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## Secular trends in the prevalence of general and abdominal obesity among Chinese adults, 1993–2009

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### Summary

The objective of this study is to examine the trends in body mass index (BMI), waist circumference (WC) and prevalence of overweight (BMI 25 kg/m<sup>2</sup> to 27.49 kg/m<sup>2</sup>), general obesity (BMI ≥ 27.5 kg/m<sup>2</sup>) and abdominal obesity (WC ≥ 90 cm for men and ≥ 80 cm for women) among Chinese adults from 1993 to 2009. Data were obtained from the China Health and Nutrition Survey, which was conducted from 1993 to 2009 and included a total of 52,621 Chinese adults. During the period of 1993–2009, mean BMI values increased by 1.6 kg/m<sup>2</sup> among men and 0.8 kg/m<sup>2</sup> among women; mean WC values increased by 7.0 cm among men and 4.7 cm among women. The prevalence of overweight increased from 8.0 % to 17.1% among men ( $P < 0.001$ ) and from 10.7% to 14.4% among women ( $P < 0.001$ ); the prevalence of general obesity increased from 2.9% to 11.4% among men ( $P < 0.001$ ) and from 5.0% to 10.1% among women ( $P < 0.001$ ); the prevalence of abdominal obesity increased from 8.5% to 27.8% among men ( $P < 0.001$ ) and from 27.8 % to 45.9 % among women ( $P < 0.001$ ). Similar significant trends were observed in nearly all age groups and regions for both men and women. The prevalence of overweight, general obesity and abdominal obesity among Chinese adults has increased greatly during the past 17 years.

### Keywords

trends; body mass index; waist circumference; obesity; China

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### Conflict of Interests

The authors declare that they have no conflict of interests.

## Introduction

General Obesity, defined by body mass index (BMI), has increased dramatically in China during the past decades (1,2). However, BMI can not provide information on the distribution of body fat (3). Abdominal obesity, as assessed by waist circumference (WC), is more strongly associated with the risk of type 2 diabetes, hypertension, dyslipidemia, cardiovascular disease, cancer, and all-cause mortality than general obesity (4,5). Measurement of WC is usually simple and convenient, requiring little training (6). The US National Institutes of Health recommended that WC be measured to screen for health risk, especially among those with a BMI more than 25.0 kg/m<sup>2</sup> (7).

As a developing country, China is presently experiencing rapid economic, social, and cultural changes, including an accelerated pace of nutrition transition that may result in a greatly increased burden of chronic diseases, such as obesity (8). National surveys are necessary to provide updated health information for the development of effective programs and strategies to prevent and control obesity. However, little is known about the recent trends in general and abdominal obesity in Mainland China.

In this study, data from the China Health and Nutrition Surveys (CHNS), a nationally representative cross-sectional health and nutrition survey in China, were used to describe the secular trends in general and abdominal obesity among Chinese adults from 1993 to 2009.

## Methods

### Study design

The CHNS is a large-scale, national cross-sectional survey that was designed to explore how the health and nutritional status of the Chinese population has been affected by social and economic changes. Currently, data are available for 1989, 1991, 1993, 1997, 2000, 2004, 2006, and 2009. A multistage, random cluster process was used to draw samples from nine provinces (Liaoning, Heilongjiang, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi, and Guizhou). This sample is diverse, with variation found in a wide-range of socioeconomic factors (income, employment, education, and modernization) and other related health, nutritional, and demographic measures (9). All participants provided written informed consent and the study was approved by institutional review board from the University of North Carolina at Chapel Hill and the National Institute for Nutrition and Food Safety, China Center for Disease Control and Prevention.

### Study Population

Participants aged 18 years or older were included in the analysis. Information on age, gender, region, BMI, and WC were collected. There were 8321, 10551, 9688, 9813, 9752, and 10039 participants included in the surveys conducted in 1993, 1997, 2000, 2004, 2006, and 2009, respectively (WC was collected initially from 1993). There were 7760 (93.2%), 8354 (79.2%), 9333 (96.3%), 8983 (91.5%), 8826 (90.5%), and 9365 (93.3%) included in the analyses across the six study periods; incomplete records were due to missing BMI or WC data. The gender distributions across the six survey periods were homogeneous ( $P=0.486$ ).

### Measurements

Weight was measured to the nearest 0.1 kg with lightweight clothing on a calibrated beam scale and height was measured to the nearest 0.1 cm without shoes using a portable stadiometer. BMI was calculated as weight in kilograms divided by the square of height in meters. WC was measured at a point midway between the lowest rib and the iliac crest in a

horizontal plane using non-elastic tape. Height, weight, and WC were measured by trained examiners following a standard protocol from the World Health Organization (WHO) (10). Height, weight, and WC measurements were made at the same location and followed the same protocol at each study visit.

## Definitions

Overweight, general obesity, and abdominal obesity were defined by WHO suggestions for Chinese (overweight: BMI 25 kg/m<sup>2</sup> to 27.49 kg/m<sup>2</sup>; general obesity: BMI ≥ 27.5 kg/m<sup>2</sup> (11); abdominal obesity: WC ≥ 90cm for men and ≥ 80cm for women (12)), the criteria recommended by Working Group on Obesity in China (WGOC) (overweight: BMI 24 kg/m<sup>2</sup> to 27.99 kg/m<sup>2</sup>; general obesity: BMI ≥ 28 kg/m<sup>2</sup>; abdominal obesity: WC ≥ 85cm for men and ≥ 80cm for women)(13), and WHO suggestions for Europids (overweight: BMI 25 kg/m<sup>2</sup> to 29.99 kg/m<sup>2</sup>; general obesity: BMI ≥ 30 kg/m<sup>2</sup>; abdominal obesity: WC ≥ 102cm for men and ≥ 88cm for women) (14).

