

Cost-Benefit Analysis of Childhood Obesity Prevention and Control in China from the Perspective of Public Health Economy

Lipei Tang^{1,#}

Xinyu Sun^{2*,#}

Xuhan Chen^{3,#}

GLORIA HUANG^{4,#}

Jiayi Han^{5,#}

¹Medical college, Lishui university, Lishui, 323000, China, Tlplxxyx666@163.com

²College of business, James cook university, Geylang, 574421, Singapore, 19859120277@163.com

³College of Liberal Arts, Purdue University, West Lafayette, 47907, the United States of America, x1449362741@163.com

⁴Shanghai High School International Division, Shanghai, 200231, China, 18301942646@163.com

⁵School of Health Sciences, University of Manchester, Manchester, M139PL, England, 15153336828@163.com

*corresponding author

#co-first authors

Abstract:

Childhood obesity poses a huge economic burden and health problem in China. However, the lack of visualized data in the past literature to verify the effectiveness of measures to prevent and control childhood obesity has led to a lack of reliability of these strategies. In this paper, we collect the cost and benefit data of the strategies through the database and existing literature, and systematically analyze them using the cost-benefit model to verify the effectiveness and benefit of these strategies. We find that implementing interventions does reduce the economic burden of childhood obesity. We also find that some measures may initially increase health care costs, but ultimately indirectly reduce total health care costs. And socioeconomic status affects the effectiveness of different policies. We have discussed the theoretical and practical implications.

Keywords: childhood obesity, cost-benefit, prevention, control.

1. Introduction

Childhood obesity is emerging as a major public health challenge worldwide. As obesity rates contin-

ue to rise, there is increasing evidence that childhood obesity is associated with many chronic diseases, such as diabetes, cardiovascular disease, and other respiratory diseases (Barton, 2012). In recent years,

the spread of obesity has had a serious impact on many countries, especially developing countries. In China, rapid economic development and urbanization have led to significant changes in children's lifestyles and eating habits. They dislike exercise, are addicted to electronic devices, and tend to eat high-calorie foods. These bad habits have led to a sharp rise in childhood obesity rates. Wang et al.(2006) mentioned an obvious example in their study. From 1985 to 2005, obesity rates in China rose sharply, especially in urban areas. The data show that the obesity rate among children aged 7 to 18 in urban areas in China has increased fourfold, from 1.8 percent to 8.1 percent. The figure in rural areas, while lower than in cities, has also risen in recent years, reflecting the severity of child health problems nationwide.

The economic burden of childhood obesity cannot be ignored. Ananthapavan et al.(2020) pointed out that the social costs of obesity, such as the increase in medical expenses and the decline in industrial productivity, unwittingly add to the increasing financial pressure.

Despite the social concern about childhood obesity, there is still a lack of comprehensive research on the basic prevention and control measures and medical costs of obesity, although there is early intervention. However, data on childhood obesity over the past few years suggest that the success of these interventions is unclear. In China, to solve the problem of childhood obesity, we must first understand regional economic disparities and rapidly changing social changes, which are two core factors, and because of these two core factors, the problem of childhood obesity is complex.

The purpose of this study was to explore these key research questions, in part to consider how to effectively address the problem of childhood obesity:

What is the cost-benefit comparison of different prevention and control strategies?

What are the economic benefits of early intervention to prevent and control childhood obesity?

How does socioeconomic status affect the cost-effectiveness of childhood obesity prevention and control?

The five modules of this paper focus on trends in childhood obesity in China and its socioeconomic implications. First, it will analyze changes in BMI in children of different age groups. It will then look at the costs of childhood obesity to society from a public health and economic perspective. Next, it will explore the factors that have contributed to the rise in obesity rates in China, including changes in diet and lifestyle. After that, it will evaluate the effectiveness of existing policies and propose potential interventions, such as school health education programs and food labeling policies, aimed at reducing obesity and easing the economic burden on society. Ultimately, this study

aims to better understand trends in childhood obesity and its economic impact, and hopefully provide professionals with effective interventions and insights for managing obesity.

2. Background

2.1 . Causes of childhood obesity

There are many reasons for childhood obesity, including family factors and social-psychological factors. In a 2015 study, Xin-Nan Zong used a case-control study design to discover a strong correlation between childhood obesity and the BMI of parents, high birth weight, and gestational hypertension. Children's appetite, fast eating, outdoor activities, and length of sleep also contribute to obesity. At the same time, obesity rates are higher in those who were reared mostly by grandparents. The incidence of childhood obesity is also increased by parental body mass index (BMI), particularly in cases of obesity in mothers and fathers. The way parents feel about their kids controlling their weight has an impact on the obesity rate as well. (s12889-015-2265-5) Yaru Guo et al. examined 26,120 kids and teenagers from 16 provinces, ages 10 to 18, in a study published in 2022. They discovered that the likelihood of obesity increased with latitude and decreased with height. Simultaneously, the risk of obesity increases with the level of family SES. (nutrients-14-00035)

2.2 . Health consequences of childhood obesity

Childhood obesity can lead to many health problems, especially related to cardiovascular, blood lipids, blood sugar, and so on. A 2005 study by Yan-Ping Li et al used controlled trials using WGOC-recommended BMI classifications and found that overweight children had 1.9, 1.4, and 1.5 times the risk of hypertriglyceridemia, low-density lipoprotein, and dyslipidemia compared with normal-weight children. After adjusting for age, sex, region, socioeconomic status, physical activity, and dietary intake, the risk was 3.3, 1.5, and 1.8 times greater in the obese group than in children of normal weight. Obese children were 3.9 times more likely to develop high blood pressure and had a significantly higher incidence of metabolic syndrome than normal children (38.1% vs. 1.5%). (bes200506005) A 2013 study by L. S. Adair using data from the 2009 China Health and Nutrition Survey, concluded that childhood obesity can lead to CM disease (diabetes, cardiovascular disease). At the same time, the combination of high waist circumference and obesity increases the likelihood of elevated HbA1c, diabetes, and insulin resistance by three to five times. (Obesity Reviews

- 2013 ...)

