Brief Epidemiologic Report

Prevalence and Risk Factors of Overweight and Obesity in China

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Abstract

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Objective: To examine the prevalence and risk factors of overweight and obesity in China.

Research Methods and Procedures: A cross-sectional survey was conducted in a nationally representative sample of 15,540 Chinese adults in 2000–2001. Body weight, height, and waist circumference were measured by trained observers. Overweight and obesity were defined according to the World Health Organization classification. Central obesity was defined according to guidelines of the International Diabetes Federation.

Results: Mean BMI and waist circumference were 23.1 kg/m^2 and 79.6 cm, respectively, for men and 23.5 kg/m^2 and 77.2 cm, respectively, for women. The prevalences of overweight and obesity were 24.1% and 2.8% in men and 26.1% and 5.0% in women, respectively. The prevalence of central obesity was 16.1% in men and 37.6% in women. The prevalences of overweight, obesity, and central obesity were higher among residents in northern China compared with their counterparts in southern China and among those in urban areas compared with those in rural areas. Lifestyle factors were the most important risk factors to explain the differences in overweight and central obesity between northern and southern residents. Among women, lifestyle and diet were the most important risk factors to explain the differences between urban and rural residents, whereas socioeconomic status, lifestyle, and diet were all important among men.

Discussion: Our study indicates that overweight and obesity have become important public health problems in China. Environmental risk factors may be the main reason for regional differences in the prevalence of overweight and obesity in China.

Key words: overweight, BMI, prevalence, cross-sectional studies, China

Introduction

A cardiovascular disease (CVD)[1] epidemic has emerged in economically developing countries during recent decades, and much of the resultant burden of illness is occurring in China (1,2). During this period, illness from infectious diseases has diminished, but changes in lifestyle and diet have led to an increase in life expectancy and a greatly increased frequency of CVD and other chronic diseases (3,4).

Overweight and obesity are important modifiable risk factors for CVD and associated conditions, including type 2 diabetes, hypertension, hypercholesterolemia, coronary heart disease, and stroke (5). The prevalence of overweight and obesity has been increasing in most economically developed countries for several decades, and there is evidence that the prevalence of overweight and obesity is also increasing in economically developing countries (6,7). The objectives of the present study were to provide current data on the prevalence of overweight and obesity, to examine geographic and urbanization differences in prevalence of overweight and obesity, and to explore the contribution of

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[1] Nonstandard abbreviations: CVD, cardiovascular disease; InterASIA, International Collaborative Study of Cardiovascular Disease in Asia; CI, confidence interval.

lifestyle and dietary risk factors to these differences in the general adult population in China.

Research Methods and Procedures

Study Population

The International Collaborative Study of Cardiovascular Disease in Asia (InterASIA) was a cross-sectional study of CVD risk factors conducted in 2000–2001 in nationally representative samples of the general adult population in China and Thailand. Details of the study's design and methods have been published elsewhere (8). Briefly, a four-stage stratified sampling method was used in China. The sampling process was stratified by rural vs. urban areas and north vs. south. In the first stage of sampling, 31 provinces were stratified into north and south China, as divided by the Yangtze River. Four provinces from northern China and four provinces from southern China, as well as Beijing in the north and Shanghai in the south, were selected. One rural region and one city region from each selected province and from Beijing and Shanghai were randomly selected at the second stage of sampling. In the third stage of sampling, one township or one street district was randomly selected from each of the rural and city regions. The final stage of sampling was stratified by sex and by age distribution, based on 1990 China census data. Only one participant was selected from each household, without replacement. A total of 19,012 persons were randomly selected and invited to participate. A total of 15,838 persons (83.3%) completed the survey and examination. The analysis reported in this article was restricted to the 15,540 adults who were ages 35 to 74 years at the time of the survey.

Measurements

Data were collected in examination centers at local health stations or community clinics in the participants' residential area. During the visits, trained research staff administered a standard questionnaire. Information on demographic characteristics, including age, sex, education, occupation, and household income; personal medical history; family history; lifestyle risk factors, including cigarette smoking, alcohol consumption, and physical activity; and health service use was collected. Metabolic equivalents were calculated by multiplying the number of hours spent per day not physically active by 0.5, watching television or other sedentary activities by 1.0, and participating in light, moderate, or vigorous activities by 1.0, 4.0, or 8.0, respectively (9). Information on dietary intake for the previous year was collected using a food frequency questionnaire. Data were recorded based on the frequency of consumption of food group (dairy, meat, vegetables).

