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Comparison of Cardiopulmonary Responses to Treadmill Walking and Running at the Same Speed in Young Women

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ABSTRACT

Gonelli RGG, Filho EG, Carraro R, Montebelo, MIL, Cesar MC. Comparison of Cardiopulmonary Responses to Treadmill Walking and Running at the Same Speed in Young Women. **JEPonline** 2011;14(3):53-59. The purpose of this study was to compare the cardiopulmonary responses to treadmill walking and running at the same speed in young women. Eight women between 18 and 24 yrs of age participated in the study. All subjects underwent two submaximal cardiopulmonary exercise tests at 7 km/hr (4.35 mi/hr), one walking and the other running, on separate days. The following variables were found to be higher during running than walking: energy expenditure, oxygen uptake, carbon dioxide output, oxygen pulse, and pulmonary ventilation. No significant differences were found in nonprotein respiratory quotient, heart rate, and ventilatory equivalents for oxygen and carbon dioxide. These results indicate that, at 7 km/hr, running is more indicated than walking for improving cardiorespiratory fitness and body mass in young women.

Keywords: Exercise, Energy Expenditure, Oxygen Uptake.

INTRODUCTION

There is a growing interest in studies that focus on exercise for promoting health and improving health status, particularly as it relates to energy expenditure (14). The beneficial effects of physical training in women have been investigated in several studies involving healthy individuals, patients with chronic diseases, and athletes (6,9,15,17-19). Walking and running are exercise modalities that require very little skill, and they are easily accessible to the general population (1). When starting an exercise program, it is recommended that 10 to 15 minutes of walking should precede any initial running (9). Walking is more effective at less than 6 km/hr, while running is more effective at a speed greater than 8.0 km/hr. Which of the two modes of exercise is more effective in raising the metabolic cost of exercise is interesting, particularly from the healthcare point of view (10,14).

A study conducted with young women (11) compared walking and jogging at different speeds and found that oxygen uptake (VO_2), heart rate (HR), and energy expenditure (EE) were similar at 7.2 km/hr (4.35 mi/hr). On the other hand, another study of physically active, middle-aged women (16) compared walking, jogging and Nordic walking at different speeds using field tests and found lower values for VO_2 during walking at 6.5 km/hr and 7.5 km/hr when compared to jogging and Nordic walking. More recently, Simões and colleagues (18) investigated the cardiopulmonary responses to treadmill walking and running at 7.0 km/hr in young men, and the following variables were found to be higher during running than walking: EE, VO_2, carbon dioxide production (VCO_2), HR, oxygen pulse (O_2 pulse), and pulmonary ventilation (V_E). This suggests that running at 7.0 km/hr is better than walking for improving cardiorespiratory fitness and body composition. However, it has been demonstrated (4) that physiological responses of men and women walking on a treadmill differ. If this is the case, there is the need for a study that compares the cardiopulmonary responses to walking and running at the same speed in women.

Given that 7.0 km/hr (4.35 mi/hr) is an intermediate speed or a transition speed between walking and running, the purpose of this study is to determine whether it is better to walk or run to improve physical fitness, health, and well-being. Thus, this study compared cardiopulmonary responses to treadmill walking and running at 7.0 km/h in young women (10).

METHODS

Subjects

Eight active, healthy women were included in the study. Their mean age, height, and body mass were 21.63 ± 2.07 yrs (range, 18 to 24), 166.19 ± 4.85 cm, and 60.64 ± 5.92 kg, respectively. All subjects signed an informed consent form after being fully informed about the potential risks. The study was part of a thematic project approved by the Research Ethics Committee of the Universidade Metodista de Piracicaba (File No.83/83). Before undergoing the exercise tests, the subjects completed a health history questionnaire (7) that was evaluated by the investigators to rule out any contraindications to the exercise tests.