2.3 . Economic burden and the importance of early intervention

Prevention of childhood obesity is essential because of the rising rate of childhood obesity in China, the increasing cost of health care to address childhood obesity, and the higher incidence of chronic diseases that, if left unchecked, can mean significant increases in medical expenses in adulthood. A 2006 study by Na Zhang estimated that the economic cost of obesity-related diseases would reach 49.05 billion CNY yuan annually by 2030. (Wang et al. (2006)) A 2006 study by J. Jiang involved three years of nutrition education and exercise interventions in

five primary schools in Beijing, China. After three years, the obesity rate in the intervention group was reduced by 32.5%, effectively reducing the obesity rate. In the long run, it also reduces the economic burden. (j.1365-2214.2007.00738.x.) A study in Beijing by XIAO-YI SHAN in 2010 through statistical analysis, found that a series of behavioral factors related to obesity, such as lack of exercise, playing electronic products for too long, unhealthy lifestyle, etc., will cause obesity, and early intervention can prevent and control childhood obesity. (International Journal of Pediatric Obesity, 2010; 5:383-389)

3. Analysis of BMI data of Chinese children

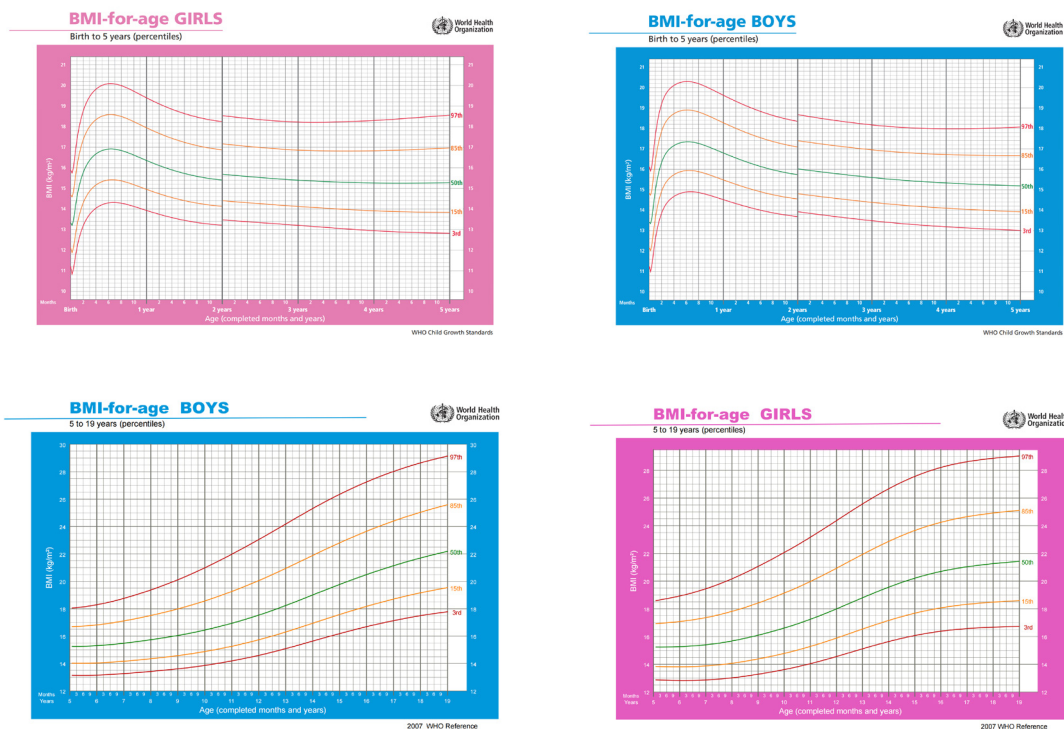


Figure 1 BMI-for-age Percentages for Girls from Birth to 5 Years

According to the WHO report, the analysis of BMI data for children aged 0 to 5 years showed little difference in the overall trend, especially between birth and one year of age, children's BMI changes are most obvious, this period is one of the most important developmental stages in their lives, physical development is rapid. In gender comparisons, there were small differences in BMI changes between boys and girls.

At this stage, important factors affecting BMI changes in young children include:

Diet: Eating habits are the most critical factor in a young child's BMI. The timing and quality of breastfeeding and

the introduction of complementary foods directly affect the growth and development of children. Unbalanced or improper dietary choices can lead to obesity or malnutrition.

Economy: Family economic status has a significant impact on children's dietary choices and lifestyle. Better-off families tend to have more nutritious food available, while poorer families may be at risk of malnutrition.

Regional differences: Cultural practices and living environments in different regions can also affect children's eating habits and BMI. For example, there are differences in food access, education levels, and health awareness be-

tween urban and rural areas, which can lead to significant differences in children's BMI.

In summary, the change in BMI of children aged 0 to 5 years is not only influenced by physiological development

but also closely related to many factors such as diet, economy, and region. Understanding these factors is essential for developing effective intervention strategies to promote healthy growth in children.

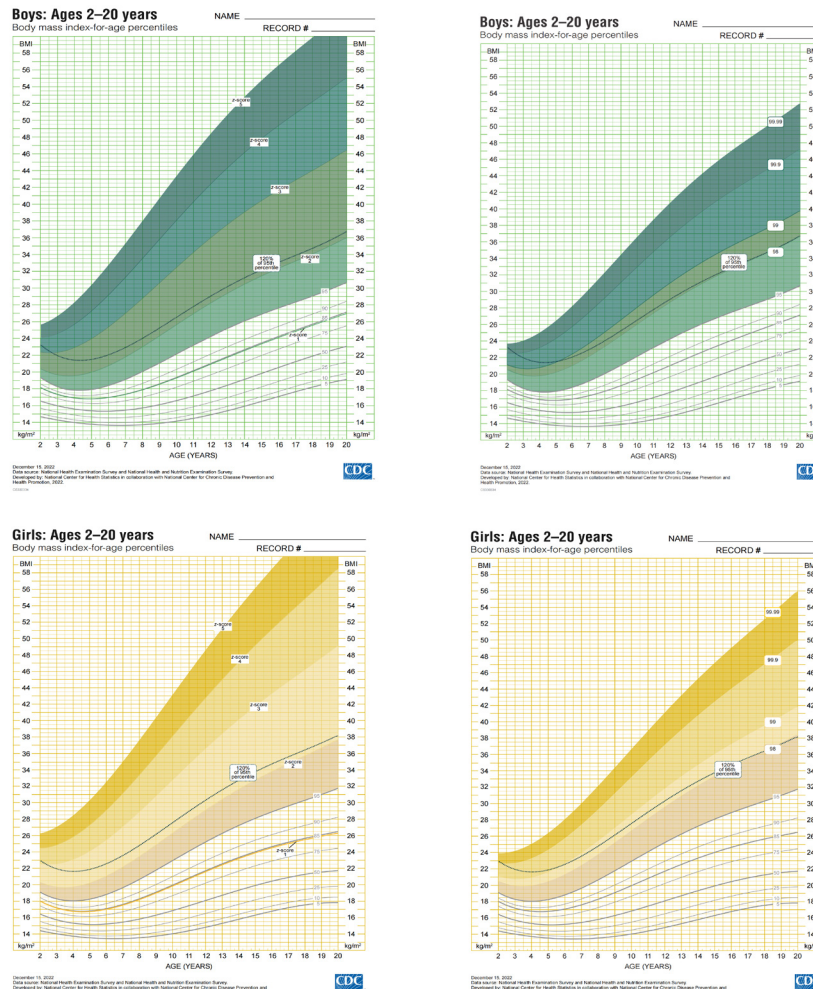


Figure 2 Age and Gender Records (Ages 2 - 20 years)

According to CDC report BMI in children is generally on the rise, especially during adolescence (11-18 years of age), the change is most obvious and the variance is large. Changes in BMI at this age reflect the characteristics of physiological development during adolescence, as well as the relationship with lifestyle. The age range covered by the data analysis was 2-20 years old. Although there was some gap in BMI change between boys and girls, the trends were relatively similar, showing a similar upward pattern.

