

Preplanned Studies

Trends of Overweight and Obesity Among Chinese Rural Children and Adolescents Aged 6 to 15 Years — the Central and Western Regions, China, 2012–2023

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Summary

What is already known about this topic?

Childhood overweight and obesity pose significant risks to physical and mental health. The Nutrition Improvement Programme for Rural Compulsory Education Students (NIPRCES) has demonstrated effectiveness in reducing malnutrition.

What is added by this report?

From 2012 to 2023, obesity prevalence increased more rapidly (AAPC=10.6%) than overweight prevalence (AAPC=2.0%) among children aged 6–15 years in central and western rural China. A quicker increase in the trends of overweight and obesity was observed in rural western China (AAPC for overweight=3.0%, AAPC for obesity=11.8%), among males (AAPC for overweight=2.1%, AAPC for obesity=10.8%). Additionally, while the prevalence of overweight/obesity was lower in older age groups of children, these cohorts showed more rapid increases.

What are the implications for public health practice?

Continuous monitoring of prevalence and implementation of targeted interventions are essential to prevent and control the expansion of overweight and obesity.

Both international and domestic evidence demonstrates that school feeding programs effectively reduce undernutrition. However, the rising prevalence of overweight and obesity has emerged as a global health concern, even in regions implementing school feeding programs (1). Childhood overweight and obesity negatively impact health outcomes, increasing the risk of non-communicable diseases in adulthood while hampering human capital development and economic growth (2). The Nutrition Improvement Programme for Rural Compulsory Education Students (NIPRCES), initiated in 2012, is a government-funded

initiative providing meal subsidies to enhance school meal quality, aimed at improving the nutritional status of primary and secondary students in economically underdeveloped rural areas of China (3). Previous NIPRCES surveys have documented increases in children's and adolescents' height (4), accompanied by concurrent weight gains. In this study, we analyzed NIPRCES survey data using joinpoint regression to evaluate overweight and obesity trends among children aged 6–15 years in central and western rural regions of China from 2012 to 2023. Our findings reveal regional, age, and gender disparities in the increasing trends of overweight and obesity, providing a scientific foundation for developing targeted dietary guidance, health education, and intervention strategies in rural China.

Data were obtained from the NIPRCES surveillance program conducted from 2012 to 2023. The study employed a multi-stage, stratified, random cluster sampling design encompassing rural areas of 699 counties across 22 provincial-level administrative divisions (PLADs) in central and western China from 2012 to 2019, expanding to 727 counties in 2021–2023. Analysis included children aged 6–15 years from 9 surveys, with participant numbers of 1,629,899 (2012), 1,768,253 (2013), 1,830,167 (2014), 1,910,146 (2015), 1,405,174 (2016), 1,394,620 (2017), 1,437,184 (2019), 1,583,061 (2021), and 2,009,076 (2023). While surveys were typically conducted from October to December, the 2019 survey was conducted between April and June due to scheduling changes. Regional segmentation into central and western regions was based on economic development levels (5). Height and weight measurements were performed by trained investigators using standardized equipment according to the *Anthropometric Methods for Population Health Surveillance* (WS/T 424-2013). Height was measured to the nearest 0.1 cm using a height meter, and weight

to the nearest 0.1 kg using an electronic scale. Body mass index (BMI) was calculated as weight (kg) divided by height squared (m²). Overweight and obesity classifications were determined using age-gender-specific BMI cut-off values from the *Overweight and Obesity in School-aged Children and Adolescents* (WST 586-2018) criteria. Overweight was defined as BMI greater than or equal to the overweight cut-off point but below the obesity cut-off point for the corresponding gender and age group, while obesity was defined as BMI greater than or equal to the obesity cut-off point.

Data analysis was performed using SAS 9.4 (version 9.4, SAS Institute Inc., Cary, NC, USA) to clean data and calculate annual prevalence of overweight and obesity. Linear interpolation was employed to estimate prevalence for 2018, 2020, and 2022 to maintain consistent yearly intervals. Segmented line regression was conducted using Joinpoint Regression Program (version 5.0.2 Statistical Research and Applications Branch, National Cancer Institute, Bethesda, MD, USA) to identify significant changes in prevalence trends. The annual percentage change (APC) and annual average percentage change (AAPC) were

calculated to quantify trend direction and magnitude (6). Statistical significance was set at $P < 0.05$.

