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Association of anthropometric indicators with hemodynamic variables, glycaemia and physical fitness of adults

Associação de indicadores antropométricos com variáveis hemodinâmicas, glicemia e aptidão física de adultos

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RESUMO

O estudo associou indicadores antropométricos com variáveis hemodinâmicas, glicemia e aptidão física de adultos. Participaram do estudo 60 adultos de ambos os sexos (32,90 ± 10,26), sedentários e iniciantes de uma academia de ginástica. Foram analisadas variáveis de pressão arterial, frequência cardíaca, glicemia, circunferência da cintura (CC), circunferência do quadril, relação cintura-quadril, relação cintura-estatura (RCEst), índice de massa corporal, flexibilidade, e flexões de braço e abdominais. As variáveis antropométricas se correlacionaram positivamente com as hemodinâmicas e negativamente com os testes de aptidão física ($p<0,05$), e a CC e a RCEst foram os melhores preditores de riscos cardiovasculares entre as variáveis analisadas. Os indicadores antropométricos se correlacionam com as variáveis hemodinâmicas e de aptidão física, tendo a CC e a RCEst como os melhores preditores de riscos cardiovasculares indicando um potencial desempenho no rastreamento precoce dos riscos de doenças cardíacas em adultos.
Palavras-chave: Composição corporal. Fatores de Risco. Pressão arterial. Saúde.

ABSTRACT

This study associated anthropometric indicators with hemodynamic variables, glycaemia and physical fitness of adults. The participants in the study were 60 adults of both sexes (32.90 ± 10.26), sedentary and beginners of a gym. We analyzed variables of blood pressure, heart rate, glycaemia, waist circumference (WC), hip circumference, waist-hip ratio, waist-height ratio (WSR), body mass index, flexibility, and arm and abdominal flexions. Anthropometric variables correlated positively with hemodynamic variables and negatively with physical fitness tests ($p<0.05$). The results showed WC and WSR as the best predictors of cardiovascular risk among the variables analyzed, indicating their potential performance in early screening for risk of heart disease in adults.
Keywords: Blood Pressure; Body Composition; Health; Risk Factors.

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INTRODUCTION

The adoption of an active lifestyle, including regular exercising, has contributed significantly to improving and maintaining good levels of health-related fitness[1].Thus, the broad search for fitness or gym spaces is directly associated with improved physical appearance and health, reducing exposure to risk factors, commonly attributed to inadequate body composition values[2,3].

In contrast, lack of physical activity is the fourth major risk factor of death in the world, and one of the main causes for the incidence of chronic non-communicable diseases, such as cardiovascular ones[4]. In this sense, anthropometric indicators, such as visceral obesity, are associated with the incidence of heart and metabolic diseases and have been used in the health area to prevent and assist in the treatment of these diseases[5-7].

In general, physical training facilities offer physical assessment programs that verify health-related items. For better results, they demand caution from their professionals on doing this assessment[8]. However, there are a lot of limitations and inconsistencies in the evaluation of individuals who start and remain working out in these health or fitness centers[9].

Different studies have demonstrated the influence of anthropometric variables on cardiovascular risk factors and physical fitness, mainly when evaluating how much the different indexes usually used in body composition interfere with the prediction of these risks. Thus, the objective of this study was to verify relationships between anthropometric measurements and hemodynamic variables, glycaemia, localized muscle resistance and flexibility of adults, beginners in a fitness centre.

METHODOLOGY

This is a cross-sectional and quantitative study that was approved by the Research Ethics Committee (CEP) of the Federal University of Vale do São Francisco (UNIVASF) under protocol number 18122010.

The sample consisted of 60 individuals of both sexes (male n=17, female n=43) who had started working out at a gym in the city of Petrolina-PE. They were aged 18 to 59 years, classified as sedentary (IPAQ short version)[10], had not exercised regularly for at least three months and agreed to participate in the research by signing an informed consent form. Initially, 75 volunteers were eligible but we excluded individuals with osteomyoarticular problems, the ones who were taking any medications for hypertension and/or diabetes, or were not willing to undergo the evaluations.

