

Postprint: Trends in Overweight and Obesity Among Adults Aged 20 Years and Above in Shanxi Province, 2010-2018

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Abstract

Background Overweight, obesity, and central obesity have become serious public health problems affecting residents' life and health globally. Analyzing the epidemic trends of overweight, obesity, and central obesity among residents in Shanxi Province can provide certain scientific value for the prevention and treatment of related diseases.

Objective To analyze the status and trends of overweight, obesity, and central obesity among adults aged 20 years and above in Shanxi Province from 2010 to 2018.

Methods Survey data of adults aged 20 years and above from Shanxi Province were selected from the "China Chronic Disease Surveillance" project from August 2010 to November 2018 (in 2010, 2013, 2015, and 2018). The rates of overweight, obesity, and central obesity among adults aged 20 years and above were calculated by year, sex, age, and region to analyze the epidemic trends of overweight, obesity, and central obesity in study subjects with different characteristics.

Results This study obtained valid samples of 3,527, 4,066, 4,545, and 4,788 individuals in 2010, 2013, 2015, and 2018, respectively, aged 20-108 years. The survey subjects were predominantly in the 40-59 age group, with more female residents than male residents, and more rural residents than urban residents. From 2010 to 2018, the overall crude overweight rate and age- and sex-standardized overweight rate among adults aged 20 years and above in Shanxi Province were 37.7%-40.1% and 36.1%-39.6%, respectively, with no significant upward trend ($Z=0.005$, 2.413; $P=0.942$, 0.120). The overall standardized obesity rate and the overall crude and standardized central obesity rates increased from 17.2%, 53.8%, and 52.4% in 2010 to 20.0%, 61.6%, and 60.2% in 2018, respectively ($Z=8.100$, 10.994, 12.218; $P<0.05$). From 2010 to 2018, there was no significant

upward or downward trend in the overall crude and standardized overweight rates among adults aged 20 years and above when compared across different age, sex, and region groups ($P>0.05$). In 2013, the standardized overweight rate in males was higher than that in females ($\chi^2=4.259$, $P=0.039$), while the standardized obesity rate in males was lower than that in females ($\chi^2=13.724$, $P<0.001$); no statistically significant differences between sexes were observed at other time points ($P>0.05$). The overall obesity rate, male obesity rate, and male and female central obesity rates in the 20–39 age group all showed an upward trend ($P<0.05$). From 2010 to 2018, the standardized overweight, obesity, and central obesity rates among urban residents were higher than those among rural residents ($P<0.05$), with statistically significant differences between urban and rural residents in the standardized overweight rates in 2013 and 2015, the standardized obesity rates in 2010 and 2015, and the standardized central obesity rates in 2015 and 2018 ($P<0.05$). Joinpoint regression analysis results showed that from 2010 to 2018, the standardized overweight rate among females in Shanxi Province showed a decreasing trend ($APC=-0.57$, $P<0.05$), the standardized obesity rate among males showed an increasing trend ($APC=2.72$, $P<0.05$), while the standardized overweight, obesity, and central obesity rates among urban and rural residents showed an upward trend ($P>0.05$), and there was no significant difference in trends between different sexes and regions ($P>0.05$).

Conclusion From 2010 to 2018, the overweight rate among adult residents aged 20 years and above in Shanxi Province tended to be stable, while the obesity rate and central obesity rate showed an overall increasing trend. For the prevention and treatment of obesity and central obesity, the 20–39 age group of young and middle-aged adults should be targeted as the key intervention population to slow down the growth rate, while those aged 40 years and above should be the key prevention population, with corresponding preventive and intervention measures implemented to control the epidemic of overweight, obesity, and central obesity.

Full Text

A Study on the Prevalence Trend of Overweight and Obesity among Adults Aged 20 and Above in Shanxi Province from 2010 to 2018

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Abstract

Background: Overweight, obesity, and central obesity have become significant global public health issues affecting population health. Analyzing the prevalence trends of these conditions among residents in Shanxi Province can provide valuable scientific evidence for disease prevention and control.

Objective: To analyze the prevalence and trends of overweight, obesity, and central obesity among adults aged 20 and above in Shanxi Province from 2010 to 2018.

Methods: Survey data were collected from adults aged 20 and above in Shanxi Province during four rounds of the China Chronic Disease Surveillance project (August 2010 to November 2018, in 2010, 2013, 2015, and 2018). The rates of overweight, obesity, and central obesity were calculated by year, gender, age, and region to analyze prevalence trends across different subgroups.