Procedures

All women underwent two submaximal cardiopulmonary tests in a temperature-controlled laboratory maintained at 20 to 25 °C on an Inbrasport ATL® treadmill using a continuous graded protocol. This protocol consisted of 2 min of rest, followed by 1 min at 3.0 km/hr, a single 15-min stage at 7.0 km/hr, and a 2-min recovery period at 3 km/hr (8). Throughout the exercise protocol, VO_2 was continuously measured. The treadmill test protocol was undertaken twice, once walking and the other time running on separate days with a maximum of 7 days apart. Four women performed the first test walking and

the other four running. Oxygen uptake, VCO_2 and V_E were measured directly, using a VO2000 metabolic gas analyzer – Medical Graphics®. Heart rate was recorded using a telemetry system (Polar® Vantage NV). Mean V_E, VO_2, VCO_2, nonprotein respiratory quotient (npRQ), HR, O_2 pulse, ventilatory equivalents for oxygen (V_E/VO_2) and carbon dioxide (V_E/VCO_2) were measured during the last 10 min of the workload of 7.0 km/hr. Exercise energy expenditure (EE) was calculated by multiplying VO_2 values by the thermal equivalent of oxygen (13).

Statistical Analyses

The data were analyzed using SSPS version 13.0. Study results were assessed using the Wilcoxon test at a level of significance of 5% ($P \leq 0.05$), and were expressed as mean ± standard deviation (SD). Power analysis was performed based on paired t-test data (99% confidence interval), using the Bioestat software with at least six volunteers for VO_2.

RESULTS

Energy expenditure and VO_2 relative to body mass were higher in running than in walking (Figures 1 and 2) at 7 km/hr, as were absolute VO_2, VCO_2, O_2 pulse, and V_E. No significant differences were found in npRQ, HR, V_EO_2 and V_ECO_2 (Table 1).

Table 1. Cardiopulmonary responses during treadmill walking and running at 7 km/hr.

Variable	Walking			Running		
	Mean ± SD	Minimum	Maximum	Mean ± SD	Minimum	Maximum
VO_2 ($L \cdot min^{-1}$)*	1.39 ± 0.13	1.12	1.51	1.63 ± 0.15	1.41	1.82
VCO_2 ($L \cdot min^{-1}$)*	1.18 ± 0.09	0.99	1.28	1.41 ± 0.15	1.14	1.60
NpRQ	0.85 ± 0.03	0.81	0.88	0.86 ± 0.03	0.81	0.90
HR ($beats \cdot min^{-1}$)	141.9 ± 9.5	130.07	155.60	145.6 ± 23.0	129.17	198.03
O_2 pulse ($mL \cdot beat^{-1}$)*	9.8 ± 0.8	8.51	10.81	11.4 ± 1.6	8.53	13.39
V_E ($L \cdot min^{-1}$)*	36.3 ± 3.5	29.81	39.79	44.4 ± 7.3	35.12	56.49
V_EO_2	26.2 ± 1.6	23.39	27.53	27.1 ± 3.1	23.28	33.43
V_ECO_2	30.9 ± 1.4	28.75	32.83	31.5 ± 3.1	27.97	38.43

VO_2 = oxygen uptake; VCO_2 = carbon dioxide output; npRQ = nonprotein respiratory quotient; HR = heart rate; VO_2/HR = oxygen pulse; V_E = ventilation; V_EO_2 = equivalent for oxygen; V_ECO_2 = equivalent for carbon dioxide.
* Statistically significant P = 0.05.