The prevalence of overweight increased from 8.0% in 2012 to 10.2% in 2023, with an AAPC of 2.0% [95% confidence interval (CI): 0.6%, 3.5%] (Table 1 and Figure 1). Further analysis of the joinpoint regression model shown in Table 1 revealed an increasing trend from 2012 to 2023, with an APC of 2.0% (95% CI: 0.6%, 3.5%). Regional analysis revealed that overweight prevalence increased from 9.5% to 12.2% in the central region and from 6.9% to 9.5% in the western region between 2012 and 2023. The western region demonstrated a significantly faster increase (AAPC=3.0%, 95% CI: 1.3%, 4.7%) compared to the central region (AAPC=2.0%, 95% CI: 0.5%, 3.6%) (Table 1 and Figure 1). Gender analysis showed that male overweight prevalence increased from 9.0% to 11.5%, while female prevalence rose from 7.0% to 8.8% during the study period. Males exhibited a higher significant increase (AAPC=2.1%, 95% CI: 1.0%, 3.3%) compared to females (AAPC=2.0%, 95% CI: 0.4%, 3.6%) (Table 1 and Figure 1). Age-specific analysis revealed that overweight prevalence ranged from 15.0% in 6-year-

TABLE 1. The prevalence and trends of overweight among children aged 6 to 15 years in rural areas of central and western China, 2012–2023.

Category	Prevalence (%)		AAPC (95% CI)	APC (95% CI) in 2012–2023
	2012	2023	2012–2023	
Total	8.0	10.2	2.0* (0.6, 3.5)	2.0† (0.6, 3.5)
Region				
Central	9.5	12.2	2.0* (0.5, 3.6)	2.0† (0.5, 3.6)
Western	6.9	9.5	3.0* (1.3, 4.7)	3.0† (1.3, 4.7)
Gender				
Male	9.0	11.5	2.1* (1.0, 3.3)	2.1† (1.0, 3.3)
Female	7.0	8.8	2.0* (0.4, 3.6)	2.0† (0.4, 3.6)
Age (years)				
6	15.0	12.6	-1.0 (-2.1, 0.1)	-1.0 (-2.1, 0.1)
7	11.1	10.9	-0.2 (-1.7, 1.4)	-0.2 (-1.7, 1.4)
8	8.1	9.3	1.0 (-0.4, 2.5)	1.0 (-0.4, 2.5)
9	6.8	9.2	2.3* (0.9, 3.8)	2.3† (0.9, 3.8)
10	6.9	9.9	3.1* (1.9, 4.3)	3.1† (1.9, 4.3)
11	6.7	10.2	3.9* (2.7, 5.1)	3.9† (2.7, 5.1)
12	6.1	10.5	5.2* (3.9, 6.5)	5.2† (3.9, 6.5)
13	6.0	10.5	5.3* (4.0, 6.7)	5.3† (4.0, 6.7)
14	5.5	9.9	6.0* (4.7, 7.2)	6.0† (4.7, 7.2)
15	4.9	8.5	5.8* (4.7, 6.8)	5.8† (4.7, 6.8)

Abbreviation: AAPC=annual average percentage change; APC=annual percentage change; CI=confidence interval.

* Indicates that the AAPC is significantly different from zero at the $P=0.05$ level.

† Indicates that the APC is significantly different from zero at the $P=0.05$ level.

