

# Predictive capacity of anthropometric indicators for abdominal fat in the oldest old

## *Capacidade preditiva de indicadores antropométricos na indicação da gordura abdominal em idosos longevos*

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**Abstract** – Cardiovascular diseases are a growing public health problem that affects most people over the age of 65 years and abdominal obesity is one of the risk factors for the development of these diseases. There are several methods that can be used to measure body fat, but their accuracy needs to be evaluated, especially in specific populations such as the elderly. The aim of this study was to assess the accuracy of anthropometric indicators to estimate the percentage of abdominal fat in subjects aged 80 years or older. A total of 125 subjects ranging in age from 80 to 95 years ( $83.5 \pm 3$ ), including 79 women ( $82.4 \pm 3$  years) and 46 men ( $83.6 \pm 3$  years), were studied. The following anthropometric indicators were used: body mass index (BMI), waist circumference (WC), waist-hip ratio (WHR), and waist-to-height ratio (WHtR). The percentage of abdominal fat was measured by DEXA. Sensitivity and specificity were analyzed using an ROC curve. The sensitivity, specificity and AUC were 0.578, 0.934 and 0.756 for BMI, respectively; 0.703, 0.820 and 0.761 for WC; 0.938, 0.213 and 0.575 for WHR, and 0.984, 0.344 and 0.664 for WHtR. BMI and WC were the anthropometric indicators with the largest area under the curve and were therefore more adequate to identify the presence or absence of abdominal obesity.

**Key words:** Abdominal adiposity; Anthropometric indicators; Elderly.

**Resumo** – As doenças cardiovasculares são um problema crescente de saúde pública que afeta grande parte das pessoas acima de 65 anos, sendo a obesidade abdominal um dos vários fatores para o desenvolvimento dessas doenças. Existem vários métodos para mensurar gordura corporal, mas é necessário analisar a capacidade preditiva desses métodos, principalmente em algumas populações específicas como, por exemplo, os idosos. O objetivo do presente estudo foi analisar a capacidade preditiva de indicadores antropométricos na estimativa do percentual de gordura abdominal de idosos com 80 anos ou mais. Foram avaliados 125 idosos com idade entre 80 e 95 ( $83,5 \pm 3$  anos), sendo 79 mulheres ( $82,4 \pm 3$  anos) e 46 homens ( $83,6 \pm 3$  anos). Utilizaram-se os indicadores antropométricos: Índice de Massa Corporal (IMC), Circunferência de Cintura (CC), Razão Cintura Quadril (RCQ) e Razão Cintura Estatura (RCEst), e o percentual de gordura de tronco foi mensurado por meio do DEXA. Foi realizada a análise de sensibilidade (SENS) e especificidade (ESP) mediante a curva ROC, e o IMC apresentou valores de SENS=0,578; ESP=0,934 e AUC=0,756, a CC SENS=0,703; ESP=0,820 e AUC=0,761, a RCQ SENS=0,938; ESP=0,213 e AUC=0,575 e a RCEst SENS=0,984; ESP=0,344 e AUC=0,664. O IMC e a CC foram os indicadores antropométricos que apresentaram maior área sob a curva, e sucessivamente com maior capacidade em detectar aqueles que têm ou não obesidade abdominal.

**Palavras-chave:** Adiposidade abdominal; Idosos; Indicadores antropométricos.

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## INTRODUCTION

The life expectancy of the population is growing around the world. In Brazil, the aging rate has increased from 10.5% in 1980 to 19.4% in 2006. This increase was more expressive in the group of individuals older than 75 years, particularly those aged 80 years or older<sup>1</sup>. Aging is a dynamic and progressive process characterized by morphological, functional and biochemical alterations and is associated with the prevalence of chronic non-communicable diseases (NCDs) such as cardiovascular diseases, hypertension, diabetes, and other metabolic disorders<sup>2</sup>. The proportion of Brazilian older adults with some type of NCD is approximately 77%<sup>3</sup>. The treatment of these diseases leads to increases in public health spending and in the number of subjects attending basic health units. In addition, NCDs affect the quality of life of elderly people, decreasing independence in instrumental activities of daily living and daily life activities<sup>4</sup>, and may even cause death.

The prevalence of death due to NCDs has increased from 14.2% in 1901 to 49.6% in 2005<sup>5</sup>, with cardiovascular diseases accounting for about 16.6 million of these deaths in the world<sup>6</sup>. Studies have shown that the diagnosis of some of these diseases is associated with obesity, mainly abdominal obesity<sup>7,8</sup>, which is an inherent feature of the aging process<sup>9</sup>. Gomes et al.<sup>10</sup>, investigating the frequency of cardiovascular risk factors in the oldest old, observed that 45% of the participants presented abdominal obesity. This finding is a matter of concern since excess fat in this region compromises the mobility of older adults more than total body fat or fat accumulation at other sites. Bouchard et al.<sup>11</sup> therefore considered the identification of excess fat in this region to be of the utmost importance.