Body weight and height were measured twice during the visit by trained observers using a standard protocol and techniques. Weight was measured in light indoor clothing without shoes to the nearest 10th of a kilogram. Height was measured without shoes to the nearest 10th of a centimeter with a stadiometer. Waist circumference was measured at 1 cm above the navel at minimal respiration, and hip circumference was measured at the level of maximum extension of the buttocks. All study investigators and staff successfully completed a training program that oriented them both to the aims of the study and to the specific tools and methodologies used. All observers participated in a special training session on the use of a standardized protocol for anthropometric measurement techniques.

The Institutional Review Board at the Tulane University Health Sciences Center approved the InterASIA study. In addition, ethics committees and other relevant regulatory bodies in China approved the study. Informed consent was obtained from each participant before data collection.

Statistical Analysis

The InterASIA study was designed to provide precise estimates of prevalence and mean levels of BMI and waist circumference by sex, area of residence (rural vs. urban), and region (northern vs. southern China) among the four age groups: ages 35 to 44, 45 to 54, 55 to 64, and 65 to 74 years. Survey weights were applied to obtain population level estimates of the total Chinese adult population ages 35 to 74 years. Weights were calculated based on data from the year 2000 China Population Census and the InterASIA sampling scheme. BMI was calculated as weight (in kilograms) divided by the square of height (in meters). Overweight and obesity were defined according to the World Health Organization classifications (7) as a BMI of 25.0 to 29.9 kg/m^2 and a BMI of $\geq$30.0 kg/m^2, respectively. Additional BMI cut-off points for underweight, overweight, and obesity that have been recommended for Asian populations were also used [BMI $\leq$23.0, BMI $\geq$24.0, and BMI $\geq$28.0, respectively (10,11)]. Central obesity was defined according to guidelines of the International Diabetes Federation for Chinese populations as a waist circumference $\geq$90 cm for men and $\geq$80 cm for women (12). Prevalence estimates of overweight, obesity, and central obesity were calculated for the overall population and by the four age groups. Additionally, age-standardized prevalence estimates were calculated by the direct method for men and women, northern and southern China, and urban and rural areas, separately, after age standardization to the overall year 2000 population distribution for China. Standard errors were calculated by a technique appropriate to the complex survey design. All data analyses were conducted using SUDAAN software (version 8.0; Research Triangle Institute, Research Triangle Park, NC).

Results

Characteristics of the study participants by sex are presented in Table 1. Men had significantly higher education,

Table 1. Age-standardized characteristics of study participants by sex

Characteristic	Men (n = 7526)	Women (n = 8014)	p
Age (years)	50.0 (0.2)	50.2 (0.2)	0.586
High school education (%)	21.5 (0.5)	13.4 (0.4)	<0.001
Occupation			
Professional (%)	19.8 (0.5)	10.3 (0.3)	<0.001
Laborer (%)	71.7 (0.6)	82.3 (0.5)	<0.001
Other (%)	8.5 (0.5)	7.2 (0.4)	0.027
Income (Yuan/yr)	10,874 (180)	9,988 (259)	0.006
Urban (%)	20.5 (0.3)	20.6 (0.3)	0.797
North (%)	42.2 (0.6)	42.8 (0.5)	0.560
Alcohol consumption			
Drinks/wk	13.7 (0.5)	0.9 (0.1)	<0.001
Drinkers (%)	57.2 (0.8)	10.2 (0.5)	<0.001
Cigarette smoking			
Cigarettes/d*	17.0 (0.2)	10.2 (0.5)	<0.001
Current smokers (%)	60.3 (0.7)	6.9 (0.4)	<0.001
Fruits and vegetables/wk	17.7 (0.1)	18.2 (0.1)	<0.001
Red meat/wk	3.7 (0.1)	3.0 (0.04)	<0.001
BMI			
Mean	23.1 (0.1)	23.5 (0.1)	<0.001
Overweight or obesity (%)†	26.9 (0.6)	31.1 (0.7)	<0.001
Weight (kg)	63.4 (0.2)	56.2 (0.2)	<0.001
Waist circumference (cm)	79.6 (0.1)	77.2 (0.1)	<0.001
Waist-to-hip ratio	0.86 (0.00)	0.83 (0.00)	<0.001
Mean physical activity (METS/wk)	53.7 (0.3)	50.4 (0.3)	<0.001