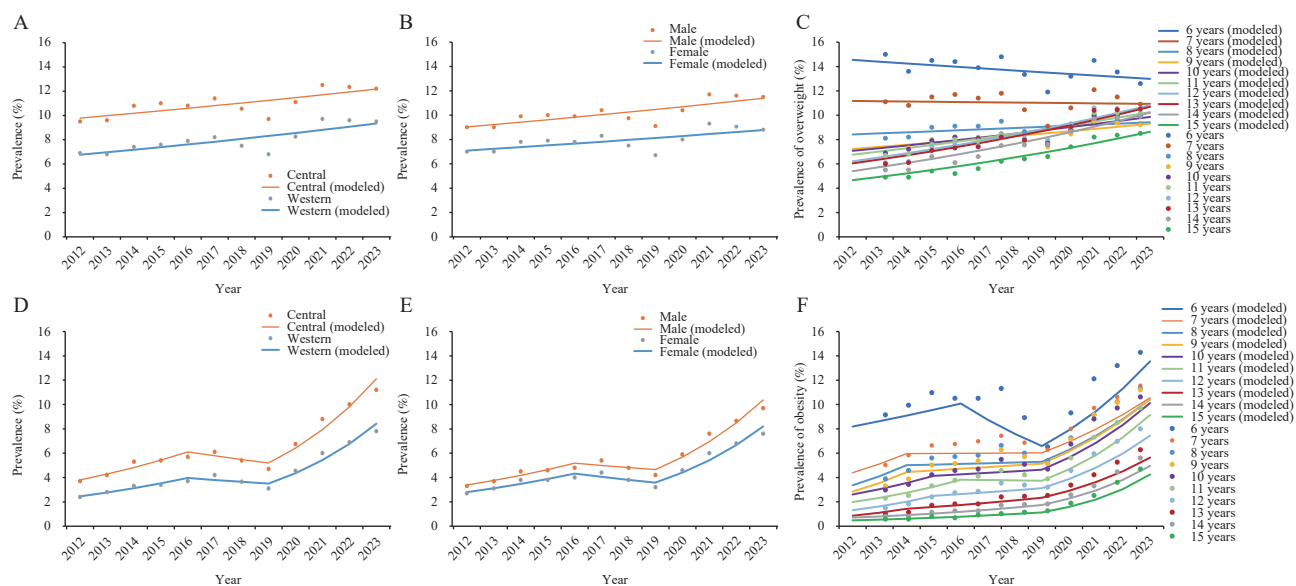


FIGURE 1. Trends in overweight and obesity prevalence among children aged 6 to 15 years in rural areas of central and western China, 2012–2023. (A) Overweight trends by region; (B) Overweight trends by gender; (C) Overweight trends by age; (D) Obesity trends by region; (E) Obesity trends by gender; (F) Obesity trends by age.

olds to 4.9% in 15-year-olds in 2012, and from 12.6% to 8.5%, respectively, in 2023. Significant increases were observed in age groups 9 (AAPC=2.3%, 95% CI: 0.9%, 3.8%) through 15 (AAPC=5.8%, 95% CI: 4.7%, 6.8%), while no significant changes were found in ages 6 to 8 (Table 1 and Figure 1).

The overall obesity prevalence increased substantially from 3.0% to 8.7%, with an AAPC of 10.6% (95% CI: 8.1%, 14.1%). Joinpoint regression analysis identified three distinct trends in obesity prevalence from 2012 to 2023, the corresponding APC values were 11.4% (95% CI: 3.6%, 35.9%), -4.7% (95% CI: -12.4%, 5.8%) ($P > 0.05$), and 22.8% (95% CI: 13.3%, 47.9%), respectively (Table 2 and Figure 1). Regional analysis showed obesity prevalence increased from 3.7% to 11.2% in the central region and from 2.4% to 7.8% in the western region between 2012 and 2023. The western region demonstrated a higher significant increase (AAPC=11.8%, 95% CI: 9.9%, 14.5%) compared to the central region (AAPC=11.1%, 95% CI: 8.3%, 15.0%) (Table 2 and Figure 1). Gender analysis revealed that male obesity prevalence increased from 3.3% to 9.7%, while female prevalence rose from 2.7% to 7.6% during the study period. Males showed a higher significant increase (AAPC=10.8%, 95% CI: 8.3%, 14.2%) compared to females (AAPC=10.3%, 95% CI: 7.6%, 14.1%) (Table 2 and Figure 1). Age-specific analysis demonstrated that obesity prevalence ranged from 8.0% in 6-year-olds to 0.5% in 15-year-olds in 2012, and from 12.5%

to 4.1%, respectively, in 2023. Significant increases were observed across all age groups, from age 6 (AAPC=4.7%, 95% CI: 2.7%, 7.2%) through age 15 (AAPC=21.9%, 95% CI: 20.0%, 23.8%) (Table 2 and Figure 1).