The main factors that affect BMI in children include:

Diet: Changes in eating habits are a major factor in the increase in BMI, especially the increased intake of high-calorie, high-sugar foods.

Economic: The level of economic development affects the

dietary choices and lifestyle of families, which in turn affects the weight of children.

Regional differences: Living environments and cultural habits in different regions also lead to significant differences in BMI, and certain regions may face a greater risk of obesity.

4. Potential obesity factor

Dietary Changes and Increased Calorie Intake

Shift in Diet Patterns: In the past few decades, Chinese children's diets have shifted from traditional foods (rich in vegetables, rice, and legumes) to more energy-dense, high-fat, and high-sugar foods. The rise of fast food, snacks, and sugary drinks plays a key role in this shift.

Table 1: The proportion of fat in the diet of Chinese children significantly increased from 1991 to 2015.

Year	Percentage of fat in diet	Daily intake of sugar-sweetened beverages
1991	20%	50ml
2015	30%	200ml

Urbanization and Reduced Physical Activity

Sedentary Lifestyles: With increased urbanization, children in urban areas are less physically active, spending

more time on sedentary activities such as watching TV, playing video games, and using mobile devices. This reduced physical activity leads to a higher risk of obesity.

Table 2: Daily screen time and physical activity time for urban children

City	Children's daily screen time	Daily physical activity time
BeiJing	4.5h	0.5h
ShangHai	4.0h	0.6h
GuangZhou	5.0h	0.4h

Parental Influence and Socioeconomic Factors

Parental Perceptions: Many parents, particularly in urban China, associate a chubbier appearance with good health

and prosperity. This cultural preference can lead to over-feeding or less concern about weight gain.

Table 3: Obesity rates among children from affluent and impoverished families in urban areas

Income level	Childhood obesity rate	Average daily caloric intake
High level	20%	2800kcal
Middle level	15%	2500kcal
Low level	10%	2200kcal

Educational Pressures

Reduced Time for Exercise: Chinese students face significant academic pressure, often spending long hours study-

ing or attending after-school tutoring. This leaves little time for physical activity, contributing to obesity.

Table 4: The recommended daily physical activity time and achievable time for elementary school students.

Age	Recommended daily physical activity time	Actual physical activity time
Age7-12	1h	0.6h
Age12-15	1h	0.4h

Marketing and Advertising

Exposure to Unhealthy Food Ads: Children are frequently exposed to marketing campaigns promoting unhealthy

food products, including sugary snacks and beverages, which influences their food preferences and purchasing behaviors.

Table 5: Food advertisements that children are exposed to on television and social media

Medium type	Increased advertising exposure	Increased consumption of unhealthy foods
Tv	30%	25%
Social medium	40%	35%

5. Method

The purpose of this methodology is to evaluate the eco-

nomie burden of childhood obesity in China and to conduct a cost-benefit analysis of various intervention strategies aimed at reducing obesity rates and improving health

outcomes. First of all, data is collected from existing literature. Primary data includes the components of medical cost data and intervention cost data. Medical cost data are collected upon medical costs related to childhood obesity, including hospitalization, outpatient visits, medications, and non-hospital healthcare from national healthcare databases. Intervention cost data obtain cost estimates for each proposed intervention (e.g., taxation on sugar-sweetened beverages, physical activity initiatives) from government reports and academic studies, some of which from other countries as China may not have implemented the respective policy or had not displayed its cost and benefit evaluations publicly. Then, secondary data is collected, comprising economic burden data and health impact data. Existing studies and economic reports that quantify the indirect costs, such as lost productivity and DALYs (Disability-Adjusted Life Years), associated with childhood obesity are used for economic burden data. Data on health outcomes, such as BMI reduction and HALYs (Health-Adjusted Life Years) gained from both national health surveys and academic literature are gathered for quantifying health impact. With the data collected, the significance of policy intervention is exemplified through the direct and indirect costs that childhood obesity incur upon children in the short run and long run.

5.1 Data Collection

Primary Data

Medical Cost Data: Collect data on medical costs related to childhood obesity, including hospitalization, outpatient visits, medications, and non-hospital healthcare from national healthcare databases.

Intervention Cost Data: Obtain cost estimates for each proposed intervention (e.g., taxation on sugar-sweetened beverages, physical activity initiatives) from government reports and academic studies.

Secondary Data

Economic Burden Data: Use existing studies and economic reports that quantify the indirect costs, such as lost productivity and DALYs (Disability-Adjusted Life Years), associated with childhood obesity.

Health Impact Data: Gather data on health outcomes, such as BMI reduction and HALYs (Health-Adjusted Life Years) gained from both national health surveys and academic literature.

5.2 . Cost Analysis

Direct Medical Costs

Annual Total Medical Costs: Calculate the average annual medical costs per child affected by obesity, including:

Non-hospital healthcare: \$56.52

Outpatient visits: \$14.27

Medication: \$46.38

Hospitalization: \$1975.06

Aggregate Direct Costs: Multiply the average annual medical costs by the estimated number of obese children to determine total annual direct costs: \$13.62 billion.

Indirect Costs

Productivity Loss: Estimate the economic impact of lost productivity due to childhood obesity-related health issues, resulting in a total annual indirect cost of \$49.02 billion.

Disability-Adjusted Life Years (DALYs): Calculate the impact on public health using DALYs, with an estimated loss of 3.3 billion DALYs.

Lifetime Economic Impact: Estimate the long-term economic impact, including future healthcare costs and productivity losses, amounting to \$31.6 trillion.

Lifetime Loss per Child: Calculate the individual lifetime economic loss per affected child or adolescent: \$350 thousand.

5.3 . Cost-Benefit Analysis

Direct Costs Evaluation

Analyze all costs required to implement each intervention. Summarize total expenditures for each intervention strategy.

Indirect Costs Evaluation

Assess the indirect cost savings due to reduced health service needs and enhanced productivity. Project long-term economic impacts resulting from decreased childhood obesity prevalence.

