CORRELATION BETWEEN IPAQ AND VO$_{2MAX}$ AMONG OBESE WOMEN

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Abstract
Physical activity is widely recommended for obese and overweight individuals, due to their higher cardiovascular risk. Thus, the short form of the International Physical Activity Questionnaire (IPAQ) has been used as a good tools for evaluating and monitoring physical activity in adults. Moreover, the determination of maximum oxygen uptake (VO$_{2max}$) has been described as one of the best methods for evaluation of physical capacity. **Objective:** To investigate the correlation between level of physical activity measured by IPAQ short form and VO$_{2max}$ in women with overweight or obesity, and the association between body mass index (BMI) and waist circumference (WC) with the two methods. **Methods:** In this cross-sectional study, 48 women, aged 45.27 ± 11.56 years, 35 (72.9%) obese, answered to the IPAQ short version and underwent exercise testing to determine the maximal oxygen uptake. **Results:** The IPAQ continuous score was not correlated with VO$_{2max}$, nor with BMI or WC. On the other hand, it was demonstrated a significant inverse correlation between VO$_{2max}$ and BMI (r = -0.50, p <0.01) and WC (r = -0.65, p <0.01). **Conclusions:** The IPAQ proved to be an inadequate instrument for assessing the physical performance of overweight or obese women. In contrast, the VO$_{2max}$ showed a significant inverse correlation with BMI and waist circumference, reinforcing the central role of obesity as a limiting factor for aerobic performance.

Keywords: Physical activity; International physical activity questionnaire; Metabolic expenditure; Obesity; Waist circumference.

INTRODUCTION

The assessment of physical activity has been important for identifying individuals with increased cardiovascular risk. In this sense, the short form of the International Physical Activity Questionnaire (IPAQ) has been seen as a good method for evaluation and monitoring of individuals aged between 15 and 69 years on the practice of physical activities. The short form of IPAQ measures total physical activity, estimating the exercises in three specific ways: walking, moderate activity and vigorous activities.[1]

On the other hand, the maximum oxygen consumption (VO$_{2max}$), determined by the ergometric test, has been described as the metabolic variable that represents the best objective index of exercise capacity, as it reflects the efficiency of cardiopulmonary and cardiovascular systems.[2] The cardiorespiratory responses to exercise are directly proportional to the oxygen demand of skeletal muscles as oxygen uptake and heart rate increases linearly with the physical work performed.[3] Overweight and obesity, especially when associated with abdominal distribution of adipose tissue, are related to an increased risk for cardiovascular morbidity and mortality, as well as cancer-related mortality, resulting in a decreased life expectancy.[4-7] Moreover, the practice of aerobic physical activity was shown to reduce mortality risk in obese and non-obese patients, independent of body mass index (BMI).[8]

In this context, the practice of physical activities, and its control and monitoring, are widely recommended for individuals suffering from obesity or overweight, since they have an increased risk for cardiovascular events and other chronic diseases. Thus, this study had the objective to investigate the association between physical activity measured by IPAQ short form and the VO$_{2max}$ in women with obesity or overweight. When performing, so a comparison between a subjective method and an objective physiological measure for assessing the level of physical activity, contributes in this way for the validation of the method within this specific population group, women who were obese or overweighed. Furthermore, this study evaluated the relationship between obesity, overweight and waist circumference (WC), and methods of assessment of physical activity studied.

METHODS

This is a cross-sectional study. The sample consisted of adult women aged over 18 years with obesity or overweight, according to WHO criteria.[9] The sample size calculation was made based on the analytical objective of establishing the correlation between level of physical activity by IPAQ short form and VO$_{2max}$. Hoping to get a correlation coefficient r = 0.45, alpha = 0.05 and beta = 0.10, was attended by 48 individuals required to perform the search.

We excluded patients who had clinical condition incompatible with the performance of physical exercise programs, or who reported use of dietary supplements or hypo-or hyperlipidemic diet, use of lipid-lowering drugs, corticosteroids, fever up to two weeks prior to the start of the study and process thromboembolism in the month prior to enrollment.