DISCUSSION

While national and international studies have demonstrated that school feeding programs effectively reduce childhood undernutrition (1,7), our analysis reveals a concurrent increase in overweight and obesity prevalence. We observed a significant rise in both conditions, with obesity trends (AAPC=10.6%) accelerating more rapidly than overweight trends (AAPC=2.0%). This pattern suggests that once children become obese, weight reduction becomes particularly challenging. Between 2012 and 2023, the obesity trend exhibited three distinct periods of change magnitude, whereas the overweight trend showed a continuous period of increase. This indicating that obese children are especially susceptible to environmental and dietary influences. Both overweight and obesity trends increased more rapidly in the western region (AAPC_{overweight}=3.0%, AAPC_{obesity}=11.8%) compared to the central region (AAPC_{overweight}=2.0%, AAPC_{obesity}=11.1%). Additionally, while the prevalence of overweight/obesity was lower in older age groups, these cohorts showed more rapid increases. These regional and age-

TABLE 2. The prevalence and trends of obesity among children aged 6 to 15 years in rural areas of central and western China, 2012–2023.

Category	Prevalence (%)		AAPC (95% CI)	Period 1		Period 2		Period 3	
	2012	2023	2012–2023	Years	APC (95% CI)	Years	APC (95% CI)	Years	APC (95% CI)
Total	3.0	8.7	10.6* (8.1, 14.1)	2012–2016	11.4 [†] (3.6, 35.9) [†]	2016–2019	-4.7 (-12.4, 5.8)	2019–2023	22.8 [†] (13.3, 47.9)
Region									
Central	3.7	11.2	11.1* (8.3, 15.0)	2012–2016	12.5 [†] (4.1, 40.0)	2016–2019	-5.2 (-13.6, 5.8)	2019–2023	23.6 [†] (13.2, 51.2)
Western	2.4	7.8	11.8* (9.9, 14.5)	2012–2016	12.7 [†] (7.7, 28.3)	2016–2019	-4.1 (-10.2, 4.4)	2019–2023	24.5 [†] (17.2, 44.2)
Gender									
Male	3.3	9.7	10.8* (8.3, 14.2)	2012–2016	11.3 [†] (3.0, 34.8)	2016–2019	-3.5 (-11.3, 7.2)	2019–2023	22.3 [†] (13.0, 46.3)
Female	2.7	7.6	10.3* (7.6, 14.1)	2012–2016	11.6 [†] (3.9, 38.3)	2016–2019	-6.1 (-14.3, 4.7)	2019–2023	23.0 [†] (12.7, 50.5)
Age (years)									
6	8.0	12.5	4.7* (2.7, 7.2)	2012–2016	5.3 [†] (0.3, 20.2)	2016–2019	-13.2 [†] (-19.0, -4.2)	2019–2023	19.7 [†] (12.3, 36.1)
7	4.4	10.1	8.3* (7.1, 9.5)	2012–2014	16.6 [†] (7.9, 24.5)	2014–2019	0.2 (-5.1, 2.5)	2019–2023	15.0 [†] (10.8, 21.8)
8	3.4	9.9	10.9* (9.3, 12.5)	2012–2014	22.1 [†] (10.7, 32.8)	2014–2019	1.1 (-5.8, 4.2)	2019–2023	18.5 [†] (13.1, 28.2)
9	2.9	9.8	12.6* (10.8, 14.5)	2012–2014	25.3 [†] (12.6, 37.9)	2014–2019	2.9 (-4.8, 6.2)	2019–2023	19.3 [†] (13.6, 31.6)
10	2.6	9.3	13.1* (11.2, 15.7)	2012–2015	16.7 [†] (9.6, 34.2)	2015–2019	2.9 (-5.4, 8.4)	2019–2023	21.6 [†] (14.7, 38.8)
11	2.0	8.5	14.9* (13.3, 17.1)	2012–2016	17.9 [†] (13.5, 30.2)	2016–2019	-0.7 (-5.9, 7.2)	2019–2023	25.1 [†] (18.9, 40.7)
12	1.3	7.0	17.1* (15.2, 19.8)	2012–2015	24.0 [†] (16.8, 43.5)	2015–2019	5.7 (-2.6, 10.9)	2019–2023	24.3 [†] (17.4, 42.0)
13	0.9	5.5	18.7* (17.0, 20.7)	2012–2014	29.2 [†] (18.2, 42.2)	2014–2019	10.3 [†] (2.8, 13.5)	2019–2023	24.7 [†] (19.1, 37.7)
14	0.7	4.9	19.5* (16.9, 21.6)	2012–2019	13.9 [†] (4.3, 17.3)	2019–2023	29.8 [†] (21.3, 49.2)	-	-
15	0.5	4.1	21.9* (20.0, 23.8)	2012–2019	13.1 [†] (9.0, 16.1)	2019–2023	39.2 [†] (31.0, 52.6)	-	-