The sample selection occurred at random, during eight weeks, as individuals enrolled in the gym. The participants were informed about the general characteristics of the study, and were asked not to consume alcoholic or caffeine-based beverages for a period of 24 hours before data collection. In addition, they were recommended to maintain the usual activities during the research period.

The following hemodynamic measurements were performed: systolic (SBP) and diastolic (DBP) blood pressure, resting heart rate (RHR); mean blood pressure (MBP)[11]. Postprandial blood glucose (one hour after the last meal)[12] was calculated. The anthropometric indexes measured were: body mass (kg), height (cm), waist circumference (WC) and hip circumference (HC). We also calculated the waist-hip ratio (WHR), waist-stature ratio (WSR), body mass index (BMI) and physical fitness: flexibility and localized muscle resistance (arms and abdominal). A single trained and experienced evaluator with a 90% reliability level performed all data collection procedures[13].

HEMODYNAMIC AND GLYCAEMIC MEASUREMENTS

Each participant was seated on a chair for 10 minutes before data collection. Then, while they remained seated, in a calm and comfortable place at the temperature between 21 and 23 ºC[11], three SBP, DBP and RHR measurements were taken from their arm, which was raised to the height of the midpoint of the sternum and supported on a table. A digital oscillometric device (BP 3AC1-1, Microlife, USA) properly calibrated and validated[14] was used.

Blood samples were collected for the postprandial glycaemic index test using the OptiumXceedTM, Abbott, USA, validated device[15]. During the procedure, the participants had their index finger pressed and perforated with a disposable and sanitized needle. Later, the glycaemic value of the samples was assessed according to the guidelines of the Brazilian Diabetes Society[12].

ANTHROPOMETRIC MEASUREMENTS

Body mass (BM), expressed in kilograms (kg), was measured through a digital platform scale (Tec-Silver, Techline, Brazil)[16]. Stature, expressed in centimetres (cm) was measured through an aluminium stadiometer (ES2030, Sanny, Brazil) with a resolution of 0.1 cm. The body mass index (BMI) was determined by the body mass value divided by stature[2]. The WC and the HC measures were taken through an inextensible metal anthropometric tape, from Cescorf (Porto Alegre/RS/Brazil), with a resolution of 0.1 cm. WHR was calculated by the WC value divided by HC (both in centimetres) and WSR, by dividing WC by stature[17].

MEASURE OF HEALTH-RELATED FITNESS

To evaluate flexibility, we performed the sit-and-reach test proposed by Wells & Dillon[18], using a Sanny® brand seat with dimensions of 30.5 cm x 30.5 cm x 30.5 cm, and a 26.0 cm extension scale[19]. The participants made three attempts and we analysed the best performance.

Two localised muscle endurance tests were conducted: 1) Arm flexion (AF), which records the number of correct elbow flexion repetitions per minute, with two supports (adapted for women with additional knee support on the floor[20]); 2) One-minute ABS, which records the number of correct abdominal repetitions per minute.

STATISTICAL ANALYSIS

Kolmogorov Smirnov test was used to verify the normality of the data, which were expressed as mean and standard deviation. The variables between the sexes were compared through the *unpaired T* test; *Pearson and Spearman* tests were used for data correlation during the analysis and the *stepwise linear regression,* for the selection of variables and predictions. To classify the data we adopted the methodology of Hopkins et al.[22]: 0 – 0.01 (very low), 0.1 – 0.3 (low); 0.3 – 0.5 (moderate); 0.5 – 0.7 (high); 0.7 – 0.9 (very high); 0.9 – 1.0 (almost perfect). In the analysis we also used the IBM Statistical Package for the Social Sciences, version 22.0 (IBM Corp., Armonk, USA) and adopted the significance level of $P<0.05$.