## Statistical analysis

SPSS version 13.0 (SPSS, Inc., Chicago, Illinois) was used for data statistical analyses. Trends in BMI, WC, and the prevalence of general and abdominal obesity from 1993 to 2009 were assessed by multiple linear regression or logistical regression models controlling for covariates such as sex, age, and region (15). Since the age distributions across six study periods were greatly different, all survey data (i.e. BMI, WC, and the prevalence of general and abdominal obesity) were standardized to the age distribution of the China Census population in 2000 (16). A *P* value < 0.05 was considered statistically significant.

## Results

The summary of previous studies on trends in overweight, general obesity, and abdominal obesity among Chinese adults (1,17–25) are shown in Table 1. During the past decades, the prevalence of overweight, general obesity, and abdominal obesity increased significantly among both men and women in Mainland China. However, the prevalence of those overweight decreased among Chinese women in Beijing, Taiwan and Hong Kong.

Secular changes in mean BMI and WC among Chinese adults from 1993 to 2009 are displayed in Table 2. Overall, both mean BMI and WC values increased significantly across the 6 study periods among both men and women (*P* < 0.001). Averaged BMI values increased by 1.6 kg/m<sup>2</sup> in men and 0.8 kg/m<sup>2</sup> among women. Mean WC values increased by 7.0 cm among men and 4.7 cm among women. Similar significant trends were observed among all age groups and regions for both men and women (*P* < 0.001). Notably, mean BMI and WC values increased more rapidly among individuals living in rural regions than those residing in urban areas. In addition, both parameters increased more rapidly among men aged 18–59 years, while more rapidly among women over 40 years of age.

The BMI and WC distribution curves between 1993 and 2009 in men and women are shown in Figure 1. Among both men and women, the distribution of higher BMI and WC greatly increased from 1993 to 2009. In addition, men experienced a greater increase in WC than women.

Table 3 shows the trends in prevalence of overweight, general obesity, and abdominal obesity by WHO criteria for Chinese among Chinese adults during the period 1993–2009. The prevalence of those overweight increased from 8.0% to 17.1% among men (*P* < 0.001) and from 10.7% to 14.4% among women (*P* < 0.001); the prevalence of general obesity increased from 2.9% to 11.4% among men (*P* < 0.001) and from 5.0% to 10.1% among women (*P* < 0.001); the prevalence of abdominal obesity increased from 8.5% to 27.8%

among men ( $P<0.001$ ) and from 27.8% to 45.9% among women ( $P<0.001$ ). In stratified analysis, the prevalence increased over time in each subgroup by age and region for both men and women ( $P<0.001$ ) with the exception of general overweight among women living in urban regions ( $P=0.056$ ). Notably, the prevalence of general overweight and obesity and abdominal obesity increased more rapidly among those residing in rural regions. In addition, the two types of obesity increased more rapidly in men aged 18–59 years, while more rapidly among women over 40 years of age. The trends in prevalence of general overweight and obesity and abdominal obesity by WGOc criteria for Chinese and by WHO criteria for Europeans among Chinese adults during the period of 1993–2009 are depicted in Supplementary Table 1 and 2.

## Discussion

The present data indicate that mean BMI and WC and the prevalence of overweight, general obesity, and abdominal obesity increased significantly among both men and women in China from 1993 to 2009. Similar trends were observed among nearly all age groups, and in both regions. Notably, the distribution of higher WC greatly increased from 1993 to 2009, especially among men. Additionally, among both men and women, the prevalence of general and abdominal obesity increased more rapidly among individuals aged 40–59 years. The prevalence of general obesity increased more rapidly among men residing in urban areas, while abdominal obesity increased more rapidly among women living in rural regions. Moreover, the abdominal obesity prevalence was alarmingly higher than general obesity, especially among women. These results are of great concern since abdominal obesity assessed by WC is considered to be more closely associated with risk of obesity-related morbidity and mortality (26).

The findings from the current study were consistent with those from the previous studies on general obesity defined by BMI in Mainland China (1,19–21). For instance, the prevalence of general obesity using BMI of  $28\text{kg/m}^2$  or more increased from 1.8% to 6.9% among men and 4.1% to 9.0% among women during the period of 1991–2000 (20). In other countries/regions, the patterns of general obesity trends were greatly different (27). General obesity was stable among Chinese men in Hong Kong but declined in women between 1996 and 2005 (23). There was an upward trend in general obesity among adults in Thailand from 1991 to 2004 (28) and Malaysia from 1996 to 2009 (29). Data from the US National Health and Nutrition Examination Survey (NHANES) shows a significantly upward trend among US men but no significant trend among women from 1999 to 2008 (30). By contrast, significantly increasing trends in abdominal obesity were found in other countries although they may vary by sex, age or ethnicity. Abdominal obesity increased significantly among both men and women in the US from 1999 to 2008 (16). Significant trends were observed only among men, but not women in South Korea during the period of 1998–2007 (31). Increasing abdominal obesity among Swedish women is of particular alarm since 1990 (32).

Environmental changes (e.g. increase in energy intake and decrease in physical activity) may account for the major proportion of the increase in general overweight and obesity and abdominal obesity among Chinese adults since it is unlikely that there was a population level genetic shift in the past 17 years. Data from CHNS shows that Chinese food consumption patterns have changed from predominantly rice, wheat and related products to high animal food consumption between 1991 and 2004 (8). It is well documented that gene-environment interactions may better explain human obesity (33). These interactions can also explain the differences in weight gain rates across sex, age and region. Other explanations for the greater increase of abdominal obesity prevalence among men than women might be sex hormone responses to obesogenic environmental changes (31). The increase was larger among subjects between the ages of 40–59 years, which suggests that interventions should