Results: The study obtained valid samples of 3,527, 4,066, 4,545, and 4,788 individuals in 2010, 2013, 2015, and 2018, respectively, aged 20-108 years. The majority of participants were in the 40-59 age group, with more female than male residents and more rural than urban residents. From 2010 to 2018, the overall crude overweight rate and age- and gender-standardized overweight rate among adults aged 20 and above in Shanxi Province ranged from 37.7%-40.1% and 36.1%-39.6%, respectively, showing no significant upward trend ($Z = 0.005$, 2.413 ; $P = 0.942$, 0.120). In contrast, the standardized obesity rate, crude central obesity rate, and standardized central obesity rate increased significantly from 17.2%, 53.8%, and 52.4% in 2010 to 20.0%, 61.6%, and 60.2% in 2018, respectively ($Z = 8.100$, 10.994 , 12.218 ; $P < 0.05$). No significant upward or downward trends were observed in the crude or standardized overweight rates when stratified by age, gender, or region ($P > 0.05$). In 2013, the standardized overweight rate was higher in males than females ($\chi^2 = 4.259$, $P = 0.039$), while the standardized obesity rate was lower in males ($\chi^2 = 13.724$, $P < 0.001$); no other significant gender differences were found at other time points ($P > 0.05$). The overall obesity rate, male obesity rate, and both male and female central obesity rates in the 20-39 age group showed significant upward trends ($P < 0.05$). From 2010 to 2018, urban residents had higher standardized rates of overweight, obesity, and central obesity than rural residents ($P < 0.05$), with significant differences observed in standardized overweight rates in 2013 and 2015, standardized obesity rates in 2010 and 2015, and standardized central obesity rates in 2015 and 2018 ($P < 0.05$). Joinpoint regression analysis revealed that the standardized overweight rate among females decreased significantly ($APC = -0.57$, $P < 0.05$), while the standardized obesity rate among males increased significantly ($APC = 2.72$, $P < 0.05$) from 2010 to 2018. No significant

upward trends were observed in the standardized rates of overweight, obesity, or central obesity among urban and rural residents ($P > 0.05$), and no significant differences were found in trends between genders or regions ($P > 0.05$).

Conclusion: From 2010 to 2018, the overweight rate among adults aged 20 and above in Shanxi Province remained stable, while obesity and central obesity rates showed overall increasing trends. Prevention and control efforts should target young adults aged 20–39 to slow the growth rate, and focus on residents over 40 and urban populations with tailored interventions to control the epidemic of overweight, obesity, and central obesity.

Keywords: Overweight; Obesity; Central obesity; Joinpoint regression; Epidemiological trend; Shanxi

Introduction

With rapid and sustained socioeconomic development, living standards have gradually improved, accompanied by changes in lifestyle and dietary habits. Overweight and obesity have become serious global public health issues affecting population health [1]. In 2016, over 1.9 billion adults worldwide aged 18 and above were overweight, with an overweight rate of 39%, and more than 650 million had obesity, with an obesity rate of 13% (15% in men and 11% in women) [2]. In China, the rates of overweight and obesity have also continued to rise. By 2012, the overweight and obesity rates among Chinese adults reached 30.1% and 11.9%, respectively, representing increases of 7.3% and 4.8% since 2002 [3]. Central obesity rates have similarly increased, rising from 18.6% in 1993 to 37.4% in 2009 among adults in nine Chinese provinces, with an average annual growth rate of 1.1% [4]. Furthermore, obesity is closely associated with hypertension, type 2 diabetes, hyperlipidemia, and cardiovascular disease [5–7]. Epidemiological studies have demonstrated a strong correlation between body fat distribution, particularly abdominal fat accumulation, and type 2 diabetes, insulin resistance, and cardiovascular disease [8–9]. To understand the distribution and trends of overweight, obesity, and central obesity among adults in Shanxi Province, this study utilized surveillance data from Shanxi Province in the China Chronic Disease Surveillance project (2010, 2013, 2015, and 2018) to analyze the prevalence and trends of these conditions among permanent residents aged 20 and above by gender, age, and region.

1. Methods

1.1 Study Subjects The study participants consisted of permanent residents aged 20 and above from 6–8 surveillance sites in Shanxi Province under the China Chronic Disease Surveillance project (6 sites in 2010; 8 sites in 2013–2018). All participants provided informed consent for the project.

1.2 Sampling Method The China Chronic Disease Surveillance project employed a multi-stage stratified cluster sampling method. Within each surveillance site, four townships (streets, regiments) were randomly selected; within each township, three villages (neighborhood committees, companies) were randomly selected; and within each village, 50 households were randomly selected. One resident aged 20 or above from each household was randomly selected for investigation using the KISH table method. The sampling process is detailed in .

1.3 Definitions and Diagnostic Criteria Overweight and obesity were defined according to the Guidelines for the Prevention and Control of Overweight and Obesity in Chinese Adults [10]: BMI < 18.5 kg/m² as underweight, 18.5–23.9 kg/m² as normal weight, 24.0–27.9 kg/m² as overweight, and ≥ 28.0 kg/m² as obesity. Central obesity was defined as waist circumference ≥ 80 cm in women and ≥ 85 cm in men.