RESULTS

Table 1 shows the general characteristics of the sample, composed of 43 female volunteers (71.67%) and 17 male volunteers (28.33%). The variables body mass, height, WC, WHR, SBP and the abdominal test were higher in males compared to females ($p<0.05$). However, age, BMI, HC, WSR, glycaemia, DBP, flexibility and the arm flexion test did not differ between genders ($p>0.05$). When performing a BMI frequency analysis, we found that 10.00% of the sample had normal weight, 16.67% were overweight and 73.33% had obesity.

Table 1. General characteristics of the sample in mean ± standard deviation (n=60)

	General (n=60)	Male (n= 17)	Female (n= 43)
Age (years)	32,90 ± 10,26	31,17 ± 8,81	33,58 ± 10,79
Body mass (kg)	100,08 ± 17,14	100,22 ± 16,43*	80,89 ± 14,47
Stature (cm)	163 ± 0,09	173 ± 5,70*	158 ± 6,35
BMI (kg/m²)	32,56 ± 5,65	33,13 ± 4,82	32,32 ± 5,96
WC (cm)	92,37 ± 12,59	102,00 ± 11,03*	88,56 ± 11,13
HC (cm)	110,82 ± 10,06	110,35 ± 10,31	111,00 ± 10,07
WHR (cm)	0,83 ± 0,10	0,92 ± 0,09*	0,79 ± 0,08
WSR (cm)	0,57 ± 0,07	0,59 ± 0,06	0,56 ± 0,08
Glycaemia (mg/dL)	100,08 ± 17,14	100,17 ± 22,97	100,04 ± 14,54
SBP (mm Hg)	125,20 ± 14,52	131,58 ± 15,82*	122, 67 ± 13,33
Flexibility (cm)	24,72 ± 7,30	22,64 ± 8,48	25,53 ± 6,71
AF (rep/min)	10,85 ± 7,73	13,23 ± 10,24	9,90 ± 6,38
Abdominals (rep/min)	12,72 ± 10,37	20,35 ± 11,85*	9,70 ± 8,04
Classification	**Normal weight**	**Overweight**	**Obesity**
n	06	10	44
Percentage (%)	10,00	16,67	73,33

Note: *p<0.05 compared to female gender; BMI: body mass index; WC: waist circumference; HC: hip circumference; WHR: waist/hip ratio; WSR: waist/stature ratio; SBP: systolic blood pressure; DBP: diastolic blood pressure; AF: arm flexions per minute,

Table 2 shows the correlations between the anthropometric, hemodynamic, glycaemic and fitness variables of the participants. It was evident that only the

WHR variable had a positive correlation with post--prandial glycaemia (p<0.05). None of the anthropometric variables showed correlation with RHR (p>0.05) while all of them showed positive correlation with SBP, DBP and MBP, and negative correlation with flexibility (p<0.05), with the exception of HC (p>0.05). Analysing the correlation between anthropometric variables and localized muscle resistance, WSR obtained negative correlation with AF and ABS (p<0.05) and BMI and WC negative correlation with AF (p<0.05).

Table 2. Correlational analysis (r) between anthropometric indicators and hemodynamic variables, glycaemia and physical fitness

Variables	GLYC#	AF	SBP#	DBP	MBP	FLEX	AF#	ABS#
Mass	-0,020	0,052	**0,461****	**0,391****	**0,440****	**-0,271***	-0,144	0,063
BMI	0,063	0,150	**0,517****	**0,401****	**0,472****	**-0,271***	**-0,279***	-0,233
WC	0,166	0,173	**0,573****	**0,513****	**0,566****	**-0,422****	**-0,269***	-0,153
HC	-0,069	-0,008	**0,285***	0,223	**0,261***	-0,134	-0,214	-0,133
WHR	**0,270***	0,218	**0,468****	**0,442****	**0,477****	**-0,392****	-0,154	-0,085
WSR	0,214	0,243	**0,574****	**0,488****	**0,552****	**-0,411****	**-0,354***	**-0,360****

Note: *p<0.05; **p<0.01; #variable with non-parametric distribution. BMI: body mass index; WC: waist circumference; HC: hip circumference; WHR: waist/hip ratio; WSR: waist/height ratio; GLIC: glycaemia; RHR: resting heart rate; SBP: systolic blood pressure; DBP: diastolic blood pressure; MBP: mean blood pressure; FLEX: flexibility; AF: arm flexions; ABS: abdominals.