prioritize efforts to reduce obesity among this subpopulation (34). It is notable that prevalence of those overweight among women living in urban regions increased from 1993 to 2004 but decreased from 2004 to 2009. The reasons for this decrease are presently unknown and further studies are necessary to explore these reasons. Weight gain among Chinese adults was more rapid between 1993 and 2000, and the rate has since slowed. By contrast, WC increased persistently from 1993 to 2009. These findings suggest a trend in increasing abdominal fat given that mean BMI tends to be somewhat stable. A particular interesting finding is that the prevalence of abdominal obesity increased more rapidly among those living in rural regions. For example, in 1993, the abdominal obesity prevalence by WHO criteria for Chinese was higher among men living in urban areas (12.8%) than those living in rural areas (6.3%), while the differences between the two types of regions diminished in 2009 (urban (27.9%) vs. rural (27.7%)). Economic development and change in diet may help explain the findings. The prevalence of general obesity defined by either WHO criteria or WGOC criteria remained relatively low, while the abdominal obesity diagnosed by each criterion was a major problem among Chinese adults. Studies have revealed that most Asians have a more central distribution of body fat for a given BMI than Europeans (35). The secular trends in mean WC in China over the past 17 years are surprising; the mean WC increased by 7.0 cm among men and 4.7 cm among women. Data from NHANES indicates that each 1 cm increase in WC was associated with approximately a 2%–7% increased odds of hypertension, dyslipidemia and metabolic syndrome. Moreover, the high prevalence of abdominal obesity (37.4 % by WHO criteria and 45.3% by WGOC criteria for Chinese) in 2009 poses a serious public health challenge in China.

This study has several strengths. The sample is nationally representative, even though only nine of China's 31 provinces were included. The response rate was higher than 90% for all study years, with the exception that it was 79.2% in 1997. Training was conducted for all study staff to ensure standardization of data collection. Vigorous quality assurance and control procedures were employed. This study was, however, subject to several limitations. Social and environmental variables, which would affect obesity, such as education level, family income, dietary habits, sedentary behavior, and physical activity, were not considered. Further studies are necessary to investigate the specific reasons for the observed upward trends in obesity. The results of subgroup analyses should also be interpreted with caution due to limited statistical power.

These results provide new information on the trends of BMI, WC, and the prevalence of overweight, general obesity, and abdominal obesity in China. These health variables increased greatly among nearly all sexes, ages, and regions over the 17 years of the study, with greater increases in abdominal obesity among those living in rural areas. Abdominal obesity appears to be of greater concern than general obesity among Chinese adults. Public health prevention strategies are urgently needed to modify health behaviors in order to reduce abdominal obesity in China and prevent deleterious obesity-related health outcomes (36).

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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## References

1. Dearth-Wesley T, Wang H, Popkin BM. Under- and overnutrition dynamics in Chinese children and adults (1991–2004). *Eur J Clin Nutr.* 2008; 62:1302–1307. [PubMed: 17637598]
2. Wang Y, Mi J, Shan XY, Wang QJ, Ge KY. Is China facing an obesity epidemic and the consequences? The trends in obesity and chronic disease in China. *Int J Obes (Lond).* 2007; 31:177–188. [PubMed: 16652128]
3. Janssen I, Shields M, Craig CL, Tremblay MS. Prevalence and secular changes in abdominal obesity in Canadian adolescents and adults, 1981 to 2007–2009. *Obes Rev.* 2011; 12:397–405. [PubMed: 20977603]
4. Janssen I, Katzmarzyk PT, Ross R. Waist circumference and not body mass index explains obesity-related health risk. *Am J Clin Nutr.* 2004; 79:379–384. [PubMed: 14985210]
5. Bigaard J, Frederiksen K, Tjønneland A, et al. Waist circumference and body composition in relation to all-cause mortality in middle-aged men and women. *Int J Obes (Lond).* 2005; 29:778–784. [PubMed: 15917857]
6. Okosun IS, Choi ST, Boltri JM, et al. Trends of abdominal adiposity in white, black, and Mexican-American adults, 1988 to 2000. *Obes Res.* 2003; 11:1010–1017. [PubMed: 12917507]
7. Expert Panel on the Identification, Evaluation, and Treatment of Overweight in Adults. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: executive summary. Expert Panel on the Identification, Evaluation, and Treatment of Overweight in Adults. *Am J Clin Nutr.* 1998; 68:899–917. [PubMed: 9771869]
8. Zhai F, Wang H, Du S, et al. Prospective study on nutrition transition in China. *Nutr Rev.* 2009; 67:S56–61. [PubMed: 19453679]
9. Popkin BM, Du S, Zhai F, Zhang B. Cohort Profile: The China Health and Nutrition Survey--monitoring and understanding socio-economic and health change in China, 1989–2011. *Int J Epidemiol.* 2010; 39:1435–1440. [PubMed: 19887509]
10. WHO. Report of a WHO Expert Committee Technical Report Series. World Health Organization; Geneva: 1995. Physical Status: The Use and Interpretation of Anthropometry.
11. WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet.* 2004; 363:157–163. [PubMed: 14726171]
12. Alberti KG, Zimmet P, Shaw J. IDF Epidemiology Task Force Consensus Group. The metabolic syndrome--a new worldwide definition. *Lancet.* 2005; 366:1059–1062. [PubMed: 16182882]
13. Zhou BF. Working Group for Obesity in China. Predictive value of body mass index and waist circumference for risk factors of certain related diseases in Chinese adults – study on optimal cut-off points of body mass index and waist circumference in Chinese adults. *Biomed Environ Sci.* 2002; 15:83–95. [PubMed: 12046553]
14. WHO/FAO. Report of the Joint WHO/FAO Expert Consultation. World Health Organization; Geneva: 2003. Expert Consultation on Diet, Nutrition and the Prevention of Chronic Diseases.
15. Li C, Ford ES, Mokdad AH, Cook S. Recent trends in waist circumference and waist-height ratio among US children and adolescents. *Pediatrics.* 2006; 118:e1390–1398. [PubMed: 17079540]
16. Ford ES, Li C, Zhao G, Tsai J. Trends in obesity and abdominal obesity among adults in the United States from 1999–2008. *Int J Obes (Lond).* 2011; 35:736–743. [PubMed: 20820173]
17. Wang W, Wu ZS, Zhao D, et al. The trends of body mass index and overweight in population aged 25–64 in Beijing during 1984–1999. *Chinese Journal of Epidemiology.* 2003; 24:272–275. [PubMed: 12820943]
18. Li F, Fan JG, Cai XB. Study on the prevailing trend of overweight and obesity in Shanghai Baosteel Company based population from 1995 to 2002. *Chinese Journal of Preventive Medicine.* 2007; 41:38–41. [PubMed: 17484209]
19. Wildman RP, Gu D, Muntner P, et al. Trends in overweight and obesity in Chinese adults: between 1991 and 1999–2000. *Obesity (Silver Spring).* 2008; 16:1448–1453. [PubMed: 18388899]

