Original Article

Changes in Waist Circumference and Abdominal Obesity among Chinese Adults over a Ten-year Period*

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Abstract

Objective The aim of this study was to describe changes in waist circumference (WC) and prevalence of abdominal obesity over a period of 10 years among Chinese adults in different socio-economic status (SES).

Methods Data derived from the China Nutrition and Health Surveillance during 2002 and 2010-2012. We calculated the mean WC and the prevalence of abdominal obesity by gender, place of residence, SES indicators (education, income, and marital status), and body mass index (BMI) categoriesand used pooled *t*-tests to assess the differences between the two time periods.

Results 26.0% of men and 25.3% of women had abdominal obesity in 2010-2012. The age-adjusted mean WC increased by 2.7 cm among men and 2.1 cm among women; the age-adjusted prevalence of abdominal obesity increased by 7.7% among men and 5.3% among women. The rising trends were observed in all subgroups except for a negative growth in high-income women. People living in rural areas with low education and income and with a BMI of 18.5 to 23.9 kg/m^2 had a greater absolute and relative increase in WC. People living in rural areas with low income had a greater relative increase in abdominal obesity.

Conclusion The mean WC and prevalence of abdominal obesity among Chinese adults have increased during the past 10 years. Gender differences were noted using various SES indicators.

Key words: Waist circumference; Abdominal obesity; Socio-economic indicators; Trends; China

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INTRODUCTION

Obesity as a major health issue is closely associated with morbidity and mortality from chronic disease[1]. Normally, we used the body mass index (BMI) to evaluate obesity in the population. Waist circumference (WC) provides a complementary measure of excess bodyweight. Accumulating evidence showed that measurement of abdominal obesity was strongly and positively associated with all-cause CVD and cancer mortality[2-3] independently of general obesity and may be a better predictor for the risk of myocardial infarction[4], type 2 diabetes[5], and metabolic syndrome[6]. The increase in WC in the population has been greater than expected from the observed increases in BMI among US adults. Adverse health consequences associated with obesity may be

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increasingly underestimated by trends in BMI alone. Since WC is closely linked to adverse cardiovascular outcomes, it is important to know the prevailing trends in both of these parameters[7].

In addition to genetic and lifestyle factors, many socio-demographic and socio-economic indices are closely associated with obesity[8]. Obesity may affect men and women with different socio-economic status to a different degree[9]. Some studies reported large and persistent social inequalities in obesity and overweight by age, gender, educational level, and socio-economic status[10-11]. However, there has been a limited report on the secular trends in abdominal obesity, especially in changes of WC and abdominal obesity according to various socio-economic indicators, which are worth investigating. Here we analyzed the recent secular trends in mean WC and the prevalence of abdominal obesity among Chinese adults by gender and socio-economic status between 2002 and 2010-2012 using comparable and nationally representative cross-sectional data from China Nutrition and Health Surveillance (CNHS).

METHODS

Study Design and Subjects

This study examined data from two cross-sectional surveillance programs of China: China Nutrition and Health Surveillance conducted in 2002 and 2010-2012. Participants were selected using a multi-stage and proportional to population size sampling design, which included 132 monitoring sites in 2002 and 150 sites during 2010-2012. The National Bureau of Statistics (NBS) and the Chinese Center for Disease Control and Prevention (China CDC) assisted in the sampling of each county (city and region) and village (neighborhood) committees. Project teams at county (district) levels selected sample households for the principle of uniform sampling. The selected sample was representative of China from urban and rural areas. The physical examinations response rates were 87.9% in 2002[12] and 76.5% in 2010-2012[13]. A total of 142,240 subjects in 2002 and 119,856 subjects in 2010-2012 were analyzed. Pregnant women were excluded. Ethics approval was obtained from the Ethics Committee of the National Institute for Nutrition and Food Safety, China CDC (IRB code: 2013-018). Informed consent forms were signed by the participating subjects.

Measurements and Definitions

The survey included inquiries and medical physical examinations. The inquiring survey covered basic information such as age, nationality, marital status, education, occupation, and financial income of the family members. Education, household income, and marital status were used as socio-economic indicators. Education was divided into three categories: (1) ≤ 6 years of schooling (elementary school or lower); (2) 7-12 years of schooling (high school); and (3) ≥ 13 years of schooling (junior college or higher). Taking into account the increase in income level, different options were used in the two programs. Household annual per capita income was grouped into three categories. In CNHS 2002: (1) low level: ≤ 1,999 Yuan (1 US dollar = 8.28 Yuan RMB in 2001); (2) medium level: 2,000-9,999 Yuan; (3) high level: ≥ 10,000 Yuan. In CNHS 2010-2012: (1) low level: < 10,000 Yuan (1 US dollar = 6.83 Yuan RMB in 2011); (2) medium level: 10,000-24,999 Yuan; (3) high level: ≥ 25,000 Yuan. Marital status was categorized as: (1) unmarried, including single, widowed or separated; (2) married.

