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ARTÍCULO ORIGINAL

# Evaluation of the relationship between self-reported physical activity and metabolic syndrome and its components in apparently healthy women

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**Introduction:** The metabolic syndrome, a set of metabolic anomalies that include insulin resistance, central obesity, dyslipidemia, hypertension and inflammation, is an important tool to explore factors associated to cardiometabolic disease.
**Objective:** The aim of this study was to evaluate the relationship of the levels of self-reported physical activity and the International Physical Activity Questionnaire items and the metabolic syndrome and the variables related to cardiovascular risk in 89 women.
**Materials and methods:** The short version of International Physical Activity Questionnaire was applied to classify participating subjects into three categories: insufficient, sufficient and very active physical activity. The metabolic syndrome was assessed according to the International Diabetes Federation criteria. Biochemical and anthropometrical parameters were measured.
**Results:** Twenty-two participants (23%) presented metabolic syndrome and 66 women (74.2%) were classified in the insufficient physical activity category. No association was found between insufficient physical activity and metabolic syndrome. Inverse correlations were found among the days and minutes per week of physical activity of moderate-intensity, waist circumference ($\rho$=−0.327, and $\rho$=−0.313, p<0.005, respectively), and body mass index ($\rho$=−0.262, and $\rho$=−0.218, p<0.05, respectively).
**Conclusion:** A high prevalence of insufficient physical activity was found in the study participants, but this was not associated with metabolic syndrome. Moderate but not vigorous physical activity items from the International Physical Activity Questionnaire correlated inversely with anthropometrical markers related to cardiovascular risk.

**Key words:** Motor activity, women, cardiovascular diseases.

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**Evaluación de la relación de actividad física autorreportada con el síndrome metabólico y sus componentes en mujeres aparentemente sanas**

**Introducción.** El síndrome metabólico, conjunto de anomalías metabólicas que incluyen resistencia a la insulina, obesidad central, dislipidemia, hipertensión e inflamación, es una herramienta importante para explorar los factores asociados a enfermedades cardiovasculares.
**Objetivo.** El objetivo de este estudio fue evaluar la relación de los niveles autorreportados de actividad física y los elementos del Cuestionario Internacional de Actividad Física (*International Physical Activity Questionnaire*), con el síndrome metabólico y las variables relacionadas con el riesgo cardiovascular en 89 mujeres.
**Materiales y métodos.** La versión corta del Cuestionario Internacional de Actividad Física se aplicó para clasificar a los sujetos en tres categorías: actividad física insuficiente, suficiente y muy activa. El síndrome metabólico se evaluó según los criterios de la Federación Internacional de Diabetes y se midieron los parámetros bioquímicos y antropométricos.
**Resultados.** Veintidós participantes (23 %) presentaron síndrome metabólico y 66 mujeres (74,2 %) fueron clasificadas en la categoría de actividad física insuficiente. No se encontró asociación entre la actividad física insuficiente y el síndrome metabólico. Se encontraron correlaciones inversas entre los días y minutos de actividad física de moderada intensidad por semana con la circunferencia de cintura

**Author contributions:**
Milton Fabián Suárez-Ortegón participated in designing the project, in field work, statistical analysis and in drafting the document.
Alejandra Arbeláez, Mildrey Mosquera, Cecilia Aguilar-De Plata participated in designing the project, in field work and in correcting the document.
Robinson Ramírez-Vélez participated in drafting the document..

($\rho$=-0,327, y $\rho$=-0,313, p<0,005, respectivamente) y el índice de masa corporal ($\rho$=-0,262, y $\rho$=-0,218, p<0,05, respectivamente).
**Conclusión.** Una alta prevalencia de actividad física insuficiente se encontró en las participantes en el estudio, pero esto no se asoció con el síndrome metabólico. Los elementos de la actividad física moderada del Cuestionario Internacional de Actividad Física, pero no así los de actividad vigorosa, se correlacionan inversamente con marcadores antropométricos relacionados con riesgo cardiovascular.