Data are expressed as means or proportions (standard error). METS, metabolic equivalents.
* Among current smokers.
† BMI ≥25 kg/m^2.

income, alcohol consumption, cigarette smoking, intake of red meat, waist circumference, waist-to-hip ratio, and physical activity and lower BMI and intake of fruits and vegetables compared with women.

Prevalence of Overweight and Obesity

The age-standardized prevalence of overweight and obesity is shown in Table 2. Men ages 45 to 54 years had the highest prevalence of overweight and obesity, whereas prevalence of overweight and obesity varied among age groups in women. The age-specific prevalence of overweight was higher among women compared with men after age 45 years. For every age group, the age-specific prevalence of obesity was higher among women compared with men. Prevalence of overweight and obesity was also higher in northern compared with southern China and urban compared with rural areas. On the basis of our prevalence estimates and the number of adults in the Chinese population for the year 2000, the number of adults ages 35 to 74 years in China with a BMI of ≥25.0 kg/m^2 and ≥30.0 kg/m^2 is estimated to be 137 million (approximately 66 million men and 72 million women) and 18 million (7 million men and 11 million women), respectively.

Different BMI Cut-Off Points

Prevalences of a BMI of ≥23.0, ≥24.0, ≥25.0, ≥28.0, and ≥30.0 among men and women in urban and rural areas and northern and southern China are shown in Figure 1. Prevalence of a BMI of ≥23.0 for men and women was 46.9% [95% confidence interval (CI), 45.4 to 48.3%] and 51.7% (95% CI, 50.3 to 53.1%), respectively; prevalence of a BMI of ≥24.0 for men and women was 36.4% (95% CI,

Table 2. Age-specific and age-standardized* prevalence of overweight and obesity† in the adult population ages 35 to 74 years in China, 2000–2001

Population group	BMI			
	Overweight (25.0 to 29.9 kg/m^2)		Obesity (≥30.0 kg/m^2)	
	% (SE)	Estimated population‡ (SE)	% (SE)	Estimated population‡ (SE)
Men				
Age (years)				
35 to 44	25.5 (1.0)	24,163 (1,104)	2.9 (0.4)	2,728 (358)
45 to 54	26.0 (1.2)	19,324 (1,028)	3.1 (0.4)	2,295 (303)
55 to 64	21.3 (1.3)	9,527 (616)	1.9 (0.3)	867 (157)
65 to 74	19.9 (1.8)	5,934 (585)	2.8 (0.7)	830 (212)
35 to 74*	24.1 (0.6)	58,948 (1,641)	2.8 (0.2)	6,720 (535)
Region*				
North	36.8 (1.1)	38,204 (1,261)	4.8 (0.5)	5,126 (468)
South	15.3 (0.7)	20,745 (1,050)	1.2 (0.2)	1,594 (258)
Urban	35.0 (0.9)	17,956 (505)	5.0 (0.4)	2,644 (220)
Rural	21.7 (0.7)	40,993 (1,562)	2.2 (0.3)	4,076 (487)
Women				
Age (years)				
35 to 44	22.6 (1.0)	20,163 (979)	4.1 (0.5)	3,619 (434)
45 to 54	30.4 (1.3)	21,241 (1,038)	5.5 (0.6)	3,867 (461)
55 to 64	28.4 (1.4)	11,876 (691)	6.2 (0.7)	2,607 (319)
65 to 74	23.4 (1.9)	7,100 (628)	4.5 (0.8)	1,352 (239)
35 to 74*	26.1 (0.6)	60,380 (1,608)	5.0 (0.3)	11,445 (737)
Region*				
North	36.9 (1.1)	36,534 (1,220)	8.6 (0.6)	8,322 (620)
South	18.4 (0.7)	23,846 (1,048)	2.5 (0.3)	3,124 (399)
Urban	32.6 (0.8)	15,962 (456)	5.6 (0.4)	2,722 (202)
Rural	24.6 (0.8)	44,418 (1,542)	4.9 (0.4)	8,723 (709)

* Age-standardized to the 2000 China adult population.
† Defined according to the World Health Organization classification.
‡ In thousands.

