Diabetes & Metabolic Syndrome: Clinical Research & Reviews 10 (2016) 143–148

Contents lists available at ScienceDirect

Diabetes & Metabolic Syndrome: Clinical Research & Reviews

journal homepage: www.elsevier.com/locate/dsx

Original Article

Comparison of adiposity indices and cut-off values in the prediction of metabolic syndrome in postmenopausal women

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ARTICLE INFO

Keywords:
Metabolic syndrome
Obesity
Aging
Menopause

SUMMARY

Aims: To compare adiposity indices and to assess their various cut-off values for the prediction of metabolic syndrome (MetS) in postmenopausal women.
Methods: One hundred forty nine volunteers (67.17 ± 6.12 years) underwent body composition assessment using DXA and had 5 anthropometric indices measured (Waist Circumference, WC; Waist-to-Height Ratio, WHtR; Body Mass Index, BMI; Body Adiposity Index, BAI; and Conicity Index). Blood pressure was assessed using an oscillometric device and fasting blood samples were collected. MetS was classified according NCEP-ATP III. Cut-off values to predict MetS were obtained using Receiver Operating Characteristic (ROC) curve analyses and odds ratios were also calculated.
Results: MetS prevalence was 29.5% and subjects who were classified with MetS showed worse cardiometabolic outcomes and higher anthropometric indices values ($p < 0.05$). With the exception of total- and LDL-cholesterol, all remaining variables were significantly correlated with at least one of the adiposity indices, with the strongest relationships observed for the indices reflecting central body fat. The cut-off values were 88 cm, 0.57 cm/cm, 26.85 kg/m^2, 43.7%, 36.34%, and 1.24 units for WC, WHtR, BMI, DXA-derived body fat percentage, BAI, and conicity index, respectively. Significant greater risks for MetS were found for volunteers who had WHtR (odds = 9.08; CI: 1.81–45.47) or WC (odds = 5.20; CI: 1.30–20.73) measurements above cut-off values.
Conclusion: Adiposity indices are associated with MetS in postmenopausal women in different degrees. Indices which consider central adiposity such as WC and WHtR have a stronger relationship with MetS compared to DXA-derived body fat percentage, which is considered a gold standard.

1. Introduction

The aging process is associated with a decline in most physiological functions; thus, there exists a need for research related to maintaining physical function as the World's population ages [1]. Important changes that occur with advancing age include fat mass accumulation, which has been consistently linked with impaired cardiometabolic health in older individuals [2]. Moreover, the prevalence of obesity is greater in women, with adiposity accumulation peaking around the fifth decade of life [1,3], coinciding with menopause. Menopause is also associated with reductions in muscle mass and strength, particularly among sedentary women [4], contributing further to increased cardiometabolic risk. Taken together, the postmenopausal period itself is an independent risk factor for the development of metabolic disorders [5].

The clustering of cardiometabolic risk factors has been referred to as metabolic syndrome (MetS), a complex disorder that is considered a worldwide epidemic [6,7]. The prevalence of MetS has increased and is dependent on sex and age, with a higher incidence reported in postmenopausal women [8]. MetS negatively impacts quality of life, is a major risk factor for cardiovascular disease and has important health care costs implications. Thus, measurement strategies with high predictive accuracy for the identification of MetS are critical to optimally define this syndrome. In this regard, although a variety of adiposity indices have been associated with

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http://dx.doi.org/10.1016/j.dsx.2016.01.005
1871-4021/

cardiometabolic risk [9–11], optimal definitions and cutpoints for the detection of MetS in postmenopausal women have not been fully explored. Gold standard equipment to assess body composition such as dual-energy X-ray absorptiometry (DXA) is not widely accessible for large populations [12]. Therefore, low cost measurements of adiposity for the prediction of MetS merits attention and would provide important practical applications.

In an effort to improve upon commonly used methods to estimate percent body fat, Bergman et al. [13] recently proposed the body adiposity index (BAI), which was strongly associated ($r = 0.85$) with DXA-derived body fat percentage. However, its significance for diagnosing obesity-related conditions is unclear. Several other adiposity indices are commonly used to identify cardiometabolic risk, but further studies are necessary in the context of predicting MetS. Even though body mass index (BMI) has been the most widely used measurement to classify obesity, it has been criticized because it lacks consideration of fat distribution [14]. In this regard, it is well known that excessive intra-abdominal fat accumulation is an independent risk factor for developing MetS, so that waist circumference (WC) is considered a criterion for its definition [9–11]. Other indices in addition to WC have been used to estimate central adiposity such as waist-to height ratio (WHtR), and the conicity index [15,16]. All of these indices have demonstrated significant relationships with cardiometabolic risk. However, when compared to one another, indices that consider abdominal adiposity have consistently been shown to be superior predictors of metabolic risk and adverse outcomes [16–21]. Noteworthy, none of these studies used a gold standard for body composition analysis.