20. Wang H, Du S, Zhai F, Popkin BM. Trends in the distribution of body mass index among Chinese adults, aged 20–45 years (1989–2000). *Int J Obes (Lond)*. 2007; 31:272–278. [PubMed: 16788569]
21. Jones-Smith JC, Gordon-Larsen P, Siddiqi A, Popkin BM. Emerging disparities in overweight by educational attainment in Chinese adults (1989–2006). *Int J Obes (Lond)*. 2011 Jul 5. [Epub ahead of print]. 10.1038/ijo.2011.134
22. Yeh CJ, Chang HY, Pan WH. Time trend of obesity, the metabolic syndrome and related dietary pattern in Taiwan: from NAHSIT 1993–1996 to NAHSIT 2005–2008. *Asia Pac J Clin Nutr*. 2011; 20:292–300. [PubMed: 21669598]
23. Ko GT, Tang JS, Chan JC. Worsening trend of central obesity despite stable or declining body mass index in Hong Kong Chinese between 1996 and 2005. *Eur J Clin Nutr*. 2010; 64:549–552. [PubMed: 20332802]
24. Wang H, Wang Z, Li Y, Yu W, Liu A, Zhai F. Trends in the prevalence of abdominal adiposity among Chinese adults from 1993 to 2004. *Food and Nutrition in China*. 2007; 6:47–50.
25. Wang H, Wang Z, Yu W, Zhang B, Zhai F. Changes in waist circumference distribution and the prevalence of abdominal adiposity among Chinese adults from 1993 to 2006. *Chinese Journal of Epidemiology*. 2008; 29:953–958. [PubMed: 19173871]
26. Li C, Ford ES, McGuire LC, Mokdad AH. Increasing trends in waist circumference and abdominal obesity among US adults. *Obesity (Silver Spring)*. 2007; 15:216–224. [PubMed: 17228050]
27. Rokholm B, Baker JL, Sørensen TI. The levelling off of the obesity epidemic since the year 1999--a review of evidence and perspectives. *Obes Rev*. 2010; 11:835–846. [PubMed: 20973911]
28. Aekplakorn W, Mo-Suwan L. Prevalence of obesity in Thailand. *Obes Rev*. 2009; 10:589–592. [PubMed: 19656310]
29. Khambalia AZ, Seen LS. Trends in overweight and obese adults in Malaysia (1996–2009): a systematic review. *Obes Rev*. 2010; 11:403–412. [PubMed: 20233309]
30. Flegal KM, Carroll MD, Ogden CL, Curtin LR. Prevalence and trends in obesity among US adults, 1999–2008. *JAMA*. 2010; 303:235–241. [PubMed: 20071471]
31. Yoo S, Cho HJ, Khang YH. General and abdominal obesity in South Korea, 1998–2007: gender and socioeconomic differences. *Prev Med*. 2010; 51:460–465. [PubMed: 20955726]
32. Lilja M, Eliasson M, Stegmayr B, Olsson T, Söderberg S. Trends in obesity and its distribution: data from the Northern Sweden MONICA Survey, 1986–2004. *Obesity (Silver Spring)*. 2008; 16:1120–1128. [PubMed: 18449186]
33. Xi B, Wang C, Wu L, et al. Influence of physical inactivity on associations between single nucleotide polymorphisms and genetic predisposition to childhood obesity. *Am J Epidemiol*. 2011; 173:1256–1262. [PubMed: 21527513]
34. Ford ES, Mokdad AH, Giles WH. Trends in waist circumference among U. S. adults. *Obes Res*. 2003; 11:1223–1231. [PubMed: 14569048]
35. Deurenberg P, Yap M, van Staveren WA. Body mass index and percent body fat: a meta-analysis among different ethnic groups. *Int J Obes Relat Metab Disord*. 1998; 22:1164–1171. [PubMed: 9877251]
36. Chen CM. Overview of obesity in Mainland China. *Obes Rev*. 2008; 9:14–21. [PubMed: 18307694]

