



ORIGINAL ARTICLE

Sex differences in the relationship between vigorous vs moderate intensity exercise and risk markers of overweight and obesity in healthy adults[☆]

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KEYWORDS

Physical training;
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Abstract

Introduction: Several studies have extensively documented the benefits of moderate intensity physical training for reducing the risk of cardiovascular death in the management of overweight and obesity. However, the benefits of vigorous intensity training are small.

Objective: To examine sex differences in the relationship between vigorous vs moderate intensity exercise and risk markers for overweight and obesity in healthy adults.

Methods: A cross-sectional, descriptive study in 304 healthy subjects (n=218 men, n=86 women). The short version of the International Physical Activity Questionnaire (IPAQ) was used to stratify exercise intensity into two categories, moderate and vigorous. Body mass index (BMI) and percent body fat (%BF) were calculated, and waist circumference (WC) was measured as risk markers of overweight and obesity.

Results: No significant differences were found in risk markers of overweight and obesity in the male group depending on exercise intensity. As compared to women training at moderate intensity, those making vigorous exercise had lower BMI ($25.7 \pm 3.0 \text{ kg/m}^2$ vs $22.5 \pm 1.7 \text{ kg/m}^2$), WC ($79.2 \pm 6.8 \text{ cm}$ vs $76.0 \pm 3.1 \text{ cm}$), and BF ($33.5 \pm 2.6\%$ vs $28.1 \pm 5.3\%$) levels ($P < 0.05$ for all).

Conclusions: Vigorous intensity training is associated with lower values of markers of overweight and obesity in women, but not in men.

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PALABRAS CLAVE

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Diferencias por sexo de la relación entre ejercicio de intensidad vigorosa vs. intensidad moderada y marcadores de riesgo de sobrepeso/obesidad en adultos saludables

Resumen

Introducción: Varios estudios han documentado en forma extensa los beneficios del entrenamiento físico de moderada intensidad en la reducción del riesgo de morir por enfermedades cardiovasculares, en el control del sobrepeso y la obesidad. Sin embargo, los beneficios del entrenamiento a intensidades vigorosas son escasos.

Objetivo: Examinar las diferencias por sexo de la relación entre el ejercicio de intensidad vigorosa vs. intensidad moderada y marcadores de riesgo de sobrepeso y obesidad en adultos saludables.

Métodos: Estudio descriptivo, transversal en 304 sujetos saludables (n=218 hombres; n=86 mujeres). Se aplicó la versión corta del *International Physical Activity Questionnaire* (IPAQ) para estimar la intensidad de ejercicio en 2 categorías: intensidad moderada e intensidad vigorosa. Se calculó el índice de masa corporal (IMC), el porcentaje de grasa corporal (%GC) y se midió la circunferencia de cintura (CC), como marcadores de sobrepeso y obesidad.

Resultados: Respecto a la intensidad del ejercicio, no se encontraron diferencias significativas en los marcadores de sobrepeso y obesidad en el grupo de hombres. En comparación con el entrenamiento de moderada intensidad, las mujeres que se entrenaban a intensidad vigorosa presentaron menores valores en el IMC ($25,7 \pm 3,0 \text{ kg/m}^2$ vs. $22,5 \pm 1,7 \text{ kg/m}^2$), en la CC ($79,2 \pm 6,8 \text{ cm}$ vs. $76,0 \pm 3,1 \text{ cm}$), y en el %GC ($33,5 \pm 2,6\%$ vs. $28,1 \pm 5,3\%$) respectivamente, $P < 0,05$.

Conclusiones: El entrenamiento de intensidad vigorosa se relaciona con menores valores en los marcadores de sobrepeso y obesidad en mujeres pero no en hombres.

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Introduction

The problem of overweight/obesity is reaching crisis dimensions in both developed and developing countries.¹ This increased prevalence is associated with an increase in chronic conditions, decreased quality of life, impaired work capacity and increased cardiovascular risk factors (CVRFs), leading to a significant increase in healthcare costs.² In response to this problem, the American Heart Association considers overweight, obesity and excess adiposity to be major CVRFs.³ Physical activity itself reduces the risk in obese subjects and promotes the treatment of overweight and obesity through an increased basal metabolic rate. Physical exercise also contributes to the maintenance of fat-free mass by reducing body fat.⁴ In addition, several epidemiological and observational studies have also shown that the regular taking of exercise of moderate intensity decreases the risk of coronary artery disease, metabolic syndrome and type 2 diabetes mellitus and improves health perception.⁵⁻⁷