Anthropometry is the method most commonly used for the estimation of body fat because of its easy application, low cost, and high correlation with more precise methods<sup>12</sup>. In addition, the predictive capacity of anthropometric indicators for abdominal fat in adults and younger elderly has been demonstrated in the literature<sup>13-15</sup>. However, studies investigating the predictive capacity of these indicators the oldest old are scarce. In view of the apparent association of aging with increased adiposity and the incidence of NCDs, accessible and inexpensive procedures such as anthropometry are important to estimate excess abdominal fat in subjects over the age of 80 years. Therefore, the objective of the present study was to evaluate the predictive capacity of anthropometric indicators to estimate the percentage of abdominal fat in older adults aged 80 years or older.

## METHODOLOGICAL PROCEDURES

### Sample

A cross-sectional study was conducted between October 2009 and May 2010 in the town of Presidente Prudente (approximately 210,000 inhabitants), located in the western region of the State of São Paulo. The human development index of the municipality is 0.846, occupying 14<sup>th</sup> position in the state<sup>3</sup>.

Data were collected between October 2009 and May 2010. Older adults of both genders aged 80 years or older, who lived in the urban area of the municipality, were invited to participate in the study. The municipal department of health provided the name, address and telephone number of subjects  $\geq 80$  years, who used the public health service of the town. On the basis of this information, individuals were invited by telephone and the study was also disseminated through local media.

Excluded from the sample were subjects unable to walk, bedridden and institutionalized subjects, rural residents, subjects with a pacemaker, and those with incomplete data in the database. The final sample consisted of 125 older adults of both genders aged 80 years or older.

The subjects invited to participate received detailed information about the objectives of the study and method used for data collection and only those who signed the free informed consent form were included in the sample. The study protocol was approved by the Ethics Committee of Universidade Estadual Paulista (Permit No. 26/2009).

## Anthropometry

The following anthropometric measures were obtained: body weight, height, waist circumference (WC), and hip circumference for the calculation of body mass index (BMI), waist-hip ratio (WHR), and waist-to-height ratio (WHtR).

### BMI

Body weight was measured with a Filizola® electronic scale (maximum capacity of 180 kg) to the nearest 0.1 kg. A Sanny® stadiometer (2.20 m) fixed to the wall was used for the measurement of height to the nearest 0.1 cm. These values were used to calculate BMI as weight divided by the square of the height. The following cut-offs suggested by Troiano et al. (1996)<sup>16</sup> were used to classify excess weight: eutrophic  $< 28 \text{ kg/m}^2$  and obese  $\geq 28 \text{ kg/m}^2$ .

### Waist circumference

WC was measured in millimeters at the midpoint between the iliac crest and last rib with an anthropometric metal tape. The cut-off values adopted for the indication of abdominal obesity were 88 cm for women and 102 cm for men<sup>17</sup>.

### Waist-hip ratio

Waist and hip circumferences were used for the calculation of WHR. WC was measured at the midpoint between the iliac crest and last rib. For hip circumference measurement, the tape was positioned around the hips at the greatest protuberance. WC was then divided by hip circumference, both measured in centimeters, and the cut-off values suggested by Pereira<sup>18</sup> were used for analysis (0.95 for men and 0.80 for women).

### Waist-to-height ratio

WHtR was determined by dividing WC (cm) by height (cm). The cut-off values suggested by Pitanga and Lessa<sup>19</sup> were adopted (0.52 for men and 0.53 for women).

## Dual-energy X-ray absorptiometry

Total body fat was measured by dual-energy X-ray absorptiometry (DEXA) using the Lunar DPX-NT system (Lunar/GE Corp., Madison, WI), which uses a three-compartment model (lean mass, fat mass, and bone mass). This technique permits to estimate whole body composition and the composition of subregions.

## Statistical analysis

For numerical variables, normality of the data was confirmed by the Kolmogorov-Smirnov test. Thus, descriptive statistics consisted of mean values (central tendency) and standard deviation (dispersion). The mean values of each variable were compared between genders by the Student t-test for independent samples. Sensitivity and specificity were calculated using an ROC curve. The SPSS 13.0 software was used for statistical analysis, adopting a level of significance of 5%.