An improvement in cut-off points above which individuals would be at greater risk for MetS would be an important advance. Such an improvement in classification would be helpful for the earlier and more accurate identification of MetS, permitting an implementation of early preventive strategies during the aging process. Recently, Mora-García et al. [15] suggested cutpoints for identifying MetS using anthropometric variables among adult-Colombian women. These authors proposed cut-off values for WC, BMI, BAI, Waist to hip ratio, and WHtR. However, cut-off values for indices of adiposity in postmenopausal women have not been clearly defined. Such cutpoints are important given that the prevalence of MetS is expected to increase as the population ages worldwide. Thus, the aim of the present study was to compare adiposity indices and to assess their various cut-off values for the prediction of MetS in postmenopausal women.

2. Material and methods

2.1. Experimental approach

To compare the ability of adiposity indices to predict MetS and determine optimal cut-off values in postmenopausal women, a representative sample of postmenopausal women from Brazil took part in this cross-sectional study. Volunteers underwent blood pressure measurements, blood sample analyses, anthropometric measurements, and body composition assessments using DXA. MetS was identified according to the NCEP-ATP III definition. In addition, correlations between indices of adiposity, body composition, and MetS-phenotypes were examined. Cut-off values with the highest sensitivity and specificity were proposed and odds ratios for predicting MetS were calculated.

2.2. Subjects

We considered MetS prevalence, 95% confidence intervals and a study error of 8%, to derive an appropriate sample size of 144 postmenopausal women. Thus, a representative sample of older women was recruited by visits to leisure and physical activity centers for elderly people, phone calls, and advertisements. Initially, 200 volunteers answered an in-person questionnaire addressing medical history, years of post-menopause, medication use, and co-morbidities. After exclusion criteria were applied, 149 women (67.17 ± 6.12 years; 16.65 ± 8.17 post-menopause years) took part in the present cross-sectional study. Exclusion criteria included those unable to walk without assistance, metallic prosthesis implants, and pacemaker use.

All volunteers were informed about the study procedures and voluntarily signed an informed consent form. The authors declare that all experiments on human subjects were conducted in accordance with the Declaration of Helsinki and the study protocol was previously approved by the Ethics Committee from the University under Registration 001/13.

2.3. Anthropometric measurements and calculations

All anthropometric measurements were conducted in the morning, after an overnight fast. Body mass was evaluated with 0.1 kg precision on a physician's digital balance beam scale and height was measured to the nearest 0.1 cm using a wall stadiometer. Waist circumference was assessed at the level of umbilicus and hip circumference was determined at the level of the maximum extension of the buttocks posteriorly in a horizontal plane. An anthropometric tape (Sanny Anthropometric Medical) was used to measure both waist and hip circumferences. All measurements were carried out by the same experienced researcher. BMI was calculated as weight (kg) divided by height squared (m^2). WHtR was calculated as waist divided by height in centimeters and BAI was calculated as [(hip circumference)/((height)$^{1.5}$) − 18)]. Lastly, conicity index was determined according to the following equation: conicity index = waist circumference (m)/0.109$\sqrt{(\text{total body mass (kg)/height (m)})}$.

2.4. Body composition assessments

Body composition was measured using DXA (lunar model 8743, GE Medical Systems, USA) according to procedures specified elsewhere [22]. Body fat percentage was registered and considered for subsequent analyses. All measurements were carried out by the same trained technician and the equipment was calibrated daily according to manufacturer specifications. The DXA equipment has been demonstrated to a coefficient of variation of 1.9% with 6 measurements on consecutive days.

2.5. Metabolic syndrome

Blood pressure was measured twice following 5 and 10 min of rest using an oscillometric automated device (BP 3AC1- 1PC, Microlife, Switzerland) with volunteers in the seated position. The mean values of systolic and diastolic blood pressure from the two measurements were considered for analyses. Within-subject coefficient of variation for the device was 6.0% and 5.7% for systolic and diastolic blood pressure, respectively.

Blood was collected following an overnight fast of at least 12 h. Samples were immediately moved to a laboratory for analysis for glucose, lipid profile, and insulin. Triglycerides, cholesterol and sub-fractions as well as blood glucose were measured using an enzymatic colorimetric method, processed in an Autohumalyzer A5 (Human-2004). Plasma insulin concentration was assayed using the Automated Chemiluminescence System ACS-180 (Ciba-Corning Diagnostic Corp., 1995, United States). Inter- and intra-assay coefficients of variation for blood variables determination did not exceed 4.5%.