6. Cost-Benefit Analysis Model for Childhood Obesity in China

Cost of childhood obesity:

a. Increased annual total medical costs: \$237.55

i. Non-hospital healthcare: \$56.52

ii. Outpatient visits: \$14.27

iii. Medication: \$46.38

iv. Hospitalization: \$1975.06

b. Annual direct costs: \$13.62 billion

c. Annual indirect costs: \$49.02 billion

d. DALYs: 3.3 billion

e. Lifetime economic impact: \$31.6 trillion

f. Lifetime loss per affected child or adolescent: \$350 thousand

Solutions through interventions:

a. Taxation on sugar sweetened beverages

i. Total intervention cost: \$120 M

ii. Total healthcare cost offsets: -\$1.7 B

- iii. HALYs gained: 28,981
- iv. Tax revenue: \$600 M
- b. Reformulation to reduce sugar in sugar sweetened beverages:
 - i. Total intervention cost: \$45 M
 - ii. Total healthcare cost offsets: -\$295 M
 - iii. HALYs gained: 28,981
- c. Restriction on price promotions of sugar sweetened beverages:
 - i. Total intervention cost: \$17 M
 - ii. Total healthcare cost offsets: -\$498 M
 - iii. Reduction on healthcare savings: \$295 M to \$1.7 B
 - iv. HALYs gained: 48,336
 - v. Reduction in childhood obesity rates: 18%
- d. Restrictions on TV ads:
 - i. Total intervention cost: \$6 M
 - ii. Total healthcare offsets: -\$784 M
 - iii. HALYs gained: 88,396
 - iv. Reduction in childhood obesity rates: 0.352 unit reduction in BMI
- e. Community based intervention program:
 - i. Total intervention cost: \$878 M
 - ii. Total healthcare cost offsets: -\$452 M
 - iii. HALYs gained: 51,792
 - iv. Reduction in childhood obesity rates: 0.26 unit reduction in BMI

7. Result

The economic burden of childhood obesity in China is substantial and impacts both individual families and the healthcare system as a whole. The average annual medical costs for a child affected by obesity are estimated to be around \$237.55. This figure includes various healthcare expenditures, such as non-hospital healthcare costs, which

amount to \$56.52. These costs cover routine check-ups and preventive care aimed at managing weight and related health issues. Outpatient visits account for \$14.27, reflecting the expenses incurred from consultations with healthcare providers for obesity-related concerns. Additionally, medication costs average \$46.38, covering prescriptions for conditions associated with obesity, such as diabetes or hypertension. The most significant expense comes from hospitalization, which can reach as high as \$1,975.06 for severe complications, underscoring the serious health risks linked to obesity. Overall, the direct costs related to childhood obesity are estimated at approximately \$13.62 billion per year. This figure encompasses all medical expenses directly attributed to managing obesity and its related health conditions, representing a significant financial burden on families and the healthcare system. In addition to direct medical costs, childhood obesity incurs substantial indirect costs, totaling around \$49.02 billion annually. These costs stem from lost productivity, including missed school days due to health issues, and the potential long-term economic impact on affected individuals as they enter the workforce. The impact of childhood obesity is also reflected in the loss of Disability-Adjusted Life Years (DALYs), which estimates a loss of about 3.3 billion DALYs. This metric illustrates the years of healthy life lost due to obesity-related health complications, highlighting the severe implications for public health. The lifetime economic impact of childhood obesity in China is staggering, estimated at approximately \$31.6 trillion. This figure encompasses future healthcare costs, lost productivity, and other associated economic burdens over the lifetimes of affected individuals. Each child or adolescent facing obesity can expect a lifetime economic loss of about \$350,000. This loss reflects not only healthcare expenses but also diminished earning potential and reduced quality of life.

Childhood Obesity Guidelines in China from 1949-2020	Health Standards and Practice Guidelines	
	Physical Exercise Promotion / Maternal Related Guidelines	Nutrition and Food Safety Related
	School Physical Education Regulations	Guidelines for Snack Consumption for Chinese Children and Adolescents
		Questions and Answers on Nutrition Knowledge for Junior Middle School Students
	National Fitness Ordinance	Dietary Guidelines for Chinese Citizens
		Chinese Dietary Guidelines for School-Age Children (2016)
	National Fitness Program (2016-2020)	Student Meal Nutrition Guide (2016)
		Chinese Children and Adolescent Snacks Guide (2018)
	Opinions of the General Office of the State Council on Strengthening School Physical Education to Promote the Comprehensive Development of Students' Physical and Mental Health	Dietary Guidelines for Preschool Children in China (2016)
		A Guide to Learning and Development for Children 3-6
	National Student Physical Health Standard	Outline of Healthy China 2030
	Guidelines for Physical Activities of Chinese Children and Adolescents	Guidelines for Prevention and Control of Overweight and Obesity in Chinese School-Age Children and Adolescents
	Guide to Breastfeeding Infants within 6 Months of Age	Preschool Children (3-6 years) Exercise Guide (expert consensus edition)
	7-24 Months Old Infant Feeding Guide	China Blue Paper on Obesity Prevention and Control

Figure 3: Childhood Obesity Guidelines in China from 1949-2020 (Ma 2020)

Therefore a cost-benefit analysis is conducted upon existing policies around the world that could be implemented by China in order to identify the top cost-effective and efficient policies. In analyzing policies, we first focused on past Chinese health policies, particularly those aimed at addressing childhood obesity from 1949 to 2020 that had been conducted.

These guidelines have predominantly centered around four main areas:

Firstly, physical exercise promotion has been a significant emphasis, encouraging regular activity to maintain a healthy lifestyle. Regulations such as the School Physical Education Regulations and the National Fitness Ordinance

have been pivotal. Next, we see a strong focus on maternal-related guidelines, recognizing the vital role of maternal health in the early development of children. This includes initiatives like the Guide to Breastfeeding Infants within 6 Months of Age. Nutrition literacy enhancement is another critical area, emphasizing the importance of educating children and parents about balanced diets and proper nutrition. This can be seen in documents like the Dietary Guidelines for China Citizens and the Student Meal Nutrition Guide. Lastly, obesity control and prevention is a cornerstone of these efforts. Guidelines specifically addressing obesity, such as the Guidelines for Physical Activities of Chinese Children and Adolescents.