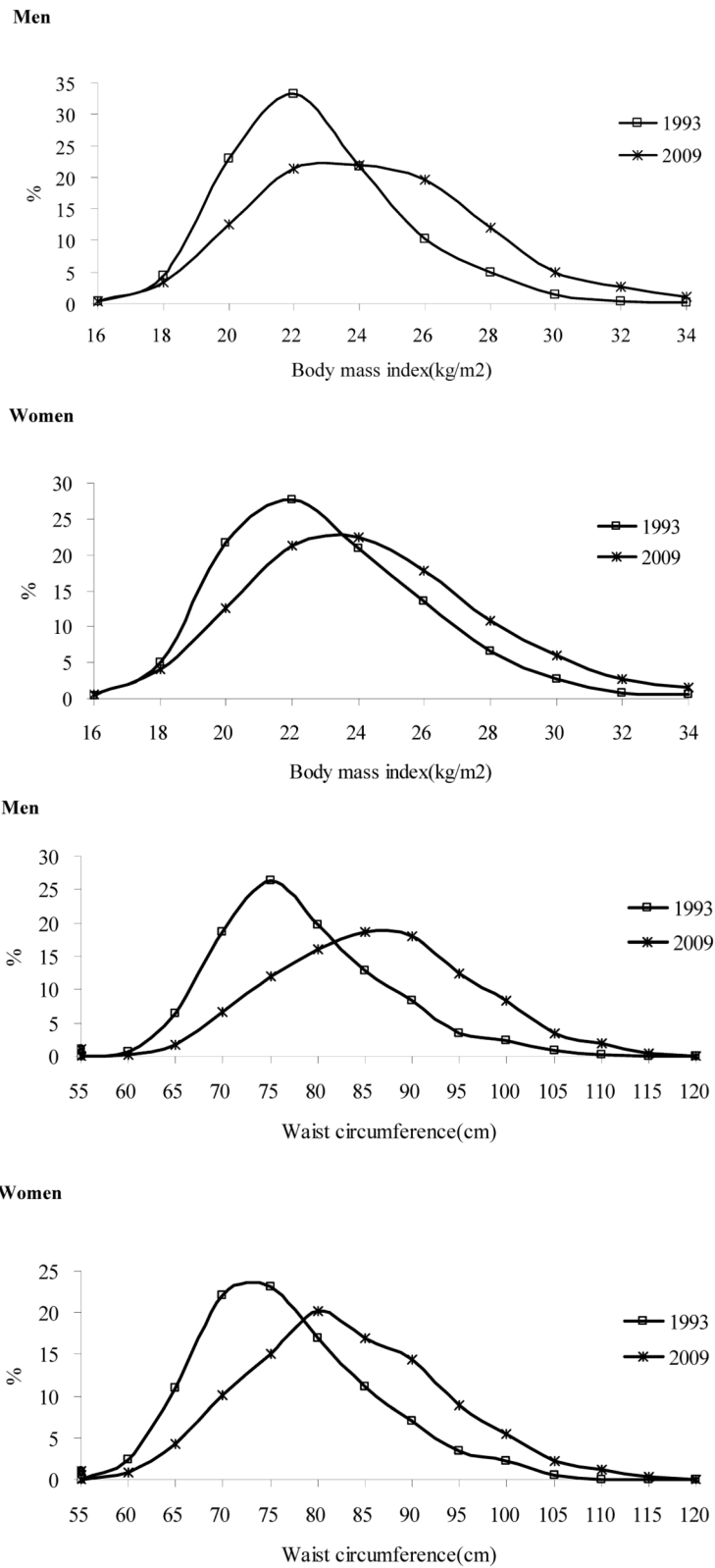


Figure 1.



Distribution of body mass index and waist circumference in Chinese adults from 1993 to 2009

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**Table 1**  
 Summary of previous studies on trends in overweight, general obesity, and abdominal obesity among Chinese adults

Author	Year	Location	Period	Age (Years)	Definition	Trend for men	Trend for women
Overweight or general obesity							
Wang <i>et al.</i> (17)	2003	Beijing	1984–1999	25–64	BMI≥25kg/m <sup>2</sup>	Increase	Decrease
					BMI≥30kg/m <sup>2</sup>	Increase	Decrease
Li <i>et al.</i> (18)	2007	Shanghai	1995–2002	18–94	BMI≥24kg/m <sup>2</sup> and BMI<28kg/m <sup>2</sup>	Increase	Stable
					BMI≥28kg/m <sup>2</sup>	Increase	Increase
Wildman <i>et al.</i> (19)	2008	Mainland China	1991–2000	45–79	BMI≥25kg/m <sup>2</sup>	Increase	Increase
					BMI≥30kg/m <sup>2</sup>	Increase	Increase
Wang <i>et al.</i> (20)	2007	Mainland China	1989–2000	20–45	BMI≥25kg/m <sup>2</sup>	Increase	Increase
Dearth-Wesley <i>et al.</i> (1)	2008	Mainland China	1991–2004	18–54.9	BMI≥25kg/m <sup>2</sup>	Increase	Increase
Jones-Smith <i>et al.</i> (21)	2011	Mainland China	1989–2006	≥18	BMI≥25kg/m <sup>2</sup>	Increase	Increase
					BMI≥30kg/m <sup>2</sup>	Increase	Increase
Yeh <i>et al.</i> (22)	2011	Taiwan	1993–2008	≥18	BMI≥24kg/m <sup>2</sup> and BMI<27kg/m <sup>2</sup>	Increase	Decrease
					BMI≥27kg/m <sup>2</sup>	Increase	Increase
Ko <i>et al.</i> (23)	2010	Hong Kong	1996–2005	20–98	BMI≥25kg/m <sup>2</sup>	Stable	Decrease
Abdominal obesity							
Wang <i>et al.</i> (24)	2007	Mainland China	1993–2004	20–65	WC≥85 cm for men and WC≥80 cm for women	Increase	Increase
Wang <i>et al.</i> (25)	2008	Mainland China	1993–2006	20–65	WC≥85 cm for men and WC≥80 cm for women	Increase	Increase
Ko <i>et al.</i> (23)	2010	Hong Kong	1996–2005	20–98	WC≥90 cm for men and WC≥80 cm for women	Increase	Stable