Note: “-” Indicates no APC value for the period.

Abbreviation: AAPC=annual average percentage change; APC=annual percentage change; CI=confidence interval.

* Indicates that the AAPC is significantly different from zero at the $P=0.05$ level.

[†] Indicates that the APC is significantly different from zero at the $P=0.05$ level.

related disparities in both prevalence and growth trends underscore the need for targeted, hierarchical preventive measures to address this rapid expansion of overweight and obesity.

The World Health Organization reports that global overweight and obesity prevalence among children and adolescents aged 5–19 has increased dramatically from 4% in 1975 to over 18% in 2016 (8). In China, the overweight and obesity prevalence among children aged 6–17 years reached 19.0% in 2016–2017 (9). This study found overweight and obesity prevalence of 11.0% in 2012 and 13.3% in 2016, indicating that the gap between China’s central and western regions as well as national and global levels, is narrowing. Socioeconomic status is positively associated with overweight and obesity prevalence (10). The western region, characterized by a lower socioeconomic level compared to the central region (5), exhibits lower prevalence of overweight and obesity but is experiencing a more rapid increase in these prevalence, warranting particular attention. This study reveals that the prevalence of overweight and obesity is

higher in males than in females, and obesity prevalence increases rapidly among males than females. This result is consistent with a paper on the relationship between obesity phenotypes and gender differences, suggesting the necessity of managing obesity from a gender perspective (11). We also found higher obesity prevalence among younger children, which is especially concerning given that weight loss before puberty offers greater benefits in reducing obesity-related diseases (12). This emphasizes the critical importance of early intervention to prevent overweight and obesity development. Notably, the obesity trend acceleration observed during 2019–2023 exceeded that of 2012–2016 especially among 10–12 and 14–15 years. This may parallel findings from an Italian longitudinal study that documented adverse changes in eating, sleeping, and activity behaviors among children with obesity during COVID-19 lockdowns in 2019, which compromised weight control efforts (13). These findings suggest that adverse lifestyle changes may have exacerbated childhood obesity prevention and control challenges.

This study has two notable limitations. First, in 2019, the monitoring protocol changed from annual to biennial frequency, with the survey period shifting from October–December to April–June only in this year, while maintaining consistent geographical coverage. Further research is needed to evaluate the impact of these temporal changes on the results. Second, to satisfy the joinpoint model's requirement for consistent intervals between independent variables, we employed linear interpolation to estimate data for years without direct observations.

While previous research has demonstrated NIPRCES's effectiveness in reducing undernutrition among students (7), comprehensive nutritional improvement requires preventing and controlling the rapid increase in overweight and obesity. We recommend a multi-level approach: In forward-looking policy planning, the previously uniform subsidy standard should be adjusted to regional and individual variations based on trends in nutritional status changes; local governments should improve supporting policies to ensure effective NIPRCES implementation and oversight of dietary funding management; health departments should maintain continuous surveillance to track long-term patterns and characteristics of overweight and obesity across regions, genders, and age groups; schools should foster healthy food and exercise environments while strengthening nutrition education for teachers and cafeteria staff. Additionally, enhanced dietary guidance and health education should target both parents and students, improving parental capacity to provide nutritious meals while developing children's ability to make healthy food choices and reduce adverse behaviors such as prolonged sedentary activity and excessive caloric intake.

Conflicts of interest: No conflicts of interest.

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