Different Policies Implemented Around the World			
1	Promote healthy diets and reducing unhealthy foods and sugar-sweetened beverages	Taxations	Sugary drinks taxes in Mexico
			Sugary Drink Industry Levy in UK Tax revenue reinvested into obesity reduction programs
			Public health product tax based on sugar, salt, methylxanthine content for prepackaged foods in Hungary; tax revenue reinvested into reformulation of foods and into health sector; reduced taxes for poultry, milk, fish...
		Marketing restrictions	Statutory ban issued in 2014 on the sale of energy drinks to youth under 18 years of age, prohibition of ads and promo of energy drinks to persons under 18 years of age in education institutions, sports events or media outlets in Lithuania
			Restricted food marketing during children's programming, code of conduct regarding the ads of foods with energy-dense profile in Slovenia
			Marketing bans in educational sector in Spain under the Law on Nutrition and Food Safety
		Equal access to nutritious foods	Collab with food industry to improve population-level dietary intake: Directorate of Health and food industry sign agreement to reduce salty intake by 8g per person per day and added sugar by 12.5% in Norway
		Dietary guidelines	Advocate increased consumption of fruits vegetables, whole grains... in Norway
			Portuguese Law: Integrated Strategy for the Promotion of Healthy Eating
			Monitor nutrition composition of food, food reformulation Nutritional labeling model, market restrictions to children Nutritional literacy with education and promo of med diet
2	Promo of Physical Activity	The Sport is the Norm of Life project in Russian Federation	
		Schools in Motion project in Estonia: active lessons, active recesses, active transport, physical exercise	
		Active transport such as cycling programs in UK	
		Active School Travel Programme in Northern Ireland	
3	Preconception and antenatal advice	Amsterdam Healthy Weight Programme "first 1000 days" promo of healthy diet among expectant mothers, support adolescent parent in Netherlands	
4	Healthy Diet, Quality Sleep, Lifelong Habits	Support breast feeding in Croatia	
		"Healthy Eating from the Start!" Health promo program in Austria	
5	Health Literacy	Directorate of Education has embedded food preparation classes as part of the curriculum in food and health (MHEI-02) for children in Grades 4, 7, and 10 in Norway	
		Drinking Water of Ukraine 2006-2020	
6	Family Based Weight Management Services for Youth Diagnosed with Obesity	Community-based interventions and a primary care surveillance and referral system. in Ireland's Obesity Policy and Action Plan 2016-2025	
		Emilia-Romagna in Italy developed a management model for childhood obesity by way of a regional, multidisciplinary framework that engages an escalating model of network providers who deliver supervision, counseling, and intervention	

Figure 4: Different Obesity Intervention Policies Implemented Across the World (Wickramasinghe 2021)

Furthermore we investigated various intervention programs implemented at the national level. Some of the key initiatives include the "Healthy Lifestyle for All" Cam-

paign, the "Chinese Student Milk Plan Program," and "The 1000 Days of Early Life Nutrition and Health Action." While these efforts are commendable, there are several

critical areas of concern: Most of these programs are primarily in the form of guidelines rather than enforceable regulations or policies. Furthermore, there's a noticeable gap in upstream policies that address the root causes of obesity, such as socioeconomic factors and urban planning. Additionally, many programs lack thorough evaluations to assess their long-term effectiveness and impact on childhood obesity rates. Detailed financial records of implementation costs are often missing, making it difficult to evaluate the cost-effectiveness and sustainability of these initiatives.

Seeing several major areas of problems in the current policy implementation in China, research upon global issues targeting childhood obesity is conducted, achieving the following table:

Addressing childhood obesity requires a multifaceted approach, involving various interventions designed to promote healthier lifestyles and reduce obesity rates. Data on the cost and benefit results are estimated derived from global collections, particularly Australia. 5 key policies that could be good choices for China to try upon are the following:

a. Taxation on Sugar-Sweetened Beverages

Imposing a tax on sugar-sweetened beverages has emerged as an effective strategy to curb consumption. The total intervention cost for this measure is approximately \$120 million. However, the anticipated healthcare cost offsets could be as high as \$1.7 billion, indicating a substantial reduction in obesity-related medical expenses. Additionally, this intervention could generate about \$600 million in tax revenue, further supporting public health initiatives. The estimated gain of 28,981 Health-Adjusted Life Years (HALYs) highlights the positive impact on the population's health.

b. Reformulation to Reduce Sugar in Beverages

Encouraging beverage manufacturers to reformulate products to reduce sugar content represents another intervention. The total cost of this initiative is around \$45 million, with expected healthcare cost offsets of approximately \$295 million. This intervention aims to decrease sugar intake among children, ultimately contributing to healthier dietary patterns.

c. Restriction on Price Promotions of Sugar-Sweetened Beverages

Implementing restrictions on price promotions for sugar-sweetened beverages is another potential intervention. With a total intervention cost of \$17 million, this approach could lead to significant healthcare cost offsets, ranging from \$295 million to \$1.7 billion. Moreover, it is expected to yield 48,336 HALYs gained and achieve an 18% reduction in childhood obesity rates, demonstrating its effectiveness in promoting healthier choices among children.

d. Restrictions on TV Ads

Limiting advertising for unhealthy foods targeted at children can also play a crucial role in reducing obesity rates. With a total intervention cost of \$6 million, this measure aims to limit advertising targeting children. The total healthcare offsets are projected at -\$784 million, leading to an estimated 88,396 HALYs gained. This initiative could also result in a reduction of 0.352 units in BMI among children.

e. Community-Based Intervention Program

This comprehensive program has a total intervention cost of \$878 million, with anticipated healthcare cost offsets of -\$452 million. The program aims to promote healthier lifestyles and physical activity within communities, involving multiple stakeholders: do nutritionist, health sector, and physical exercise experts, expecting to gain about 51,792 HALYs and achieve a 0.26 unit reduction in BMI among children.

After comparing the costs against the expected outcomes, the policies c and d showcase the higher returns to investment relative to other potential policy choices. Physical Activity Initiatives, Taxation on Sugar-Sweetened Beverages, Physical activity initiatives, taxation on sugar-sweetened beverages, Reformulation to Reduce Sugar in Beverages, Restriction on Price Promotions of Sugar-Sweetened Beverages, Restrictions on Both TV Ads and Community-Based Intervention Program are effective, which can reduce the rate of childhood obesity and offset the medical expenses caused by childhood obesity to varying degrees. Taxation on Sugar-Sweetened Beverages, Restriction on Price Promotions of Sugar-Sweetened Beverages, Restrictions on TV Ads These interventions have all reduced the sales of sugary foods to varying degrees. The difference of social and economic status has different consumption differences, and these differences also create different consumer groups. The policy of taxing sugary drinks and limiting the preferential price of sugary drinks means that the increase in the price of sugary drinks has less impact on the high consumption group and more impact on the low consumption group. Therefore, the greater the number of people of lower socio-economic status, the greater the effectiveness and effectiveness of these policies should be.

8. Discussion

This study focuses on conducting an economic evaluation to explore the pros and cons of incorporating strategies for the prevention and control of childhood obesity in the public health system. Studies show that programs such as dietary instruction, promoting physical exercise, and nutritious diets may initially result in increased healthcare ex-

penditures. Despite this, these techniques can significantly reduce chronic obesity challenges like type 2 diabetes and heart disease, thereby cutting down healthcare costs and improving public health. Research highlights the financial advantages of prompt measures, demonstrating the success of these preventive tactics in reducing impending healthcare expenses, thus underscoring the importance of addressing and regulating childhood obesity in governmental strategies.

