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Central obesity and hypertension in Chinese adults: A 12-year longitudinal examination

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ABSTRACT

Objective. In Chinese adults, the trend of central obesity and its longitudinal association with hypertension, independent of general obesity, was examined.

Methods. A 12-year longitudinal analysis was conducted using data retrieved from the China Health and Nutrition Survey. This study examined 6096 individuals (normotensive in 1997) who were followed up with in 2000, 2004, 2006, and 2009. Prevalence of hypertension in 2009 was predicted by baseline central obesity and waist circumference changes during a 12-year follow-up period along with confounding covariates using multiple logistic regressions.

Results. Between 1997 and 2009, the prevalence of central obesity increased from 17.3% to 39.4% and was highest among individuals ≥60 years of age in 1997. By 2009, 26.8% of the participants developed hypertension. The odds ratio of developing hypertension during the 12-year study period for Chinese adults with central obesity at baseline was 1.79 (95% confidence interval = 1.36–2.35) compared to those without central obesity, controlling for general obesity, demographics, smoking/drinking behavior, and fat intake.

Conclusions. Among Chinese adults, central obesity increases the risk for developing hypertension later in life, even after controlling for general obesity, smoking, drinking, and high fat intake among other factors. Waist circumference should be targeted in the efforts of hypertension prevention.

Introduction

Cardiovascular disease (CVD) is a leading cause of disability and death worldwide (World Health Organization, 2002). In China, CVD contributes to approximately one third of the total deaths, and the number is predicted to double by 2020 (China Ministry of Health, 2006; Wang et al., 2007). Hypertension, the most important and modifiable risk factor for CVD, is one of the major public health issues in China (Gu et al., 2002; Wu et al., 2008). According to the 2002 China National Nutrition and Health Survey (China NNHS), approximately 153 million Chinese adults had hypertension.

Body mass index (BMI) has been widely used in China to assess obesity and CVD (Wang et al., 2007); however, BMI can only predict part of obesity-related health risks (Zaninotto et al., 2010). Waist circumference (WC), a simple and effective measure of central obesity, has often been shown to be a strong predictor of an increased risk of hypertension, diabetes, dyslipidemia, metabolic syndrome, and coronary heart disease independent of BMI (Berglund et al., 1982; Pouliot et al., 1994; Wang et al., 2005). The strength of association between central obesity and hypertension has been inconsistent across ethnic groups (Alberti et al., 2006; Bell et al., 2002). Moreover, the longitudinal contribution of central obesity versus general obesity to hypertension is poorly defined (Wildman et al., 2005). Studies are needed to understand the longitudinal trend in central obesity (Walls et al., 2011) and the association with hypertension among Chinese adults (Wildman et al., 2005; Wang et al., 2006). Therefore, it is important to examine newly released longitudinal data from Chinese adults.

This study examined trends in WC, central obesity, and hypertension development in normotensive Chinese adults and whether or not baseline central obesity and WC changes during a 12-year follow-up period are longitudinal predictors for hypertension. Also this study investigated relative effects of longitudinal changes of WC versus baseline WC on the development of hypertension under adjustment of current BMI. An obesity epidemic is occurring in China due to the increasing availability of food, the decreasing demand for physical activity, and changes in lifestyle behaviors (Wang et al., 2007; Wu et al., 2008). Previous studies have suggested that the prevalence of hypertension rises quickly in parallel with lifestyle changes and obesity epidemics (Doll et al., 2002; Wang et al., 2007). Cross-sectional studies involving

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Americans, Mexicans, and Chinese have shown that WC is associated with higher blood pressure (Janssen et al., 2004; Wildman et al., 2005; Flores-Huerta et al., 2009). We have thus formulated the following two hypotheses: (1) between 1997 and 2009, WC, the prevalence of central obesity, and hypertension increased significantly among Chinese adults; and (2) baseline central obesity, as defined by WC, and changes in WC are significantly associated with hypertension prevalence in 2009, independent of the BMI category.

Methods

Study design and population

The China Health and Nutrition Survey (CHNS) is an ongoing nationwide survey of the health and nutritional status of the Chinese. The CHNS was completed in 1989, 1991, 1993, 1997, 2000, 2004, 2006, and 2009. Using multistage random cluster sampling, the CHNS covers 9 provinces that vary in economic and demographic circumstances. Details about the CHNS have been published elsewhere (Popkin et al., 2010). Adult participants of the 1997 CHNS who were interviewed repeatedly in the subsequent surveys are included in our analyses. WC data has been collected since 1993. This study only used longitudinal data between 1997 and 2009 due to the low response rate of the 1993 participants. Participants with missing data necessary for key analyses (such as gender, WC, and blood pressure) were excluded from our analyses. The final sample of this study included 24,129 observations from 2933 men and 3163 women (6096, 5124, 4628, 4360, and 3921 observations in 1997, 2000, 2004, 2006, and 2009, respectively). The mean age was 42.1 for 1997 and 54.4 years for 2009. The study protocol for this study was approved by the Human Subjects Committee of the authors' institution.

