**

Oleh

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**Pengerusi : Profesor Madya Norashidah binti Mohamed Nor, PhD**
**Sekolah : Perniagaan dan Ekonomi**

Hasil pemakanan kanak-kanak (CMOs) memberi ancaman serius terhadap kelangsungan hidup, perkembangan, dan kesejahteraan kanak-kanak di seluruh dunia. Di China, perbezaan wilayah dan bandar-luar bandar menjadikan isu ini cabaran besar untuk mencapai Matlamat Pembangunan Lestari (SDGs). Tesis ini bertujuan untuk mengkaji penentu sosial yang mempengaruhi CMOs, kesan CMOs terhadap modal insan kesihatan, serta hubungannya dengan pertumbuhan ekonomi.

Objektif pertama mengkaji penentu sosial yang mempengaruhi CMOs (diukur oleh kebantutan, kesusutan berat badan, dan berat badan berlebihan) dengan mengguna Analisis Model KesanTetap (FE) dan data daripada China Health and Nutrition Survey (CHNS) dari tahun 1991 hingga 2015. Hasil kajian menunjukkan faktor yang signifikan untuk kebantutan kanak-kanak (4012 pemerhatian) adalah samada kanak-kanak mempunyai insuran, tahap pendidikan ibu, pekerjaan ibu, hari bekerja ibu, pendapatan isi rumah per

kapita, aset isi rumah, perbandaran komuniti, dan kawasan tempat tinggal. Manakala, faktor yang signifikan bagi kesusutan berat badan kanak-kanak (4229 pemerhatian), adalah pekerjaan ibu, hari bekerja ibu, wilayah, dan kawasan tempat tinggal. Sementara itu, bagi berat badan berlebihan (4429 pemerhatian), faktor yang signifikan teadalah pendidikan sekolah menengah-rendah ibu, pekerjaan ibu, hari bekerja ibu, pendapatan isi rumah per kapita, insurans perubatan ibu, dan wilayah tempat tinggal.

Objektif kedua mengkaji kesan CMOs terhadap modal insan kesihatan untuk tempoh data yang sama dari CHNS. Berdasarkan model FE dan model logit (1612 pemerhatian), hasil kajian menunjukkan CMOs memberi kesan berterusan, bermula dari awal usia dan pertengahan hingga akhir usia kanak-kanak, terhadap modal insan kesihatan dewasa. CMOs yang diukur oleh kebantutan adalah signifikan dalam mempengaruhi modal insan kesihatan dewasa yang diukur oleh ketinggian, indek jisim badan (BMI), kesihatan dinilai sendiri (SRH), dan samada sakit dalam empat minggu terakhir (SH). CMOs yang diukur oleh berat badan berlebihan adalah signifikan dalam mempengaruhi modal insan kesihatan dewasa yang diukur oleh BMI, tekanan darah (1165 pemerhatian), dan persepsi tekanan (PP).

Akhirnya, objektif ketiga mengkaji impak modal insan kesihatan terhadap pertumbuhan ekonomi menggunakan data 29 wilayah di China bagi tempoh 1990 hingga 2020. Dengan menggunakan model FE, ralat piawai panel (model PCSE), dan *model FGLS* menunjukkan hubungan positif yang signifikan antara modal insan kesihatan dan pertumbuhan ekonomi di China.

Secara keseluruhan, kajian ini menunjukkan penentu sosial yang signifikan mempengaruhi CMOs, kesan jangka panjangnya terhadap modal insan kesihatan, dan hubungan positif antara modal insan kesihatan dan pertumbuhan ekonomi. Untuk mencapai SDGs, kerajaan China disaran memberi keutamaan kepada pengurangan kebantutan dan kesusutan berat badan di kalangan kanak-kanak berusia 5 tahun di wilayah barat menerusi penambahbaikkan pendidikan ibu serta pengetahuan pemakanan, dan memberi subsidi kewangan. Pada masa yang sama, usaha perlu diberi ditekan untuk mengawal berat badan berlebihan di kalangan kanak-kanak di wilayah timur. Dengan berbuat demikian, ia boleh mengurangkan beban penyakit pada masyarakat dan meningkatkan stok modal insan kesihatan untuk penduduk di masa hadapan. Di peringkat makro, untuk mengurangkan jurang wilayah, cadangan eksplisit adalah untuk memberi tumpuan kepada modal ihsan kesihatan, khususnya pelaburan kesihatan dengan keutamaan di wilayah tengah dan barat.

**Kata kunci:** Hasil Pemakanan Kanak-Kanak, Pertumbuhan Ekonomi, Modal Insan Kesihatan.

**SDG:** MATLAMAT 2: Sifar Kelaparan, MATLAMAT 3: Kesihatan dan Kesejahteraan yang Baik, MATLAMAT 8: Kerja Layak dan Pertumbuhan Ekonomi

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy.The members of the Supervisory Committee were as follows:

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Date: 13 January 2025

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| | |
|---|---|
| ADF Test | Augmented Dickey-Fuller Test |
| ANOVA | Analysis of Variance |
| ASR | Adult Survival Probability |
| BMI | Body Mass Index |
| BMIZ | BMI-for-Age Z Score |
| BP LM | Breusch Pagan LM |
| CF | Community Factors |
| CHNS | China Health and Nutrition Survey |
| CMOs | Child Malnutrition Outcomes |
| CSD | Cross Sectional Dependency Test |
| DBMO | Double Burden Malnutrition Outcomes |
| DBP | Diastolic Blood Pressure |
| DF | Demographic Factors |
| DOHaD | Developmental Origins of Health and Disease Hypothesis |
| FE Model | Fixed-Effect Model |
| FGLS | Feasible Generalized Least Square |
| FOA | First Order Autocorrelation Test |
| FOAD | Fetal Origin of Adult Disease Hypothesis |
| GDP | Gross Domestic Product |
| GH | Groupwise Heteroskedasticity |
| HAZ | Height-for-Age Z Score |
| HHC | Health Human Capital |
| IPS Test | Im, Pesaran and Shin Unit Root Test |
| IV | Instrumental Variable |

| | |
|---|---|
| LLC Test | Levin, Lin, and Chu (LLC) Unit Root Test |
| LMICs | Low and Middle-income Countries |
| MDGs | Millennium Development Goals |
| MH | Mental Health |
| NCDS | National Child Development Study |
| OECD | Organization for Economic Co-operation and Development |
| OH | Objective Health |
| OLS | Ordinary Least Square |
| PCA | Principal Component Analysis |
| PP | Perceived Pressure |
| PSS-14 | Perceived Stress Scale 14 |
| RE Model | Random-Effect Model |
| SBP | Systolic Blood Pressure |
| SD | Standard Deviation |
| SDGs | Sustainable Development Goals |
| SDH | Social Determinants of Health |
| SF | Socioeconomic Factors |
| SH | Subjective Health |
| SRH | Self-reported Health |
| UN | United Nations |
| UNICEF | United Nations Children's Fund |
| WASH | Water, Sanitation and Hygiene Interventions |
| WHO | World Health Organization |
| WHZ | Weight-for-Heigh Z Score |

# CHAPTER 1

# INTRODUCTION

## 1.1 Background of the Study

Child malnutrition outcomes (CMOs), refer to all nutritional issues, including undernutrition, overnutrition, and imbalances in vitamins or minerals (World Health Organization (WHO), 2021a). Globally, CMOs continue to be a major health threat in low and middle-income countries (LMICs), undermining children's survival, growth and development (Black et al., 2008; Black et al., 2013). According to the latest estimates (United Nations Children's Fund (UNICEF), 2021), undernutrition is responsible for about 45 percent of deaths among children under the age of five, implying that more than 2 million children die each year. Those children who survive undernutrition are less likely to reach their original growth potential. Child undernutrition was previously predominantly seen in LMICs, but overnutrition is now prevalent in these nations. The effects of childhood overnutrition are broad-ranging, affecting physical and psychological health throughout subsequent life phases. In severe cases, it engenders sustained risks for premature mortality and chronic non-communicable diseases during adulthood (Raychaudhuri & Sanyal, 2012; Sahoo et al., 2015; Abarca-Gómez et al., 2017; Wells et al., 2020; WHO, 2021b; Cockerham, 2022).

A substantial body of empirical research focusing on CMOs commonly employs stunting and wasting to evaluate undernutrition, while overweight or obesity indicates overnutrition. Child stunting is a failure to achieve one's genetic potential for height (Golden, 2009). This is the best indicator to estimate children's well-being and reflect social equality in the early life stage (de Onis & Branca, 2016). Whereas, wasting is a form of acute malnutrition due to food shortages or high incidence of infectious diseases, especially diarrhea (WHO, 2021a). It is a significant predictor of mortality in children under the age of five (Provo et al., 2017). Being overweight is one hidden form of CMOs, resulting from an excessive intake of nutrients and ultimately leading to a high body mass index (BMI) (WHO, 2021b). Currently, most developing countries are witnessing a noteworthy nutritional trend, characterized by the coexistence of stunting, wasting and overweight within a country, also referred to as double burden malnutrition outcomes (DBMO) (de Onis & Branca, 2016).