Exercise intensity may be expressed in terms relative to the functional capacity of each person such as the percentage of maximum oxygen uptake ($\text{VO}_{2\text{max}}$) or metabolic equivalents (METs). $\text{VO}_{2\text{max}}$ indicates the physical work capacity of a subject and generally reflects the system of oxygen transport from the atmosphere to use by the muscle.⁷ It has been stated that cardiovascular disease mortality may be decreased by 20–40% in middle-aged people who perform physical exercise of moderate intensity, ranging from 3 to 6 METs, with a minimum energy expenditure of 1000 kcal/week.⁶⁻⁹ However, several authors have reported different results after changing the training intensity

variable.⁷⁻⁹ Wenger et al.¹⁰ showed that exercise of vigorous intensity showed greater cardiometabolic benefits, including decreased high blood pressure, atherosclerosis and obesity, as compared to a group training at moderate intensity. Jiménez and Ramírez-Vélez¹¹ recently assessed the effect of eight weeks of high-intensity aerobic training in middle-aged subjects with CVRFs. After intervention, the exercise group showed improved insulin sensitivity, decreased LDL-C levels and arterial index and increased HDL-C levels with no significant differences in body composition. Ramírez-Vélez et al.⁷ similarly reported that exercise intensity and duration are two factors inversely and independently related to most CVRFs. In men, the effect is greater in relation to exercise intensity, while the duration of physical activity is more influential in women. While vigorous intensity training is an attractive model for research into the impact of physical exercise on metabolic health, its indication should be analyzed in greater depth. The purpose of this study was to examine the impact of two physical exercise intensities (vigorous vs moderate) on the risk markers of overweight and obesity in healthy adult subjects of both sexes.

Materials and methods

A descriptive, cross-sectional study was conducted during the first six months of 2011 on 304 healthy subjects (n=218 men; n=86 women) aged 18–35 years from the metropolitan area of Cali, Colombia. Subject selection was made by public notice and intentional sampling and participants with a medical or clinical diagnosis of a major

systemic disease (including malignancies), type 1 or 2 diabetes mellitus, high blood pressure, hypothyroidism or hyperthyroidism, BMI < 18 kg/m² or >35 kg/m², a history of drug or alcohol abuse, inflammatory (trauma, contusion) or infectious conditions or who were using multivitamin preparations or statins were excluded. Written informed consent was obtained from each participant and the ethics committee of the academic center approved the study in compliance with the ethical standards set out in the Declaration of Helsinki and the applicable legal regulations in Colombia governing research in humans (Decision 008430 of the Colombian Ministry of Health).

Overweight and obesity markers

The following data were collected from each participant: (a) family history of cardiovascular risk, (b) personal history, (c) 24-hour dietary recall, and (d) an anthropometric assessment including height, weight, and waist circumference, measured using procedures standardized by López et al.¹² Height was measured using a Krammer anthropometer (Holtain Ltd., Crymych Dyfed, UK) of 4 segments and with 1-mm precision. Weight was measured using floor scales (Health-o-Meter, Continental Scale Corp., Bridgeview, Ill, USA) with a 500-g precision calibrated with known weights. These variables were used to calculate body mass index (BMI) in kg/m². Waist circumference (WC) was measured at the midpoint between the iliac crests and lower costal margin using a plastic measuring tape with a precision of 0.5 cm (Holtain Ltd., Crymych Dyfed, UK). Percent body fat (%BF) was calculated by indirect calorimetry using the equation recommended and modified by Faulkner^{12,13} for healthy subjects. The formulas used were %BF = 1.2 × (BMI) + (0.23) × (age) – (10.8 × 0) – 5.4 for women and %BF = 1.2 × (BMI) + (0.23) × (age) – (10.8 × 1) – 5.428 for men. The abovementioned measurements were taken using certified devices and according to the standards of the international biological program prepared by the International Council of Scientific Unions, including the essential procedures for the biological study of human populations.¹⁴

Classification of exercise intensity

The short version of the International Physical Activity Questionnaire (IPAQ) recommended by the World Health Organization (www.ipaq.ki.se/questionnaires/ColombialQshtel.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 in different contexts of daily living. Metabolic equivalents (METs)¹⁵ were calculated to classify subjects into two intensity groups: (1) *vigorous intensity*: participation in vigorous physical activity at least four days and at least 1500 MET-min/week and/or five days of any kind of physical activity and at least 3000 MET-min/week; subjects with scores in the Borg perceived exertion scale ranging from 8 to 10 and HR ≥ 85% during

training. (2) *Moderate intensity*: Less than three days of vigorous physical activity and less than 20 min daily and/or walking less than 20 min daily or a calorie expenditure less than 600 MET-min/week; subjects with scores in the perceived exertion scale < 7 and HR < 85% during training. To be included in this classification, participants had to have been regularly attending the program “Cali in Motion: Hills, the Healthy Route”. This consists of 45 min of uphill activity, three times weekly, in which all the various social and occupational strata of the city of Cali are represented.

Statistical analysis

A Kolmogorov–Smirnov test was used for testing the normal distribution of the study variables. This allowed for the use of the parametric Student's *t* test based on the distribution for independent samples. All statistical tests were performed using software SPSS 15.0 for Windows (Graphpad Instat, Graphpad Software, University of London, London, UK). A value of $p \leq 0.05$ was considered statistically significant.