BMI, body mass index; WC, waist circumference

**Table 2**  
Trends in mean body mass index and waist circumference among Chinese Adults: the CHNS 1993–2009

	1993		1997		2000		2004		2006		2009		<i>p</i> for trend <sup>a</sup>	$\Delta^b$
	<i>n</i>	Mean (SE)	<i>n</i>	Mean (SE)	<i>n</i>	Mean (SE)	<i>n</i>	Mean (SE)	<i>n</i>	Mean (SE)	<i>n</i>	Mean (SE)		
<b>Body mass index(kg/m<sup>2</sup>)</b>														
Total	7760	21.8 (0.1)	8354	22.2 (0.1)	9333	22.7 (0.1)	8983	22.8 (0.1)	8826	22.9 (0.1)	9365	23.0 (0.1)	<0.001	1.2
<b>Men</b>														
Overall	3678	21.6 (0.1)	4048	22.1 (0.1)	4443	22.6 (0.1)	4263	22.8 (0.1)	4147	23.0 (0.1)	4420	23.2 (0.1)	<0.001	1.6
<b>Age (years)</b>														
18–39	1823	21.4 (0.1)	1839	21.8 (0.1)	1844	22.4 (0.1)	1391	22.5 (0.1)	1197	22.9 (0.1)	1177	23.0 (0.1)	<0.001	1.6
40–59	1269	22.1 (0.1)	1506	22.5 (0.1)	1776	23.0 (0.1)	1911	23.3 (0.1)	1931	23.5 (0.1)	2049	23.7 (0.1)	<0.001	1.6
≥60	586	21.6 (0.1)	703	22.3 (0.1)	823	22.6 (0.1)	961	22.7 (0.1)	1019	22.7 (0.1)	1194	22.9 (0.1)	<0.001	1.3
<b>Region</b>														
Urban	1152	22.0 (0.1)	1421	22.5 (0.1)	1506	22.9 (0.1)	1489	23.0 (0.1)	1408	23.1 (0.1)	1450	23.4 (0.1)	<0.001	1.4
Rural	2526	21.4 (0.1)	2627	21.9 (0.1)	2937	22.4 (0.1)	2774	22.7 (0.1)	2739	23.0 (0.1)	2970	23.1 (0.1)	<0.001	1.7
<b>Women</b>														
Overall	4082	22.0 (0.1)	4306	22.3 (0.1)	4890	22.7 (0.1)	4720	22.8 (0.1)	4679	22.8 (0.1)	4945	22.8 (0.1)	<0.001	0.8
<b>Age (years)</b>														
18–39	2063	21.5 (0.1)	1881	22.0 (0.1)	1973	22.2 (0.1)	1501	22.3 (0.1)	1324	22.1 (0.1)	1289	22.1 (0.1)	<0.001	0.6
40–59	1390	22.7 (0.1)	1634	23.0 (0.1)	1967	23.6 (0.1)	2147	23.7 (0.1)	2179	23.8 (0.1)	2311	23.9 (0.1)	<0.001	1.2
≥60	629	22.2 (0.1)	791	22.5 (0.1)	950	22.9 (0.1)	1072	23.2 (0.1)	1176	23.4 (0.1)	1345	23.5 (0.1)	<0.001	1.3
<b>Region</b>														
Urban	1269	22.3 (0.1)	1553	22.7 (0.1)	1670	22.8 (0.1)	1664	22.8 (0.1)	1598	22.8 (0.1)	1652	22.7 (0.1)	<0.001	0.4
Rural	2813	21.9 (0.1)	2753	22.1 (0.1)	3220	22.6 (0.1)	3056	22.8 (0.1)	3081	22.8 (0.1)	3293	22.9 (0.1)	<0.001	1.0
<b>Waist circumference(cm)</b>														
Total	7760	75.6 (0.1)	8354	77.2 (0.1)	9333	78.9 (0.1)	8983	79.9 (0.1)	8826	80.2 (0.1)	9365	81.3 (0.1)	<0.001	5.7
<b>Men</b>														
Overall	3678	76.5 (0.1)	4048	78.6 (0.1)	4443	80.7 (0.1)	4263	82.0 (0.1)	4147	82.5 (0.2)	4420	83.5 (0.2)	<0.001	7.0
<b>Age (years)</b>														
18–39	1823	74.9 (0.2)	1839	77.2 (0.2)	1844	79.6 (0.2)	1391	80.8 (0.3)	1197	81.5 (0.3)	1177	82.1 (0.3)	<0.001	7.2
40–59	1269	78.0 (0.2)	1506	80.0 (0.2)	1776	81.9 (0.2)	1911	83.5 (0.2)	1931	83.8 (0.2)	2049	85.4 (0.2)	<0.001	7.4

	1993		1997		2000		2004		2006		2009		$p$ for trend <sup>a</sup>	$\Delta^b$
	<i>n</i>	Mean (SE)	<i>n</i>	Mean (SE)	<i>n</i>	Mean (SE)	<i>n</i>	Mean (SE)	<i>n</i>	Mean (SE)	<i>n</i>	Mean (SE)		
≥60	586	79.1 (0.4)	703	81.2 (0.4)	823	82.8 (0.4)	961	83.3 (0.3)	1019	83.4 (0.3)	1194	84.7 (0.3)	<0.001	5.6
Region														
Urban	1152	78.4 (0.3)	1421	80.0 (0.3)	1506	81.7 (0.3)	1489	83.0 (0.3)	1408	83.0 (0.3)	1450	84.2 (0.3)	<0.001	5.8
Rural	2526	75.6 (0.2)	2627	77.8 (0.2)	2937	80.2 (0.2)	2774	81.4 (0.2)	2739	82.1 (0.2)	2970	83.1 (0.2)	<0.001	7.5
Women														
Overall	4082	74.5 (0.1)	4306	75.7 (0.1)	4890	77.1 (0.1)	4720	77.9 (0.1)	4679	78.0 (0.1)	4945	79.2 (0.1)	<0.001	4.7
Age (years)														
18–39	2063	72.4 (0.2)	1881	73.5 (0.2)	1973	74.4 (0.2)	1501	75.3 (0.2)	1324	75.3 (0.2)	1289	76.4 (0.3)	<0.001	4.0
40–59	1390	77.3 (0.2)	1634	78.0 (0.2)	1967	80.1 (0.2)	2147	80.8 (0.2)	2179	80.9 (0.2)	2311	82.0 (0.2)	<0.001	4.7
≥60	629	78.8 (0.4)	791	79.4 (0.4)	950	81.6 (0.4)	1072	82.2 (0.3)	1176	82.9 (0.3)	1345	84.2 (0.3)	<0.001	5.4
Region														
Urban	1269	75.8 (0.3)	1553	75.9 (0.3)	1670	76.9 (0.2)	1664	77.8 (0.3)	1598	78.1 (0.3)	1652	78.5 (0.3)	<0.001	2.7
Rural	2813	74.3 (0.2)	2753	75.6 (0.2)	3220	77.2 (0.2)	3056	78.0 (0.2)	3081	78.1 (0.2)	3293	79.6 (0.2)	<0.001	5.3

<sup>a</sup>Linear trends in the mean body mass index and waist circumference were tested using linear regression model adjusted for sex, age and region.

