Lack of relationship of physical activity level with cardiovascular risk factors and metabolic syndrome in apparently healthy men

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Abstract

Background: The World Health Report 2002 of the World Health Organization estimated that physical inactivity is one of the 10 main causes of morbidity and mortality and that the proportion of people whose health is at risk due to a sedentary lifestyle is approximately 60%.

Objective: To assess the relationship of physical activity level with cardiovascular risk factors and metabolic syndrome in 61 healthy men.

Methods: The short version of the International Physical Activity Questionnaire (IPAQ) recommended by the World Health Organization was used as a valid measure to estimate two categories of physical activity, low (insufficient and sedentary) and vigorous (moderate and very active). Cardiovascular risk factors and metabolic syndrome were defined using the criteria of the National Cholesterol Education Program of the United States and the International Diabetes Federation respectively. Serum levels of C-reactive protein and ferritin were also measured, and insulin sensitivity was estimated using the Homeostatic Model Assessment-Insulin Resistance (HOMA-IR).

Results: Mean population age was 47.1 ± 6.9 years. Seventeen participants (28%) had metabolic syndrome. There were no differences between the categories of low and vigorous physical activity, nor a relationship with total physical activity (MET x week). No association was observed between low levels of physical activity and metabolic syndrome criteria.

Conclusions: The high prevalence of physical inactivity found in study participants using the IPAQ questionnaire was not associated with cardiovascular risk factors and metabolic syndrome.

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KEYWORDS
Physical activity; Physical inactivity; Cardiovascular risk; Metabolic syndrome; Male; Colombia
PALABRAS CLAVE
Actividad física; Sedentarismo; Riesgo cardiovascular; Síndrome metabólico; Hombres; Colombia

Falta de relación entre el nivel de actividad física con marcadores de riesgo cardiovascular y síndrome metabólico en hombres aparentemente sanos

Resumen
Fundamento: El Informe sobre la salud en el mundo 2002 de la Organización Mundial de la Salud estimó que el sedentarismo constituye una de las 10 causas fundamentales de morbimortalidad y que la proporción de la población cuya salud está en riesgo debido a una vida sedentaria se aproxima al 60%.

Objetivo: Evaluar la relación entre el nivel de actividad física (AF) con marcadores de riesgo cardiovascular y síndrome metabólico en 61 hombres aparentemente sanos.

Métodos: Se aplicó la versión corta del International Physical Activity Questionnaire (IPAQ) para estimar la AF en dos categorías: baja actividad física (insuficiente y sedentario) y alta actividad física (moderado y muy activo). Los marcadores de riesgo cardiovascular y síndrome metabólico fueron definidos siguiendo los criterios del ATP-III y de la Federación Internacional de Diabetes, respectivamente. Se tomaron niveles séricos de proteína C reactiva, ferritina y se calculó la sensibilidad a insulina mediante el Homeostatic Model Assessment-Insulin Resistance (HOMA-RI).

Resultados: El promedio de edad de la población fue 47,1 ± 6,9 años. Diecisiete participantes (28%) presentaron síndrome metabólico. No se encontraron diferencias entre las categorías según el cuestionario IPAQ baja o vigorosa AF, ni relación con la AF total (MET x semana). Tampoco asociaciones entre bajo nivel de AF con los criterios de síndrome metabólico.

Conclusiones: Una alta prevalencia de sedentarismo se encontró en los participantes cuando se miden con el cuestionario IPAQ, aunque los niveles de AF no se asociaron con los marcadores de riesgo cardiovascular o síndrome metabólico.

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Introduction
Cardiovascular diseases represent the main cause of mortality and account for almost 60% of all deaths and 43% of all diseases worldwide. In the 1980s, Reaven et al noted that dyslipidemia, hypertension, and hyperglycemia were conditions frequently associated in the same individual and involved a greater cardiovascular risk. This condition was called metabolic syndrome (MS). MS is a group of metabolic abnormalities including glucose intolerance, insulin resistance, central obesity, arterial hypertention, and a prothrombotic state. MS has been found in subjects reporting behavior and preferences related to an unhealthy lifestyle including inadequate diet, sedentary lifestyle, alcohol consumption, and smoking.

