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Influence of age on the relation between waist circumference and cardiometabolic risk markers

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Abstract *Background and aims:* To determine whether the relation between waist circumference (WC) and cardiometabolic risk markers is attenuated with advancing age.
Methods and results: The study population consisted of 5222 adults from the 1999 to 2004 U.S. National Health and Nutrition Examination Survey, a nationally representative cross-sectional study. Study variables were assessed in a clinical exam. Subjects were grouped into low, moderate, and high sex-specific WC tertiles. The cardiometabolic risk markers examined consisted of insulin resistance (HOMA method), high C-reactive protein, hypertension, and high LDL-cholesterol. Logistic regression was used to determine and compare the association between WC categories with high-risk cardiometabolic risk marker values within young (20–39 years), middle-aged (40–59 years), and older (60+ year) adults. With few exceptions, within each of the three age categories, individuals with a moderate and high WC were significantly more likely to have elevated cardiometabolic risk markers than individuals with a low WC. There was a significant interaction between age and WC indicating that the relation between WC with insulin resistance, high CRP, and hypertension was attenuated in older adults. For example, the odds ratio for hypertension in those with a high relative to low WC was 11.07 (95% CI: 6.13–20.00) in young adults, 3.67 (2.47–5.46) in middle-aged adults, and 2.68 (2.00–3.59) in older adults. Similar observations were made for BMI to those reported for WC.
Conclusions: A high WC was associated with elevated cardiometabolic risk markers irrespective of age. However, the association between WC and cardiometabolic risk markers was greatly attenuated with advancing age.

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Introduction

Overweight and obesity are highly prevalent conditions in all age groups, including the elderly [1,2], the age group that represents the fastest growing segment of the population in most industrialized countries. Overweight and obesity are most commonly diagnosed in both the clinical and research settings using the body mass index (BMI). Although BMI thresholds of 25 kg/m^2 (overweight) and 30 kg/m^2 (obesity) are recommended for adults of all ages [3], a substantial body of evidence indicates that the relation between an elevated BMI with cardiometabolic and mortality risk is severely attenuated in older adults in comparison to young and middle-aged adults [4–6].

It has been suggested that the relatively weak relation between BMI and health risk in the elderly is explained in part by the fact that BMI is a poorer marker of body composition in this age group [4,7]. Indeed, the correlation between BMI and total fat mass is weaker in older adults than it is in young adults [8]. This observation may reflect age-related changes in body composition including a loss in skeletal muscle mass [9,10] and a redistribution of fat from the periphery to the abdomen, particularly to the intra-abdominal/visceral depot [11,12]. Waist circumference (WC) is a superior marker of abdominal and visceral fat than is BMI [13,14], and should be influenced to a lesser degree by age-related muscle loss. Therefore, one may hypothesize that, unlike BMI, the effects of an elevated WC on health risk are not significantly attenuated in old age. Confirmation of this hypothesis would provide additional support for the opinion of many experts in the obesity field that WC rather than BMI be used as the primary measure of overweight and obesity status. Therefore, the purpose of this study was to determine whether or not the relation between an elevated WC and cardiometabolic risk markers is attenuated in old age.

Methods

Study population

The study sample was obtained from the 1999 to 2000, 2001 to 2002, and 2003 to 2004 rounds of the U.S. National Health and Nutrition Examination Survey (NHANES). The NHANES was designed to be a nationally representative cross-sectional survey, and two or three survey rounds can be combined, as done here. NHANES was conducted by the U.S. National Center for Health Statistics to estimate the prevalence of major diseases, nutritional disorders, and risk factors for these diseases. The sampling plan used a stratified, multistage, probability cluster design. All data were collected by the NHANES team using standardized procedures. Full details of the study design and procedures are available elsewhere [15]. Informed consent was obtained from all participants and the protocol was approved by the National Center for Health Statistics. The secondary analysis presented here was approved by the Queen's University Health Sciences Research Ethics Board.

The present study included adult (≥20 years) participants that completed both the home exam and mobile exam portions of the NHANES study and had fasting blood samples. Of the 6934 eligible participants, 387 were excluded due to pregnancy and 1325 were excluded due to missing data on the exposure or outcome measures required for analyses (943 for LDL-cholesterol, 353 for glucose, 449 for insulin, 377 for C-reactive protein, 199 for BMI, 290 for waist circumference, and 311 for blood pressure). This left a total of 5222 participants for analysis. In comparison to those included in the present study, the excluded NHANES participants were 4.3 years older and had significantly less favorable values for many of the metabolic risk markers and anthropometric variables (difference between group means = − 4.1 mg/dL for HDL-cholesterol, 17.1 mg/dL for glucose, 5.9 mmHg for systolic blood pressure, 2.3 cm for waist circumference, and 0.82 kg/m^2 for BMI).

Measurement and classification of anthropometric variables

WC was measured during minimal respiration to the nearest 0.1 cm at the level of the iliac crest. Height was measured to the nearest 0.1 cm and body mass to the nearest 0.1 kg. BMI was determined as body mass/height^2 (kg/m^2). Subjects were divided into sex-specific tertiles for WC and BMI. WC and BMI groups were determined based on tertiles rather than commonly employed clinical thresholds so that the groups would be matched for size and variation both within (i.e., three equally sized WC groups) and across (i.e., high WC group the same size as high BMI group) anthropometric measures. In men the WC tertiles were defined by the following thresholds: ≤92.7 cm, 92.8–104.0 cm, and ≥104.1 cm. The corresponding values in women were ≤86.8 cm, 86.9–99.6 cm, and ≥99.7 cm. In men the BMI tertiles were defined by the following thresholds: ≤25.2 kg/m^2, 25.3–29.1 kg/m^2, and ≥29.2 kg/m^2. The corresponding values in women were ≤24.8 kg/m^2, 24.9–30.3 kg/m^2, and ≥30.4 kg/m^2.

Measurement and classification of cardiometabolic risk markers

Cardiometabolic health is a measure of a person's risk for type 2 diabetes and cardiovascular disease and is a gauge of overall health. Four risk factor markers were examined in this study to capture different aspects of cardiometabolic risk.

Blood pressure and hypertension

Three blood pressure measurements were obtained with the subject in a seated position using a standard manual mercury sphygmomanometer. The average of the three readings was utilized. Mean arterial blood pressure was calculated as diastolic blood pressure +1/3 of systolic blood pressure. Participants were considered to have hypertension if their systolic blood pressure was ≥140 mmHg and/or their diastolic blood pressure was ≥90 mmHg according to established clinical guidelines [16]. Participants who reported taking blood pressure medication were considered to have hypertension regardless of their blood pressure measurements.

Abnormal lipid metabolism

LDL-cholesterol was used as the measure of lipid metabolism given its availability within the NHANES database and