<sup>b</sup>2009–1993

**Table 3**

Trends in prevalence of overweight, general obesity and abdominal obesity among Chinese Adults: the CHNS 1993–2009 (using WHO criteria for Chinese)

	1993		1997		2000		2004		2006		2009		<i>p</i> for trend <sup>a</sup>	$\Delta^b$
	<i>n</i>	% (SE)	<i>n</i>	% (SE)	<i>n</i>	% (SE)	<i>n</i>	% (SE)	<i>n</i>	% (SE)	<i>n</i>	% (SE)		
<b>Overweight</b>														
Total	7760	9.4 (0.3)	8354	11.3 (0.3)	9333	13.8 (0.4)	8983	14.9 (0.4)	8826	15.4 (0.4)	9365	15.7 (0.4)	<0.001	6.3
<b>Men</b>														
Overall	3678	8.0 (0.4)	4048	10.4 (0.5)	4443	13.7 (0.5)	4263	15.0 (0.5)	4147	16.5 (0.6)	4420	17.1 (0.6)	<0.001	9.1
<b>Age (years)</b>														
18–39	1823	6.3 (0.6)	1839	8.4 (0.6)	1844	11.7 (0.7)	1391	12.9 (0.9)	1197	14.6 (1.0)	1177	14.7 (1.0)	<0.001	8.4
40–59	1269	10.6 (0.9)	1506	12.9 (0.9)	1776	17.0 (0.9)	1911	17.8 (0.9)	1931	19.5 (0.9)	2049	20.3 (0.9)	<0.001	9.7
≥60	586	9.2 (1.2)	703	12.8 (1.3)	823	14.5 (1.2)	961	17.0 (1.2)	1019	17.3 (1.2)	1194	19.1 (1.1)	<0.001	9.9
<b>Region</b>														
Urban	1152	10.7 (0.9)	1421	13.0 (0.9)	1506	16.0 (0.9)	1489	16.2 (1.0)	1408	16.4 (1.0)	1450	17.5 (1.0)	<0.001	6.8
Rural	2526	6.8 (0.5)	2627	8.9 (0.6)	2937	12.5 (0.6)	2774	14.1 (0.7)	2739	16.4 (0.7)	2970	16.9 (0.7)	<0.001	10.1
<b>Women</b>														
Overall	4082	10.7 (0.5)	4306	12.1 (0.5)	4890	13.9 (0.5)	4720	14.9 (0.5)	4679	14.4 (0.5)	4945	14.4 (0.5)	<0.001	3.7
<b>Age (years)</b>														
18–39	2063	7.4 (0.6)	1881	9.5 (0.7)	1973	10.9 (0.7)	1501	11.3 (0.8)	1324	11.2 (0.9)	1289	10.3 (0.8)	<0.001	2.9
40–59	1390	15.6 (1.0)	1634	16.1 (0.9)	1967	19.7 (0.9)	2147	21.1 (0.9)	2179	19.9 (0.9)	2311	20.5 (0.8)	<0.001	4.9
≥60	629	12.9 (1.3)	791	13.3 (1.2)	950	12.9 (1.1)	1072	15.6 (1.1)	1176	15.4 (1.1)	1345	17.2 (1.0)	<0.001	4.3
<b>Region</b>														
Urban	1269	13.4 (1.0)	1553	13.7 (0.9)	1670	15.6 (0.9)	1664	16.3 (0.9)	1598	13.1 (0.8)	1652	13.3 (0.8)	0.056	-0.1
Rural	2813	9.5 (0.6)	2753	11.0 (0.6)	3220	12.9 (0.6)	3056	14.1 (0.6)	3081	15.0 (0.6)	3293	14.9 (0.6)	<0.001	5.4
<b>General obesity</b>														
Total	7760	4.0 (0.2)	8354	6.2 (0.3)	9333	8.0 (0.3)	8983	8.7 (0.3)	8826	9.2 (0.3)	9365	10.7 (0.3)	<0.001	6.7
<b>Men</b>														
Overall	3678	2.9 (0.3)	4048	5.5 (0.4)	4443	7.2 (0.4)	4263	8.2 (0.4)	4147	9.4 (0.5)	4420	11.4 (0.5)	<0.001	8.5
<b>Age (years)</b>														
18–39	1823	1.9 (0.3)	1839	4.1 (0.5)	1844	6.8 (0.6)	1391	6.9 (0.7)	1197	9.4 (0.8)	1177	11.8 (0.9)	<0.001	9.9