All study participants were enrolled in a clinical record containing information on sex, age, comorbidities and medication use. The participants were also submitted to physical examination that included measurements of weight, height, heart rate, blood pressure (BP) and waist circumference, and calculation of BMI (weight in kg / height in m). The measurement of blood pressure and heart rate counts were performed using a digital sphygmomanometer (*Omron®* model HEM-711), on the right arm with the patient correctly positioned in the chair with their feet on the floor and arm supported at heart level, after 5 minutes of rest. Blood pressure was measured twice with an interval of 1 minute, determining the average of two measures.[10]

Waist circumference was measured in standing position during normal expiration, the middle third of the iliac crest and last rib on the right, using inelastic flexible tape measure to the nearest 0.1 cm. Body weight was measured with the individual with minimal clothing, standing on a digital scale (Tanita WB-2001). The height was determined by measuring the distance from the vertex to the ground when the subject positioned in the Frankfurt plane and under a wall stadiometer with resolution of 0.1 cm.

The clinical avaliation also included the IPAQ short form. The continuous scores are expressed in the IPAQ MET-minutes/week (METs). Was used to estimate recommended by the IPAQ METs: vigorous physical activity corresponding to 8 METs, moderate activity and

walking to 4 METs to 3.3 METs. Also we used the classification recommended by the categorical IPAQ, corresponding to three levels of physical activity (low, moderate and high).

After clinical evaluation, women underwent exercise testing, in order to perform the measurement of VO$_{2max}$ of these individuals. The intervention protocol used was the Bruce protocol. This protocol consists of a first low-intensity, allowing the heating, and subsequent application of progressive loads, made by variations in speed and inclination, every 3 minutes in a continuous manner. VO$_{2max}$ was estimated in woman by VO$_{2max}$ mL.kg^{-1}.min^{-1} = 8.03 + (2.74 x time).[11]

STATISTICAL ANALYSIS

For the characterization of the measured variables were used the mean and standard deviation. Before the analysis were performed testing (symmetry and kurtosis) to identify the normality of the data and testing the assumptions of the analysis. Means were compared by Student's t test for independent samples.

The degree of correlation between the level of physical activity and aerobic performance, as well as their correlation with the anthropometric variables studied, BMI and waist circumference was obtained by calculating the Pearson correlation coefficient. It was performed a logarithmic transformation in the variable that represents the total amount of physical activity assessed by the IPAQ short (continuous score), thus enabling the realization of parametric analyzes such as this variable. All analyzes were performed by SPSS (Statistical Package for Social Sciences) version 13.0, adopting a significance level of 5%.

ETHICAL ASPECTS

Throughout the study it was observed the guidelines on human research of the Declaration of Helsinki and Resolution 196/96 of National Health Council. This study is part of a project approved by the Ethics Committee in Research of Bahia School of Medicine and Public Health. All subjects received detailed information about the study objectives, risks and benefits involved in the procedures and signed an informed consent form (ICF).

SOURCE OF FUNDING

RESULTS

As shown in Table 1, the average age of the population studied was 45.27 ± 11.56 years. The overall mean BMI was 34.59 ± 6.22 kg/m^2 (25.8 to 48.67), with 13 women (27.1%) presenting overweight (27.54 ± 1.21 kg/m^2; 25.8 to 29.06) and 35 (72.9%) obesity (37.22 ± 5.18 kg/m^2; 30.57 to 48.67). The WC measured 104.09 ± 11.40 cm and mean BP was 142/89 ± 25/12 mmHg. It was also shown the average VO$_{2max}$ of the population, which was 22.8 ± 6.7 mL.kg^{-1}.min^{-1}, and the mean result of the short IPAQ continuous score, which was 2568.3 ± 2397.07 MET-minutes/week.

Table 1 - Characteristics of women with overweight/obesity submitted to the evaluation of physical activity by short IPAQ and measurement of VO$_{2max}$

	N	Mean ± SD	Maximum	Minimum
Age (years)	48	45,27 ± 11,56	74	23
Weight (Kg)	48	87,05 ± 16,51	124,6	59,3
Height (m)	48	1,59 ± 0,06	1,81	1,49
BMI (Kg/m^2) Total	48	34,59 ± 6,22	48,67	25,8
Sobrepeso	13	27,54 ± 1,21	29,06	25,8
Obesidade	35	37,22 ± 5,18	48,67	30,57
Waist circumference (cm)	45	104,09 ± 11,40	133	84
BP (mmHg)	48	142/89 ± 25/12	232/137	110/70
VO$_{2max}$ (mL.kg^{-1}.min^{-1})	48	22,80 ± 6,70	34,44	6,55
IPAQ continuous score (MET-minutes/week)	48	2568,3 ± 2397,07	12395	0

Table 2 presents the IPAQ categorical classification that divides the subjects into low, moderate and high physical activity level. Eleven (22.9%) of them are classified as low level of physical activity, 24 (50%) as moderate, and 13 (27.1%) high. Twenty-two women (45.8%) had hypertension, 16 (33.3%), dyslipidemia, and four (8.3%) type 2 diabetes mellitus .