Over time, relevant initiatives have been enacted to tackle child and maternal mortality rates and eradicate child poverty and hunger. Back in 2015, despite progress made during the Millennium Development Goals era (MDGs), there were still significant numbers of children affected by CMOs, globally (UNICEF et al., 2021). Considering the imperative for sustained improvements, the United Nations (UN) initiated the Sustainable Development Goals (SDGs) in 2015, prominently highlighting SDG 2, which centers on improving nutrition and eradicating every facet of malnutrition outcomes. Key targets include reducing the prevalence of stunting in children under five to 40% by 2025, lowering the wasting rate below 5% by 2025, and preventing a rise in obesity rates by 2025 (McGuire, 2015).

Generally, the factors that contribute to CMOs are multifaceted from biological, and social to environmental factors (UNICEF,1990; Wamani et al., 2006; Black et al., 2013; Campbell, 2016; Black et al., 2020; Cockerham, 2022). First and foremost, undernutrition is directly linked to the interconnection between insufficient dietary intake, such as food shortage, poor feeding and care practices, and the heightened susceptibility to infectious disease environment (UNICEF, 1990; Wang et al., 2017; Chowdhury et al., 2018). Essentially, insecure living environments are connected to prevalent illnesses that result in undernutrition (Black et al., 2011; Reinhardt and Fanzo, 2014). Then, infectious diseases diminish nutritional intake due to appetite loss and poor absorption, while diet deficiency in turn accelerates the illness susceptibility. By contrast, child overnutrition results from dietary behaviors marked by the disproportionate intake of high-fat, high-sugar, high-salt, and high-calorie foods, in addition to sweetened drinks (Okubo et al., 2020; WHO, 2021b).

Next, factors related to the household environment, encompassing the construction levels of infrastructure, such as limited access to water and sanitation, electricity, housing, and healthcare, are also underlying causes for CMOs. Delving into micro-level division, the whole living environment of children is closely related to the socioeconomic status of households. This includes the educational and occupational backgrounds of the parents, as well as the economic advancement of the communities in which they live (Hien & Kam, 2008; Kuchenbecker et al., 2014). Basically, CMOs are inextricably tied to families' availability of nourishing food, while the absence of adequate food and nutrition is essentially linked to household food security (Moradi et al.,

2019). For example, under extreme circumstances, shocks from the external environment such as drought (Meng & Qian, 2009; Almond & Currie, 2011) and conflicts (Akresh et al., 2012) can profoundly impact household income, resulting in insufficient food availability. Consequently, this impact can exert a substantial influence on children's growth and development. Conversely, children living in urban communities and developed cities are more prone to exposure to environments characterized by high levels of oil, salt, and fat, thereby increasing susceptibility to overweight.

Additionally, building upon prior research and following the life course approach, CMOs have a detrimental impact on children's potential growth, reproductive health, cognitive development, and academic performance and make individuals more susceptible to diseases throughout their lives (Mahmud et al., 2019). Physically, to be specific, CMOs are associated with an increased risk of non-communicable diseases in adulthood, such as cardiovascular complications, neurological disorders, motor development issues, and impaired social-emotional development (Barker, 1990; Silveira et al., 2007; Black et al., 2013). Particularly, children who have experienced early overweight are more prone to emotional challenges such as low self-esteem and depression, which can have profound effects on their overall psychological well-being. Moreover, children who experience these adverse consequences are inevitably impeded in attaining peak levels of labor productivity and wage rates as they mature (Bloom & Canning, 2000).

Furthermore, drawing upon the principles of health economics theory, health is regarded as a vital factor of human capital, denoted as the accumulation of health stock. This health capital not only carries intrinsic value but also serves as an instrumental asset across various dimensions, including but not limited to labor productivity, income augmentation, and contributions to overall economic growth. Early studies primarily measured human capital in terms of education, recognizing that an increase in years of schooling enhances workforce knowledge and skills (Barro, 1991). However, the human capital is not limited to the knowledge and technology it possesses, but should also encompass labor's health (Mushkin,1962; Grossman, 1972; Barro, 1996). Consequently, the long-term impact of CMOs on the overall health status of the future population has sustainable implications for long-term economic development (Black et al., 2008; Black et al., 2013; De Onis & Branca, 2016).

According to the latest joint estimates by UNICEF, WHO and the World Bank (2021), from 1991 to 2020, there has been a general decline in the prevalence of child stunting worldwide. However, the global number of stunted children under the age of five is estimated to be 149.2 million. Contrary to child stunting, the prevalence of child overweight is increasing globally, with around 38.9 million overweight children. Overall, the global and regional wasting prevalence among children under 5 exhibited a slight decrease, and approximately 45.4 million wasted children. The Asian region, home to a significant portion of the global population, faces considerable challenges in addressing CMOs (de Onis et al., 2011, WHO, 2021a). According to Figure 1.1 below, there has been a gradual decline in the prevalence of child stunting in

all Asian countries. However, India, Bangladesh, Indonesia, Vietnam and Nepal still account for a higher prevalence. Despite being the world's second-highest contributor to child stunting in 1990, China has since experienced substantial advancements, demonstrating a trajectory of steady progress.

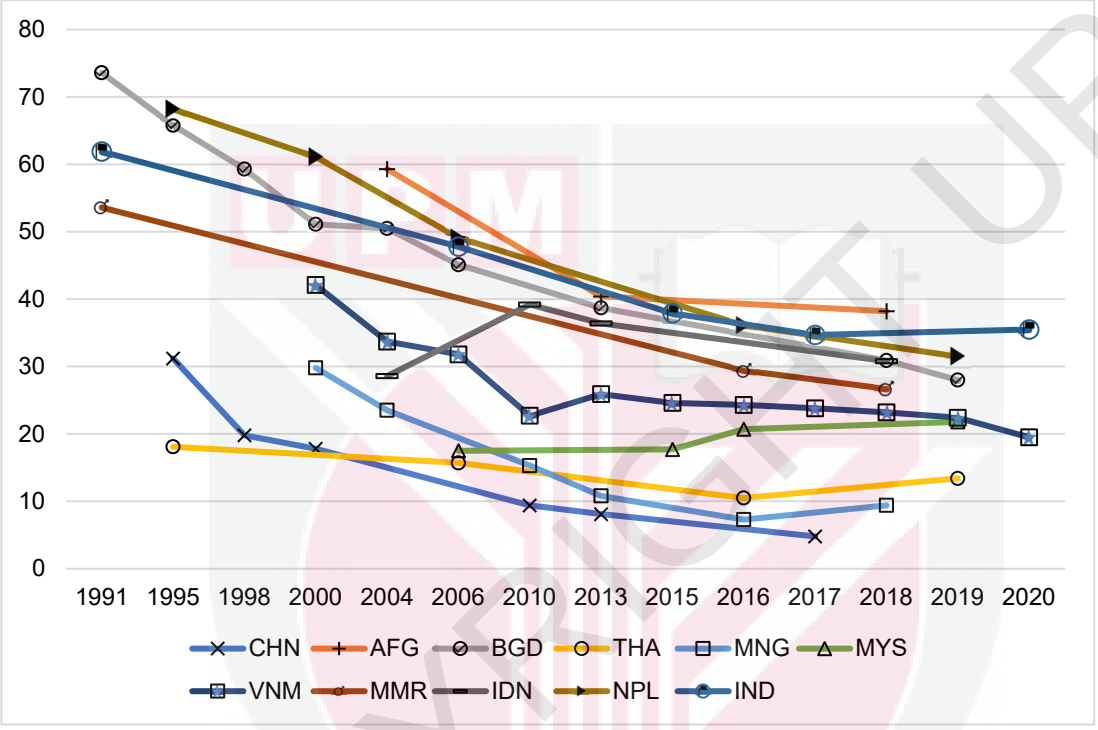


**Figure 1.1: The Prevalence of Child Stunting Among Asia Countries From 1991-2020 (%)**
[Source: World Development Indicators, World Bank (2021)]

Figure 1.2 below shows that the prevalence of child overweight in Asian countries, from 1991 to 2020, has followed a similar trend to the global average, with Mongolia being an exception by showing a decrease. In particular, the prevalence of overweight in Indonesia rose gradually from 1.5% in 2000 to 8% in 2018. In China, the prevalence of overweight rose from 3.4% in 2000 to 8.5% in 2017.