	1993			1997			2000			2004			2006			2009			<i>p</i> for trend <sup>c</sup>	$\Delta^b$
	<i>n</i>	% (SE)	<i>n</i>	% (SE)	<i>n</i>	% (SE)	<i>n</i>	% (SE)	<i>n</i>	% (SE)	<i>n</i>	% (SE)	<i>n</i>	% (SE)	<i>n</i>	% (SE)				
40-59	1269	3.7 (0.5)	1506	6.2 (0.6)	1776	7.5 (0.6)	1911	10.0 (0.7)	1931	10.0 (0.7)	2049	12.2 (0.7)	2049	12.2 (0.7)	2049	12.2 (0.7)	<0.001	8.5		
≥60	586	4.9 (0.9)	703	9.5 (1.1)	823	8.5 (1.0)	961	9.2 (0.9)	1019	8.1 (0.9)	1194	7.8 (0.8)	1194	7.8 (0.8)	1194	7.8 (0.8)	0.045	2.9		
Region																				
Urban	1152	4.2 (0.6)	1421	7.7 (0.7)	1506	8.9 (0.7)	1489	9.2 (0.7)	1489	9.2 (0.7)	1408	9.5 (0.8)	1450	12.1 (0.9)	1450	12.1 (0.9)	<0.001	7.9		
Rural	2526	2.2 (0.3)	2627	4.3 (0.4)	2937	6.3 (0.4)	2774	7.6 (0.5)	2739	9.2 (0.6)	2970	10.9 (0.6)	2970	10.9 (0.6)	2970	10.9 (0.6)	<0.001	8.7		
Women																				
Overall	4082	5.0 (0.3)	4306	6.7 (0.4)	4890	8.6 (0.4)	4720	9.2 (0.4)	4679	9.0 (0.4)	4945	10.1 (0.4)	4945	10.1 (0.4)	4945	10.1 (0.4)	<0.001	5.1		
Age (years)																				
18-39	2063	2.8 (0.4)	1881	4.6 (0.5)	1973	5.7 (0.5)	1501	6.3 (0.6)	1324	5.4 (0.6)	1289	7.0 (0.7)	1289	7.0 (0.7)	1289	7.0 (0.7)	<0.001	4.2		
40-59	1390	7.3 (0.7)	1634	8.9 (0.7)	1967	11.7 (0.7)	2147	12.0 (0.7)	2179	12.8 (0.7)	2311	13.6 (0.7)	2311	13.6 (0.7)	2311	13.6 (0.7)	<0.001	6.3		
≥60	629	8.4 (1.1)	791	10.4 (1.1)	950	13.2 (1.1)	1072	14.1 (1.1)	1176	14.6 (1.0)	1345	14.9 (1.0)	1345	14.9 (1.0)	1345	14.9 (1.0)	<0.001	6.5		
Region																				
Urban	1269	5.0 (0.6)	1553	8.0 (0.7)	1670	9.3 (0.7)	1664	9.5 (0.7)	1598	9.3 (0.7)	1652	10.0 (0.7)	1652	10.0 (0.7)	1652	10.0 (0.7)	<0.001	5.0		
Rural	2813	4.9 (0.4)	2753	6.0 (0.5)	3220	8.2 (0.5)	3056	8.8 (0.5)	3081	8.7 (0.5)	3293	10.2 (0.5)	3293	10.2 (0.5)	3293	10.2 (0.5)	<0.001	5.3		
Abdominal obesity																				
Total	7760	18.6 (0.4)	8354	22.6 (0.5)	9333	28.8 (0.5)	8983	31.4 (0.5)	8826	32.8 (0.5)	9365	37.4 (0.5)	9365	37.4 (0.5)	9365	37.4 (0.5)	<0.001	18.8		
Men																				
Overall	3678	8.5 (0.5)	4048	13.8 (0.5)	4443	19.5 (0.6)	4263	21.6 (0.6)	4147	23.2 (0.7)	4420	27.8 (0.7)	4420	27.8 (0.7)	4420	27.8 (0.7)	<0.001	19.3		
Age (years)																				
18-39	1823	5.0 (0.5)	1839	9.8 (0.7)	1844	16.0 (0.9)	1391	17.4 (1.0)	1197	19.3 (1.1)	1177	23.9 (1.2)	1177	23.9 (1.2)	1177	23.9 (1.2)	<0.001	18.9		
40-59	1269	11.2 (0.9)	1506	16.4 (1.0)	1776	22.0 (1.0)	1911	26.4 (1.0)	1931	27.9 (1.0)	2049	32.9 (1.0)	2049	32.9 (1.0)	2049	32.9 (1.0)	<0.001	21.7		
≥60	586	16.4 (1.5)	703	23.5 (1.6)	823	27.8 (1.6)	961	27.4 (1.4)	1019	27.9 (1.4)	1194	32.0 (1.3)	1194	32.0 (1.3)	1194	32.0 (1.3)	<0.001	15.6		
Region																				
Urban	1152	12.8 (1.0)	1421	17.4 (1.0)	1506	22.3 (1.1)	1489	23.8 (1.1)	1408	23.9 (1.1)	1450	27.9 (1.2)	1450	27.9 (1.2)	1450	27.9 (1.2)	<0.001	15.1		
Rural	2526	6.3 (0.5)	2627	11.8 (0.6)	2937	17.8 (0.7)	2774	20.1 (0.8)	2739	22.5 (0.8)	2970	27.7 (0.8)	2970	27.7 (0.8)	2970	27.7 (0.8)	<0.001	21.4		
Women																				
Overall	4082	27.8 (0.7)	4306	30.8 (0.7)	4890	37.1 (0.7)	4720	40.3 (0.7)	4679	41.4 (0.7)	4945	45.9 (0.7)	4945	45.9 (0.7)	4945	45.9 (0.7)	<0.001	18.1		
Age (years)																				
18-39	2063	16.5 (0.8)	1881	20.3 (0.9)	1973	24.3 (1.0)	1501	27.4 (1.2)	1324	28.9 (1.2)	1289	33.3 (1.3)	1289	33.3 (1.3)	1289	33.3 (1.3)	<0.001	16.8		
40-59	1390	38.6 (1.3)	1634	41.2 (1.2)	1967	50.7 (1.1)	2147	54.0 (1.1)	2179	54.4 (1.1)	2311	58.6 (1.0)	2311	58.6 (1.0)	2311	58.6 (1.0)	<0.001	20.0		

	1993		1997		2000		2004		2006		2009		<i>p</i> for trend <sup>a</sup>	$\Delta^b$
	<i>n</i>	% (SE)	<i>n</i>	% (SE)	<i>n</i>	% (SE)	<i>n</i>	% (SE)	<i>n</i>	% (SE)	<i>n</i>	% (SE)		
Region	629	47.4 (2.0)	791	47.7 (1.8)	950	56.2 (1.6)	1072	59.1 (1.5)	1176	60.7 (1.4)	1345	66.3 (1.3)	<0.001	18.9
Urban	1269	32.9 (1.3)	1553	33.6 (1.2)	1670	36.9 (1.2)	1664	39.9 (1.2)	1598	41.5 (1.2)	1652	42.9 (1.2)	<0.001	10.0
Rural	2813	25.1 (0.8)	2753	28.7 (0.9)	3220	36.6 (0.8)	3056	40.0 (0.9)	3081	41.1 (0.9)	3293	47.1 (0.9)	<0.001	22.0

<sup>a</sup>Linear trends in the prevalence of overweight, general obesity and abdominal obesity were tested using logistic regression model adjusted for sex, age and region.

<sup>b</sup>2009–1993

Overweight and general obesity were defined as a BMI from 25 kg/m<sup>2</sup> to 27.49 kg/m<sup>2</sup> and a BMI  $\geq 27.5$  kg/m<sup>2</sup>, respectively. Abdominal obesity was defined as a WC  $\geq 90$  cm for men and  $\geq 80$  cm for women.