Physical examinations were performed by health professionals from the local county CDCs. Body height and weight were measured using standard protocols (without shoes and outerwear). Height was measured to the nearest 0.1 cm on a column stadiometer and weight to the nearest 0.1 kg on a lever weight scale. WC was measured to the nearest 0.1 cm by a non-elastic flexible tape. We used the method recommended by the World Health Organization (WHO), which consists measuring midway between the lowest rib margin and the iliac crest at the mid-axillary line[14]. BMI was calculated as weight (kg)/height squared (m^2). BMI was categorized as: (1) low BMI: < 18.5 kg/m^2; (2) normal BMI: 18.5-23.9 kg/m^2; (3) overweight: 24.0-27.9 Kg/m^2; and (4) obesity: ≥ 28 kg/m^2. Pre-abdominal obesity was defined as WC of 85-89.9 cm for men and 80-84.9 cm for women while abdominal obesity was defined as WC ≥ 90 cm for men and ≥ 85 cm for women[15].

Statistical Analysis

This study analyzed the mean and standard error (SE) of WC and the prevalence of abdominal obesity and 95% confidence interval (*CI*) in men and non-pregnant women ≥ 18 years old for subgroups defined by age, place of residence, education,

income, marital status, and BMI in CNHS in 2002 and 2010-2012. To take into account the changes in population age structure during the study period, the mean WC and prevalence of abdominal obesity was age-standardized using stratum-specific weights from the standard population of the 2009 Chinese census. We used absolute and relative differences to describe the change of WC and prevalence of abdominal obesity in the past 10 years. The statistical significance of the changes was tested using the pooled *t*-test (pooled *t*-statistic = difference in the means or proportions of the two estimates divided by the pooled standard error of the two estimates, which was calculated as the square root of the sum of the squares of the two standard errors)[16]. Two-sided $P < 0.05$ was considered statistically significant. All analyses were performed using the SAS software, version 9.3 (SAS Institute Inc., Carey, NC, USA).

RESULTS

Between the periods of 2002 and 2010-2012, the age-adjusted mean WC increased from 80.0 cm to 82.7 cm among men ($P < 0.0001$) (Table 1) and from 76.4 cm to 78.5 cm among women ($P < 0.0001$) (Table 2). Men had a higher absolute and relative increase than women. Men and women had a similar steady increase trend in WC among all subgroups except those of age and marital status subgroups. The largest increase occurred among men ages 30-39 years while among women between ages of 18-29 years. WC increase was greater for those with a lower socio-economic status (lived in rural areas, had lower education, and lower income level) and for those with normal BMI (18.5-23.9). The age-adjusted mean WC increased by 4.1 cm among rural men ($P < 0.0001$) and 1.4 cm among urban men ($P < 0.0001$); 3.1 cm among rural women ($P < 0.0001$);

Table 1. Trends in Mean WC (cm) among Chinese Male ≥ 18 Years, CNHS 2002 to CNHS 2010-2012