Table 2 - Categorical classification of the short IPAQ in women with overweight/obesity submitted to the evaluation of physical activity (N=48)

Level of physical activity	Absolute frequency	Relative frequency (%)
Low	11	22,9
Moderate	24	50,0
High	13	27,1

There was no correlation between VO$_{2max}$ and the short IPAQ continuous score (r = 0.08, p = 0.59), however there was a moderate inverse correlation between VO$_{2max}$ and BMI (r = -0.50, p <0.01) (Figure 1), and waist circumference as well (r = -0.65, p <0.01) (Figure 2). On the other hand, the IPAQ continuous score was not correlated with BMI (r = -0.24, p = 0.11), nor with waist circumference (r = -0.24, p = 0.12).

Figure 1 - Correlation between maximal oxygen uptake (Vo$_{2max}$) and body mass index (BMI) in obese/overweight women. N = 48.
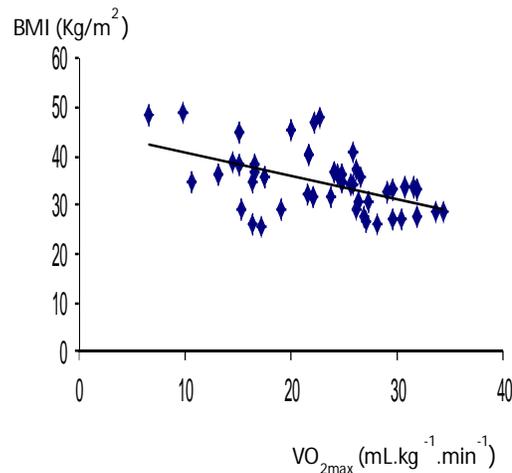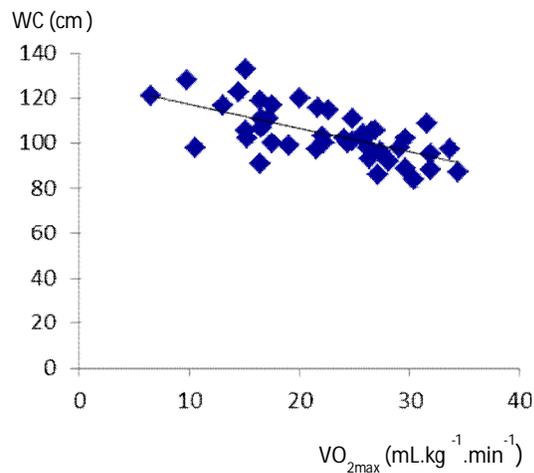
Figure 2 - Correlation between maximal oxygen uptake (Vo$_{2max}$) and waist circumference (WC) in overweight/obese women. N = 48.

When compared the mean VO$_{2max}$ between the groups of volunteers with overweight and obesity, it was observed a trend of lower VO$_{2max}$ in obese women (25.87 ± 6.66 mL.kg^{-1}.min^{-1} versus 21.66 ± 6.43 mL.kg^{-1}.min^{-1}, p = 0.052), however no difference was observed when compared the IPAQ continuous score between these two groups (2435.7 ± 2204.8 MET-minutes/week versus 2617,6 ± 2493.6 MET-minutes/week, p = 0.818).

DISCUSSION

In this study, no correlation was found between VO$_{2max}$ and the short form IPAQ continuous score. In this way, there was no correlation between the subjective method of evaluation of physical activity and aerobic performance in obese or overweight women. This questionnaire has been studied throughout the world to assess the validity and reliability compared with other methods and the results were controversial.[12-14]

The Chinese version of IPAQ (long and short versions) has demonstrated acceptable reliability and validity, compared to other physical activity instruments used in large epidemiologic studies.[15] Similar to this, another study suggested that the IPAQ is a reliable and valid measure of total physical activity in a subset of the Chinese population, but did not reach the same conclusions regarding the sub-components of the IPAQ (walking, moderate activity and vigorous activity) since these had reduced validity and reliability.[14]

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Another study compared the IPAQ with the pedometer, an instrument that counts the number of steps per day for an individual, and demonstrated an association between these two methods in men, but the correlation was not significant in women.[16] Bilitário et al.[17] found a positive relationship between level of physical activity measured by IPAQ and pedometrics, and this relationship was stronger in activities that involve walking, and among women.