Results

Of the 304 healthy subjects, 71% (n = 218) were males and 29% (n = 86) females. After classification by intensity level, no differences were found in age, weight, height, BMI, %BF or WC in the male group. As compared to the group training at moderate intensity, women training at vigorous intensity had lower values of BMI (25.7 ± 3.0 vs 22.5 ± 1.7), WC (79.2 ± 6.8 vs 76.0 ± 3.1) and %BF (33.5 ± 2.6 vs 28.1 ± 5.3) ($P < 0.05$).

Discussion

Physical activity consists of a complex group of behaviors and may be measured according to its duration, frequency, intensity or setting. Several studies have shown that increased physical activity, by controlling overweight and obesity, is associated with a reduction in the risk of dying from cardiovascular disease.^{4–11} We therefore examined sex differences and the relationship between vigorous vs moderate intensity exercise in risk markers for overweight and obesity in healthy adults (Table 1). The main findings of this study concerned sex differences in the anthropometric parameters: BMI, percent body fat and waist circumference. Such findings agree with the association with the risk of myocardial infarction found in the INTERHEART study on patients from 52 countries.¹⁶ In the general population, regular physical activity (within ranges equivalent to those reported in this study) was related to an odds ratio (OR) for the first infarction of 0.86 with a population attributable risk of 12%. Such a relationship was also seen in women and young subjects in all countries. Differences found in the female group are consistent with studies by Lee et al.,¹⁷ Manson et al.,¹⁸ Hu et al.,¹⁹ and Jeon et al.²⁰ who reported that vigorous training intensities are associated with a decreased risk of cardiometabolic disease as compared to activities of low to moderate intensity. However, we cannot state that high intensity training induced no changes in other compartments such as visceral fat or limbs

Table 1 Sex differences in training levels and markers of obesity/overweight.

	Age (years)	Weight (kg)	Height (m)	BMI (kg/m ²)	BF (%)	WC (cm)	VO _{2max} (mL.kg ⁻¹ min ⁻¹)
Male (n = 218)							
High intensity (n = 118)	46.9 ± 11.7	73.2 ± 10.2	1.70 ± 0.1	26.3 ± 2.0	24.0 ± 3.9	86.4 ± 7.6	48.3 ± 1.4
Low intensity (n = 100)	42.8 ± 12.6	70.7 ± 8.5	1.70 ± 0.1	25.8 ± 2.8	23.4 ± 4.8	85.3 ± 8.9	30.5 ± 1.7**
Female (n = 86)							
High intensity (n = 40)	38.7 ± 7.8	57.8 ± 4.9	1.60 ± 0.1	22.5 ± 1.7	28.1 ± 5.3**	76.0 ± 3.1**	49.2 ± 6.8
Low intensity (n = 46)	39.9 ± 12.3	59.8 ± 7.8	1.60 ± 0.1	25.7 ± 3.0	33.5 ± 2.6	79.2 ± 6.8	31.0 ± 3.1**

WC: waist circumference; %BF: body fat; BMI: body mass index; VO_{2max}: percentage of maximum oxygen uptake.

Differences by training intensity.

* P < 0.05.

** P < 0.01.

because these were not assessed in this study. The women in our study may possibly have better health behavior (e.g. they are less likely to smoke and have better dietary patterns and behavior). This agrees with the 2012 report by Loprinzi and Cardinal²¹ using representative data from 1146 men and women participating in the 2005–2006 National Health and Nutrition Examination Survey (NHANES). However, this is only speculation because these variables were not examined in our study. The potential mechanisms by which routine vigorous intensity training provides cardiometabolic benefits are multiple and have not been fully elucidated yet due to the scarcity of studies.⁹ Vigorous intensity is certainly more effective than moderate intensity for increasing aerobic physical capacity.⁷ Other epidemiological and observational studies have shown that each increase by 1 MET in exercise capacity results in an 8–17% reduction in cardiovascular and all-cause mortality.⁷ However, the pending question is how increased aerobic capacity, or maybe other adaptations, achieve the greater physiological benefits attributed to the accumulation of calorie expenditure found with physical exercise of vigorous intensity.^{21–23}

This study has three basic limitations. The first limitation is the cross-sectional nature of the measurements, which did not allow for establishing causal relationships. The second is related to the indirect classification of the training level using the IPAQ questionnaire, HR and the Borg perceived exertion scale. The third limitation is that dietary patterns, smoking, alcohol consumption and mineral or vitamin intake, which may modulate the anthropometric parameters assessed, were not considered either. Overall, however, our results represent a challenge to healthcare professionals and all other people responsible for the promotion of physical activity to reinforce the impact of different physical training proposals in this type of population. In conclusion, this study shows that vigorous intensity training is associated with lower values of overweight and obesity markers in women, but not in men.

Conflicts of interest

The authors state that they have no conflicts of interest.

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