35.0 to 37.8%) and 40.2% (95% CI, 38.8 to 41.6%), respectively; and prevalence of a BMI of ≥28.0 for men and women was 8.2% (95% CI, 7.4 to 8.9%) and 11.6% (95% CI, 10.7 to 12.5%), respectively. Based on our prevalence estimates and the number of adults in the Chinese population for the year 2000, the number of adults ages 35 to 74 years in China with a BMI of ≥23.0, ≥24.0, and ≥28.0 is estimated to be 234 million, 182 million, and 47 million, respectively.

Prevalence of Central Obesity

The age-standardized prevalence of central obesity is shown in Table 3. Men ages 45 to 54 years had the highest prevalence of central obesity, whereas women ages 55 to 64 years had the highest prevalence of central obesity. For every age group, the age-specific prevalence of central obesity was higher among women than among men. Prevalence of central obesity was also higher in northern compared with southern China and urban compared with rural areas.

Risk Factors for Overweight or Obesity and Central Obesity

The multivariate-adjusted odds ratios of overweight or obesity and central obesity along with the excess risk explained are shown in Table 4 for men and women in urban vs. rural

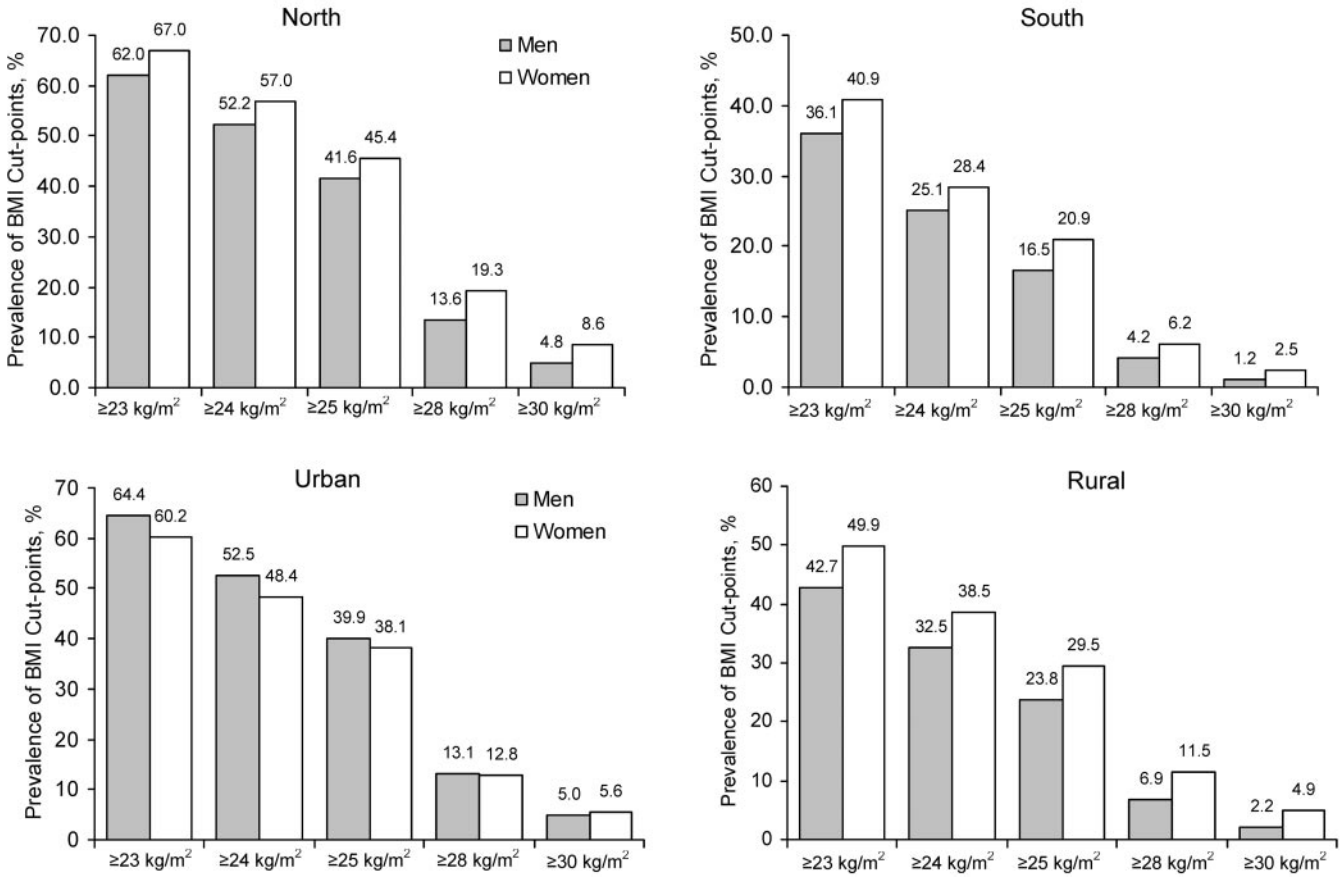

Figure 1: Age-standardized prevalence of BMI cut-off points among men and women in north and south China (upper panels) and urban and rural areas (lower panels) of China.

residents and northern vs. southern China. Socioeconomic status explained 44.1% and 44.5% of the excess risk of overweight or obesity and central obesity, respectively, among men in urban areas. Lifestyle factors explained 52.5% and 56.8% of the excess risk of overweight or obesity and 44.8% and 62.1% of the excess risk of central obesity among men and women, respectively, in urban areas. Diet explained 44.9% and 36.4% of the excess risk of overweight or obesity and 44.8% and 48.3% of the excess risk of central obesity among men and women, respectively, in urban areas. The full model explained 90.7% and 54.5% of the excess risk of overweight or obesity and 87.4% and 65.5% of the excess risk of central obesity among men and women, respectively, in urban areas. Socioeconomic status, lifestyle, and dietary factors explained very little of the differences in overweight and obesity between northern and southern China.