## RESULTS

The general characteristics and anthropometric variables of the sample, stratified according to gender, are shown in Table 1. There was no difference in mean age between genders. Men presented higher weight, height ( $p=0.000$ ), WC and WHR ( $p=0.001$ ) than women. However, the percentage of trunk fat was higher in women ( $p\leq 0.001$ ).

**Table 1.** General characteristics of the sample according to gender.

Variable	Men (n=46)	Women (n=79)	t	p
Age (years)	83.2±2.8	83.3±2.9	0.382	0.703
Body weight (kg)	72.7±16.7	59.0±10.8	4.961	0.000
Height (cm)	164.8±8.0	150.9±7.2	10.118	0.000
BMI (kg/m <sup>2</sup> )	26.6±5.1	25.9±4.1	0.883	0.379
Waist circumference (cm)	97.1±13.6	87.9±11.5	4.064	0.001
Hip circumference (cm)	98.4±10.6	97.7±8.8	0.380	0.705
WHR (cm/cm)	0.99±0.08	0.90±0.07	6.591	0.001
WHtR (cm/cm)	0.59±0.08	0.58±0.08	0.408	0.684
Trunk fat (%)	34.2±10.4	41.7±10.3	-3.904	0.000
Total body fat (%)	29.5±8.8	40.2±8.5	-6.664	0.001

Values are reported as the mean ± standard deviation.

BMI: body mass index; WHR: waist-hip ratio; WHtR: waist-to-height ratio.

Table 2 shows the Spearman correlations between the anthropometric indicators and fat percentage determined by DEXA. The correlation was 0.73 for BMI ( $p\leq 0.001$ ), 0.55 for WC ( $p\leq 0.001$ ), 0.22 for WHR ( $p\leq 0.013$ ), and 0.72 WHtR ( $p\leq 0.001$ ). Correlations using the cut-off values of the anthropometric indicators were also performed. No difference was observed between genders when the older adults were classified as overweight based on BMI ( $p=0.577$ ), high WC ( $p=0.246$ ), high WHR ( $p=0.225$ ), or high WHtR ( $p=0.206$ ).

**Table 2.** Correlation between abdominal fat and different anthropometric indicators in older adults.

Variable	% Trunk fat			
	Men		Women	
	r	p	r	p
BMI	0,731	p≤0,001	0,860	p≤0,001
WC	0,663	p≤0,001	0,819	p≤0,001
WHR	0,511	p≤0,001	0,508	p≤0,001
WHtR	0,777	p≤0,001	0,786	p≤0,001

BMI: body mass index; WC: waist circumference; WHR: waist-hip ratio; WHtR: waist-to-height ratio.

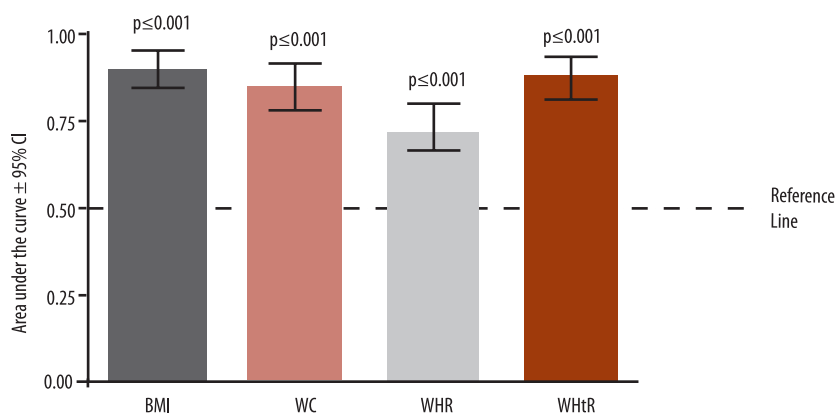
Among the anthropometric indicators studied, BMI presented a sensitivity of 0.578 in identifying abdominal, specificity of 0.934, and area under the curve (AUC) of 0.756. WC presented a sensitivity of 0.703, specificity of 0.82, and AUC of 0.761. The sensitivity and specificity of WHR was 0.938 and 0.213, respectively, with a predictive capacity of 0.575. WHtR presented the best sensitivity (0.984) in identifying abdominal fat, with a specificity of 0.344 and predictive capacity of 0.664. Table 3 shows the sensitivity, specificity and AUC of the anthropometric indicators according to gender.