Variables	2002			2010-2012			Absolute Change (cm)	Relative Change (%)	*P*
	N	Mean	SE	*N*	Mean	SE			
Age (y)									
Total	64,599	80.0	0.30	52,315	82.7	0.35	2.7	3.4	< 0.0001
18-29	9,471	76.4	0.31	3,998	79.4	0.52	3.0	3.9	< 0.0001
30-39	15,360	80.3	0.31	6635	83.7	0.39	3.4	4.2	< 0.0001
40-49	13,953	81.5	0.33	11,527	84.5	0.29	3.0	3.7	< 0.0001
50-59	12,368	82.1	0.37	12,762	84.2	0.33	2.1	2.6	< 0.0001
60-69	8,948	81.9	0.40	10,837	83.4	0.36	1.5	1.8	< 0.0001
70+	4,499	80.8	0.46	6,556	82.3	0.42	1.5	1.9	< 0.0001
Region*									
Urban	21,366	-82.7	0.46	25,388	84.1	0.47	1.4	1.7	< 0.0001
Rural	43,233	77.3	0.39	26,927	81.4	0.45	4.1	5.3	< 0.0001
Education (y)*									
≤ 6	22,857	78.2	0.34	18,282	81.2	0.38	3.0	3.8	< 0.0001
7-12	36,772	80.3	0.33	29,434	83.1	0.38	2.8	3.5	< 0.0001
≥ 13	4,856	83.3	0.35	4,597	84.2	0.58	0.9	1.1	< 0.0001
Income*									
Low	30,076	77.3	0.34	25,988	81.9	0.42	4.6	6.0	< 0.0001
Middle	27,704	81.4	0.33	18,299	83.3	0.38	1.9	2.3	< 0.0001
High	5,592	83.9	0.48	5,138	84.7	0.55	0.8	1.0	< 0.0001
Marital status*									
Unmarried	8,023	76.1	0.32	5,185	78.8	0.46	2.7	3.5	< 0.0001
Married	56,475	81.0	0.32	47,126	83.6	0.32	2.6	3.2	< 0.0001
BMI (kg/m^2)*									
< 18.5	4,243	67.3	0.16	2,373	67.8	0.29	0.5	0.7	< 0.0001
18.5-23.9	38,698	75.5	0.15	26,646	77.3	0.19	1.8	2.4	< 0.0001
≥ 24	16,685	87.7	0.17	17,432	88.5	0.15	0.8	0.9	< 0.0001
≥ 28	4,973	97.8	0.25	5,864	98.8	0.22	1.0	1.0	< 0.0001

Note. *Adjusted for age.

and 1.1 cm among urban women ($P < 0.0001$). As education and income levels rose, absolute and relative growth in WC tended to decline. Unmarried men and married women had the higher increase in the marital status subgroups.

Twenty-six percentage (26.0%) of men and 25.3% women adults had abdominal obesity in the period of CNHS 2010-2012. The age-adjusted prevalence of abdominal obesity increased by 42.1% among men ($P < 0.0001$) (Table 3) and 26.5% among women ($P < 0.0001$) (Table 4). The prevalence significantly increased in all subgroups with the exception of women with high income. The largest relative increase in the age-adjusted prevalence of abdominal obesity occurred: among individuals aged 18-29 years (99.0% among men and 86.4% among women); among individuals living in rural areas (99.1% women); with low-income level (104.4% among men among men and 51.5% among and 54.4% among women); and in unmarried men (88.2%). The results showed a decrease of abdominal obesity among high-income women, declining by 3.1% ($P < 0.0001$). Gender differences in the relationship of education and BMI groups with abdominal obesity were found. Men with low education level and low BMI and women with high education level and normal BMI tended to have the largest relative increase of abdominal obesity.

DISCUSSION

Our results showed an overall increasing trend of waist circumference in both genders and different study subgroups in Chinese adults in the last 10 years. The age-adjusted mean WC increased from

Table 2. Trends in Mean WC (cm) among Chinese Female ≥ 18 Years, CNHS 2002 to CNHS 2010-2012

Variables	2002			2010-2012			Absolute Change (cm)	Relative Change (%)	*P*
	N	Mean	SE	*N*	Mean	SE			
Age (y)									
Total	77,641	76.4	0.26	67,541	78.5	0.28	2.1	2.8	< 0.0001
18-29	12,488	70.7	0.23	5,594	73.9	0.33	3.2	4.5	< 0.0001
30-39	20,298	74.2	0.25	9,480	76.8	0.31	2.6	3.5	< 0.0001
40-49	16,992	77.4	0.28	16,282	79.9	0.25	2.5	3.2	< 0.0001
50-59	14,319	80.4	0.31	16,908	82.1	0.34	1.7	2.1	< 0.0001
60-69	9,073	80.5	0.38	12,519	82.7	0.34	2.2	2.7	< 0.0001
70+	4,471	79.4	0.43	6,758	81.1	0.44	1.7	2.1	< 0.0001
Region*									
Urban	26,429	77.6	0.34	34,581	78.7	0.38	1.1	1.4	< 0.0001
Rural	51,212	75.2	0.39	32,960	78.3	0.41	3.1	4.1	< 0.0001
Education (y)*									
≤ 6	39,436	77.5	0.34	32,497	80.3	0.33	2.8	3.6	< 0.0001
7-12	34,542	75.8	0.28	30,545	77.8	0.30	2.0	2.6	< 0.0001
≥ 13	3,504	72.9	0.36	4,493	74.3	0.55	1.4	1.9	< 0.0001
Income*									
Low	36,488	75.4	0.31	33,274	78.7	0.31	3.3	4.4	< 0.0001
Middle	33,074	77.0	0.28	23,698	78.4	0.31	1.4	1.8	< 0.0001
High	6,470	77.5	0.47	6,523	77.6	0.37	0.1	0.1	< 0.0001
Marital status*									
Unmarried	10,767	73.9	0.27	9,546	75.8	0.39	1.9	2.6	< 0.0001
Married	66,714	77.0	0.28	57,985	79.1	0.28	2.1	2.8	< 0.0001
BMI (kg/m^2)*									
< 18.5	5,445	63.9	0.16	3,195	65.1	0.28	1.2	1.9	< 0.0001
18.5-23.9	43,235	72.0	0.13	33,294	74.0	0.19	2.0	2.8	< 0.0001
≥ 24	20,960	82.5	0.17	22,265	83.8	0.21	1.3	1.6	< 0.0001
≥ 28	8,001	92.5	0.23	8,787	93.2	0.26	0.7	0.8	< 0.0001

