



Association between waist circumference (WC) values and hypertension, heart disease (HD) and diabetes, reported by the elderly – SABE survey: Health, wellness and aging, 2000 and 2006



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ABSTRACT

The positive association between WC and systemic arterial hypertension (SAH), diabetes mellitus (DM) and HD calls for investigation in the elderly. The objective of the present study was to identify WC values, so as better to determine the risk of these diseases. This was a longitudinal study using the data of 405 elderly participants of the SABE Survey: Health, Well-being and Aging, undertaken in São Paulo, in 2000 and 2006. The study variables were WC, sex, age group, ethnicity, and body mass index (BMI) (2000) and SAH, DM and HD (2006). The area under the Receiver Operating Characteristics (ROC) curve (AUC) and confidence intervals of 95% was used to estimate the performance of WC values in correctly discriminating among the elderly, according to the reference or not to diseases associated with WC. WC critical values were identified by the highest positive likelihood ratio (PLR), and negative likelihood ratio (NLR) equal to zero. The AUC showed the satisfactory performance of WC critical values in discriminating between reports of DM in individuals of 60–74 years of age. The WC critical values identified were ≥ 87 cm for women and ≥ 99 cm for men, which presented a better performance in relation to the AUC value than to the WC values commonly used. The WC critical values identified in this study showed better discriminatory power of foretelling reference to DM than did the WC values commonly used.

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1. Introduction

The increase in the proportion of elderly people in the population influences the prevalence of noncommunicable diseases (Wild, Roglic, Green, Sicree, & King, 2004; WHO, 2011). The most prevalent diseases among the elderly are (1) DM, which consists of an inability to produce insulin or a resistance to its action; (2) SAH, i.e. different degrees of increased systolic and diastolic blood pressure; and (3) dyslipidemias in which occur changes in plasma lipoprotein levels and which are related to the risk of HDs such as myocardial infarction, angina, coronary HD and congestive disease (Gonzalez-Campoy et al., 2013; Gravina, Rosa, Franken, Freitas, & Liberman, 2010; Mancina et al., 2013; Reiner et al., 2011).

Abdominal fat is, in the same way as aging, associated with metabolic alterations such as resistance to insulin and DM which are related to the risk of cardiovascular diseases (CVD) (Ferreira, Valente, Gonçalves-Silva, & Sichieri, 2006; WHO, 2000a). WC is considered to be the variable most closely related to abdominal fat and indicative of the risk of CVD, metabolic alterations and mortality (Picon et al., 2007; Roriz et al., 2011; Scafoglieri, Provyn, Bautman, Van Roy, & Clarys, 2011; WHO, 2000b).

According to the World Health Organization (WHO) and the International Diabetes Federation (IDF), the values of WC related to the metabolic risk of developing CVD and DM should be used only for the population in which they have been identified seeing that such variables depend on other risk factors such as the BMI, age and the ethnic characteristics of the location of body fat, to be used as indications of these diseases (Alberti, Zimmet, & Shaw, 2006; WHO, 2000b).

Due to the greater time of exposure to the risk variables during the lifetime, beyond the physiological, biochemical and hormonal alterations inherent in the process of aging, it is necessary to

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identify the values of WC specific to the elderly population and which make the correct detection of risk for the development of diseases possible (Matos, Giorelli, & Dias, 2011; Paula, Ribeiro, Rosado, Pereira, & Franceschini, 2010; Picon et al., 2007; Vasques, Priore, Rosado, & Franceschini, 2010; WHO, 2000b).

As has been done in similar studies in other parts of the world (Heim et al., 2011; Huang et al., 2005; Lim et al., 2012; Nilsson et al., 2008; Seo et al., 2009; Woo, Ho, Yu, & Sham, 2002), this study also seeks to meet this need in the scientific field, by identifying those WC values which better discriminate the risk of elderly people's resident in the municipality of São Paulo developing noncommunicable diseases.

2. Materials and methods

This is a longitudinal study of association, conducted in 2011 and 2012, using data of the SABE: Saúde, Bem-estar e Envelhecimento (Health, Well-being and Aging) Survey, a household-based study undertaken in the municipality of São Paulo in 2000 and 2006 (Lebrão & Duarte, 2008; Silva, 2003).

A total of 2 143 elderly people (≥ 60 years of age), of both sexes, selected by probabilistic sampling, participated in the SABE Survey in 2000. These elderly folk were reassessed in 2006 for the purpose of ascertaining the alterations in their health and living conditions that had occurred during that period. In this latter year, 1 115 elderly people, survivors from 2000, were again interviewed (Lebrão & Duarte, 2008).

In 2000, the SABE Survey was approved by the National Committee of Ethics in Research and by the Ethics in Research Committee of the Public Health School of the University of São Paulo (USP) and, in 2006, by the Ethics in Research Committee of the Public Health School of USP.