In addition to already known metabolic markers of cardiovascular risk such as glucose, cholesterol, and triglycerides (TGs), new markers have been studied in the past decades related to the risk of MS and non-transmissible chronic diseases (NTCDs). Subclinical inflammation, as assessed by levels of high-sensitivity C-reactive protein (hs-CRP), and iron deposits based on ferritin levels have been associated with risk of type 2 diabetes and MS.

The current obesity epidemic and high levels of physical inactivity have doubled the prevalence of MS in overweight US adults in only 10 years (1988-1994 and 1999-2004) according to the US National Health and Nutrition Survey. MS prevalence in the United States (NHANES III Study) using the diagnostic criteria of the Third Expert Panel of the National Cholesterol Education Panel (NCEP-ATP III) was close to 24% in subjects aged 20 years or older. This definition, using fasting glucose levels ranging from 110 to 125 mg/dL, has been used in many studies. The combined efforts of the International Diabetes Federation (IDF), the US National Heart, Lung, and Blood Institute, and the American Heart Association have resulted in a definition of MS for use in clinical practice worldwide.

This health problem is becoming a critical problem in developing countries, which are highly influenced by modernization and urbanization. Lifestyle changes including reduced physical activity and the replacement of traditional diets by high-fat, high-calorie diets are two explanations for this phenomenon. In addition, age, sex, and genetics are factors with a significant impact on predisposition to MS.

Several studies have assessed the association of the different characteristics of physical activity, as defined by the international physical activity standard (International Physical Activity Questionnaire or IPAQ), with cardiovascular risk factors and MS but without definitive results. The purpose of this study was to assess the relationship of the level of physical activity, as assessed with the IPAQ, to cardiovascular risk factors and MS in apparently healthy males.

Methods
Study population
Sixty-one males aged 25-64 years from the metropolitan area of Cali (Colombia) working at three private and
public companies were recruited for the study. Two of the authors separately verified the quality of the data collected from standardized questionnaires such as the IPAQ, the sociodemographic survey, and the health history survey. Blood samples were drawn shortly after the interview, and after informed consent and approval by the ethics committee in humans had been given. Participants with a medical or clinical diagnosis of major systemic disease (including malignant conditions), diabetes, arterial hypertension, hypothyroidism or hyperthyroidism, body mass index (BMI) of 35.0 kg/m² or higher, a history of drug or alcohol abuse, use of multivitamin preparations, use of statins, and current inflammatory (trauma, contusion) or infectious conditions were excluded from the study.

Measurement of cardiovascular risk factors and metabolic syndrome risk factors

Assessments were made of cardiovascular risk factors reported in the National Cholesterol Education Program (NCEP) in the United States, hs-CRP and ferritin levels, and insulin sensitivity calculated by the Homeostatic Model Assessment-Insulin Resistance (HOMA-IR) index (using the formula: \[ \text{basal insulin in mIU/L} \times \text{basal blood glucose in mmol/L/22.5} \]) as new markers associated with MS and cardiovascular disease. The IDF criteria and definition, used as cut-off points in the Colombian population, were applied to MS. For this purpose, the presence of MS components had to be assessed. Such components included abdominal obesity (waist circumference ≥ 88 cm), TG ≥ 150 mg/dL, low HDL cholesterol (HDL-C) levels (< 40 mg/dL in males), systolic blood pressure ≥ 130 mmHg, diastolic blood pressure ≥ 85 mmHg, and fasting blood glucose ≥ 100 mg/dL. MS was defined as the presence of abdominal obesity plus at least two other components.