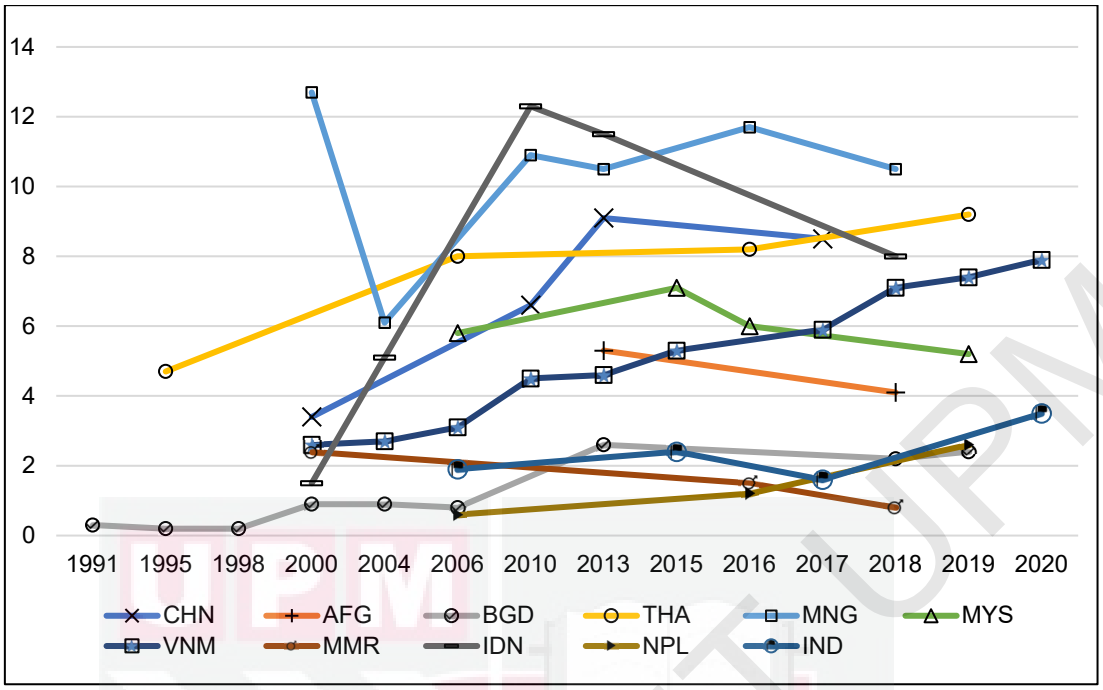


**Figure 1.2: The Prevalence of Child Overweight Among Asia Countries From 1991-2020 (%)**
[Source: World Development Indicators, World Bank (2021)]

Trends in the prevalence of wasting vary across Asian countries, and the changing trend is modest compared to child stunting and overweight. According to Figure 1.3 below, the top three countries in terms of child wasting are India, Nepal, and Indonesia. In China, the child wasting prevalence remained at a low level in 2019. The analysis regarding CMOs in global and Asian contexts clearly demonstrates that the issue of child stunting and wasting persists, with the new concern of the rising prevalence of overweight. This highlights the emerging global nutritional issue of the DBMO (WHO, 2017).

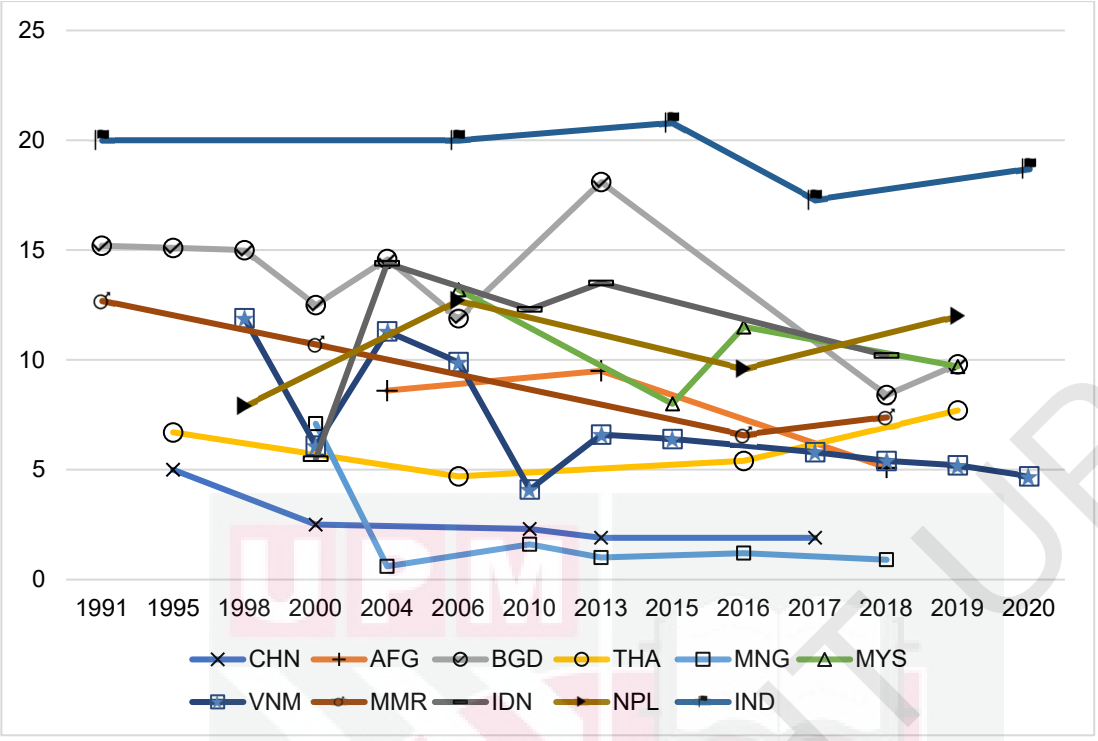


**Figure 1.3: The Prevalence of Child Wasting Among Asia Countries From 1991-2020 (%)**
[Source: World Development Indicators, World Bank (2021)]

### 1.1.1 Features of Child Malnutrition Outcomes and its Trends in China

To achieve the SDGs' nutritional goals, the Chinese government has implemented targeted strategies, yielding significant progress. In 1992, the prevalence of stunting among children under the age of five in China was 38%, which notably decreased to 4.7% by 2020. China's stunting prevalence falls significantly below the average rate of 21.8% observed in the Asian region (Global Nutrition Report, 2021; UNICEF et al., 2021). Despite rapid socioeconomic development, there are still 3,944.8 thousand stunted children in China in 2021, highlighting the need for further efforts to achieve the SDGs' objective 2 of eliminating all forms of malnutrition. The prevalence of wasting in children under 5 in China fell to 1.9% in 2017 with about 1644.2 thousand

numbers, well below the Asia region's average of 8.9% (Global Nutrition Report, 2021; UNICEF et al., 2021). On the other hand, the overweight prevalence among children increased from 6.4% in 2000 to 8.3% in 2020.

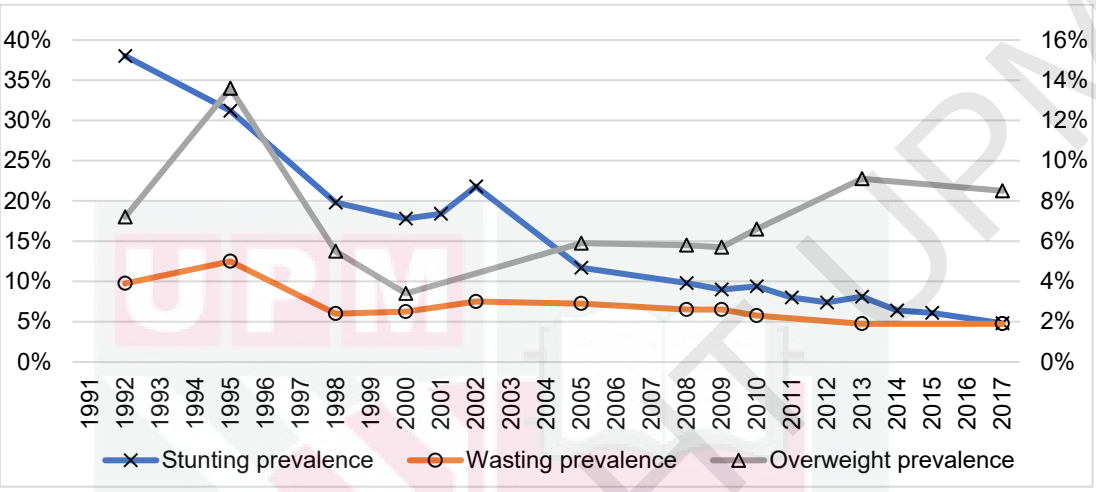


**Figure 1.4: The Prevalence of Child Malnutrition Outcomes in China From 1992 to 2017 (%)**
(Source: UNICEF, WHO, and World Bank Group joint child malnutrition estimates, 2021)

### a) Regional Gaps of CMOs by Provinces

Even though China's prevalence of child stunting and wasting has considerably decreased since the 1990s, there are still regional and urban-rural disparities in the nutritional status of Chinese children under the age of five. Figure 1.5 below illustrates the prevalence of CMOs in provinces within China in 2013. In the more developed eastern regions such as Beijing, Liaoning, Heilongjiang, Shanghai, Jiangsu, and Shandong, the prevalence of stunting has already been below 5%. In the central regions, including Henan, Hubei, and Hunan, the prevalence of stunting ranges from 5% to 6.2%. However, the western regions, specifically Guangxi, Chongqing, and Guizhou,

still face a higher prevalence of stunting. Regarding overweight prevalence, except for Guangxi and Guizhou provinces, the other provinces' prevalence ranges from 5% to 14.3%. Overall, the prevalence of wasting in each province is relatively low. This prevalent pattern aligns with global and Asian trends in child nutrition.