Note. *Adjusted for age.

80.0 cm to 82.7 cm among men and from 76.4 cm to 78.5 cm among women in our study. Several studies reported secular increases in WC. In the US, the overall age-adjusted mean WC increased progressively and significantly from 99.4 cm to 101.0 cm among men and 92.6 cm to 96.0 among women between 2001-2002 and 2011-2012[17]. In a 12-year follow-up cohort of Australian adults, the mean WC were 95.8 cm for men and 82.3 cm for women at baseline and the increase in WC was 4.3 cm and 6.2 cm for men and women, respectively. Low physical activity, sedentary lifestyles, changes in diet, and higher energy intake are suggested to play key roles in this increasing trend[18]. We found a dramatic rising trend of mean WC and the prevalence of abdominal obesity in the younger age groups (18-39 years for men and 18-29 years for women). This finding is in agreement with previous studies which had stressed this alarming increase in younger age groups[8,19-20]. Although the mean WC of subjects in urban areas was still higher than those in rural areas, the absolute and relative changes of WC and the prevalence of abdominal obesity of the rural population were obviously higher than that of the urban people. Surprisingly, the prevalence of abdominal obesity in this study was double among rural men in the last 10 years. Our finding that rural residents saw a more rapid increase in the prevalence

Table 3. Trends in the Prevalence of Abdominal Obesity among Chinese Male ≥ 18 Years, CNHS 2002 to CNHS 2010-2012

Variables	2002				2010-2012				Absolute Change (%)	Relative Change (%)	*P*
	n	%	95% *CI*		*n*	%	95% *CI*				
Age (y)											
Total	11,281	18.3	16.6	20.0	14,568	26.0	23.7	28.3	7.7	42.1	< 0.0001
18-29	883	9.8	8.2	11.3	798	19.5	16.5	22.5	9.7	99.0	< 0.0001
30-39	2,320	17.5	15.7	19.3	1,803	28.4	25.5	31.3	10.9	62.3	< 0.0001
40-49	2,627	21.4	19.3	23.6	3,427	29.7	27.3	32.1	8.3	38.8	< 0.0001
50-59	2,403	23.4	21.0	25.9	3,741	29.0	26.4	31.5	5.6	23.9	< 0.0001
60-69	2,078	25.1	22.6	27.6	3,040	26.4	23.7	29.1	1.3	5.2	< 0.0001
70+	970	22.0	19.5	24.6	1,759	24.1	21.1	27.0	2.1	9.5	< 0.0001
Region*											
Urban	6,024	25.4	22.4	28.4	8,663	29.7	26.5	33.0	4.3	16.9	< 0.0001
Rural	5,257	11.2	9.6	12.9	5,905	22.3	19.3	25.2	11.1	99.1	< 0.0001
Education (y)*											
≤ 6	2,903	13.6	12.0	15.2	3,896	20.1	18.1	22.2	6.5	47.8	< 0.0001
7-12	6,967	19.2	17.3	21.1	9,028	27.4	25.0	29.9	8.2	42.7	< 0.0001
≥ 13	1,395	25.7	22.8	28.5	1,644	32.5	28.5	36.6	6.8	26.5	< 0.0001
Income*											
Low	3,307	11.4	9.9	12.9	6,126	23.3	20.6	25.9	11.9	104.4	< 0.0001
Middle	5,976	21.7	19.7	23.8	5,698	27.8	25.3	30.2	6.1	28.1	< 0.0001
High	1,756	28.8	24.9	32.6	1,841	31.8	27.5	36.1	3.0	10.4	< 0.0001
Marital status*											
Unmarried	791	9.5	8.2	10.9	1,012	17.9	15.3	20.5	8.4	88.2	< 0.0001
Married	10,476	20.5	18.6	22.4	13,555	27.8	25.6	30.1	7.3	35.6	< 0.0001
BMI (kg/m^2)*											
< 18.5	16	0.4	0.1	0.6	34	1.2	0.3	2.2	0.8	200.0	0.0010
18.5-23.9	648	1.7	1.4	2.0	1,252	3.5	2.6	4.3	1.8	105.9	< 0.0001
≥ 24	6,212	37.3	35.2	39.4	7,896	42.6	40.2	45.1	5.3	14.2	< 0.0001
≥ 28	4,405	88.4	86.9	90.0	5,386	92.7	91.5	93.9	4.3	4.9	< 0.0001