Self-reported measurement of physical activity level

The short version of the IPAQ recommended by the World Health Organization (www.ipaq.ki.se/questionnaires/CoombiaIQshtel.pdf) was self-administered by the participants as a valid measurement for the estimation of physical activity by a trained interviewer. This version consists of seven questions inquiring into the frequency, duration, and intensity of participation in physical activities such as walking or running in the week immediately prior to participation in the study and into different aspects of daily living. Metabolic equivalents (METs) were calculated in order to classify subjects into two groups:

1) high physical activity level: participation on at least 3 days in vigorous physical activity and at least 1,500 MET-min/week or more days of any combination of physical activity and at least 3,000 MET-min/week.
2) low physical activity level (less than 3 days of vigorous activity and less than 20 min/day and/or walking less than 20 min daily or a calorie expenditure lower than 600 MET-min/week).

Anthropometric measurement and body composition

A physical examination including anthropometric measurements following the Lopez et al protocol was used to record height using Kramer® equipment and body weight using a Tanita® scale. Waist circumference was measured between the lowest rib and the iliac crest using a measuring tape, with the participant standing and in light clothing. Body composition was determined by a bioimpedance analysis using the Bodystat® device (Quadscan 4000, United Kingdom) to indirectly calculate body fat percentage from total fat mass (kg) and body weight.

Clinical measurement

Blood pressure was measured with a digital sphygmomanometer (OMRON®) in the right arm at two separate times, 5 min apart, with the participants sitting in a comfortable position and after a 10-min rest. Participants also completed a survey of their personal and family health history.

Biochemical measurements

Ten milliliters of blood were drawn into Vacutainer tubes with no additive by puncture into an antecubital vein. Blood samples were transported to the laboratory in iceboxes at between 4 and 8 °C, and were centrifuged at 3,000 rpm within one hour to obtain serum until processing. Biochemical markers were measured using the following techniques: hs-CRP and ferritin by immunoturbidimetric methods in an automated A-15 spectrophotometer (Biosystems, Spain), glucose, total cholesterol, TG, and HDL-C by a direct colorimetric method in an automated spectrophotometer by solubilization with detergent (Biosystems, Spain). Arterial index was calculated using the formula: total cholesterol/HDL-C. VLDL and LDL cholesterol levels were calculated using the Friedewald et al equations: \[ \text{VLDL-C} = \frac{\text{TG}}{5} \] and \[ \text{LDL-C} = \text{total cholesterol} - \text{HDL-C} - \text{VLDL-C} \] (for subjects with TG < 400 mg/dL). Insulin levels were measured by a chemiluminescence assay (IMMULITE 1000 kit, San Jose, CA).

Data analysis

An exploratory analysis was first performed to determine the frequency and distribution of each of the variables tested. Pearson and Spearman correlation coefficients were used to estimate the relationship between variables of the IPAQ and cardiovascular and MS risk markers depending on variable distribution. The differences between the means obtained in the two IPAQ categories (low and high physical activity level) were assessed using a Student’s t test for all variables. Variables not normally distributed were log-transformed for normalization. When variable normalization was not possible, a non-parametric Mann-Whitney U test was used to estimate differences by IPAQ categories. The association between physical activity and MS criteria was estimated using a Chi-square test, and odds ratios were calculated for each category. A value of p < 0.05 was considered significant, and all analyses were performed using SPSS software (Statistical Program Version 13, Chicago, IL).
Activity level with cardiovascular risk factors

Results

Description of body composition, anthropometry, and biochemical and clinical markers of the study population

The mean age of the study population was 47.1 ± 6.9 years. Mean systolic and diastolic blood pressure values were 123 ± 14 mmHg and 76 ± 9 mmHg respectively. Mean anthropometric measurements included a waist circumference of 86.8 ± 9.7 cm, BMI of 26.7 ± 3.1 kg/m², body fat percentage of 25.8 ± 6.0, and visceral fat percentage of 12.3 ± 9.8. Seventeen participants (28%) had MS. Table 1 shows the mean values of the biochemical parameters.

Self-reported measurement of physical activity level

Table 2 classifies participants by self-reported physical activity level. The lowest proportion of participants was found in the sedentary lifestyle category, while most were in the “moderately active” category. No differences were found between the low and high physical activity categories (Table 3), or between total physical activity (MET x week) and clinical, anthropometric, and biochemical variables (Table 4).

