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Comparative analysis of abdominal obesity anthropometric indices for the diagnosis of physio-metabolic disorders

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ABSTRACT

Objective: To examine the efficiency of anthropometric indicators of abdominal obesity in order to identify physio-metabolic disorders in Spanish adults.

Method: We analyzed 3,122 women and 2,103 men attending diet consultation and registered their height, weight and umbilical perimeter. Body mass index (BMI), body roundness (BRI), body shape (ABSI) and waist to height ratio (WHtR) were estimated. Blood pressure and serum levels of glucose, cholesterol and triglycerides were taken. ROC curves were applied to compare the utility of anthropometric indices in the diagnosis of physio-metabolic disorders.

Results: The BRI and the WHtR showed the largest areas under the curve (AUC) for the identification of hypertension, hyperglycemia and hypercholesterolemia in both sexes and for hypertriglyceridemia in men. The ABSI presented AUCs below the BMI for the diagnosis of all components.

Conclusions: Due to its diagnostic efficiency and ease of calculation, the waist to height ratio is the most recommended parameter in the prediction of physio-metabolic alterations.

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KEYWORDS

Body roundness index; body shape index; waist to height ratio; hypertension; hyperglycemia; hypercholesterolemia; hypertriglyceridemia.

INTRODUCTION

Obesity has increased worldwide over the last twenty to thirty years, becoming a major public health problem in both children-adolescents and adults; it has been linked with the risk of cardiovascular disease and with premature death. Likewise, excess abdominal fat is one of the main risk factors for the development of metabolic syndrome, which is related to insulin resistance and other comorbidities[1].

Initially, the body mass index (BMI) has been the most frequently applied anthropometric parameter for assessing nutritional status; however, there is increasing evidence supporting the use of other variables that more accurately reflect the distribution of fat and that are more effective in detecting physio-metabolic risk[2]. Some proposed variables have been the umbilical perimeter (WC) and the waist to height ratio (WHtR). More recently, the use of the Body Shape Index (ABSI)[3] has been suggested, which is formulated based on the WC, height and BMI.

Also, the Body Roundness Index (BRI) has been proposed[4]. This index is based on height and the WC. Both indicators have been analyzed as predictors of different alterations associated with cardiometabolic diseases and only in few studies have been applied in Spanish population[5]. For that reason the present study aims to comparatively as-

sess the diagnostic efficacy of indicators related to abdominal obesity to identify the presence of hypertension, hypercholesterolemia, hyperglycemia and elevated triglycerides in Spanish adults.

METHOD

This study was conducted within the framework of the collaboration agreement between the Arkopharma laboratories, the Spanish Society of Dietetics and Food Sciences (SEDCA) and the EPINUT research group of the Complutense University of Madrid (ref 920325). We analyzed 3,122 women and 2,103 men, aged between 18 and 75 years, who during 2016 attended a diet consultation in pharmacies located in all the Spanish autonomous communities. The informed consent of the participants was obtained according to the Helsinki regulations of the World Medical Association. The following anthropometric parameters were taken: height (cm), weight (kg) and WC (cm). From these measurements, the WHtR (WC/height), BMI (weight kg /height m^2), BRI[4]:

$$(364.2 - (365.5 \times \sqrt{1 - \left(\frac{\left(\frac{WC}{(2\pi)^2}\right)}{(0.5 x height^2)}\right)}$$

and ABSI[3]: $(WC/BMI^{2/3} \times height^{1/2})$ were calculated.

In addition, using an OMRON digital tensiometer, model M6, blood pressure levels were recorded, hypertensive patients being considered as those who presented systolic blood pressure SBP ≥ 130 mmHg and /or diastolic blood pressure (DBP) ≥ 85 mmHg[6]. Glucose, total cholesterol and triglyceride levels in blood were collected using the ACCUTREND PLUS self-analyzer. Hyperglycemia and hypertriglyceridemia were evaluated following the criteria of the International Diabetes Federation (IDF)[6] and hypercholesterolemia using the Spanish Heart Foundation cut-offs[7]. Subjects who had already been diagnosed or treated for hypertension, hyperglycemia or dyslipidemia were also included in the risk groups.

Based on the normality of the quantitative variables, the Mann Whitney U test or Student's t test was applied. For the comparison of categorical variables, chi-square contrast tests were performed. ROC (Receiver Operating Characteristics) curves were applied to evaluate the usefulness of anthropometric indexes in the diagnosis of the physio-metabolic components related to the Metabolic Syndrome (MetS) (hypertension, hyperglycemia, hypercholesterolemia and hypertriglyceridemia). All statistical analyses were performed using SPSS v. 24.0.

RESULTS

The anthropometric and physio-metabolic characteristics of the sample are shown in Table 1. Both, direct measures and the indices (BMI, WHtR, BRI, and ABSI) were higher in men (p <0.001). The prevalence of hypertension, hyperglycemia and elevated triglycerides also showed higher values among men, although hypercholesterolemia was higher in women (p <0.001).

Table 2 shows that WHtR and the BRI presented the greatest area under the ROC curve (AUROC) for each physio-metabolic alteration except for hypertriglyceridemia in the case of women, where the area under the ROC curve was higher for the BMI. The AUROC ranged between 0.639 – 0.712, in women and between 0,650 – 0.744 in men. The ABSI was the index with the lowest AUROC for both women (0.546 – 0.620) and men (0.586-0.644).

DISCUSSION

The participants in this study are women and men recruited during diet consultation. For this reason, BMI average is in the range of overweight and obesity and the prevalence of the alterations linked to the metabolic syndrome are relatively high. This sample of convenience favors the development of a study in which it is intended to associate central obesity with the presence of hypertension or high levels of glucose, cholesterol or triglycerides.