**Palabras clave:** actividad motora, mujeres, enfermedades cardiovasculares.
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Cardiometabolic diseases constitute the main cause of world mortality and represent almost 60 % of all deaths and 43 % of all disease in the world (1). During the 1980s, Reaven, *et al.* (2), observed that dyslipidemia, hypertension and hyperglycemia were events frequently associated in the same individual, a condition that increased cardiovascular risk and became known as the metabolic syndrome. Metabolic syndrome is a set of metabolic anomalies that include glucose intolerance, insulin resistance, central obesity, atherogenic dyslipidemia, hypertension, inflammation, and prothrombotic state. This metabolic alteration, initially described by Reaven (2), has been found in subjects who report conducts and preferences related to unhealthy lifestyles, which include inadequate diet, sedentary habits, alcohol consumption and smoking.

According to the National Health and Nutrition Surveys, the current obesity epidemic and the high levels of sedentary habits have duplicated the prevalence of metabolic syndrome in American overweight adults during a period of only 10 years (3,4). The prevalence of metabolic syndrome in the USA (NHANES III Study) (5), found using the diagnosis criteria from the Third Panel of Experts from the National Cholesterol Education Program (NCEP-ATP III) (6), was close to 24% in 20-year-old and older individuals. Combined efforts by the International Diabetes Federation (IDF) (7), the US National Heart, Lung, and Blood Institute (NHLBI) and the American Heart Association (AHA) produced a new definition of metabolic syndrome to be used in clinical practice.

This health problem is becoming a critical issue in developing countries highly influenced by modernization and urbanization (8). Lifestyle changes including reduction in physical activity and substitution of traditional diets for diets with high fat content and caloric density are some of the explanations of this phenomenon (9). Additionally, age, gender, and genetics are factors with significant impact on the predisposition to metabolic syndrome.

Several studies have evaluated the association among cardiovascular risk factors, metabolic syndrome, and the different physical activity characteristics defined by the standards of the International Physical Activity Questionnaire (IPAQ) with uncertain results (10,11). The objective of this study was to evaluate the relationship between the levels of self-reported physical activity and IPAQ items and metabolic syndrome and other variables related to cardiovascular risk in 89 women from the urban area of Cali, Colombia.

## Materials and methods

The study included 89 women workers from the public and private sectors aged between 25 and 64 years from whom blood samples were taken shortly after the interview and after having obtained informed signed consent. Exclusion criteria included women with medical or clinical diagnosis of systemic disease (including malignant processes), non-transmissible chronic disease (such as diabetes, hypertension, obesity, dyslipidemia, atherosclerosis), a history of drug or alcohol abuse, intake of multivitamins, use of statins at the moment of inclusion in the study, pregnancy, current or previous breastfeeding (<1 year), and inflammation disorders or systemic infection. This study was approved by the institutional Human Ethics Committee of the Universidad del Valle.

A trained survey taker applied the self-reported short version of the IPAQ recommended by the World Health Organization (WHO) as a valid measurement to estimate physical activity. This version has seven questions regarding the frequency, duration, and intensity of participation

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in physical activity (such as walking or running during the week) immediately before participating in the study and in different daily life contexts. Participants were classified based on their weekly energy expenditure expressed as metabolic equivalents (MET): ≤600 MET/wk, insufficiently active; 601-1,500 MET/wk, sufficiently active, and ≥1.500 MET/wk, very active (12).

Waist circumference was measured between the lower rib and the iliac crest with a measuring tape; participants were asked to remain in standing position and undressed. Body mass index (BMI) was calculated as weight/height$^2$. Body composition was determined through bio-impedance analysis using the Bodystat® device (Quadscan 4000, UK) to indirectly calculate body fat percentage from total fat mass (kg) and body weight.

Blood pressure was measured with a digital sphygmomanometer (OMRON®) on the right arm on two different occasions, five minutes apart, with the participants seated comfortably and after ten minutes of rest.

Via antecubital venipuncture, 10 ml of blood were extracted onto vacutainer tubes without additive. The blood samples were taken to the laboratory in less than one hour in coolers kept between 4 and 8 ºC, and they were centrifuged at 3,000 rpm to obtain serum until processing. The biochemical markers were determined as follows: lipid levels and glycemia, via semi-automated A-15 colorimetric assay (Biosystems, Spain).