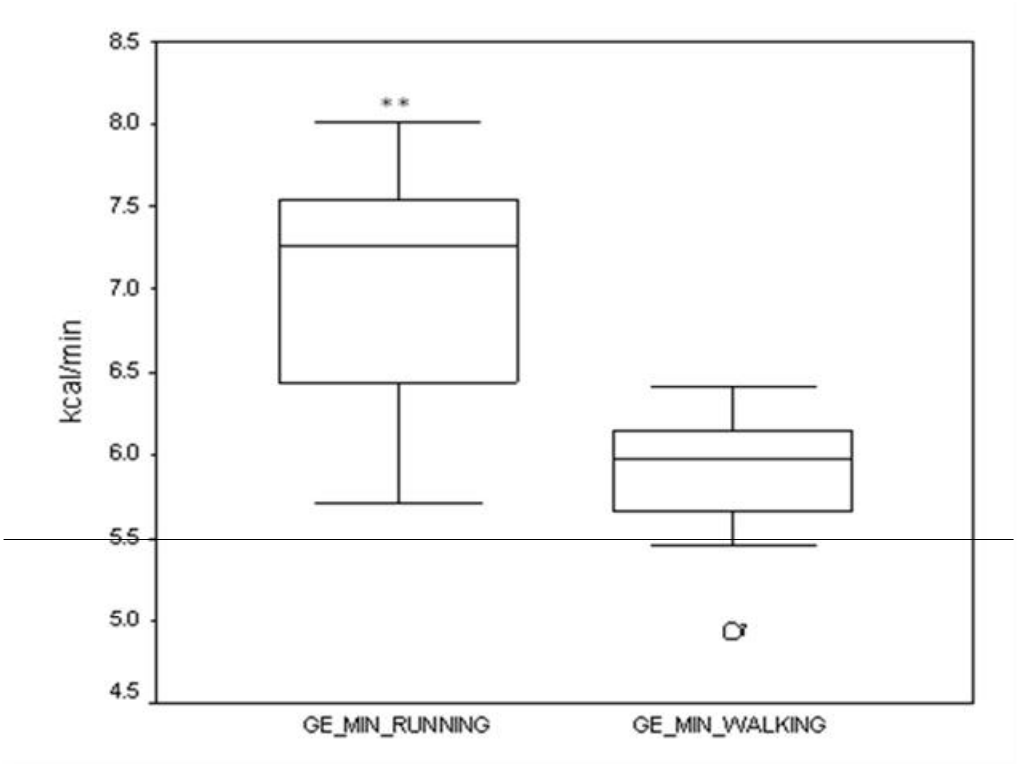

Figure 1. Energy expenditure during walking and running at 7 km/hr. Data presented as mean ± standard deviation. N = 8 in each group. ** P ≤ 0.05 (Wilcoxon test).