Also, Kurtze et al.,[13] studying the relationship between IPAQ and the VO$_{2max}$, showed that the IPAQ short form continuous score was correlated with VO$_{2max}$ (r = 0.3), as well as the categorical classification of IPAQ (r = 0,31). They concluded further that the IPAQ short version has acceptable test-retest reliability. The correlation between the IPAQ continuous score and VO$_{2max}$ was similar to that usually found in general populations, with correlation coefficients typically between 0.3 and 0.5.[18]

On the other hand, the European Physical Activity Surveillance System found a poor comparability between traditional indicators of physical activity used in Europe and the IPAQ short form.[19] Moreover, the IPAQ long form seems to estimate physical activity far greater than reality, as well as the IPAQ short, which tends to overestimate the levels of total physical activity.[20-22] Some of these authors suggest that many people in the general population, especially in a lower socioeconomic environment, with lower levels of education, do not understand the questions in the questionnaire properly, and this could be one explanation for the inadequate results obtained.[21]

Fogelholm et al.[12] reported in the same way, an overestimation of physical activity by IPAQ compared to aerobic physical activity, through the VO$_{2max}$, and other muscular physical activities. Furthermore, they demonstrated that a simple question on weekly frequency of vigorous physical activity showed higher correlation with cardiorespiratory and muscular exercises than the IPAQ short version.

Also in this work, the IPAQ was not correlated with BMI and WC, as well as VO$_{2max}$. The questionnaire, because it is a subjective method of evaluation, can generate inappropriate results, which seems to have occurred also in the current study due to difficulty in interpretation of questions and overestimation of physical activity.

Moreover, our study showed a significant inverse relationship between VO$_{2max}$ and anthropometric indexes evaluated, BMI and WC. This is probably because the practice of regular physical activity can favor smaller values of anthropometric indices. Thus, it is

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assumed that individuals who have lower BMI and WC also practice more physical activity, and therefore have a better aerobic performance compared to those with higher BMI and WC, and who do not exercise at the same level. This indicates how cardiorespiratory exercises attenuate the risks associated with obesity and reinforce the importance of regular physical activity in the prevention and control of obesity related diseases.

The relationships found in this study with VO$_{2max}$ and anthropometric indices are agreement in the literature. Orsi et al.,[23] in assessing functional capacity in women with different body mass indices, showed that obese women had significantly lower VO$_{2max}$ values than groups with overweight and normal BMI, suggesting therefore that the physical fitness of obese women is lower than overweight and normal weight women, as the VO$_{2max}$ measured is the variable that best expresses physical performance.

Likewise, Oliveira et al.[24] analyzed the differences in BMI and WC according to cardiorespiratory fitness (through VO$_{2max}$) in male soldiers, and concluded that for the same BMI, individuals with better cardiorespiratory fitness have significantly lower waist circumference when compared to subjects with lower fitness capacity. These findings suggest a reduction of abdominal fat in better physically conditioned military, since physical exercise leads to reductions in visceral fat and waist circumference independent of changes in BMI.[25] Both the subcutaneous and the visceral abdominal adipose tissue are associated with several health problems. Thus, these findings reinforce the idea that a large mobilization of abdominal fat may be the mechanism by which cardiorespiratory fitness reduces the risk of premature death associated with obesity.[26]

Data from this study make clear the limitations of the IPAQ instrument for assessment of physical activity in overweight women. On the other hand, reinforce the importance of assessing the aerobic performance in this population through the inverse correlation between VO$_{2max}$ and BMI and WC, which shows not only the value of physical activity on cardiovascular disease prevention, as is the role of overall obesity, particularly the abdominal fat as an aggravating factor factor to health.

ACADEMIC LINKING

This article is part of the course conclusion essay of the medical student Gustavo Barreto da Cunha at Bahia School of Medicine and Public Health, under the guidance of Professor Ana Marice Ladeia.

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