Note. *Adjusted for age.

of abdominal obesity compared with urban counterparts is also a characteristic observed in other population-based studies in China[21-22]. Several factors could explain this difference. Firstly, higher energy and fat intake were found in rural residents in the last 10 years. For example, the fat intake increased by 3.5 g/reference man per day in rural individuals and decreased by 3.6 g/reference man per day in urban individuals[13]. Secondly, lifestyle patterns are changing and with modernization the global trend is toward a decrease in physical activity that also plays an important role in the trend of abdominal obesity[23]. The average leisure sedentary time increased from 2.3 h/day to 2.6 h/day in rural individuals and decreased from 3.2 h/day to 2.8 h/day in urban individuals during the periods of 2002 to 2010-2012[12].

Our study showed a clear positive relationship between education and income level and the mean WC and the prevalence of abdominal obesity among men in both 2002 and 2010-2012. However, an inverse relationship was observed among women in 2010-2012. The increasing trends of WC and abdominal obesity were presented at all education and income levels except an obvious decrease of abdominal obesity among high-income women. Similar to us, Du et al.[24] also reported that the increasing trend was present at all educational levels. Furthermore, people with higher education and income level tended to have the slighter absolute and relative increases of mean WC. US women showed an inverse relationship between educational attainment and the prevalence of abdominal obesity while men did not. A direct relationship was found between educational attainment and relative increase

Table 4. Trends in the Prevalence of Abdominal Obesity among Chinese Female ≥ 18 Years, CNHS 2002 to CNHS 2010-2012

Variables	2002				2010-2012				Absolute Change (%)	Relative Change (%)	*P*
	n	%	95% *CI*		*n*	%	95% *CI*				
Age (y)											
Total	15,372	20.0	18.6	21.5	20,440	25.3	23.3	27.3	5.3	26.5	< 0.0001
18-29	916	6.6	5.7	7.4	656	12.3	10.6	14.1	5.7	86.4	< 0.0001
30-39	2,151	10.8	9.6	12.1	1,640	17.9	15.8	20.0	7.1	65.7	< 0.0001
40-49	3,491	20.3	18.3	22.2	4,389	27.5	25.4	29.6	7.2	35.5	< 0.0001
50-59	4,354	32.4	30.1	34.7	6,093	37.1	33.8	40.3	4.7	14.5	< 0.0001
60-69	3,059	34.8	32.3	37.3	5,104	41.2	38.4	44.0	6.4	18.4	< 0.0001
70+	1,401	31.7	29.1	34.3	2,558	35.9	32.6	39.2	4.2	13.2	< 0.0001
Region*											
Urban	6,766	23.6	21.4	25.7	11,017	25.6	22.8	28.4	2.0	8.5	< 0.0001
Rural	8,606	16.5	14.5	18.6	9,423	25.0	22.2	27.8	8.5	51.5	< 0.0001
Education (y)*											
≤ 6	8,741	24.0	22.0	25.9	10,903	31.2	28.7	33.8	7.2	30.0	< 0.0001
7-12	6,194	17.8	16.2	19.4	8,756	22.7	20.5	24.8	4.9	27.5	< 0.0001
≥ 13	410	10.1	8.5	11.8	780	13.5	10.9	16.1	3.4	33.7	< 0.0001
Income*											
Low	6,061	17.1	15.6	18.6	10,178	26.4	24.2	28.6	9.3	54.4	< 0.0001
Middle	7,378	22.0	20.2	23.8	7,234	24.9	22.7	27.1	2.9	13.2	< 0.0001
High	1,587	23.1	20.3	25.8	1,802	20.0	17.2	22.8	-3.1	-13.4	< 0.0001
Marital status*											
Unmarried	1,977	15.9	14.7	17.2	2,835	19.6	17.1	22.1	3.7	23.0	< 0.0001
Married	13,360	21.0	19.4	22.6	17,601	26.5	24.4	28.6	5.5	26.1	< 0.0001
BMI (kg/m^2)*											
< 18.5	46	0.8	0.5	1.1	45	1.0	0.3	1.7	0.2	25.0	0.0293
18.5-23.9	1,289	3.1	2.7	3.5	2,213	5.3	4.1	6.5	2.2	71.0	< 0.0001
≥ 24	7,200	34.4	32.4	36.3	10,287	41.8	39.1	44.4	7.4	21.5	< 0.0001
≥ 28	6,837	85.5	84.1	87.0	7,895	87.9	86.1	89.8	2.4	2.8	< 0.0001