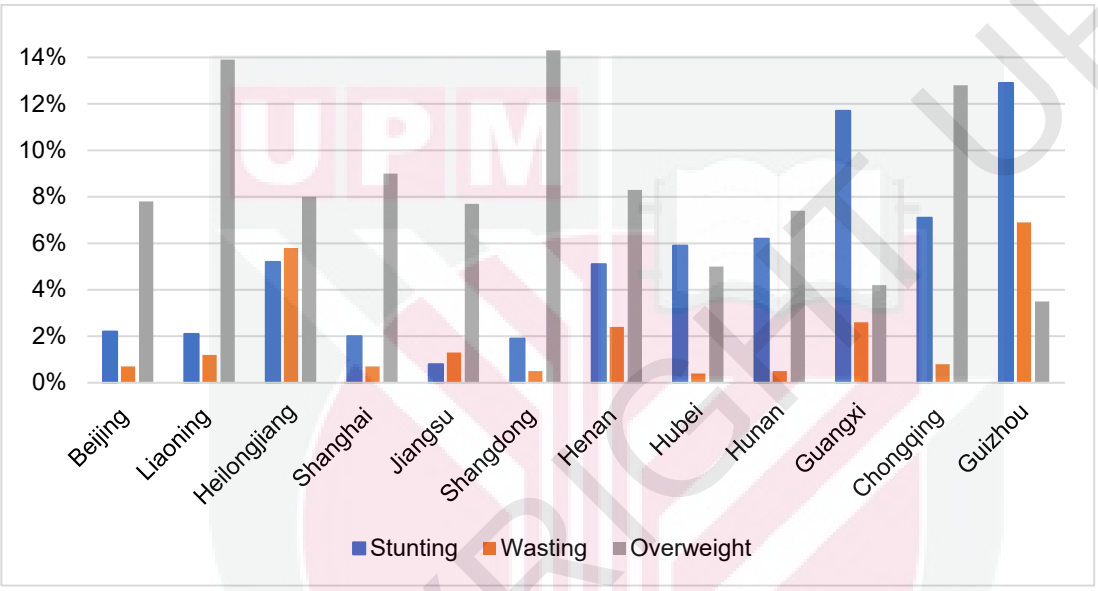


**Figure 1.5: The Prevalence of Child Malnutrition Outcomes Within China by Provinces in 2013**
Note: East area: Beijing and Shanghai are municipalities, Liaoning, Heilongjiang, Jiangsu, Shandong. Middle area: Henan, Hubei, Hunan. West area: Guangxi, Chongqing, Guizhou.
(Source: Report on Monitoring Nutrition and Health Status of Chinese Residents (2010-2013) No.9 Nutrition and health status of children aged 0-5 years in China, 2020)

### b) Area Gaps of Child Stunting

Figure 1.6 below illustrates the marked contrast between urban and rural areas from 1990 to 2019. In 2019, the stunting prevalence in rural areas was approximately 1.5 times higher than that of children in urban areas. In 2008, the stunting prevalence in poor rural areas was relatively high (18.9%), almost

twice as high as in the general rural areas. Those poor rural areas are mainly located in the western and middle regions (Chinese Ministry of Health, 2012).

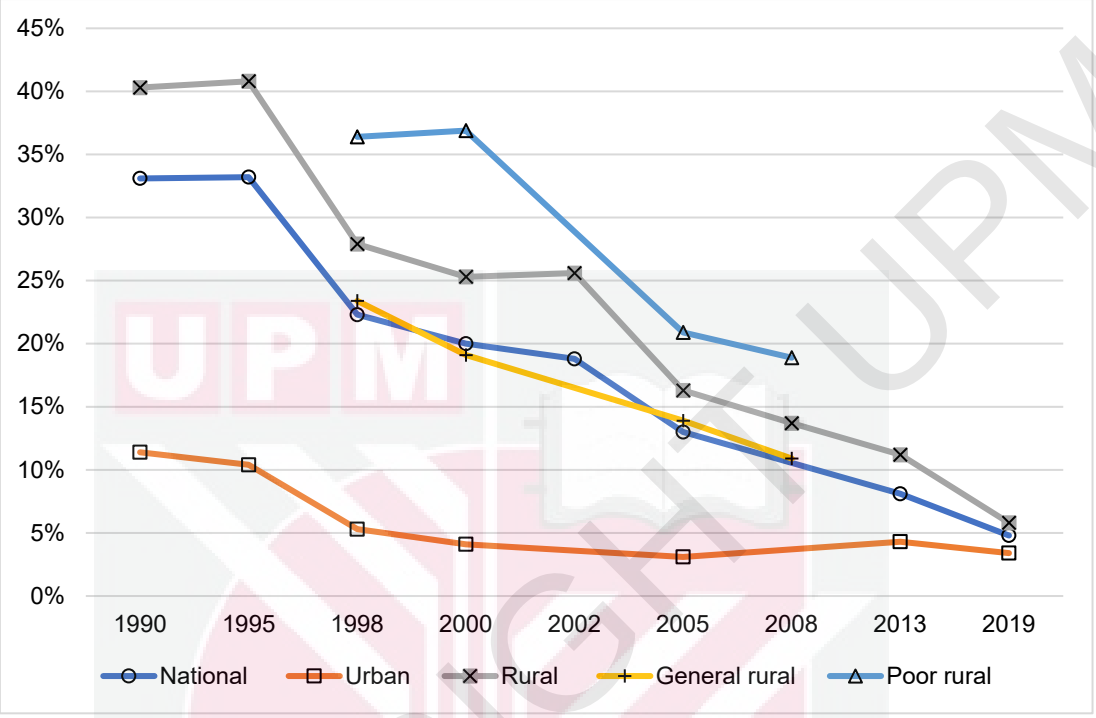


**Figure 1.6: The Prevalence of Child Stunting Within China by Areas From 1990-2019(%)**
(Source: UNICEF, National Working Committee on Children and Women and National Bureau of Statistics, 2018; Data of 2013 from China Maternal and Child Health Care Development Report 2019; Data of 2019 from the Report on the Nutrition and Chronic Disease Situation of Chinese Residents, 2020.)

Figure 1.7 presents the disparities in the prevalence of stunting among children under five in rural and urban areas across different provinces in China. The differences between urban and rural areas are primarily concentrated in the central and western regions. Particularly in the western regions, the differences between urban and rural areas are significant.

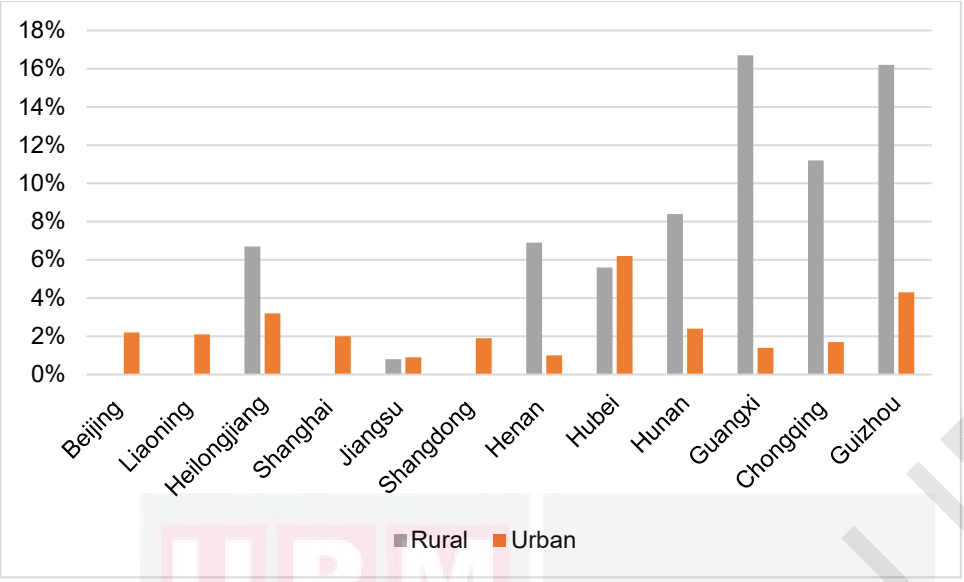


**Figure 1.7: Urban-Rural Disparities of The Prevalence of Child Stunting by Provinces Within China in 2013**
Note: East area: Beijing and Shanghai are municipalities, Liaoning, Heilongjiang, Jiangsu, Shandong. (Liaoning and Shandong provinces were unable to monitor data from rural areas). Middle area: Henan, Hubei, Hunan. West area: Guangxi, Chongqing, Guizhou. Rural data are not available in Beijing Shanghai, Liaoning, and Shandong.
(Source: Report on Monitoring Nutrition and Health Status of Chinese Residents (2010-2013) No.9 Nutrition and health status of children aged 0-5 years in China, 2020.)