The multivariate linear regression analysis (stepwise) between the anthropometric variables and the hemodynamic and fitness variables identified more than one correlation. In this analysis WSR was the best predictor for SBP ($R2_{adjusted}$ = 0.329; b= 111.167; β= 0.574) and MBP ($R2_{adjusted}$ = 0.125; b= -36.472; β= -0.354). In turn, WC was the best predictor for DBP ($_{Adjusted}R2$ = 0.263; b= 0.442; β= 0.513), MBP ($R2_{Adjusted}$ = 0.321; b= 0.519; β= 0.566) and FLEX ($R2_{Adjusted}$ = 0.178; b= -0.245; β= -0.422).

DISCUSSION

This study demonstrated that anthropometric variables correlate positively with hemodynamic variables (SPB, DBP and MBP) and negatively with physical fitness tests (FLEX, AF and ABS). In addition, the WC and WSR indicators were the best predictors among the hemodynamic variables, pointing to their potential performance in early screening for cardiovascular disease risks in adults. Almeida et al.[23] found that the association of anthropometric variables with cardiovascular risk factors are important when assessing how much the variations in body composition interfere with changes in these risk factors.

In general, the association between blood pressure values and anthropometric variables observed in this study corroborates previous studies on children[24], adults[3,7] and the elderly[25]. Similarly to our study, the research by Carvalho et al.[7] suggests that anthropometric indicators of abdominal obesity, especially WC and WSR, are more conclusive to predict high blood pressure and cardiovascular risk. In the studies of Pitanga[17] and Almeida[23], WSR was proposed as an alternative in the use of anthropometric indicators related to health, being strongly associated with coronary risk factors.

The regression analysis of this study showed that WC and WSR had a better correlation with hemodynamic measurements, compared to BMI and WHR anthropometric measurements commonly used. This result is different from those obtained in research studies on adolescents[26] and adults[27], what suggests the necessity of complementing evaluations with the use of BMI to ensure a better diagnosis. Although the use of WHR, similarly to BMI, presented a correlation with hemodynamic and physical fitness variables, it may have been masked by changes in the amount of body adiposity. It is noteworthy that this relationship may be insufficient to assess changes in central obesity during loss or gain of weight[5]. When analysing the correlation between anthropometric variables and localized muscle resistance and flexibility, WSR showed a negative correlation with anthropometric variables, except with HC. However, there are few studies analysing the association between body composition and physical fitness tests, mainly the ones on localized muscular resistance. Differently from our study, the research by Silva et al.[6] did not find the association of anthropometric variables and body composition with the performance of the elderly in the flexibility test.

Commonly, physical fitness, health and quality of life are variables with a high degree of association[28]. Moreover, excess body weight associated with lack of physical activity can pose a threat to individuals' health[29].

Professionals who work in health facilities and fitness centres need to have good knowledge on physical activity and health to be able to detect possible risk factors in simple measures, related to a physical evaluation[30]. Besides that, there are techniques for evaluating body composition, which can be adapted to time and economic resources, using a fast, easy and low-cost method, in which anthropometric measures are preferable to other techniques[5].

Finally, studies have shown that obesity and increased abdominal circumference are directly associated with higher costs of health-related procedures. When both are added to systemic arterial hypertension and diabetes mellitus, it increases the probability of hospitalization[31]. The results of this study should be interpreted with caution due to the non-normal distribution of some variables. It also presented limitations in relation to the sample size, making impossible an individualized analysis between male and female volunteers since the anthropometric indexes and glycaemia classifications differ between the sexes.

CONCLUSION

The anthropometric variables were correlated with hemodynamic variables and with physical fitness tests, pointing to WC and WSR as the best predictors of cardiovascular risks among the analysed variables. This study provides support for early screening of the risks of developing heart disease through fast, easy and low-cost techniques for assessing body composition.

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