The study followed the International Diabetes Federation criteria and definition of metabolic syndrome. It was necessary to evaluate the presence of abdominal obesity (waist circumference ≥80 cm), triglycerides (≥150 mg/dl), low levels of HDL-c (≤50 mg/dl), systolic blood pressure (≥130 mm Hg), diastolic blood pressure (≥85 mm Hg), and fasting glycemia (≥100 mg/dl) (13).

An exploratory analysis was conducted to determine the frequency and distribution of each of the variables studied. We used the Spearman correlation to estimate the relationship between the IPAQ items and variables related to cardiovascular risk. The association of the lowest physical activity level with metabolic syndrome and its components was estimated by logistic regression. A value of $p<0.05$ was considered as significant and all the analyses were performed with the SPSS statistical package (Statistical Program, version 13, Chicago, IL).

## Results

In table 1, the means and standard deviations of the study variables are shown. Metabolic syndrome prevalence and insufficient physical activity were 10.1 and 74.6%, respectively.

### *Metabolic syndrome and insufficient physical activity*

Table 2 describes the odds ratio (OR) for metabolic syndrome and its components after adjusting the insufficient physical activity level (*vs.* the other levels together) by age and menopause. The women reporting the lowest level of physical activity presented a 2.53-fold increased risk of having MS, but the confidence interval was not significant. The OR between insufficient physical activity level and metabolic syndrome components was also not significant.

**Table 1.** Clinical, anthropometric and biochemical variables related to cardiovascular risk, metabolic syndrome and physical activity level in urban area women

| N | 89 |
|---|---|
| **Age (years)[1]** | 47.1 ± 7.7 |
| **Blood pressure (mm Hg)[1]** | |
| Sistolic | 115 ± 19 |
| Diastolic | 73 ± 14 |
| **Anthropometrics[1]** | |
| Waist circumference (cm) | 77.3 ± 8.2 |
| Body mass index (kg/m$^2$) | 26.8 ± 5.2 |
| Body fat (%) | 39.6 ± 5.8 |
| **Biochemical[1]** | |
| Glucose (mg/dl) | 86.2 ± 8.8 |
| Triglycerides (mg/dl) | 125.2 ± 57.4 |
| Cholesterol (mg/dl) | 194.2 ± 36.9 |
| c-HDL (mg/dl) | 51.9 ± 10.5 |
| **Metabolic syndrome, n (%)** | |
| **Physical activity level (MET/wk), n (%)** | 9 (10.1) |
| Insufficiently active (<600) | 66 (74.2) |
| Sufficiently active (601 to 1,500) | 16 (18.0) |
| Very active (>1,500) | 7 (7.9) |

[1] Average ± standard deviation

**Table 2.** Odd ratios[1] of metabolic syndrome and its components by insufficient physical activity (*vs.* the other levels)

| | Odd ratios | 95% CI |
|---|---|---|
| Metabolic syndrome | 2.53 | 0.28-22.2 |
| Systolic blood pressure ≥130 mm Hg and/or diastolic ≥85 mm Hg | 1.15 | 0.32-4.10 |
| Triglycerides >150 mg/dl | 0.71 | 0.22-2.25 |
| c-HDL <50 mg/dl | 2.25 | 0.78-2.47 |
| Glucose >100 mg/dl | 1.18 | 0.10-13.53 |
| Waist circumference >80 cm | 1.15 | 0.38-3.44 |

[1] Adjusted for age and menopause
CI: confidence interval

### *International Physical Activity Questionnaire items and variables related to cardiovascular risk*

Significant inverse correlations were found between days and time (in days and minutes per week) of moderate physical activity and the anthropometric markers waist circumference and BMI (table 3). There were no statistically significant correlations between total physical activity (MET/week) and clinical, anthropometric and biochemical variables (data not shown).