### c) Area and Gender Gaps of Child Overweight

Figure 1.8 presents the disparities in the prevalence of overweight among children under five in rural and urban areas across different provinces in China. In general, the prevalence of overweight among children under five in both urban and rural areas of the eastern regions exceeds 6%. The rural areas in the eastern regions have slightly higher overweight rates among children compared to urban areas. Similar patterns can be observed in the central regions, where, except for a small difference in overweight rates between urban and rural areas in Hunan, the rural areas in the other two provinces have significantly higher overweight rates among children than their urban

counterparts. In the western region, except for Chongqing, the rate in rural areas is approximately three times higher than that in urban areas for the other two provinces.

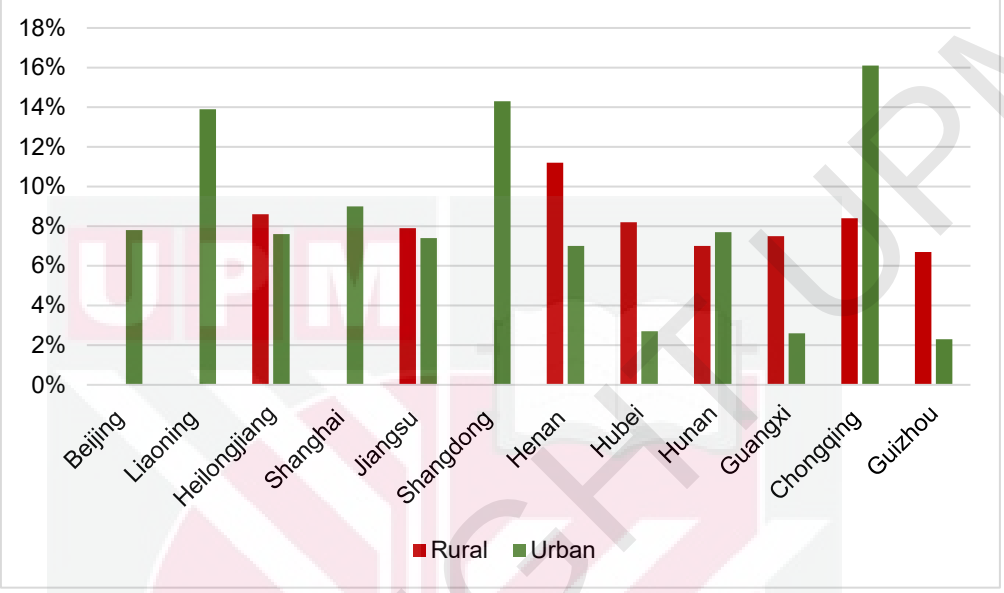


**Figure 1.8: Urban-Rural Disparities of The Prevalence of Child Overweight by Provinces Within China in 2013**
Note: East area: Beijing and Shanghai are municipalities, Liaoning, Heilongjiang, Jiangsu, Shandong. (Liaoning and Shandong provinces were unable to monitor data from rural areas). Middle area: Henan, Hubei, Hunan. West area: Guangxi, Chongqing, Guizhou. Rural data are not available in Beijing Shanghai, Liaoning, and Shandong.
(Source: Report on Monitoring Nutrition and Health Status of Chinese Residents (2010-2013) No.9 Nutrition and health status of children aged 0-5 years in China, 2020.)

According to Figure 1.9, the number of overweight children in China tripled from 1995 to 2020. The prevalence of overweight does not only show regional differences but also gender differences. In addition, gender differences are mainly reflected in the higher prevalence of overweight among boys than girls.

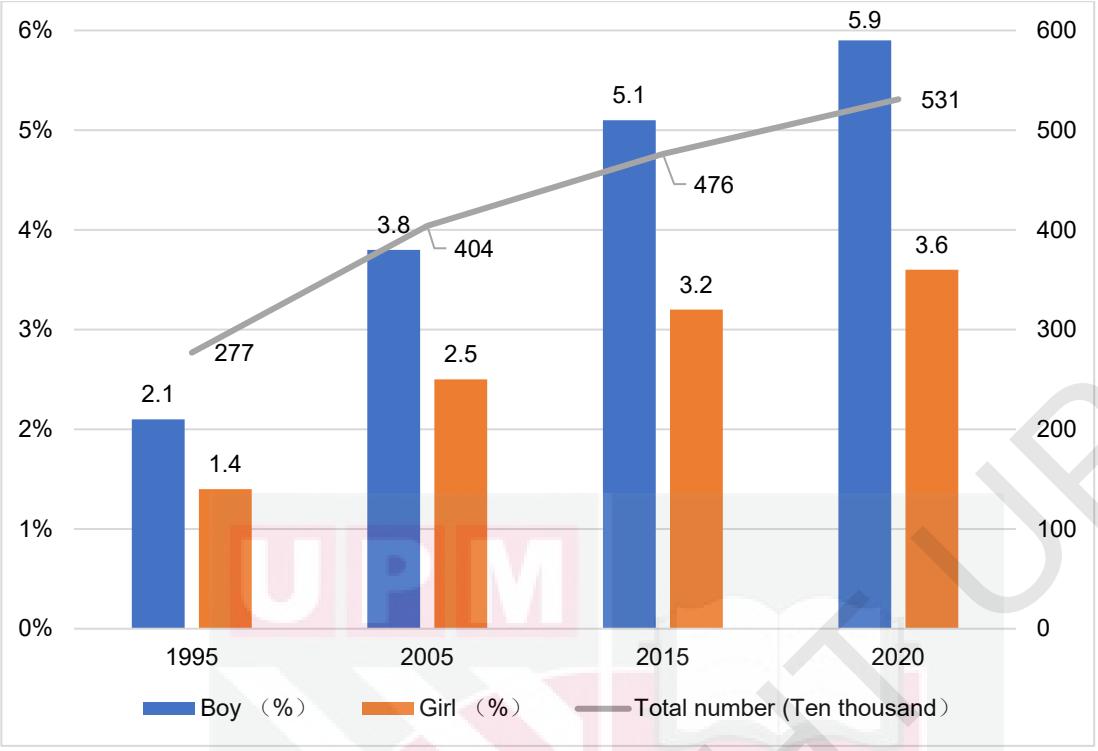


**Figure 1.9: The Prevalence (%) and Numbers (ten thousand) of Child Overweight Under Age of Five in China by Gender From 1985-2020**
(Source: Report on childhood obesity in China, 2017; Data for 2015 and 2020 are projected.)

In conclusion, the analysis of the graphs shows that the nutritional status of children under 5 in China is not only characterized by stunting and wasting but also by being overweight. The DBMO among Chinese children under 5 has been mentioned before (Wang et al., 2009; Piernas et al.,2015). Yang et al. (2020) anticipated the gaps in fulfilling child nutrition-related targets, revealing gender and geographical disparities in child malnutrition in China. Boys had 1.2 times the rate of stunting and wasting than girls. Western China had rates of stunting, and wasting that were 1.47, 1.50, greater than the east. The incidence of overweight is on the rise both in urban and rural areas. Eastern China saw the greatest rise over time when compared to other regions (6.3 percent overweight). These results highlight the urgent need for interventions

to reduce the regional gaps of child stunting and wasting, and control the prevalence of overweight if the SDG and China's national goals are to be met (Yang et. al, 2020).

### 1.1.2 The Social Determinants of Child Malnutrition Outcomes

The concept of social determinants of health (SDH) has been developed by WHO and the complex mechanisms between health disparities and social gradients have been explored both theoretically and empirically (WHO, 2013; Spencer, 2018). Based on the definition of SDH, the conditions that shape individuals' health outcomes throughout the whole life stage encompass the environments in which they are born, grow, live, work, and age. These circumstances are intricately influenced by the global, national, and local allocation of financial resources, power dynamics, and material assets, collectively termed "structural determinants," which play a pivotal role in driving health disparities (WHO, 2013).

Then, the UNICEF conceptual framework on CMOs was developed in 1990 to emphasize the multisectoral causes of malnutrition outcomes as both the intermediate and basic causes (UNICEF,1990). Generally, from the macro determinants, external shocks can ruin people's lives and livelihoods and make CMOs worse. Common shocks like famine, civil war, drought, and food shortages can increase the prevalence of CMOs, especially in children from underprivileged backgrounds (Reinhardt & Fanzo, 2014). For economic and political factors, a nation's policies and programs prioritizing economic growth

should make investments in child nutrition. CMOs are influenced by increased access to health services and improved quality of health services. More commonly, equitable economic growth increases the purchasing power of households (Stevens et al., 2012).