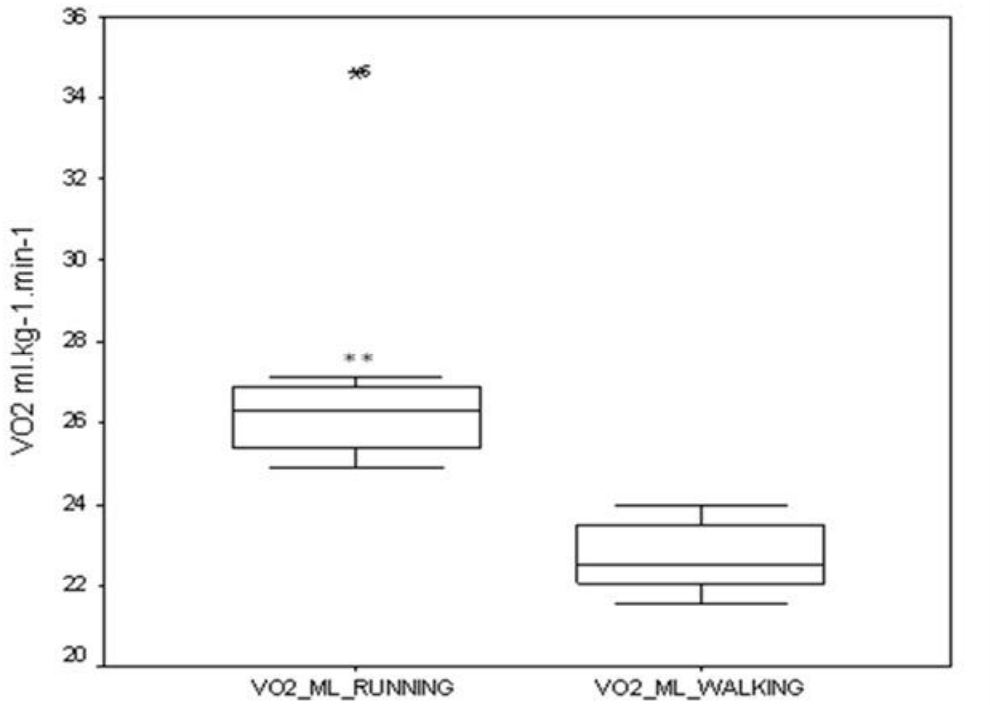

Figure 2. Oxygen uptake during walking and running at 7 km/hr. Data presented as mean ± standard deviation. N = 8 in each group. ** P ≤ 0.05 (Wilcoxon test).

DISCUSSION

Walking and running are two major exercise modalities that promote health and physical fitness by improving cardiorespiratory capacity and controlling body mass. While it has been established that at speeds lower than 6.0 km/hr (3.73 mi/hr) individuals should walk and greater than 8.0 km/hr (4.97 mi/hr) they should run, 7.0 km/hr (4.35 mi/hr) is an intermediate speed between walking and running (14). This study investigated the cardiopulmonary responses at 7.0 km/hr, since that is the speed at which people find it most difficult to decide whether to walk or run in exercise training programs.

Oxygen uptake was higher during running 7.0 km/hr than during walking 7.0 km/hr. This finding indicates a greater aerobic effort (e.g. 8.15 kcal/min running vs. 6.95 kcal/min walking). The greater expendure of energy contributes to an improvement in cardiorespiratory fitness. The increase in O_2 pulse suggests that running resulted in a greater stroke volume (SV) than when walking at the same speed, given that O_2 pulse is a good indication of the volume of blood pumped per beat (SV).

Both VCO_2 and VO_2 increased equally during running, thus the nonprotein respiratory quotient did not differ between either modality. Also, since the increase in VO_2 was supported by the significant increase in V_E, the V_EO_2 (i.e., the ratio of the volume of air ventilating the lungs to the volume of oxygen consumed) was not different during running. V_EO_2 represents the amount of ventilation required for the consumption of each liter of oxygen and reflects ventilatory efficiency. Thus, while more energy is expended during running versus walking at the same speed, the ratio of the volume of gas expired per min to the volume of O_2 consumed per minute was unchanged.

The increased V_E during running demonstrates that the stress placed on the respiratory system is higher in this modality than in walking, but the stress is proportional to VO_2 and VCO_2, as shown by the nonsignificant differences in the V_EO_2 and V_ECO_2 responses (20). Differences in VO_2 are likely to be related to the fact that the mechanical work in horizontal running differs from that during walking (5). Energy expenditure was higher in running than in walking. This indicates that running at 7.0 km/hr is more effective than walking for controlling body mass in young women. Also, it is important to point out that although the EE was determined during the treadmill exercise test, there is every reason to believe that the results will be similar to those obtained on the track (12).

Our results differ from Greiwe and Kohrt (11) who reported no significant differences in EE and VO_2 at 7.2 km/hr for women. Our HR values, however, were similar to the 2000 study. However, there has also been the report (16) of lower values for women while walking versus running at the 6.5 and 7.5. km/hr. Then, too, when Cesar and colleagues (8) investigated cardiopulmonary responses of active young men to treadmill walking and running at 7.0 km/hr, they found the following variables were higher during running than walking: EE, VO_2, VCO_2, HR, O_2 pulse, and V_E. No significant differences were found in nonprotein respiratory quotient and V_EO_2 and V_ECO_2. In the present study, VO_2, VCO_2, V_E, and O_2 pulse were lower in women. This finding may be due to gender differences in body mass and/or cardiorespiratory fitness. However, these results suggest that, except for heart rate, cardiopulmonary variables at the transition speed between walking and running are similar in men and women.

CONCLUSIONS

Our results indicate that running at 7 km/hr is better for young women than walking at the same speed for improving cardiorespiratory fitness and controlling body mass.

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