Economically speaking, the extensive prevalence of obesity among children profoundly influences the economy. The yearly direct healthcare expenditures reach around \$13.62 billion, encompassing expenses like outpatient treatment, medicinal interventions, and inpatient treatment. Significantly, the expense for hospital admission due to critical obesity-related complications may escalate to \$1,975.06, underscoring the grave healthcare hazards linked to obesity. Furthermore, children with overweight issues incur an annual expense of \$49.02 billion, primarily attributed to reduced productivity, evidenced by decreased attendance owing to health issues and limited future career opportunities. The aggregate lifelong financial burden stemming from direct and indirect expenses, amassing to \$31.6 trillion from childhood obesity, underscores the dire societal impacts of obesity.

Studies indicate that early prevention of childhood obesity offers economic advantages, as governmental financial support promotes personal health and leads to significant cost reductions for healthcare systems. It provides essential guidance on investments and aids decision-makers in the improved allocation of resources. Furthermore, a clear enhancement in social advantages is apparent. Decreasing the rates of obesity in children is crucial for bolstering public health, diminishing disease impacts, and enhancing life quality. Immediate health initiatives play a vital role in nurturing lasting health-aware habits for the advantage of upcoming generations. Studies suggest that effectively preventing and managing childhood obesity via public health methods could improve its financial sustainability. Evidence backs this hypothesis, demonstrating the considerable success of these techniques in lowering obesity and related illnesses, alleviating public health strain, and offering substantial long-term financial benefits.

In line with ongoing research, studies conducted by Gortmaker and associates, as well as Wang and his team. Studies have shown that methods such as dietary training and exercise have been effective in reducing childhood obesity and its associated health care costs over a prolonged duration. To combat obesity in children, our research evaluated the pros and cons of different tactics including endorsing physical activity, imposing taxes on sugar-rich drinks, reducing sugar content, and curtailing marketing and adver-

tising strategies. The exploration of the economic advantages of these strategies showed that encouraging physical activity results in enhanced daily exercise routines among kids in schools and broader communities. While a precise assessment of the intervention's expense is essential, appraising the financial viability of these approaches might lead to considerable cuts in treatment expenditures and encourage their growth during the Years of Healthy Living (HALYs). Taxation on sweetened drinks: This tax's projected expense hovers near \$120 million, but it surpasses the expected health care costs by \$1.7 billion. This method might bring us about \$600 million in tax advantages and 28,981 HALYs in health benefits. Under the beverage sugar reform, as much as \$45 million of US dollars were allocated as intervention funds to encourage beverage producers to reduce sugar content in their products. Expected healthcare expenses, amounting to approximately \$295 million, aim to enhance children's dietary patterns and health tactics. It's anticipated that the advertising expenses for sweet drinks will vary between \$17 million and \$295 million for healthcare services.⁷ billion, culminating in a significant 48,336 million decrease in the total expenses of HALYs' approach to foster childhood obesity, 48,336 million in broadcasted food, and 6 million,000 in overall health advantages. The suggested health strategy, centered on enhancing children's well-being and grounded in an extensive healthcare framework, aims to diminish the total health effects of this intervention. The figure stands at 5178 million, not counting the comprehensive health research.⁷⁸ million healthcare unit.⁷ million, reflecting the overall health influence of this intervention on children, stems from an extensive analysis.⁷ million health research is exclusively dedicated to examining the worldwide health implications of such research in children's health.

This study comes with limitations. Initially, the data's basis could be linked to specific health surveys and economic sustainability tactics, potentially impacting its accuracy and extensive usage. Elements like familial engagement and policy implementation may alter the real effectiveness of interventions, possibly failing to mirror the wider national or regional scenario. More samples in upcoming studies might improve the relevance of these results. Furthermore, the impact of these tactics could vary depending on how they are executed and the degree of audience involvement. (No alterations are required; the sentence remains unchanged. Elements such as the family environment, financial situation, and the level of educational backing might influence the final outcomes. The main goal of this study was to assess the outcomes at the outset and following the intervention. The postponed impacts of obesity in childhood on health lead to uncertainties in predicting enduring benefits, especially in terms of the in-

fluence of childhood interventions on the health of adults.

9. Conclusion

This study set out to analyze the cost-benefit of combating childhood obesity to evaluate how effective different prevention and control strategies in China. This study collected relevant data using databases, existing studies and government reports, and analyzed them through a cost-benefit model. In summary, the results of this investigation show that the economic burden costed by childhood obesity in China is enormous, with implications for individual families and the China's healthcare system. The research has also shown that Early intervention and prevention of obesity can reduce the cost of prevention and control of childhood obesity, and have a positive impact on public health. This study has identified implementing interventions such as physical activity, taxing sugary drinks, reducing the amount of sugar in drinks, and limiting price promotions and television advertising can be effective in reducing childhood obesity rates and reducing health care costs. Although some measures initially lead to increased medical costs, they can indirectly reduce the medical costs and economic burden of related diseases by affecting childhood obesity. The most obvious finding to emerge from this study is that compared with other feasible policies, the inhibition of unhealthy food promotion is the most effective in reducing the cost of childhood obesity. Different socioeconomic status is sensitive to different policies, so socioeconomic status will affect the effectiveness of different policies. In addition, the effectiveness analysis of the policy in this study will provide theoretical reference for the implemtors, and has great significance and guidance for reducing the cost and economic burden of childhood obesity in China. Although this study has some limitations in the number of samples, it still has great research significance as a concrete analysis of policy feasibility.

Acknowledgement

Lipei Tang, Xinyu Sun, Xuhan Chen, Jingya Huang and Jiayi Han contributed equally to this work and should be considered co-first authors.

References

[1]Adair, L. S., Gordon-Larsen, P., Du, S. F., Zhang, B., & Popkin, B. M. (2013). The emergence of cardiometabolic disease risk in Chinese children and adults: consequences of changes in diet, physical activity and obesity. *Obesity Reviews*, 15((Suppl 1)), 49–59. <https://doi.org/10.1111/obr.12123>

[2]Ananthapavan, J., Sacks, G., Brown, V., Moodie, M., Nguyen, P., Veerman, L., Mantilla Herrera, A. M., Lal, A., Peeters, A., & Carter, R. (2020). Priority-setting for obesity prevention—

The Assessing Cost-Effectiveness of obesity prevention policies in Australia (ACE-Obesity Policy) study. *PLOS ONE*, 15(6), e0234804. <https://doi.org/10.1371/journal.pone.0234804>

[3]Andersen, R. E., Crespo, C. J., Bartlett, S. J., Cheskin, L. J., & Pratt, M. (1998). Relationship of Physical Activity and Television Watching With Body Weight and Level of Fatness Among Children. *JAMA*, 279(12), 938. <https://doi.org/10.1001/jama.279.12.938>

[4]Barton, M. (2012). Childhood obesity: a life-long health risk. *Acta Pharmacologica Sinica*, 33(2), 189–193. <https://doi.org/10.1038/aps.2011.204>

[5]Beijer, U., & Andreasson, S. (2010). Gender, hospitalization and mental disorders among homeless people compared with the general population in Stockholm. *The European Journal of Public Health*, 20(5), 511–516. <https://doi.org/10.1093/eurpub/ckq033>