The impact of social determinants on the nutritional status of children has been well documented (Bambra et al., 2010; Aguayo & Menon, 2016; Ban et al., 2016; Tette et al., 2016; Ahsan et al., 2017; Chowdhury et al., 2018; Okubo et al., 2020; Alvear-Vega & Vargas-Garrido, 2022). Poverty and differences in social status are generally considered to be the most important social factors influencing CMOs. Differences in socioeconomic status ultimately translate into differential child development (Wong et al., 2015). Better economic status reduces the likelihood of childhood illness and improves children's nutritional status, as well as the ability and willingness of parents to pay for better medical care. Most of the literature employs household income or wealth index, parental education and employment status, to measure children's socioeconomic status during childhood. Factors such as water, sanitation, and region of residence are also well-documented in determining a child's nutritional status (Aguayo & Menon, 2016; Campbell, 2016; Harris et al., 2017; Joshi et al., 2017; Wu, Shi, et al., 2021; Shi et al., 2022; Lin & Feng, 2023). Infrastructure and health care services were among the crucial variables for Lao children (Kamiya, 2011). A study also implies that social determinants are significant, but that the key elements may change depending on the location (Tette et al., 2016).

### 1.1.3 The Impact of Child Malnutrition Outcomes on Health Human Capital

Theoretically, research on the impact of childhood health on health human capital in adulthood can be traced back to Dorner, (1974), who developed the concept of the "early programmatic impact of health hypothesis", whereby adult disease risk rates and body function are programmed by hormones and metabolites during the critical early years of development. Subsequently, Barker and colleagues (1990) provided strong epidemiological evidence that the concept of programmability was popularized by measuring the association between birth weight, morbidity and mortality later in adult life. As a result, the concept that early nutrition and growth programmatically influence adult disease risk rates is often referred to as the 'Barker hypothesis' or fetal origins adult disease (FOAD) (Barker, 1990). In 2003, the term developmental origins of health and disease (DOHaD) was formally used on a global scale. According to DOHaD, malnutrition experienced during the formative stages, including fetal development, infancy, and childhood can exert long-term effects extending into adulthood. These effects may manifest in the form of increased susceptibility to conditions such as diabetes, cardiovascular ailments, neoplasms, and neuropsychiatric disorders during adulthood (Mcmillen & Robinson, 2005).

Early studies concentrated on the intrauterine environment (Barker, 1990; Godfrey & Barker, 2000； Alderman, 2006; Godfrey et al., 2010; Almond & Currie, 2011; Skogen & Øverland, 2012), but it was subsequently shown that there is also a postnatal phase of sensitivity to environmental change. Strong

evidence backs up the notion that children's first 1000 days of life are a time of rapid growth, directly affecting not just the brain, language, and higher cognitive abilities but also the linear development of other organs including bone, muscle, and fat. It has been demonstrated that this crucial time has comparable development potential for many ethnic communities (Black et al, 2013; De onis, 2016). At the same time, it is widely acknowledged that early development from conception to age five lays the groundwork for learning, behavior, and health across the lifespan. Therefore, it may also have intergenerational effects on health and well-being. Many studies have relied on natural experiments as a source of external environmental shocks for children to track long-term effects. Examples include certain nutritional supplementation experiments, famine (Meng & Qian, 2009), war (Camacho, 2008; Akresh et al., 2013), and extreme weather shocks (Currie & Rossin - Slater, 2013). CMOs in childhood have long-term irreversible negative impacts on health human capital (Victora et al., 2008; Adair et al., 2013).

### 1.1.4 The Impact of Health Human Capital on Economic Growth

Scholars have extensively examined the positive relationship between health human capital and economic growth using various indicators such as life expectancy, mortality rates, and health expenditure (Barro, 1996; Bloom et al., 2004; Gyimah-Brempong and Wilson, 2004; Aghion et al., 2010; Cooray, 2013; Ogunleye, 2011; Eggoh et al., 2015; Raghupathi & Raghupathi, 2020; X. Yang, 2020; Jayadevan, 2021). Jayadevan (2021) specifically focused on the impact of declining infant mortality, poverty, and fertility on economic growth and found

a significant relationship. Meanwhile, it also yielded consistent findings from previous studies that declining fertility rates and increasing female labor force participation can achieve high returns on economic growth, especially for developing countries (Prettner et al., 2013; Bloom et al., 2018).

Since the implementation of economic reforms and opening up, China has prioritized economic development and achieved remarkable growth. From 1991 to 2019, the annual average GDP growth rate of the nation ranged from 5.6% to 13.6%. Even during the initial year of COVID-19, there was a growth rate of 2% (World Bank, 2021). This period of economic development has coincided with notable improvements in healthcare, leading to significant enhancements in population health. The demographic changes in a country, including population size and structure, are influenced by factors such as birth and death rates, with particular emphasis on indicators such as infant mortality and life expectancy. Life expectancy, which encompasses mortality patterns across different age groups, serves as a composite measure of a country's population health.

**a) Life Expectancies Gaps in China**

To be specific, China has witnessed a significant increase in life expectancy over the years, rising from 68 years in 1991 to 78 years in 2020 (World Bank, 2021a). This exceeds the average life expectancy levels of both global and middle-income countries by approximately 6 years, far surpassing low-income countries by approximately 15 years. However, there remains a gap of approximately two years compared to high-income countries. The Healthy

China 2030 initiative has established the goal of attaining an average life expectancy of 79 years by 2030 for China, posing a formidable challenge. As evidenced by China's average life expectancy plateauing at 78 years since 2018, there is no indication of improvement. Concurrently, noticeable regional variations in life expectancy exist. By the year 2020, metropolitan areas such as Beijing and Shanghai have attained life expectancies on par with those of high-income nations. Other eastern provinces also surpassed the global average by approximately 7 years and exceeded the national average, albeit lagging behind Beijing and Shanghai. There are varying degrees of disparity in life expectancy between provinces in the central and western regions compared to those in the eastern region of China, with the most significant gap ranging from 8 to 10 years (National Bureau of Statistics of China, 2022).

**b) Infant, Under-5, and Maternal Mortality Gaps in China**

Next, due to rapid economic development, China has made good progress in reducing child mortality from 1991 to 2020, achieving the MDGs of reducing child mortality by two-thirds in 2008. To be specific, the infant mortality rate decreases from 42.4 per thousand to 6 per thousand (World Bank, 2021). The under-5 mortality rate decreased from 61 per thousand in 1991 to 7.4 per thousand in 2020 (World Bank, 2021c). For maternal mortality ratio decreased from 98 per one hundred thousand in 1991 to 16.1 per one hundred thousand in 2020 (World Bank, 2021b; China Health Statistics Yearbook, 2021).

However, there still exist large disparities among infant mortality, child mortality, and maternal mortality. Elaborating on the statistics (China Health Statistics

Yearbook, 2021), notable differences persist among provinces, areas and regions. Beijing and Shanghai, for instance, achieved infant mortality rates below 3 per thousand in 2020. Within the eastern, central, and western provinces, there are variations in infant mortality rates, with Heilongjiang, Chongqing and Guizhou experiencing relatively higher rates, reaching up to 5 per thousand in 2020. Other provinces maintain infant mortality rates within the range of 3 to 4 per thousand. Likewise, the rural infant mortality rate was still about 1.5 times higher than the urban child mortality rate. Regionally, the infant mortality rate in the eastern, central and western regions is 2.7 per 1,000, 4.7 per 1,000 and 7.9 per 1,000, respectively. Furthermore, the latest estimations suggest that under-5 mortality rates in rural areas are nearly twice that in urban areas. In the eastern, central, and western regions, the under-5 mortality rates are 4.4 per thousand, 6.6 per thousand, and 10.6 per thousand, respectively. Therefore, the issue of improving child mortality still needs attention. Similarly, there are variations in maternal mortality rates among provinces. Provinces such as Beijing, Shanghai and Jiangsu, located in the economically developed eastern coastal area, exhibit lower maternal mortality rates, below 6 per 100,000. In contrast, Guizhou in the western region and Heilongjiang in the northeastern regions, as well as Hubei province in the central region, have significantly higher maternal mortality rates, exceeding 8 per 100,000 (China Health Statistics Yearbook, 2021).

**c) Health Investments in China**

In addition, in the current context of China's "Healthy China 2030" initiative, healthcare investment not only contributes to improving the overall health

status of citizens but also fosters the accumulation of human capital. This, in turn, enhances labor supply and productivity, ultimately driving economic growth (Linden & Ray, 2017; Álvarez-Gálvez & Jaime-Castillo, 2018). Health expenditure, as a vital component of healthcare investment, not only ensures population health but also demonstrates a positive causal relationship with economic growth (Raghupathi & Raghupathi, 2020). Based on Figure 1.10 below, health expenditure increased from 893.49 billion in 1991 to 72175 billion in 2020. Meanwhile, the ratio of health expenditure to GDP has increased from 4.06% to 7.12% from 1991 to 2020, an increase of about 40%.