Study variables

Data was collected at the participants' houses or a local clinic by well-trained health workers. Height, weight, blood pressure, and WC were determined following standardized methods and uniform equipment. Participants were asked to remove their shoes, hats, or heavy clothing. The height was measured within 0.1 cm using a portable stadiometer (Wang et al., 2006). The weight was measured within 0.1 kg using a portable electronic scale (Wang et al., 2006). WC was defined by the mid-point between the lower margin of the arcus costalis on the midaxillary and the inter-iliac crest lines. WC was measured twice within 0.1 cm using a measuring tape. Systolic and diastolic blood pressures were measured three times using a standard mercury sphygmomanometer. Participants were asked to avoid factors (such as smoking, intense sports, and beverages with caffeine) that may affect blood pressure 1 h before measurement. Participants were also asked to sit still in a quiet room for 5 min before measurement of the upper arm artery. The average values of the measurements were used in this study. Individual dietary intake was converted from the 24-hour recall of food consumption by averaging the records of three days (Du et al., 2004). Demographic and behavioral information, such as residency, household income, level of education, fat intake, smoking, and drinking, were collected using a standardized questionnaire (Popkin et al., 2010).

BMI category was defined by BMI cut-off points (18.5 kg/m^2 for underweight, 23.0 kg/m^2 for overweight, and 27.5 kg/m^2 for obesity) that correspond to the World Health Organization experts' recommendations for Asian adults (WHO Expert Consultation, 2004; Seo et al., 2012). Central obesity was defined by country/ethnic-specific WC (≥90 cm for males and ≥80 cm for females) as recommended by the International Diabetes Federation (IDF; Alberti et al., 2006). Hypertension was defined as an average systolic blood pressure ≥140 or an average diastolic blood pressure ≥90 or self-reported use of anti-hypertension medications (Gu et al., 2002; Chobanian et al., 2003). Participants who currently smoked cigarettes or consumed alcoholic beverage were coded as current smokers or drinkers, respectively.

Statistical analysis

The data were prepared and analyzed with SAS (version 9.3). All analyses were adjusted for clustering within communities and households. To describe longitudinal trends in behaviors and anthropometrics, means and standard deviations of continuous variables and frequencies of categorical variables were presented by age groups (18–39, 40–59, and ≥60 years) (Ford et al., 2011). Multiple logistic regressions were performed to predict prevalence of hypertension in 2009 with baseline central obesity in 1997 and WC changes during a 12-year follow-up period along with such confounding covariates as gender, age group (at baseline), BMI categories, smoking, drinking, fat intake, household income, and education level in 2009. These covariates have been shown to be significantly related to hypertension (Gu et al., 2007; Wu et al., 2008).

Results

Table 1 shows the demographic characteristics of the participants at baseline (1997). The mean ages were 41.4 (standard deviation = 13.7) years for men and 42.8 (standard deviation = 13.6) years for women. Approximately two thirds of the participants were rural residents and approximately one half had a low income. A similar percentage of men and women were urban residents with similar household incomes. Males and younger participants had higher levels of education than females and elderly participants. Individuals ≥60 years of age had the lowest household incomes and levels of education.

Table 2 presents the trends in behaviors and anthropometric measurements. During 12 years of follow-up, the WC increased approximately 5 cm for both men and women across the age groups. The prevalence of overweight, obesity, central obesity, and hypertension increased significantly. The prevalence of overweight, obesity, and central obesity slowly increased in the elderly group, whereas the prevalence of hypertension increased more rapidly in the elderly group. By 2009,

Table 1
Baseline (in year 1997) characteristics of the sample, Chinese adults.

	Men						Women					
	18–39 years (n = 1417)		40–59 years (n = 1198)		≥60 years (n = 318)		18–39 years (n = 1435)		40–59 years (n = 1329)		≥60 years (n = 399)	
	%	n	%	n	%	n	%	n	%	n	%	n
Residency												
Urban	30.6	433	29.5	353	32.7	104	33.2	477	29.8	396	35.8	143
Rural	69.4	984	70.5	845	67.3	214	66.8	958	70.2	933	64.2	256
Household income[a]												
Low income	49.7	704	46.7	559	62.3	198	48.9	701	47.4	630	60.9	243
Middle income	39.0	553	39.1	468	29.9	95	39.2	563	38.53	512	33.1	132
High income	11.3	160	14.3	171	7.9	25	11.9	171	14.07	187	6.0	24
Highest degree												
No degree	5.2	74	20.6	246	57.3	181	14.6	208	52.3	693	86.5	339
Elementary school	17.5	247	34.5	412	19.9	63	24.2	345	24.4	323	9.7	38
Lower middle school	47.4	670	27.4	327	12.7	40	38.4	548	13.4	178	2.0	8
High school or higher	30.0	424	17.6	210	10.1	32	22.9	327	9.9	131	1.8	7

[a] Household income was inflated to the 2009 level and divided into tertiles.