Discussion

Our study indicates that the mean BMI and prevalence of overweight and obesity in the general Chinese adult population are higher than previously reported from national studies conducted in China (13–15). In 1991, the prevalences of overweight and obesity were 9.9% and 0.8%, respectively, among men and 12.9% and 1.9%, respectively, among women ages 18 years and older in mainland China (14). Furthermore, these results document regional differences in mean BMI and waist circumference; prevalence of overweight, obesity, and central obesity; and risk factors. Our study suggests that 119 million Chinese adults ages 35 to 74 years were overweight and 18 million Chinese in the same age range were obese, using BMI criteria. Using waist circumference, 126 million Chinese adults ages 35 to 74 years had central obesity. The current study documents an unexpectedly large burden of overweight and obesity in the general Chinese population.

InterASIA represents the most current information on the prevalence of overweight, obesity, and central obesity based on random and nationally representative samples of the adult population in China. All study measurements were obtained by trained staff using a standard protocol. A vigorous quality assurance program was used to ensure the quality of the data collection over the entire study period.

Table 3. Age-specific and age-standardized* prevalence of central obesity† in the adult population ages 35 to 74 years in China, 2000–2001

Population group	Waist circumference			
	Men (≥90 cm)		Women (≥80 cm)	
	% (SE)	Estimated population‡ (SE)	% (SE)	Estimated population‡ (SE)
Age (years)				
35 to 44	16.2 (0.9)	15,369 (857)	28.2 (1.1)	25,173 (1,080)
45 to 54	16.8 (1.0)	12,526 (774)	40.8 (1.4)	28,568 (1,207)
55 to 64	15.1 (1.0)	6,788 (479)	46.5 (1.6)	19,435 (900)
65 to 74	15.2 (1.5)	4,529 (488)	46.0 (2.3)	13,982 (896)
35 to 74*	16.1 (0.5)	39,212 (1,297)	37.6 (0.7)	87,158 (1,883)
Region*				
North	24.7 (1.0)	25,818 (1,025)	46.1 (1.1)	45,071 (1,321)
South	10.0 (0.6)	13,394 (795)	32.1 (0.9)	42,087 (1,341)
Urban	27.3 (0.8)	13,995 (452)	43.8 (0.8)	20,597 (488)
Rural	13.4 (0.6)	25,217 (1,216)	36.6 (0.9)	66,560 (1,818)

* Age-standardized to the 2000 China adult population.
† Defined according to guidelines of the International Diabetes Federation.
‡ In thousands.