[6]BMC Public Health. (2024). BMC Public Health. <https://bmcpublihealth.biomedcentral.com>

[7]Brown, V., Ananthapavan, J., Veerman, L., Sacks, G., Lal, A., Peeters, A., Backholer, K., & Moodie, M. (2018). The Potential Cost-Effectiveness and Equity Impacts of Restricting Television Advertising of Unhealthy Food and Beverages to Australian Children. *Nutrients*, 10(5), 622. <https://doi.org/10.3390/nu10050622>

[8]Cabrera Escobar, M. A., Veerman, J. L., Tollman, S. M., Bertram, M. Y., & Hofman, K. J. (2013). Evidence that a tax on sugar sweetened beverages reduces the obesity rate: a meta-analysis. *BMC Public Health*, 13(1). <https://doi.org/10.1186/1471-2458-13-1072>

[9]Carter, R., Moodie, M., Markwick, A., Magnus, A., Vos, T., Swinburn, B., & Haby, M. M. (2009). Assessing Cost-Effectiveness in Obesity (ACE-Obesity): an overview of the ACE approach, economic methods and cost results. *BMC Public Health*, 9(1). <https://doi.org/10.1186/1471-2458-9-419>

[10]Cawley, J., & Wen, K. (2017). Policies to Prevent Obesity and Promote Healthier Diets: A Critical Selective Review. *Clinical Chemistry*, 64(1), 163–172. <https://doi.org/10.1373/clinchem.2017.278325>

[11]Du, S. F., Wang, H. J., Zhang, B., Zhai, F. Y., & Popkin, B. M. (2013). China in the period of transition from scarcity and extensive undernutrition to emerging nutrition-related non-communicable diseases, 1949-1992. *Obesity Reviews*, 15(S1), 8–15. <https://doi.org/10.1111/obr.12122>

[12]Esdaile, E., Thow, A. M., Gill, T., Sacks, G., Golley, R., Love, P., Wen, L. M., & Rissel, C. (2019). National policies to prevent obesity in early childhood: Using policy mapping to compare policy lessons for Australia with six developed countries. *Obesity Reviews*, 20(11), 1542–1556. <https://doi.org/10.1111/obr.12925>

[13]Global Economic Data, Indicators, Charts & Forecasts | CEIC. (2016). Ceicdata.com. <https://www.ceicdata.com>

[14]Gortmaker, S. L., Wang, Y. C., Long, M. W., Giles, C.

- M., Ward, Z. J., Barrett, J. L., Kenney, E. L., Sonnevile, K. R., Afzal, A. S., Resch, S. C., & Craddock, A. L. (2015). Three Interventions That Reduce Childhood Obesity Are Projected To Save More Than They Cost To Implement. *Health Affairs*, 34(11), 1932–1939. <https://doi.org/10.1377/hlthaff.2015.0631>
- [15] Grossman, D. C., Bibbins-Domingo, K., Curry, S. J., Barry, M. J., Davidson, K. W., Doubeni, C. A., Epling, J. W., Kemper, A. R., Krist, A. H., Kurth, A. E., Landefeld, C. S., Mangione, C. M., Phipps, M. G., Silverstein, M., Simon, M. A., & Tseng, C.-W. (2017). Screening for Obesity in Children and Adolescents. *JAMA*, 317(23), 2417. <https://doi.org/10.1001/jama.2017.6803>
- [16] Guo, Y., Yin, X., Sun, Y., Zhang, T., Li, M., Zhang, F., Liu, Y., Xu, J., Pei, D., & Huang, T. (2021). Research on Environmental Influencing Factors of Overweight and Obesity in Children and Adolescents in China. *Nutrients*, 14(1), 35. <https://doi.org/10.3390/nu14010035>
- [17] Hagen, A.-K. ., & Bjorbaekmo, W. S. (2010). Parents evaluation of the processes of care in child rehabilitation: a reliability study of the Norwegian translation of MPOC-20. *Child: Care, Health and Development*, 38(1), 48–53. <https://doi.org/10.1111/j.1365-2214.2010.01192.x>
- [18] He, Y., Yang, X., Xia, J., Zhao, L., & Yang, Y. (2016). Consumption of meat and dairy products in China: a review. *Proceedings of the Nutrition Society*, 75(3), 385–391. <https://doi.org/10.1017/s0029665116000641>
- [19] International Journal for Equity in Health. (2024). *International Journal for Equity in Health*. <https://equityhealthj.biomedcentral.com>
- [20] Jiang, J., Xia, X., Greiner, T., Wu, G., Lian, G., & Rosenqvist, U. (2007). The effects of a 3-year obesity intervention in schoolchildren in Beijing. *Child: Care, Health and Development*, 33(5), 641–646. <https://doi.org/10.1111/j.1365-2214.2007.00738.x>
- [21] Johnson, W., Li, L., Kuh, D., & Hardy, R. (2015). How Has the Age-Related Process of Overweight or Obesity Development Changed over Time? Co-ordinated Analyses of Individual Participant Data from Five United Kingdom Birth Cohorts. *PLOS Medicine*, 12(5), e1001828. <https://doi.org/10.1371/journal.pmed.1001828>
- [22] Kelsey, M. M., Zaepfel, A., Bjornstad, P., & Nadeau, K. J. (2014). Age-Related Consequences of Childhood Obesity. *Gerontology*, 60(3), 222–228. <https://doi.org/10.1159/000356023>
- [23] Li, M., Dibley, M. J., Sibbritt, D., & Yan, H. (2007). Factors associated with adolescents' overweight and obesity at community, school and household levels in Xi'an City, China: results of hierarchical analysis. *European Journal of Clinical Nutrition*, 62(5), 635–643. <https://doi.org/10.1038/sj.ejcn.1602757>
- [24] Ling, J., Chen, S., Zahry, N. R., & Kao, T. A. (2022). Economic burden of childhood overweight and obesity: A systematic review and meta-analysis. *Obesity Reviews*, 24(2). <https://doi.org/10.1111/obr.13535>
- [25] Liu, X., Li, W., Zhang, S., & Wang, C. (2015). "Parental perceptions of childhood obesity in China: A mixed-method study." *American Journal of Health Behavior*, 39(2), 273–284.
- [26] Liu, Y., Wang, M., Tynjälä, J., Lv, Y., Villberg, J., Zhang, Z., & Kannas, L. (2010). "Perceived physical activity correlates among adolescents in China." *European Journal of Public Health*, 20(6), 710–716.
- [27] Lobstein, T., Neveux, M., & Landon, J. (2020). Costs, equity and acceptability of three policies to prevent obesity: A narrative review to support policy development. *Obesity Science & Practice*, 6(5), 562–583. <https://doi.org/10.1002/osp4.423>
- [28] Lynteris, C. (2019). I I I (N.-T. V, P. Arwidson, G. Hastings, F. Bourdillon, L. Chanbaud, K. Gallopel Morgan, S. Fah, S. Jarman, H. Jarman, W. Palm, A. Elliott, & M. Wismar, Eds.). <https://iris.who.int/bitstream/handle/10665/370281/9789240075634-eng.pdf?sequence=1>
- [29] Ma, G., Meyer, C. L., Jackson-Morris, A., Chang, S., Narayan, A., Zhang, M., Wu, D., Wang, Y., Yang, Z., Wang, H., Zhao, L., & Nugent, R. (2023). The return on investment for the prevention and treatment of childhood and adolescent overweight and obesity in China: a modelling study. *The Lancet Regional Health - Western Pacific*, 64(6), 100977–100977. <https://doi.org/10.1016/j.lanwpc.2023.100977>
- [30] Ma, L., Wen, X., Xue, H., Zhao, L., Ding, Y., Xu, F., Ruan, G., Li, Y., Chang, S., & Wang, Y. (2022). National childhood obesity-related intervention systems and intervention programs in China in 1949 to 2020: A narrative review. *Obesity*, 30(2), 320–337. <https://doi.org/10.1002/oby.23316>
- [31] Ma, Y. N., Yang, L. J., Zhu, J. H., & Ma, L. (2014). "Prevalence and associated factors of obesity among children and adolescents in China: findings from a national study." *International Journal of Pediatric Obesity*, 9(3), 193–198.
- [32] McAuley, K. A., Taylor, R. W., Farmer, V. L., Hansen, P., Williams, S. M., Booker, C. S., & Mann, J. I. (2010). Economic Evaluation of a Community-based Obesity Prevention Program in Children: The APPLE Project. *Obesity*, 18(1), 131–136. <https://doi.org/10.1038/oby.2009.148>
- [33] Shan, X.-Y., Xi, B., Cheng, H., Hou, D.-Q., Wang, Y., & Mi, J. (2010). Prevalence and behavioral risk factors of overweight and obesity among children aged 2–18 in Beijing, China. *International Journal of Pediatric Obesity*, 5(5), 383–389. <https://doi.org/10.3109/17477160903572001>
- [34] Si, Q., & Cardinal, B. J. (2017). The Health Impact of Air Pollution and Outdoor Physical Activity on Children and Adolescents in Mainland China. *The Journal of Pediatrics*, 180(5), 251–255. <https://doi.org/10.1016/j.jpeds.2016.10.016>
- [35] The World Bank. (2023, April 7). Current health expenditure (% of GDP) | Data. [Worldbank.org. https://data.worldbank.org/indicator/SH.XPD.CHEX.GD.ZS](https://data.worldbank.org/indicator/SH.XPD.CHEX.GD.ZS)
- [36] Tuckel, P., & Milczarski, W. (2015). Walk Score™, Perceived Neighborhood Walkability, and Walking in the US. *American Journal of Health Behavior*, 39(2), 242–256. <https://doi.org/10.1111/ajhb.12111>