**Table 3.** Sensitivity and specificity of abdominal fat indicators according to gender.

	% Trunk fat					
	Men (n=46)			Women (n=79)		
	Sensitivity	Specificity	AUC	Sensitivity	Specificity	AUC
BMI	0.625	0.909	0.767	0.550	0.949	0.749
WC	0.583	0.864	0.723	0.775	0.795	0.785
WHR	0.958	0.364	0.661	0.925	0.182	0.527
WHtR	1.000	0.227	0.614	0.975	0.128	0.693

AUC: area under the curve; BMI: body mass index; WC: waist circumference; WHR: waist-hip ratio; WHtR: waist-to-height ratio.

The comparison of the predictive capacity (AUC) of the anthropometric indicators to identify the presence or absence of abdominal fat is shown in Figure 1. The highest AUC values were observed for BMI and WC, with the difference being significant when compared to WHR and WHtR ( $p < 0.05$ ).



**Figure 1.** Comparison of the area under the curves between anthropometric indicators.

## DISCUSSION

Aging is characterized by morphological alterations, especially the accumulation of body fat and reduction of lean mass, a process known as sarcopenia. Within this context, anthropometry has been used in clinical and epidemiological studies for the identification of excessive accumulation of fat in the body<sup>20</sup>. In addition, the evaluation of abdominal fat is important since excess abdominal adiposity is associated with several diseases such as hypertension<sup>21</sup>, diabetes<sup>22</sup>, and dyslipidemias<sup>23</sup>. According to Wannamethee et al.<sup>24</sup>, a positive association exists between the amount of abdominal fat and mortality risk in elderly people, but the indicator of obesity that best characterizes the risk in this population is still undefined.

Shaw et al.<sup>14</sup> compared WC and WHR with a more sophisticated method (DEXA) in adults and older adults ranging in age from 50 to 79 years. Good agreement was observed between WC and DEXA, but the WHR results were highly variable. In the study of Roriz et al.<sup>15</sup>, WC also showed good predictive capacity for visceral fat in adults and older adults when computed tomography was used as a reference. In agreement with these studies, WC also showed high predictive capacity in the present investigation.

Another indicator currently used is WHtR<sup>25,26</sup>. Haun, Pitanga and Lessa<sup>27</sup> found that WHtR possesses a good power to detect increased coronary risk (AUC = 0.76) in adults and older adults ranging in age from 30 to 74 years. Schneider et al.<sup>28</sup> showed that WHtR is a better indicator of cardiovascular risk and mortality than BMI, WC and WHR in adults and older adults of both genders. In the present study, WHtR presented high sensitivity in identifying abdominal fat (100% for men and 97.5% for women), but specificity was very low. This fact resulted in a low AUC, which was lower than that obtained for BMI and WC.

Pitanga and Lessa<sup>29</sup> evaluated different anthropometric indicators of obesity as a screening tool for coronary risk in 968 adults and observed that WHR was one of the best predictors of coronary risk. In contrast to that study, the present results showed that BMI and WC were the best predictors (higher AUC values) when compared to the other anthropometric indicators. Gomes et al.<sup>13</sup> found a strong correlation of BMI and WC with abdominal fat in older adults aged 60 to 80 years, in agreement with the present findings obtained for the population older than 80 years.

Another factor that may explain these differences is the fact that BMI is the only anthropometric indicator with pre-established cut-off values for the elderly population. One advantage of WHtR in relation to the other indicators is that normalization of WC for height permits to obtain a predictor of abdominal fat that is not influenced by the subject's height. This is an interesting aspect, particularly in older adults, since height undergoes important changes during growth and development<sup>30</sup>. However, no cut-off values are available in the literature for this population, a fact that limits the application of WHtR to older adults and may explain its low efficiency.

In this respect, the development of WC cut-off values for older adults may increase the efficiency of this anthropometric indicator. Another finding of this study was that BMI continued to show the best relationship with DEXA when only crude AUC values (without the use of cut-offs) were analyzed, as demonstrated in Figure 1.

One of the limitations of the present study is the fact that no biochemical parameters were used to discriminate increased cardiovascular risk. Furthermore, the WC, WHR and WHtR cut-offs were adapted from the adult population since no values exist for the oldest old. However, a strength of the study was the objective to evaluate subjects older than 80 years, a population that has not been explored in the literature, particularly because of the overall increase in life expectancy in different countries<sup>2</sup>.

## CONCLUSION

The anthropometric indicators studied had limited capacity to correctly identify the presence/absence of excess abdominal fat. Nevertheless, BMI and WC presented the best performance in older adults over the age of 80 years. The determination of the best anthropometric indicator of abdominal fat is important since anthropometry is an easy and low-cost method. These indicators can therefore be used in public health services to identify excess abdominal fat and cardiovascular risk, which can cause dependence in activities of daily living in elderly subjects.

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