1.4 Statistical Analysis Data were analyzed using SPSS 25.0 software. Categorical data were expressed as relative frequencies, and chi-square tests were used to compare rates between groups. Trend chi-square tests were used to analyze temporal and age-related trends. Using population data from the 2010 Sixth Census in Shanxi Province as the standard population, the direct method was applied to calculate age- and gender-standardized rates for overweight, obesity, and central obesity. Joinpoint regression analysis was performed using Joinpoint Regression Program 4.9.0.0 software to analyze trends in age-standardized rates among males, females, and urban and rural residents, with annual percent change (APC) reported. The significance level was set at $\alpha = 0.05$.

2. Results

2.1 Basic Characteristics of Study Participants After excluding non-responders and individuals with missing, questionable, or incomplete data, valid samples of 3,527, 4,066, 4,545, and 4,788 individuals were obtained in 2010, 2013, 2015, and 2018, respectively, aged 20–108 years. The majority of participants were in the 40–59 age group, with more female than male residents and more rural than urban residents. The age, gender, and regional distributions of participants differed significantly across the four survey years ($P < 0.001$), as shown in .

2.2 Overweight, Obesity, and Central Obesity Rates Among Adults Aged 20 and Above in Shanxi Province, 2010–2018 The crude overweight rate among adults aged 20 and above in Shanxi Province ranged from 37.7% to 40.1% between 2010 and 2018, with the standardized overweight rate ranging from 36.1% to 39.6%, showing no significant trend ($P = 0.942, 0.120$). The crude obesity rate increased from 17.5% in 2010 to 18.4% in 2018, with no

significant upward trend ($P = 0.813$); however, the standardized obesity rate increased significantly from 17.2% in 2010 to 20.0% in 2018 ($P = 0.004$). Both the crude and standardized central obesity rates increased significantly, from 53.8% and 52.4% in 2010 to 61.6% and 60.2% in 2018, respectively ($P < 0.05$), as detailed in -.

2.3 Trend Analysis of Overweight, Obesity, and Central Obesity Rates Among Adults Aged 20 and Above by Age, Gender, and Region

2.3.1 Trend Analysis of Overweight Rates From 2010 to 2018, no significant upward or downward trends were observed in either crude or standardized overweight rates among adults aged 20 and above when stratified by age, gender, or region ($P > 0.05$), as shown in and . In 2013, the standardized overweight rate was significantly higher in males than females ($\chi^2 = 4.259$, $P = 0.039$), while no significant gender differences were observed in 2010, 2015, or 2018 ($P > 0.05$). Joinpoint regression analysis revealed a decreasing trend in the standardized overweight rate among females from 2010 to 2018 ($APC = -0.57$, $P < 0.05$), with no inflection point, while no significant trend was observed among males ($APC = -0.36$, $P > 0.05$). Permutation tests comparing APC values between genders showed no significant difference ($P = 0.691$), as illustrated in [Figure 1: see original paper].

Urban residents had significantly higher standardized overweight rates than rural residents in 2013 and 2015 ($\chi^2 = 13.076$, 20.360 ; $P < 0.001$). However, Joinpoint regression analysis found no significant difference in trends between urban and rural residents ($P = 0.684$), as shown in [Figure 2: see original paper].

2.3.2 Trend Analysis of Obesity Rates From 2010 to 2018, obesity rates among males showed an upward trend only in the 20–39 age group ($P = 0.003$), while no significant trends were observed across age groups for females ($P > 0.05$), as shown in . In 2013, the standardized obesity rate was significantly lower in males than females ($\chi^2 = 13.724$, $P < 0.001$), with no significant gender differences in 2010, 2015, or 2018 ($P > 0.05$), as detailed in . Joinpoint regression analysis indicated a significant upward trend in the standardized obesity rate among males from 2010 to 2018 ($APC = 2.72$, $P < 0.05$), with no inflection point, while no significant trend was observed among females ($APC = 1.46$, $P = 0.579$). Permutation tests revealed no significant difference between genders ($P = 0.490$), as shown in [Figure 3: see original paper].

Urban residents had significantly higher standardized obesity rates than rural residents in 2010 and 2015 ($\chi^2 = 5.445$, $P = 0.020$; $\chi^2 = 0.007$, $P = 0.007$). However, Joinpoint regression analysis showed no significant upward trends for either urban or rural residents ($APC = 1.49$, 2.08 ; $P = 0.365$, 0.427), with no significant difference between them ($P = 0.870$), as illustrated in [Figure 4: see original paper].