Low physical activity level as a low risk factor for metabolic syndrome and its criteria

In this study, subjects with low physical activity levels had a 1.1-fold higher risk of experiencing MS, but the 95% CI for this weak association was not significant. Similarly, no significant associations were found between a low physical activity level and components associated with MS (Table 5).

Discussion

The purpose of this study was to assess the relationship of physical activity level to cardiovascular risk factors and MS in 61 apparently healthy males. Unexpectedly, our study showed no significant differences between the study groups (low and high physical activity) and no significant correlation between total physical activity (MET x week) and the clinical, anthropometric, or biochemical variables studied. This study used the short version of the IPAQ, a measurement tool supported by the World Health Organization for estimating the level of physical activity in the population aged 15-69 years whose psychometric properties, such as validity and reproducibility, make it appropriate for prevalence studies based on populations similar to the one studied. While the short version of the IPAQ has been widely tested and is used in many international studies, this study is the first one reported in Santiago de Cali where physical activity levels were measured using such a version. Today, the IPAQ is widely recognized as one of the most objective ways of measuring individual physical fitness, and it has been utilized both as a determinant of health status and as a way of measuring the risk of suffering non-transmissible chronic diseases, mainly coronary disease. There are however different factors that may modify this indicator. Age has been postulated as a factor associated with decreased physical activity which is positively attenuated in people accustomed to the routine performance of physical exercise. An epidemiological study supports this
Table 3  Mean values of clinical, anthropometric, and biochemical variables by level of physical activity

<table>
<thead>
<tr>
<th>Variables</th>
<th>Physical activity level</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low (n = 28)</td>
<td>High (n = 33)</td>
</tr>
<tr>
<td><strong>Clinical</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic BP (mmHg)</td>
<td>122.6 ± 12.5</td>
<td>122.4 ± 15.6</td>
</tr>
<tr>
<td>Diastolic BP (mmHg)</td>
<td>75.1 ± 9.8</td>
<td>74.9 ± 8.6</td>
</tr>
<tr>
<td><strong>Anthropometric</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>86.4 ± 8.2</td>
<td>87.0 ± 10.8</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>26.6 ± 2.4</td>
<td>26.9 ± 3.6</td>
</tr>
<tr>
<td>Body fat percentage</td>
<td>26.7 ± 5.9</td>
<td>25.0 ± 6.0</td>
</tr>
<tr>
<td>Visceral body fat⁷</td>
<td>13.7 ± 14.0</td>
<td>11.06 ± 3.7</td>
</tr>
<tr>
<td><strong>Biochemical</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glucose (mg/(dL))</td>
<td>90.2 ± 10.2</td>
<td>90.8 ± 8.3</td>
</tr>
<tr>
<td>Triglycerides (mg/(dL))</td>
<td>201.8 ± 99.3</td>
<td>207.3 ± 134.6</td>
</tr>
<tr>
<td>Cholesterol (mg/(dL))</td>
<td>201.4 ± 30.9</td>
<td>202.6 ± 33.7</td>
</tr>
<tr>
<td>HDL-C (mg/dL)</td>
<td>43.6 ± 8.9</td>
<td>42.1 ± 9.6</td>
</tr>
<tr>
<td>LDL-C (mg/dL)</td>
<td>119.1 ± 28.6</td>
<td>119.8 ± 29.0</td>
</tr>
<tr>
<td>Arterial index⁸</td>
<td>4.7 ± 1.0</td>
<td>4.9 ± 1.0</td>
</tr>
<tr>
<td>Ferritin (µg/L)⁹</td>
<td>262 ± 188</td>
<td>232 ± 180</td>
</tr>
<tr>
<td>hs-CRP (mg/L)⁸</td>
<td>2.3 ± 2.5</td>
<td>1.7 ± 0.9</td>
</tr>
<tr>
<td>Insulin (mIU/mL)</td>
<td>13.4 ± 7.4</td>
<td>12.5 ± 6.3</td>
</tr>
<tr>
<td>HOMA-IR</td>
<td>3.0 ± 1.7</td>
<td>2.8 ± 1.5</td>
</tr>
</tbody>
</table>

BMI: body mass index; BP: blood pressure; HDL-C: HDL cholesterol; HOMA-IR: insulin sensitivity index; hs-CRP: high-sensitivity C-reactive protein; LDL-C: LDL cholesterol.