Note. *Adjusted for age.

in abdominal obesity for both sexes[16]. Notably, women with high income presented an obvious absolute and relative decrease of abdominal obesity. This could be explained by several factors. Firstly, education attainment may as well ensure acquisition of health promotion or health-damaging behaviors while income captures material conditions[25]. Residents of low-SES areas were significantly less likely than their counterparts in advantaged areas to purchase food that were high in fiber and low in fat, salt, and sugar as well as high variety of fruits[26]. Secondly, most of the public educational programs have targeted women, somehow overlooking the male population[8]. Women's awareness and sensitivity about abdominal obesity or body shape increased. Women's financial abilities supported them to get engaged in weight reduction efforts.

Married men and women tended to have higher mean WC and prevalence of abdominal obesity. The larger absolute and relative increase of abdominal obesity occurred among unmarried men and married women. Barzin et al.[8] reported that married women and unmarried men had higher rates of obesity and abdominal obesity in a 10-year Tehranian follow-up study. Sobal et al.[27] revealed that married men were significantly fatter and more likely to be obese than never married or previously married men, but not women. In Greek adults, marital status was significantly associated with obesity and abdominal obesity status in both genders[28]. Most studies show that marriage and weight gain are positively associated. However, these associations may differ based on gender, ethnicity, and other socio-economic factors[29-30].

People with normal BMI (18.5-23.9 kg/m^2) had the largest absolute and relative increase of mean WC. Significant increases in the prevalence of abdominal obesity occurred in all sub-BMI groups. However, the significant increase in the prevalence of abdominal obesity occurred within the group with 25-29 kg/m^2 for both US men and women[16]. Some studies showed a dramatic rise in the prevalence of abdominal obesity rather than the prevalence of general obesity[21,31-33]. A recent study showed that among women, the association between WC and mortality was strongest in those with a normal BMI[21]. A large US cohort study showed that very high levels of WC were associated with an approximately 2-fold higher risk of mortality in men and women aged 50 years and above after adjustment for BMI and other risk factors[34]. Du et al.[24] found that a higher WC is associated with a higher risk of incident hypertension within the normal BMI category. Excessive WC among people with normal BMI indicated a huge potential risk for chronic diseases and burden of obesity.

This study has several strengths. First, the study participants consisted of a nationwide representative sample of adults from both urban and rural areas. Participants were selected using a multistage sampling strategy and the sampling weights, including design weight and post-stratification weight, were used in the data analysis. Second, all study measurements were made by trained staff following a standard protocol. A vigorous quality assurance program and the same strict methodology were used to ensure the quality of the data collection over the entire study period. Third, we evaluated the trend of WC and abdominal obesity using various categories. The limitations of our study should also be considered. Because CNHS collected the income information by different ordinal variables in 2002 and 2010-2012, we cannot classify the income under consistent standards. We tried to ensure a similar proportion of participants in each level of income in the data analysis.

CONCLUSIONS

In conclusion, our results provided an updated nationwide representative look at the trends in WC and abdominal obesity in China in the last 10 years. Mean WC showed a significant absolute and relative increase among all subgroups in our study. The largest increases in abdominal obesity were particularly noticeable among rural residents, younger age participants, and low-income people. Our results highlighted the critical need to understand the secular trends in abdominal obesity in China.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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