ORIGINAL ARTICLE

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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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 hypertension, and a prothrombotic state. MS has been found in subjects reporting resistance, central obesity, arterial hypertension, and atherosclerotic abnormalities including glucose intolerance, insulin resistance, and iron deposits based on ferritin levels have been 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 hospitals were included in the study. According to the version of the International Physical Activity Questionnaire (IPAQ), which evaluates different characteristics of physical activity, as defined by level of activity, the study population was divided into two categories: low activity level (insufficient and sedentary) and high activity level (moderate and very active).

Results
Forty-nine percent of the study population (41 males) had an insufficient or sedentary activity level, while 51% (30 males) had a moderate or very active level. A high prevalence of MS was found in both categories, with 28% (12 males) being classified as having MS in the insufficient and sedentary category, and 36% (10 males) in the moderate and very active category. No significant differences were found between the categories in terms of the percentage of subjects with MS (28% vs. 36%, respectively).

Conclusion
A high prevalence of MS was found in both activity levels, indicating a need for intervention strategies to promote physical activity and reduce the risk of MS in the study population.
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 States4, hs-CRP and ferritin levels, and insulin sensitivity calculated by the Homeostatic Model Assessment-Insulin Resistance (HOMA-IR) index (using the formula: [basal insulin in mIU/L x basal blood glucose in mmol/L)/22.5]) as new markers associated with MS and cardiovascular disease3,4. The IDF criteria and definition13, used as cut-off points in the Colombian population16, 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/ColombiaIQshetl.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 protocol17 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)18. Arterial index was calculated using the formula: total cholesterol/HDL-C. VLDL and LDL cholesterol levels were calculated using the Friedewald et al equations19: VLDL-C = TG/5 and LDL-C = total cholesterol — HDL-C — VLDL-C (for subjects with TG < 400 mg/dL).

Insulin levels were measured by a chemiluminescence assay (IMMULITE 1000 kit, San Jose, CA)20.

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).
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 fata</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 indexa</td>
<td>4.7 ± 1.0</td>
<td>4.9 ± 1.0</td>
</tr>
<tr>
<td>Ferritin (µg/L)b</td>
<td>262 ± 188</td>
<td>232 ± 180</td>
</tr>
<tr>
<td>hs-CRP (mg/L)a</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.

aRange difference by the Mann-Whitney U test.
bMeans difference using log-transformed values.

Hypothesis. Thus, Heath et al25 showed in the 1980s that physical fitness, as estimated by the level of physical activity performed, decreases 9% by decade in sedentary males.

The high prevalence of subjects with a low physical activity level in our study, 45%, should be noted. This is virtually double the percentage recently reported both by Rodrigues et al26 and Martins et al27. The differences found between these studies, using the same measurement criteria and physical activity levels, are probably related to how the IPAQ was administered (personal interview) and some sociodemographic conditions such as age, educational level, and socioeconomic level.

The reasons for the high prevalence of low physical activity in the evaluated participants were not identified. Certain factors that may have contributed to the high proportion of sedentary activities are related to the time available for physical activity, and include long working hours and a limited incentive to maintain an active lifestyle inside and outside the workplace. These reasons were also reported by Marcondelli et al28 in a population similar to that of our study in which 66.7% of the subjects said that they did not have the time.

The 28% prevalence of MS shown in our study is similar to that reported by other authors in neighbouring countries1,16-29. From the epidemiological viewpoint, MS is responsible for a 1.5-fold increase in the overall mortality risk and a 2.5-fold increase in cardiovascular disease22-24. There are, however, few studies which support the association between MS and cardiovascular morbidity.
Activity level with cardiovascular risk factors

Table 5  Risk indices (odds ratio) of low physical activity for metabolic syndrome and its criteria in males

<table>
<thead>
<tr>
<th>Presence</th>
<th>Low physical activity</th>
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| Metabolic syndrome        | 1.1  
| Systolic blood pressure ≥ 130 or diastolic BP ≥ 85 mmHg | 1.1  |
| Triglycerides ≥ 150 mg/dL | 1.3  |
| HDL-C < 40 mg/dL          | 0.8  |
| Waist circumference ≥ 88 cm | 1.0  |

HDL-C: HDL cholesterol; 95% CI: 95% confidence interval.

Conflict of interest

The authors state that they have no conflict of interest.

Acknowledgements

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