doi.org/10.5993/ajhb.39.2.11

[37]Tudor-Locke, C., Ainsworth, B. E., Adair, L. S., Du, S., & Popkin, B. M. (2003). Physical activity and inactivity in Chinese school-aged youth: the China Health and Nutrition Survey. *International Journal of Obesity*, 27(9), 1093–1099. <https://doi.org/10.1038/sj.ijo.0802377>

[38]Vallgård, S. (2017). Childhood obesity policies - mighty concerns, meek reactions. *Obesity Reviews*, 19(3), 295–301. <https://doi.org/10.1111/obr.12639>

[39]Wang, W., Mauleon, R., Hu, Z., Chebotarov, D., Tai, S., Wu, Z., Li, M., Zheng, T., Fuentes, R. R., Zhang, F., Mansueto, L., Copetti, D., Sanciango, M., Palis, K. C., Xu, J., Sun, C., Fu, B., Zhang, H., Gao, Y., & Zhao, X. (2018). Genomic variation in 3,010 diverse accessions of Asian cultivated rice. *Nature*, 557(7703), 43–49. <https://doi.org/10.1038/s41586-018-0063-9>

[40]Wang, Y., Mi, J., Shan, X-y., Wang, Q. J., & Ge, K-y. (2006). Is China facing an obesity epidemic and the consequences? The trends in obesity and chronic disease in China. *International Journal of Obesity*, 31(1), 177–188. <https://doi.org/10.1038/sj.ijo.0803354>

[41]Wickramasinghe, K., Chatterjee, S., Williams, J., Weber, M. W., Rito, A. I., Rippin, H., & Breda, J. (2021). Childhood overweight and obesity abatement policies in Europe. *Obesity Reviews*, 22(S6). <https://doi.org/10.1111/obr.13300>

[42]World Health Organization. (2020, October 19). Noncommunicable diseases: Childhood Overweight and Obesity. [www.who.int](https://www.who.int/news-room/questions-and-answers/item/noncommunicable-diseases-childhood-overweight-and-obesity). <https://www.who.int/news-room/questions-and-answers/item/noncommunicable-diseases-childhood-overweight-and-obesity>

overweight-and-obesity

[43]World Health Organization. (2023). Obesity. World Health Organization. https://www.who.int/health-topics/obesity/#tab=tab_1

[44]Wright, C. M., Cole, T. J., Fewtrell, M., Williams, J. E., Eaton, S., & Wells, J. C. (2021). Body composition data show that high BMI centiles overdiagnose obesity in children aged under 6 years. *The American Journal of Clinical Nutrition*, 116(1), 122–131. <https://doi.org/10.1093/ajcn/nqab421>

[45]Yang, W., Kelly, T., & He, J. (2007). Genetic Epidemiology of Obesity. *Epidemiologic Reviews*, 29(1), 49–61. <https://doi.org/10.1093/epirev/mxm004>

[46]Zong, X.-N., Li, H., & Zhang, Y.-Q. (2015). Family-related risk factors of obesity among preschool children: results from a series of national epidemiological surveys in China. *BMC Public Health*, 15(1). <https://doi.org/10.1186/s12889-015-2265-5>

[47]Zhai, F., Wang, H., Du, S., He, Y., Wang, Z., Ge, K., & Popkin, B. M. (2009). Prospective study on nutrition transition in China. *Nutrition Reviews*, 67, S56–S61. <https://doi.org/10.1111/j.1753-4887.2009.00160.x>

[48]Zhang, N., & Ma, G. - S. (2018). Childhood obesity in China: Trends, risk factors, policies and actions. *Global Health Journal*, 2(1), 1–11. <https://doi.org/10.1016/j.glohj.2018.02.001>

[49]Zhang, Y. X., Wang, S. R., & Zhao, J. S. (2011). “Association between obesity and mental health among Chinese children: a national survey.” *Child: Care, Health and Development*, 37(3), 400–405.