To allow for international comparisons, data have been presented by various BMI cut-off points (≥23.0, ≥24.0, ≥25.0, ≥28.0, and ≥30.0). It has been suggested that the current definitions of overweight and obesity recommended by the World Health Organization may not be appropriate in Asian populations, because several studies conducted in Asian populations have documented increased health risks associated with overweight and obesity at lower BMI levels (10,11). Available data indicate that the BMI cut-off point for increased risk in Asian populations might be between 22.0 and 24.0 kg/m^2 for overweight and 26.0 and 31.0 kg/m^2 for obesity (11).

Epidemiological studies have shown that central obesity, most often measured by waist circumference, is independently associated with CVD risk factors (16–19). Data from the INTERHEART study, which included 27,098 participants in 52 countries, found that waist circumference was a stronger predictor of myocardial infarction than BMI (20). Previously published data from the InterASIA study indicated that both waist circumference and BMI were strongly associated with each of the CVD risk factors examined (systolic blood pressure, diastolic blood pressure, total cholesterol, high-density lipoprotein-cholesterol, triglycerides, and glucose) (21). Measuring both BMI and waist circumference in Chinese adults will likely enhance the ability of healthcare providers to accurately identify and assess cardiovascular risk.

During the past several decades, the population mean BMI and prevalence of overweight have increased in the U.S. population (22). For example, the prevalence of a BMI of ≥25.0 increased from 46.0% to 54.4% (an 18.3% increase) between 1976–1980 and 1988–1994 (22). Compared with the U.S. population, the mean BMI and prevalence of overweight and obesity are still much lower in the Chinese population. Data from the 1989 and 1997 China Health and Nutrition Surveys indicate that the prevalence of a BMI of ≥25.0 among adults ages 20 to 45 years increased from 6.4% to 14.5% (a 127% increase) in men and 11.5% to 16.2% (a 41% increase) in women ages 20 to 45 years (15). The mean BMI and prevalence of overweight in China estimated in the present study exceeds that of other Asian countries (23,24). For instance, the age-adjusted mean BMI and prevalence of a BMI of ≥25.0 were 22.8 kg/m^2 and 22.5%, respectively, in men and 22.0 kg/m^2 and 17.0%, respectively, in women in the Japanese National Nutrition Survey conducted in 1991–1995 (23).

In the United States, the prevalence of a BMI of ≥25.0 is higher among men than among women; it tends to increase steadily from age 20 to 70 years, and thereafter it begins to decline (22). In the current study, women had a higher prevalence of overweight after age 45 years, compared with men. The prevalence increases until age 55 years among women, at which point it begins to decline. Other Asian countries have reported similar patterns (24,25).

Table 4. Adjusted odds ratios of overweight and central obesity in the adult population ages 35 to 74 years in China, 2000–2001