³Range difference by the Mann-Whitney U test.

³Means difference using log-transformed values.

Table 4  Total physical activity (MET x week) and its relationship to clinical, anthropometric, and biochemical variables

<table>
<thead>
<tr>
<th>Variables⁸</th>
<th>r value</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clinical</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic BP (mmHg)</td>
<td>0.047</td>
<td>0.720</td>
</tr>
<tr>
<td>Diastolic BP (mmHg)</td>
<td>0.062</td>
<td>0.637</td>
</tr>
<tr>
<td><strong>Anthropometry and body composition</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>-0.092</td>
<td>0.490</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>-0.042</td>
<td>0.751</td>
</tr>
<tr>
<td>Body fat percentage</td>
<td>0.041</td>
<td>0.757</td>
</tr>
<tr>
<td>Visceral fat percentage</td>
<td>0.057</td>
<td>0.667</td>
</tr>
<tr>
<td><strong>Biochemical</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glucose (mg/(dL))</td>
<td>0.080</td>
<td>0.540</td>
</tr>
<tr>
<td>Triglycerides (mg/(dL))</td>
<td>-0.013</td>
<td>0.921</td>
</tr>
<tr>
<td>HDL-C (mg/dL)</td>
<td>-0.038</td>
<td>0.771</td>
</tr>
<tr>
<td>LDL-C (mg/dL)</td>
<td>-0.032</td>
<td>0.813</td>
</tr>
<tr>
<td>Cholesterol (mg/(dL))</td>
<td>0.037</td>
<td>0.779</td>
</tr>
<tr>
<td>hs-CRP (mg/dL)</td>
<td>-0.102</td>
<td>0.440</td>
</tr>
<tr>
<td>Ferritin (µg/dL)</td>
<td>-0.037</td>
<td>0.775</td>
</tr>
<tr>
<td>Arterial index</td>
<td>-0.194</td>
<td>0.134</td>
</tr>
<tr>
<td>Insulin</td>
<td>-0.004</td>
<td>0.973</td>
</tr>
<tr>
<td>HOMA-IR</td>
<td>-0.011</td>
<td>0.935</td>
</tr>
</tbody>
</table>

BMI: body mass index; BP: blood pressure; HDL-C: HDL cholesterol; HOMA-IR: insulin sensitivity index; hs-CRP: high-sensitivity C-reactive protein; LDL-C: LDL cholesterol.

³Mean and standard deviation.
Other authors associated cell adhesion molecules and dyslipidemia and increased showed MS to be associated with an increased activity of the IPAQ. No statistically significant linear correlation relationship between BMI and the internal categories of respectively. Dalacorte et al and Delavar et al in Brazil and Iran physical activity, our results agree with those reported by criteria, and taking into account the self-reported levels of significant association with the presence of MS and its to each IPAQ question are required. As regards the non-significant association with the presence of MS and its criteria, and taking into account the self-reported levels of physical activity, our results agree with those reported by Dalacorte et al and Delavar et al in Brazil and Iran respectively.

Some limitations of this study should be taken into account. One limitation was that results were not adjusted for potential confounders such as smoking, alcohol consumption, or socioeconomic status. Different studies have shown blood pressure to be strongly associated with body weight, irrespective of smoking and socioeconomic income. It should also be noted that both the measurements and the quality of the answers to the IPAQ questionnaire may be deficient (through either overestimating or underestimating levels of physical activity) when self-reporting procedures are used because participants may avoid answering questions, something which rarely occurs in personal interviews. Finally, a small sample was used.

To conclude, the results of this study showed no significant differences between the study groups (low and high physical activity) and no significant correlation between total physical activity (MET x week) and the clinical, anthropometric, or biochemical variables studied.

### Conflict of interest

The authors state that they have no conflict of interest.

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