Table 1. Anthropometric and physio-metabolic characteristics of the sample.

	Women	Men
	Mean ± SD	**Mean ± SD**
Age, year	46.56 ± 13.87*	45.07 ± 14.23
Anthropometric measures		
Height (cm)	161.15 ± 6.51*	173.56 ± 7.77
Weight (kg)	74.50 ± 13.58*	89.61 ± 16.07
WC (cm)	95.25 ± 13.51*	105. 89 ± 15.00
WHtR	0.59 ± 0.089*	0.61 ± 0.09
BMI	28.73 ± 5.17*	29.74 ± 4.95
BRI	5.40 ± 2.03*	5.80 ± 2.12
ABSI	0.080 ± 0.007*	0.081 ± 0.007
Metabolic risk profile		
Hypertension N (%)	735 (23.6) *	695 (33.1)
Hyperglycemia N (%)	217 (7.0) *	592 (28.2)
Hypercholesterolemia N (%)	768 (24.7) *	442 (21.0)
Hypertriglyceridemia N (%)	128 (4.1) *	88 (14.9)

WC: waist circumference; WHtR: waist to height ratio; BMI: body mass index; BRI: body roundness index; ABSI: body shape index; SD: standard deviation. * sex differences p <0.001.

Table 2. Areas under the ROC curve (Confidence interval 95%) of anthropometric parameters in the diagnosis of physio-metabolic disorders.

	Hypertension	Hyperglycemia	Hypercholesterolemia	Hypertriglyceridemia
Women				
WC	0.692 (0.667-0.717)	0.700 (0.659-0.740)	0.617 (0.591-0.643)	0.641 (0.587-0.695)
WHtR	**0.711 (0.686-0.735)**	**0.712 (0.671-0.753)**	**0.639 (0.614-0.664)**	0.649 (0.593-0.704)
BMI	0.692 (0.668-0.716)	0.680 (0.636-0.723)	0.611 (0.586-0.636)	**0.664 (0.615-0.712)**
BRI	**0.711 (0.686-0.735)**	**0.712 (0.671-0.753)**	**0.639 (0.614-0.664)**	0.649 (0.593-0.704)
ABSI	0.583 (0.556-0.611)	0.620 (0.573-0.668)	0.573 (0.546-0.600)	0.546 (0.488-0.604)
Men				
WC	0.681 (0.624-0.738)	0.713 (0.640-0.786)	0.629 (0.570-0.689)	0.668 (0.591-0.744)
WHtR	**0.705 (0.649-0.761)**	**0.744 (0.674-0.814)**	**0.650 (0.592-0.709)**	**0.703 (0.628-0.778)**
BMI	0.646 (0.588-0.705)	0.720 (0.656-0.785)	0.624 (0.565-0.683)	0.665 (0.584-0.747)
BRI	**0.705 (0.649-0.761)**	**0.744 (0.674-0.814)**	**0.650 (0.592-0.709)**	**0.703 (0.628-0.778)**
ABSI	0.644 (0.583-0.704)	0.622 (0.538-0.706)	0.586 (0.525-0.647)	0.603 (0.513-0.692)

WC: waist circumference; WHtR: waist to height ratio; BMI: body mass index; BRI: body roundness index; ABSI: body shape index; bold indicates the highest values of AUCROC.

The results obtained show that the BRI and the WHtR present the same diagnostic capacity in men and women, coinciding with a sample of adults from the *China Health and Nutrition Survey project*[8]. In another cohort of rural population in northwestern China, BRI and WHtR also behaved as the best predictors of type 2 diabetes with similar AUROCs and higher than ABSI[9].

The high diagnostic capacity of WHtR has been demonstrated in numerous studies. For example, in a meta-analysis that included more than 300,000 adults, the superiority of WHtR over BMI was established in the detection of different cardiometabolic risk factors[10]. In the Spanish population, the WHtR has performed as the most significant anthropometric measurement, identifying hypertension, hyperlipidemia, type 2 diabetes, coronary risk and metabolic syndrome in adults[11]. It has also been observed that the BRI can be significantly associated with the presence of cardiovascular disease and its risk factors[12].

In the present study, ABSI had the lowest capacity to identify the components of the MetS in both sexes. However, this index had proved to be very effective, surpassing the WC or BMI, predicting premature mortality due to causes related to obesity, in adults from the United States[3]. Also, among the Australian population, the ABSI was positively associated with mortality from cancer and cardiovascular disease[13]. However, the results derived from the analysis of the Spanish cohort included in the longitudinal study of the *European Prospective Investigation of Cancer and Nutrition* (EPIC) are in line with our evidence since the ABSI had a lower association with cardiovascular accident than the WC or the BMI and this association was only significant in men (HR 1.54, 95% CI 1.06-2.23)[14]. In a recent systematic review and meta-analysis that compiled 38 studies carried out in 15 countries shows that although the ABSI exceeds the BMI and the WC in the prediction of mortality from all causes, it performs much worse in the prediction of MetS and chronic diseases[15]. In the aforementioned meta-analysis neither the WHtR nor the BRI are included, so the predictive value of the ABSI cannot be contrasted with them.

Compared to the WHtR or the BRI, the ABSI has a low capacity to identify the components of the MetS. The BRI does not exceed the viability of the WHtR and its calculation presents a greater mathematical complexity. Therefore, the WHtR is the abdominal adiposity indicator of greater diagnostic utility for clinical practice.

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