	Overweight			Central obesity		
Population group	**Odds ratio***	**95% CI**	**ERE†**	**Odds ratio***	**95% CI**	**ERE†**
Urban vs. rural‡						
Men						
Age	2.18	(1.93 to 2.46)		2.43	(2.12 to 2.79)	
Socioeconomic status§	1.66	(1.42 to 1.95)	44.1	1.78	(1.48 to 2.14)	45.5
Lifestyle¶	1.56	(1.34 to 1.81)	52.5	1.79	(1.51 to 2.11)	44.8
Diet**	1.65	(1.41 to 1.92)	44.9	1.79	(1.51 to 2.13)	44.8
Full††	1.11	(0.92 to 1.33)	90.7	1.18	(0.96 to 1.45)	87.4
Women						
Age	1.44	(1.29 to 1.61)		1.29	(1.16 to 1.43)	
Socioeconomic status§	1.60	(1.37 to 1.86)		1.44	(1.23 to 1.69)	
Lifestyle¶	1.19	(1.04 to 1.37)	56.8	1.11	(0.97 to 1.26)	62.1
Diet**	1.28	(1.11 to 1.47)	36.4	1.15	(1.01 to 1.31)	48.3
Full††	1.20	(1.01 to 1.43)	54.5	1.10	(0.92 to 1.31)	65.5
North vs. South‡‡						
Men						
Age	3.76	(3.26 to 4.33)		3.05	(2.59 to 3.59)	
Socioeconomic status§	3.68	(3.18 to 4.24)	2.9	2.90	(2.46 to 3.42)	7.3
Lifestyle¶	3.46	(2.99 to 4.01)	10.9	2.79	(2.37 to 3.30)	12.7
Diet**	4.16	(3.59 to 4.82)		3.42	(2.88 to 4.05)	
Full††	3.84	(3.29 to 4.48)		3.08	(2.58 to 3.68)	
Women						
Age	3.19	(2.79 to 3.63)		1.82	(1.61 to 2.06)	
Socioeconomic status§	3.30	(2.89 to 3.78)		1.88	(1.65 to 2.13)	
Lifestyle¶	2.97	(2.58 to 3.41)	10.0	1.70	(1.49 to 1.94)	14.6
Diet**	3.26	(2.84 to 3.73)		1.91	(1.68 to 2.17)	
Full††	3.12	(2.70 to 3.62)	3.2	1.83	(1.59 to 2.10)	

Overweight is defined as a BMI of ≥25 kg/m^2; central obesity is defined as a waist circumference of ≥90 cm for men and ≥80 cm for women.

* Odds ratios refer to urban vs. rural China or north vs. south China after adjusting for age, socioeconomic status, lifestyle factors, and dietary factors separately or after adjusting for all of these factors simultaneously in the full models.

† ERE, excess risk explained (%), defined as $(r_a - r_b)/(r_a - 1)$, where r_a is the odds ratio adjusted for age, and r_b is the odds ratio adjusted for age and other covariates.

‡ All models include adjustment for geographic region (north vs. south).

§ Age, education, income.

¶ Age, cigarette smoking, alcohol consumption, physical activity.

** Age, number of fruits and vegetables per week, servings of red meat per week.

†† Age, education, income, cigarette smoking, alcohol consumption, physical activity, number of fruits and vegetables per week, servings of red meat per week.

‡‡ All models include adjustment for urbanization (urban vs. rural).

The prevalence of a BMI of ≥25.0 in urban residents in China estimated in our study was 47% higher than in rural residents (39.1% vs. 26.6%, respectively) while the prevalence of central obesity was 104% (27.3% vs. 13.4%) higher among men and 20% (43.8% vs. 36.6%) higher among women in urban areas than in rural areas. Urbanization is

associated with a variety of lifestyle and behavioral changes, including physical inactivity and high-fat, energy-rich diets, which influence body weight.

Regional variations in overweight and obesity have been observed in other population-based studies in China and other countries (13,14,25–28). In the present study, the north-south gradient of overweight and central obesity prevalence was quite striking. Overall, the prevalence of a BMI of ≥25.0 was 134% (43.5% vs. 18.6%) higher in northern than in southern China. The prevalence of central obesity was 147% (24.7% vs. 10.0%) higher among men and 44% (46.1 vs. 32.1) higher among women in northern than in southern China. Previous studies have documented differences in dietary composition between northern and southern China (26–29). In our study, diet, socioeconomic status, and lifestyle factors did not seem to explain the significant difference in overweight and obesity between northern and southern residents of China. Genetic contributions to the regional differences in overweight and obesity should be examined.

This national survey indicates that overweight and obesity are very common in the general Chinese adult population and that the prevalence of overweight and obesity and mean BMI are higher than previously reported from national studies. Our findings have important public health implications. The rapid economic development and urbanization throughout China have brought about concurrent changes in nutrition, socioeconomics, and lifestyles. CVD has emerged as the leading cause of death in China in the last decade of the twentieth century, and excess weight and central obesity have been associated with an increased risk of several CVD risk factors. There is an urgent need to develop national strategies aimed at the prevention, detection, and treatment of overweight and obesity to reduce the increasing burden of CVD in China.

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