The population of this study consisted of elderly individuals who, in 2000, reported that they had never been diagnosed as having SAH, HD or DM, and who could be located and agreed to participate, in 2006. The elderly who were unable to respond to any of the three questions relating to the diseases under study, whether in 2000 or 2006, were considered "missing".

The elderly who, in 2000, were incapable of undergoing measurement of the WC, because they were bed-ridden, or had limited mobility (used wheel-chairs or crutches), or who were unable to stand without support (because of the amputation of the lower members) were excluded.

The variables of this study were the references to the selected diseases (SAH, HD and DM) in 2006 and, in 2000, WC, sex, age – classed in two groups: 60–74 and ≥ 75 years, ethnicity (Caucasian, for the reply "white" and non-Caucasian for all the other replies: mestizo, mulatto, negro, indigenous, Asiatic or other) and BMI. The elderly were classed as not overweight ($BMI < 28 \text{ kg/m}^2$) or overweight ($BMI \geq 28 \text{ kg/m}^2$) (PAHO, 2001).

The SAH, HD, DM, sex, age and ethnicity data were reported by the elderly themselves or some proxy or other informant. The measurements of WC, height and weight (for calculation of the BMI) were repeated in triplicate by trained interviewers and the average values were used for the analyses.

The measurement of the WC was undertaken with the use of an unstretchable tape-measure at the intermediate point between the lowest rib and the iliac crest with the abdomen relaxed, after breathing out, with the person standing erect with their arms relaxed and the abdominal region free of clothing.

2.1. Statistical methodology

The study population was selected by means of a complex sampling process, performed using the method of cluster sampling in two stages, census tracts being considered for the selection of

the sample of the first stage, and segments residing in each census tract for the selection of the sample of the second stage, plus elderly residents in the districts where previous interviews had been conducted to compensate for the lower population density of patients aged 75 years and older, and a higher mortality rate for men. Statistical tests recommended for studies of the survey type were used in the analysis of the results.

Rao & Scott's test (Lee & Forthofer, 2006) and multiple logistic regression with a significance level of 5% were used for the analysis of the association between the reported incidence of SAH, HD and DM and the other variables, the magnitude being tested by the *odds ratio* (OR) values, the confidence interval being 95% (CI 95%). The variables age group, ethnicity and BMI were maintained for the adjustment of the multiple models, regardless of the level of significance, except for the male model, which it was not possible to stratify by ethnicity because all the men who reported DM in 2006 were Caucasian.

To avoid any inadequacy in the adjustment of the models, the multicollinearity between the variables was calculated in accordance with Variance Inflation Factor (VIF) values, and only non-collinear variables, with VIF values of between 0.19 and 5.30 (Hair, Anderson, Tatham, and Black, 1995), were kept in the final model.

The area under the ROC curve (AUC – area under the curve) and respective 95% CI were used to estimate the general performance of the critical WC values in discriminating correctly between the elderly, in accordance with the disease reported.

The likelihood ratios (LR), which combine sensitivity and specificity, were calculated for each WC value. The greater the PLR, the better the test, and the smaller the NLR, the better the test (Deeks & Altman, 2004; Massad, 2004).

In order to identify the critical values of WC with the best discriminatory power for the elderly, in accordance with the reference to the disease, the PLR was maximized and the NLR minimized, that is to say, they corresponded to the WC values with the greatest PLR value, when the NLR was kept at zero (Zou, O'Malley, & Mauri, 2007).

3. Results

A total of 405 elderly people participated in this study, 58.7% of whom were women and 87.2% were of between 60 and 74 years of age in 2000. The demographic and anthropometric characteristics of the study population are given in Table 1.

No statistically significant difference was observed between the average WC of those who reported and those who did not report SAH or HD, though the average WC of those who reported DM in 2006 was significantly greater than that of those who did not report it, both for women (99.0 cm and 89.9 cm; $p = 0.003$) and for men (107.4 cm and 93.3 cm; $p = 0.008$).

In the multiple regression models, the WC did not significantly increase the chance of reporting SAH (OR 1.03; 95% CI 0.99–1.07, for women, and OR 1.02; 95% CI 0.97–1.08, for men) or HD (OR 1.04; 95% CI 0.99–1.09, for women, and OR 1.03; 95% CI 0.96–1.11, for men), in 2006, independently of age group, ethnicity and BMI.

WC was associated with the mention of DM in the models adjusted for age group, ethnicity and BMI in the female group, and for age group and BMI in the male group. Each centimeter of increase in the WC increased the possibility of reporting DM by 8% among women and by 17% among men (Table 2).

The values of the area under the ROC curve: AUC: 0.751; CI 95% 0.618–0.884 for the women and AUC: 0.867; CI 95% 0.695–1.000 for the men showed discriminatory power, in terms of the critical values of WC in describing the elderly of 60–74 years whether or not they reported DM, but this was not possible in the elderly ≥ 75 years (AUC: 0.743; CI 95% 0.456–1.000, for women, and AUC: 0.446; IC 95% 0.020–0.871, for men). The WC value with the

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