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Association between obesity phenotypes and incident hypertension among Chinese adults: a prospective cohort study



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ABSTRACT

Objectives: To explore the association between obesity phenotype and the risk of hypertension among Chinese adults.

Study design: A prospective cohort study.

Methods: Two waves of data were collected in 2009 and 2011 by the China Health Nutrition Survey. According to International Diabetes Federation and Chinese obesity criteria, participants were divided into four groups: metabolically healthy non-overweight/obesity (MHNO), metabolically healthy overweight/obesity (MHO), metabolically abnormal non-overweight/obesity (MANO), and metabolically abnormal overweight/obesity (MAO). Logistic regression model was performed to estimate the risk of hypertension with obesity phenotype.

Results: Among a total of 4604 adults aged 18–65 years at baseline, 467 developed hypertension during the 2-year follow-up period. After adjusting for several potential confounders, significantly increased risks for hypertension were found for participants in MHO (odds ratio [OR]: 1.78, 95% confidence interval [CI]: 1.39–2.27), MANO (OR: 1.71, 95% CI: 1.02–2.86), and MAO (OR: 3.35, 95% CI: 2.54–4.42) group compared with the MHNO group.

Conclusion: Metabolically abnormal individuals, regardless of their body weight status, showed significantly higher risks for hypertension compared with healthy non-overweight/obese group. Furthermore, MHO individuals had significantly increased risk of incident hypertension.

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Introduction

Obesity has become a major challenge worldwide in the last few decades. Accumulative evidence indicates that obesity is

an independent risk factor for elevated blood pressure, insulin resistance, and inflammation.^{1,2} Although it is well known that metabolically abnormal individuals, regardless of obesity or non-obesity, present increased risk of unfavorable

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cardiometabolic outcomes, some studies reported a favorable cardiometabolic profile among overweight/obese individuals as called ‘metabolically healthy overweight/obese (MHO)’ state. They did not show increased risk for diabetes and cardiovascular diseases (CVDs) compared with metabolically healthy non-overweight/obese (MHNO) individuals.^{3–5} In contrast, a recent meta-analysis of 12 studies (8 cohort and 4 cross sectional) found that MHO individuals had similar risks for all-cause mortality and CVD events to people with normal weight,⁶ while another meta-analysis of 22 cohort studies suggest a positive association between MHO phenotype and CVD but not all-cause mortality.⁷

Hypertension has been implicated as an important predictor of CVD morbidity and mortality;^{8,9} therefore, the examination of the relationship of obesity phenotype with incident hypertension may help to clarify the inconsistent findings. Nevertheless, only a few studies have examined the association between obesity phenotype and risks of hypertension.¹⁰ The obesity status among two studies in Korean adults was defined using body mass index (BMI),^{11,12} while the other study was conducted among Chinese children and adolescents.¹³ Therefore, we examined the risk of hypertension according to obesity phenotype using both BMI (total obesity) and waist circumference (WC, central obesity) definition in a nationally representative data set of Chinese adults.

Methods

Two waves of data were collected in 2009 and 2011 from the China Health and Nutrition Survey (CHNS). The CHNS is a longitudinal and ongoing survey with samples from nine diverse provinces (Hubei, Hunan, Jiangsu, Liaoning, Heilongjiang, Henan, Shandong, Guangxi, Guizhou) throughout China from 1989 to 2011. The focus of the CHNS was to investigate the influences of sociodemographic factors, diet, physical activity (PA), and health status relative to social and economic change. Details about the survey have been described elsewhere.¹⁴

Among a total of 6443 participants aged 18 years and older that were involved in both surveys in 2009 and 2011, 1839 were excluded (1598 reported hypertension in 2009, 72 females were pregnant either in 2009 or 2011, 144 had missing lab data, and 25 had missing anthropometric data in 2009), resulting a total of 4604 participants that were analyzed in the final analysis.

Anthropometric measurement and laboratory test

Height and weight were measured without caveats by trained interviewers using calibrated beam scales and BMI (kg/m^2) was calculated. WC was measured at a point midway between the lowest rib and the iliac crest by a non-elastic tape.

Fasting blood sample was collected for the first time in 2009. All blood specimens were sent to a national central lab in Beijing (medical laboratory accreditation certificate ISO 15189:2007) for process. Biochemical markers including high-density lipoprotein (HDL) cholesterol, low-density lipoprotein cholesterol, total cholesterol, triglyceride (TG), and glucose were measured by an automatic clinical chemistry analyzer (Hitachi 7600 D and P model, Japan).

Information including age, gender, fruit and vegetable (FV) intake, PA, alcohol status, current smoking, and province for mother, etc. was self-reported by participants using interviewer-administered household questionnaires. PA including domestic, occupational, transportation, and leisure-time PA was assigned metabolic equivalent values to account for both intensity and time spent on activities.¹⁵ Dietary intake was assessed by using three consecutive 24-h recalls with food models and picture aids by interviewers. FV intake over 3 days and salt intake were calculated using Chinese food coding table.¹⁶

Hypertension incidence

At the baseline (2009) and follow-up visit (2011), blood pressure (BP) was measured for each subject by trained workers at three different consecutive times on one visit. Three consecutive readings were taken and the mean value was recorded as the final BP value. Hypertension was defined as an average diastolic BP (DBP) ≥ 90 and/or systolic BP (SBP) ≥ 140 mmHg or self-reported use of anti-hypertension medications.

Definition of metabolic health, obesity status, and obesity phenotype

Metabolic syndrome (MetS) was defined using International Diabetes Federation criteria: individuals with MetS must be central obesity (defined as WC ≥ 90 cm for men and ≥ 80 cm for women, respectively) and any two of the following four symptoms: (i) TG level ≥ 150 mg/dl (1.7 mmol/l), or specific treatment for this lipid abnormality; (ii) HDL < 40 mg/dl (1.03 mmol/l) in males and < 50 mg/dl (1.29 mmol/l) in females, or specific treatment for this lipid abnormality; (iii) SBP ≥ 130 mmHg or DBP ≥ 85 mmHg or specific treatment of previously diagnosed hypertension; (iv) fasting plasma glucose ≥ 100 mg/dl (5.6 mmol/l) or previously diagnosed type 2 diabetes.¹⁷ Total obesity status was defined according to Chinese BMI criteria: overweight/obese ≥ 24 kg/m^2 and non-overweight/obese < 24 kg/m^2 .¹⁸

Obesity phenotype was defined based on obesity (BMI) status and metabolic health. The participants were divided into four groups: metabolically abnormal overweight/obesity (MAO); metabolically abnormal non-overweight/obesity (MANO); MHO, and MHNO. In order to assess the risk of hypertension with metabolic health and central obesity (WC) based on Chinese WC cut-off points (male ≥ 85 cm and female ≥ 80 cm),¹⁸ we also conducted a second set of analysis using the similar method described above, except that MetS was defined as any two of four metabolic risk factors, including adverse TG/HDL profile, hypertension and diabetes risk.

Statistical analysis

The differences of baseline characteristics among obesity phenotype groups were examined by analysis of covariance for continuous variables after adjustment for potential confounders (age, gender, PA, FV intake, and smoking, etc.) and Chi-squared test for categorical variables, respectively. Multivariate logistic regression model was used to calculate the adjusted odd ratios (ORs) and 95% confidence intervals

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