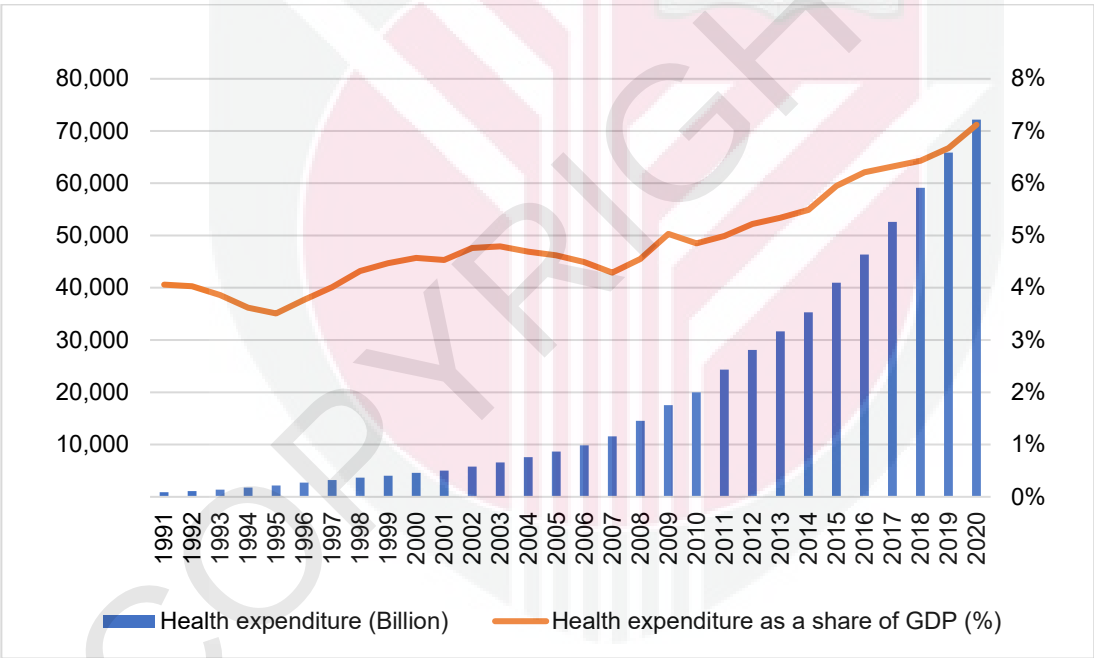


**Figure 1.10: Health Expenditure and Share of Health Expenditure in GDP, China, 1991-2020**
[Source: China Health Statistics Yearbook (China National Bureau of Statistics, 2022)]

In addition to health expenditure, adequate healthcare facilities and healthcare workers are also important for health outcomes and economic development. The variation in the number of healthcare beds per 10,000 population in Beijing

and Shanghai shows minimal changes, while other provinces in China have experienced at least a doubling in bed capacity from 1991 to 2020. Particularly in some western provinces, the increase has been approximately threefold. By 2020, provinces such as Heilongjiang, Hunan, and Sichuan reached the top three positions (China National Bureau of Statistics, 2021). Likewise, from 1995 to 2020, the number of healthcare workers per thousand population increased nationally from 3.59 to 7.57. Similarly, the number of healthcare workers also shows a significant urban-rural difference, and the difference has been widening since 2004. Finally, in 2020, the number of healthcare workers per 1,000 population in urban areas was approximately 2 times higher than in rural areas. Regionally, Beijing and Shanghai are the two municipalities with the highest number of healthcare technical personnel per 10,000 population. Other regions exhibit variations within a certain range (China National Bureau of Statistics, 2021).

**d) Real GDP Per Capita and Health Human Capital Indicators Performance**

Although life expectancy, and children and maternal mortality rates have improved considerably, improvements in population health have lagged behind economic growth relative to the strong pace of China's economic growth. Based on Figure 1.11**,** it can be seen that between 1991 and 2020, China's GDP per capita has been growing at a strong and steady rate, while the corresponding increase in life expectancy has been relatively slow. Under-five and maternal mortality rates and child stunting prevalence show a strong negative correlation with real GDP per capita. This suggests that economic

development has been accompanied by significant improvements in women's and children's health. Based on Figure 1.12, child overweight rate, health expenditure as a share of GDP, the number of healthcare workers and real GDP per capita show a positive and strong correlation. This suggests that health expenditure is increasing in the face of rapid economic growth. At the same time, childhood overweight is inextricably linked to the current high economic growth.

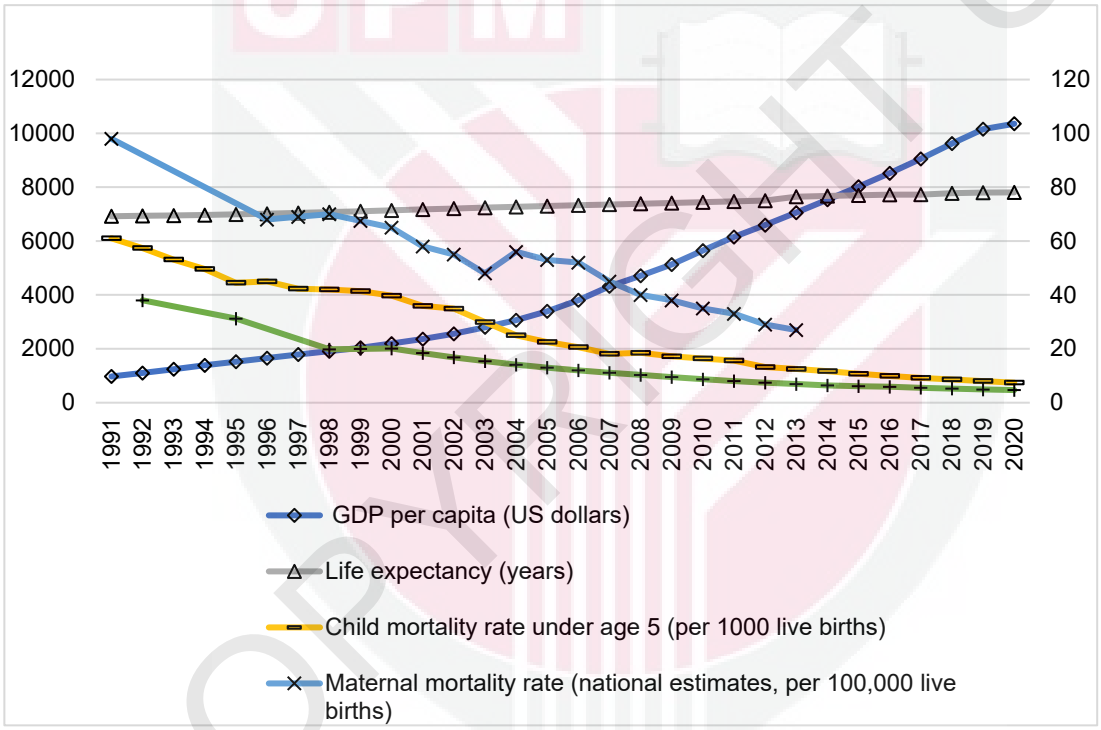


**Figure 1.11: Real GDP Per Capita and Health Human Capital Indicators Performance From 1991-2020 In China**
(Source: World Bank (2021), World Development Indicators, Online Database)