## Discussion

The objective of this study was to evaluate the relationship between different levels of physical activity and metabolic syndrome risk factors in 89 women from the urban area of Cali, Colombia. We used the IPAQ short version, a measuring instrument endorsed by the WHO, to estimate the level of physical activity in a population between 15 and 69 years of age. The questionnaire psychometric properties, as well as its validity and reproducibility, are applicable for prevalence studies based on national populations (14,15). Currently, the IPAQ is broadly known as the most objective way of estimating physical activity level (16-18). The assessment of physical aptitude has been considered relevant for health status because physical activity is a protection factor in relation to the development of chronic non-transmissible diseases, mainly coronary disease and metabolic syndrome (19). However, there are different factors that can modify this indicator. It is suggested that age is a factor associated with a decrease in physical activity, and this is attenuated positively in trained individuals who participate in the habitual practice of physical exercise (20,21). An epidemiological study carried out in the 1980s by Heath, *et al.* (22), supported this hypothesis by showing that physical aptitude estimated by the level of physical activity performed diminished by 9% per decade in sedentary subjects while in trained subjects, the reduction was only in the order of 5% per decade.

With regard to the general prevalence of subjects with insufficient physical activity in this study, the value was 72.6%, which is 2.65-fold higher than that recently described by Rodrigues, *et al.* (23), and Martins, *et al.* (24), as well as higher than that described in other studies in Colombia (25,26). However, the reasons for this high prevalence were not evaluated. A factor that may have contributed to the increased proportion of sedentary activities is related to the aspects of the time available for this purpose. In fact, when analyzing the motives for physical inactivity in other works, the main reason was insufficient time (27,28). Similar reasons were found by Marcondelli, *et al.* (29), in a comparable population to the one participating in this study, with 66.7% of those surveyed reporting lack of time. However, this motive does not oppose that of increasing daily physical activity through aerobic activities, even moderate ones such as walking from three to five times per week for 30 minutes per session, which can improve cardiovascular health (30). Consequently, lack of time is a possible factor limiting physical activity.

Although many studies have found a relationship between self-reported physical activity level and metabolic syndrome (31-33), others, such as the present study, have not observed any association

**Table 3.** Spearman correlations of International Physical Activity Questionnaire survey items with clinical, anthropometric and biochemical variables related to cardiovascular risk

| | Walking (min/week) | Intense physical activity (min/week) | Moderate physical activity (min/week) | Walking (days/week) | Intense physical activity (days/week) | Moderate physical activity (days/week) | Moderate physical activity (min/week) |
|---|---|---|---|---|---|---|---|
| **Blood pressure (mm Hg)** | | | | | | | |
| Systolic | 0.147 | 0.033 | -0.135 | 0.116 | 0.041 | -0.092 | -0.096 |
| Diastolic | 0.069 | -0.025 | -0.163 | 0.077 | -0.012 | -0.132 | -0.042 |
| **Anthropometrics** | | | | | | | |
| Waist circumference (cm) | 0.107 | -0.152 | **-0.313**** | -0.025 | -0.161 | **-0.327**** | 0.021 |
| Body mass index (kg/m$^2$) | 0.154 | -0.095 | **-0.218*** | 0.059 | 0.088 | **-0.262*** | 0.057 |
| Body fat (%) | 0.037 | -0.101 | -0.153 | 0.032 | 0.099 | -0.184 | 0.040 |
| **Biochemicals** | | | | | | | |
| Glucose (mg/dl) | **0.231*** | -0.188 | -0.029 | 0.141 | -0.191 | -0.029 | -0.061 |
| Triglycerides (mg/dl) | 0.041 | 0.004 | -0.090 | 0.014 | -0.014 | -0.066 | -0.025 |
| Cholesterol (mg/dl) | 0.002 | -0.001 | -0.037 | -0.005 | -0.026 | -0.036 | 0.069 |
| c-HDL (mg/dl) | -0.030 | 0.131 | -0.007 | 0.015 | 0.108 | -0.018 | -0.056 |

* p<0.05, ** p<0.005

(34-36) (table 4). Dalacorte, *et al.,* attributed the lack of relationship to the long time required to establish a disorder such as metabolic syndrome and the possibility that numerous individuals with metabolic syndrome may have been sufficiently active and very active recently (33). Even a study with a bigger sample size than that of the study by Dalacorte, *et al.,* did not find a relationship between self-reported physical activity level and metabolic syndrome (34). On the other hand, the women participating in the present study were apparently healthy, without clinical conditions such as hypertension or diabetes, which could represent a bias with respect to regular physical activity as a part of treatment in this situation.