2.3.3 Trend Analysis of Central Obesity Rates Central obesity rates among both males and females in the 20-39 age group showed upward trends ($P < 0.05$), while rates among males and the overall population in the 60 age group showed decreasing trends ($P < 0.05$), as shown in . In 2015, the standardized central obesity rate was $\chi^2 = 5.542$, $P = 0.019$), with no significant gender differences in 2010, 2013, or 2018 ($P > 0.05$), as detailed in . Joinpoint regression analysis revealed no significant upward trends in standardized central obesity rates for either males or females (APC = 1.64, 1.05; $P = 0.502, 0.590$), with no significant difference between genders ($P = 0.185$), as shown in [Figure 5: see original paper].

Urban residents had significantly lower standardized central obesity rates than rural residents in 2010 and 2013 ($\chi^2 = 5.591, 5.600$; $P = 0.018, 0.018$), but significantly higher rates in 2015 and 2018 ($\chi^2 = 33.725, 10.895$; $P \leq 0.001$). Joinpoint regression analysis showed no significant upward trends for urban or rural residents (APC = 2.76, 0.17; $P = 0.165, 0.947$), with no significant difference between them ($P = 0.065$), as illustrated in [Figure 6: see original paper].

Discussion

This study found that among adults aged 20 and above in Shanxi Province from 2010 to 2018, neither the crude nor age- and gender-standardized overweight rates showed significant upward or downward trends, remaining relatively stable overall. The crude obesity rate showed no significant increase, but the standardized obesity rate demonstrated a significant upward trend after age and gender standardization. Both crude and standardized central obesity rates showed significant upward trends.

Regarding gender and urban-rural distribution, after age standardization, the overall overweight rate among adults aged 20 and above in Shanxi Province was higher in males than females, while obesity and central obesity rates were higher in females than males. Urban residents had higher rates of overweight, obesity, and central obesity than rural residents. Regardless of gender or region, overweight rates showed a decreasing trend from 2010 to 2018, while obesity and central obesity rates increased. Joinpoint regression analysis revealed a decreasing trend in overweight rates among females and an increasing trend in obesity rates among males. From 2010 to 2018, the APC for standardized overweight rates was higher among males than females, while the APCs for standardized obesity and central obesity rates were higher among females than males. The APC values for overweight, obesity, and central obesity rates were all higher among urban residents than rural residents, though none reached statistical significance.

A 2013 study published in *The Lancet* on the Global Burden of Disease showed that male obesity rates were higher than female rates in developed countries but lower in developing countries [11]. Using data from the China Chronic

Disease Surveillance project in Shanxi Province, this study similarly found that obesity rates among adults aged 20 and above were higher in females than males, consistent with national findings by Wang et al. [12]. Central obesity rates were also higher in females than males, aligning with other research findings [13]. This may be related to hormonal changes in women that facilitate fat accumulation compared to men, as well as lower physical activity levels among women [14-15]. The phenomenon of higher overweight and obesity rates in urban versus rural areas is consistent with other studies [2,16], likely due to greater economic impacts on urban populations, changes in dietary patterns and behaviors during urbanization, increased availability of high-calorie, high-fat, and processed foods, and sedentary work and leisure patterns. Notably, trend chi-square tests and Joinpoint regression analysis yielded somewhat inconsistent results, possibly due to different methodological criteria.

In summary, among adults aged 20 and above in Shanxi Province, obesity and central obesity are chronic conditions requiring greater attention. Both showed increasing trends after age and gender standardization, while overweight rates remained stable but still warrant attention due to high prevalence. The problem of obesity and central obesity among urban residents remains severe, with urban rates consistently higher than rural rates from 2010 to 2018 overall, though rural rates occasionally exceeded urban rates in individual survey years, and Joinpoint regression analysis showed no significant differences in trends. Regardless of gender, rates of overweight, obesity, and central obesity were higher after age 40 compared to younger age groups. Except for higher overweight rates in males, obesity and central obesity rates were lower in males than females, with some surveys showing significant differences. However, overall Joinpoint trend analysis suggested no statistically significant differences in prevalence between genders. Based on these findings from Shanxi Province over the past decade, the problems of overweight, obesity, and central obesity remain severe and require urgent comprehensive prevention and control measures to promote healthy lifestyles and effectively reduce obesity and related chronic diseases. Prevention efforts should focus on young adults aged 20-39 to slow the growth rate, and target residents over 40 and urban populations with tailored interventions to control the epidemic.

Author Contributions: SONG Weimei, WANG Xuchun, REN Hao, and ZHAO Ying were responsible for data collection, analysis, cleaning, and chart production. SONG Weimei and WANG Xuchun drafted the manuscript. QIU Lixia and CHEN Liming conceived the research ideas and designed the study protocol. QIU Lixia revised the final version and provided overall supervision and management of the manuscript.

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