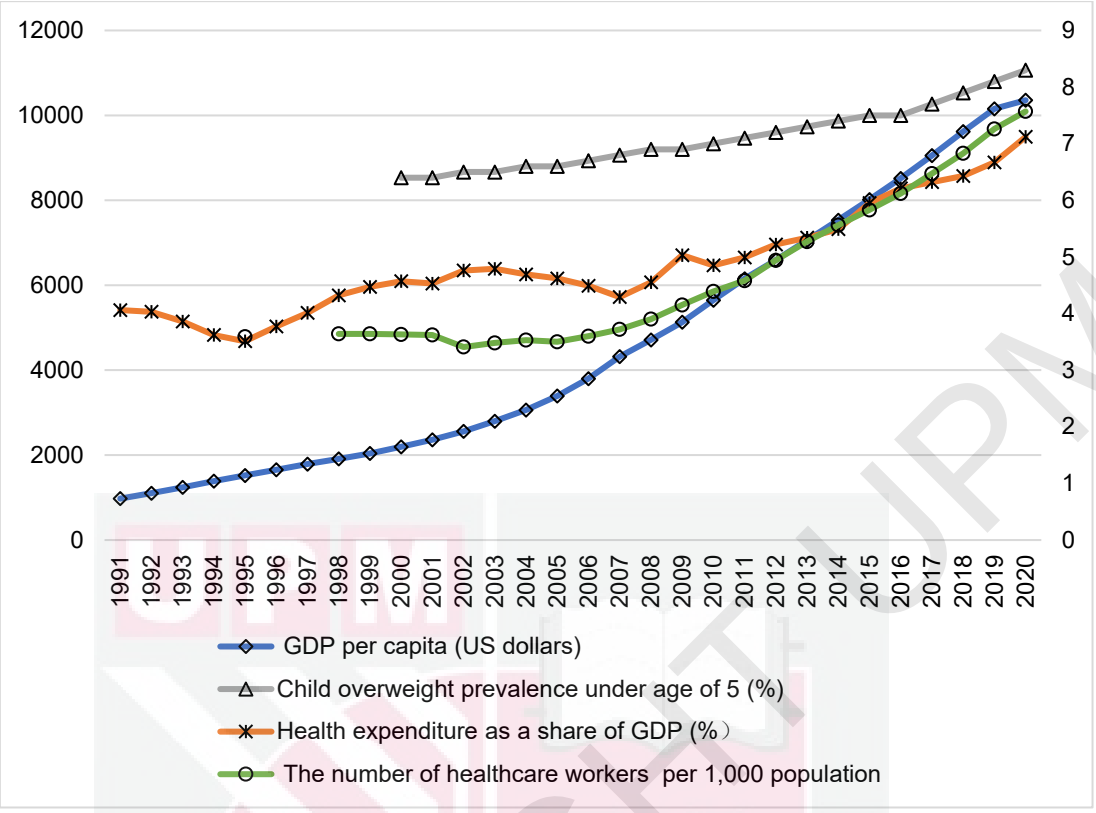


**Figure 1.12: The Link Between Real GDP Per Capita and Health Human Capital From 1991-2020 In China**
[Source: World Bank (2021), World Development Indicators, Online Database. Health expenditure as a share of GDP and the number of healthcare workers per 1,000 population from China Health Statistics Yearbook (China National Bureau of Statistics, 2022)]

To conclude, while China has made considerable progress in enhancing overall population health, significant disparities persist across provinces, urban-rural divides, and regions, particularly concerning indicators related to health human capital such as life expectancy, child mortality rates, maternal mortality rates, healthcare expenditure, and healthcare resources. Furthermore, a close interconnection between health human capital and economic growth is evident, as rapid economic advancement corresponds to decreased malnutrition rates, reduced population mortality rates, and increased life expectancy. However, economic growth also entails increased

investments in healthcare resources and the emergence of new health issues, such as rising obesity rates. Thus, what defines the relationship between health human capital and economic growth, and can it account for inter-regional disparities?

## 1.2 Problem Statement

Given China's vast children population, CMOs under 5 remain in a prominent position in China. Regional disparities and urban-rural gaps in child stunting and wasting persist as pressing issues, particularly prevalent in impoverished rural western regions. Additionally, the increasing prevalence of child overweight among children under 5 has emerged as an urgent threat to public health. Examining social determinants of CMOs is crucial to reducing the prevalence of stunting and wasting below 5% by 2030 across regions and curbing child overweight prevalence, aligning with SDG goals. Existing studies on the social determinants of both undernutrition and overnutrition are limited (Chen et al., 2021; Zhu et al., 2022). Specifically, research on child overweight in China is regionally limited and predominantly targets school-aged children (Seum et al., 2022; Liu et al., 2023), leaving a gap in early intervention for children under five.

The second research issue is the long-term impact of CMOs on health human capital in adulthood. CMOs in childhood elevate the risk of non-communicable diseases in adulthood, hindering health human capital accumulation. Importantly, the psychological effects of childhood overnutrition are overlooked.

Currently, China is undergoing a nutritional transition, with both undernutrition and overnutrition coexisting among children. Meanwhile, over 50% of obesity prevalence among adults and the burden of non-communicable diseases persistently increases (Chinese Centre for Disease Control and Prevention, 2022). Psychological health issues, driven by rapid economic development, are an emerging public health concern in China. Empirical research on early-life nutrition's impacts on health human capital is limited, primarily focusing on adulthood's socioeconomic outcomes (Alderman, 2006; Hoddinott et al., 2013). Natural experiments, like China's 1959-1961 famine, have been used to explore the long-term effects of child nutrition on human capital (Chen & Zhou, 2007; Liu et al., 2017). However, the applicability of findings from extreme nutritional shocks to China's current nutritional transition is restricted. Furthermore, these studies primarily target the elderly. As the burden of diseases shifts to younger age groups in China, evidence on the importance of early-life nutrition for later adult stages remains limited.

The third research issue is the relationship between health human capital and economic growth. China's economic growth has outpaced advancements in health human capital. Except for the unresolved health challenges, economic growth has been accompanied by significant new health concerns, including the emergence of obesity and chronic diseases. Concurrently, significant disparities in health human capital persist across regions and provinces. The provincial life expectancy gap is 8 to 10 years; the regional infant mortality rate gap is in the range of 2.7 to 7.9 per thousand; the regional under-five mortality rate is 4.4 to 10.6 per thousand; and the number of urban healthcare workers

is about twice that of rural areas (China Health Statistical Yearbook, 2021). In empirical studies, health human capital is typically measured using indicators such as life expectancy, mortality, and health investment. However, research on measuring health human capital through several dimensions is limited. Cross-country data and several empirical techniques, such as GMM, ARDL, and GLS, examine this research issue, though findings remain inconclusive (Acemoglu & Johnson, 2007; Cooray, 2013; Yang, 2020; Raghupathi & Raghupathi, 2020; Jayadevan, 2021). Some empirical studies in China focus on environmental pollution and its correlation with health and economic growth (Linden & Ray, 2017; Zhao & Zhou, 2021; Chen & Chen, 2021). Health, a key component of human capital, is crucial in economic growth models. A comprehensive assessment of health human capital can provide crucial insights into economic disparities among Chinese provinces.

## 1.3 Research Questions

In line with the research issues discussed in the previous section, the present study intends to address the following research questions:

1. What are the social determinants of child malnutrition outcomes (i.e., stunting, wasting, and overweight) in China?
2. What are the impacts of child malnutrition outcomes on health human capital in China?
3. What are the impacts of health human capital on economic growth in China?

## 1.4 Research Objectives

The general objective of the current research is to investigate the social determinants of child malnutrition outcomes and its economic implications in China.

The specific objectives of the research are:

1. To examine the social determinants of child malnutrition outcomes (i.e., stunting, wasting, and overweight) in China.
2. To examine the impact of child malnutrition outcomes on health human capital.
3. To examine the impact of the health human capital on economic growth.

## 1.5 Significance of the Study

The significance of the first objective lies in its utilization of national-level data to complement research on micro-level social determinants influencing CMOs for children under the age of five in China. It further highlights variations in the social determinants of CMOs across regions, urban-rural divides, and genders. Consequently, region-specific, urban-rural-specific, and gender-specific nutritional intervention policies are more effective in achieving the SDG goals. Additionally, the first objective employs WHO growth standards adjusted for age and gender, to reduce measurement errors in assessing stunting, wasting, and overweight in children. To provide a more precise examination of the influence of socio-economic status on CMOs, this research employed principal component analysis to create a household asset index. Furthermore, this study

holds the potential to offer policy insights for other developing countries undergoing nutritional transitions.

The second objective provides evidence regarding the long-term impact of CMOs during childhood on adult health human capital. The assessment of health human capital is multidimensional, encompassing subjective health, objective health, and mental health. Furthermore, the second objective sheds light on the potential catch-up period during the later stages of childhood, offering evidence of CMOs' sustained impact on adult health human capital. Moreover, this objective holds policy implications, the evidence provides insights into how investments in health during childhood can significantly influence the accumulation of adult health human capital.

The third objective provides evidence of health human capital's positive and significant impact on provincial-level economic growth in China. It highlights the importance of increasing investments in health, alongside physical capital and education in human capital. Moreover, health human capital is measured by synthesizing a health index from three dimensions: health inputs, health outputs, and environmental factor. This comprehensive approach enables a more thorough assessment of health human capital, elucidating the extent to which it explains economic disparities at the provincial level. The findings hold the policy implications, highlighting the imperative for heightened health investments, particularly in the central and western regions, to address economic gaps.

## 1.6 The Organization of this Study

This thesis is organized as follows. The background of the research, problem statement, research questions, research objectives, and the significance of the study are all discussed in chapter one. Chapter two provides a theoretical and empirical review related to the research topic or research objectives, namely, the social determinants of child malnutrition outcomes, the impacts of child malnutrition outcomes on health human capital, and the effects of health human capital on economic growth. Chapter three consists of detailed descriptions of research methodology which includes theoretical framework, model specifications, variables descriptions, data sources and estimation techniques. Chapter four presents and discusses the empirical findings from estimation while the final chapter provides conclusions and policy implications.

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