The IPAQ items related to moderate physical activity (time and days per week) and walking (time per week) were the only survey parameters significantly correlated with some variables related to cardiovascular risk. In the case of time and days of moderate physical activity, the correlations were exclusively with the anthropometric markers waist circumference and BMI, but in an inverse way. These inverse correlations are coherent with the premise of reduction in the recognized predictors of cardiovascular disease by regular practice of physical activity. However, time and days per week of vigorous intensity physical activity did not correlate with clinical, anthropometrical, and biochemical variables. In a prospective study, Wannamethee and Shaper described the association between moderate intensity physical activity and significant reduction in the risk of stroke and heart attacks in men both with and without pre-existing ischemic heart disease; however, vigorous activities were not associated (37). In contrast, Hu, *et al.*, reported a reduction in the risk of type 2 diabetes through both vigorous and moderate intensity physical activity (38). Moreover, the correlation between walking minutes per week and basal glucose levels was unexpectedly positive. However, in this correlation, age could be a confounding factor because this variable correlated positively with basal glucose levels ($\rho$=0.334, p=0.001) and walking minutes per week ($\rho$=0.231, p=0.029). In this case, it is possible that older women tend to practice more walking and have higher glucose levels, or that this unexpected finding between fasting glucose and walking minutes per week could be a simple circumstantial and statistical relationship.

Some limitations must be considered in this study, one being the fact that ethnicity was not an adjustment variable. Another aspect to highlight is the measurement and quality of the responses to the IPAQ, which could be deficient (overestimating or underestimating the level of physical activity).

**Table 4.** Findings regarding the association between self-reported physical activity and metabolic syndrome in some studies

| Country, authors (Reference) | n | Questionnaire | Metabolic syndrome criteria | Association |
|---|---|---|---|---|
| China<br>Yu, *et al.*<br>(31) | 1,831 women/<br>1,458 men | IPAQ, short form | ATP III | Yes. Higher levels of total physical activity had a lower risk of having metabolic syndrome. |
| Iran<br>Esteghamati, *et al.*<br>(32) | 1,629 women/<br>1,667 men | GPAQ<br>(Global Physical Activity Questionnaire) | ATP III | Yes. Highest metabolic syndrome prevalence in individuals with lowest physical activity level |
| Líbano<br>Sibai, *et al.*<br>(33) | 284 women/<br>215 men | IPAQ, short form | IDF | Yes. Lack of physical exercise was associated significantly with higher odds ratio for metabolic syndrome. |
| Brazil<br>Dalacorte, *et al.*<br>(34) | 246 women/<br>116 men | IPAQ, short form | IDF | No. Odds ratio not significant for metabolic syndrome presence by physical activity levels |
| Irán<br>Sann, *et al.*<br>(35) | 984 women | IPAQ, long form | ATP III | No. There was no statistically significant difference in level of physical activity between women with and without metabolic syndrome. |
| USA<br>Kang, *et al.*<br>(36) | 52 women/<br>39 men | Paffenbarger IPAQ | ATP III | No. Physical activity was similar between the with and without metabolic syndrome groups |
| Colombia<br>Present study | 89 women | IPAQ, short form | IDF | No. Lack of association between lowest physical activity level and metabolic syndrome |

IPAQ: International Physical Activity Questionnaire; ATP III: National Cholesterol Education Program (NCEP) - Adult Treatment Panel
IDF: International Diabetes Federation

Likewise, it is possible that with a larger sample size, the relationship between vigorous physical activity and clinical, biochemical and anthropometrical variables could have been evident. Furthermore, we must indicate the need for programs, including preventive and educational measures, aimed at continually promoting more active lifestyles based on the regular practice of physical activity, given that the findings of this work have revealed that moderate physical activity (estimated by minutes and days of activity) is related to the indicators of cardiovascular and metabolic risk. Likewise, development of research designs to study all the possible variables influencing the relationship between self-reported physical activity level and metabolic syndrome is also important.

## Conflicts of interest

The authors declare that there are not conflicts of interest.

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