The Influence of Fitness and Body Weight on Preferred Exercise Intensity

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ABSTRACT

PINTAR, J. A., R. J. ROBERTSON, A. M. KRISKA, E. NAGLE, and F. L. GOSS. The Influence of Fitness and Body Weight on Preferred Exercise Intensity. Med. Sci. Sports Exerc., Vol. 38, No. 5, pp. 981-988, 2006. Purpose: The purpose of this investigation was to determine the individual and combined effects of aerobic fitness and body weight on physiological responses, perceived exertion, and speed variables during self-selected steady-state treadmill (TM) walking in 60 healthy college-age women. Methods: The women were placed into one of four categories based on body mass index (BMI) and fitness level, assessed by a graded TM test. Subjects walked continuously on a TM at a self-selected pace for 15 min at a 2.5% grade. The dependent variables were oxygen uptake (VO2), HR, percentage of maximal oxygen uptake (%VO2max), percentage of HRmax (%HRmax), RPE for the overall body, TM belt speed, and total energy expenditure (EE). Results: There were no significant interactions or body weight main effects for any of the dependent variables. However, lower-fitness subjects walked at a TM speed that resulted in a higher (P < 0.0005) %VO2max (52.4 vs 39.56) than the higher-fitness subjects. Conclusion: These findings suggest that fitness, and not body weight, influences preferred exercise intensity as measured by %VO2max during TM walking in college-age women. The self-selected walking speed did not result in an intensity, as determined by %VO2max, that is consistent with the enhancement of cardiorespiratory fitness for higher-fitness women regardless of body weight. Key Words: SELF-SELECTED EXERCISE, WALKING, EXERCISE REGULATION, EXERCISE ADHERENCE, RPE

Walking is the most popular form of exercise for adult Americans (32), most likely because it is safe (27), effective (8,12,35), and simple (5,19,31). Furthermore, walking at 4.8-6.4 km·h⁻¹ (~3-4 mph) is a moderate-intensity (~3-6 METs) (25) activity that can improve the health and well-being of many individuals when done on a regular basis (14,34). This statement is based on the Centers for Disease Control and Prevention and the American College of Sports Medicine recommendation of a minimum of 30 min of moderate-intensity activity on most days of the week to improve health (25).

Walking, like many other daily activities, can be self-regulated by exertional perceptions, allowing successful completion without physiological strain (24). This is an important attribute when developing an exercise program because, from a behavioral standpoint, the more enjoyable the exercise experience is, the better the adherence (9). However, it is also important that the various components of the walking program are consistent with the American College of Sports Medicine (ACSM) guidelines for exercise to increase or maintain cardiorespiratory fitness. These guidelines suggest an exercise intensity that ranges between 50 and 85% of maximal oxygen uptake (VO2max) and 55% and 90% of HRmax and an RPE of 12-16 on the Borg 6-20 scale (1). The energy expenditure (EE) required for this type of physical activity and/or exercise should accumulate to 150-400 kcal·d⁻¹ (1).

While some studies indicate that a self-selected walking pace can elicit an intensity that is perceptually preferred and that falls within established health/fitness guidelines (7,33), others suggest the resultant conditioning stimulus is suboptimal (4,11,13,28) to improve cardiorespiratory fitness. Such differences between previous reports could be the result of variations in the participant's level of fitness (4,7,11,14,22,34) and body weight (2,22,28), both of which appear to influence the selection of exercise intensities. It is unclear whether the selection of pace during walking is related to maximal aerobic power. For example, Procari
et al. (28) reported that highly fit subjects (\(\text{VO}_{2\text{max}} > 59 \text{ mL/kg}^{-1}\cdot\text{min}^{-1}\)) selected a walking pace that elicited 43% \(\text{VO}_{2\text{max}}\) or an intensity equivalent to a \(\text{VO}_2\) of 26 mL/kg\(^{-1}\cdot\text{min}^{-1}\). In contrast, Spelman et al. (33) found that habitual walkers (\(\text{VO}_{2\text{max}} = 35.7 \text{ mL/kg}^{-1}\cdot\text{min}^{-1}\)) selected walking paces that elicited a higher percentage of maximal aerobic power (52\%\(\text{VO}_{2\text{max}}\)), but a lower absolute oxygen uptake of 18.56 mL/kg\(^{-1}\cdot\text{min}^{-1}\).

Although body weight may influence self-selected exercise intensity, Bar-Or et al. (2) did not find any difference in self-selected walking speed among lean, normal, and overweight subjects. However, the percentage of body fat values for these groups ranged only from 10% (lean) to 20% (overweight). In contrast, Mattisson et al. (22) found that normal-weight and obese subjects selected walking paces that elicited different percentages of maximal aerobic power. However, this investigation was methodologically limited in that data from obese subjects were compared with values for normal-weight subjects determined from a reference text. Therefore, the influence of body weight on self-selected walking speed remains unclear.

To date, studies have not examined the combined effect of aerobic fitness and body weight on preferred walking intensities as measured by the percentage of oxygen uptake (\%\(\text{VO}_{2\text{max}}\)), percentage of \(\text{HR}_{\text{max}}\) (%\(\text{HR}_{\text{max}}\)), RPE, and EE. However, Glass and Chvala (15) and Lind et al. (20) studied the self-selection of exercise intensity among subjects who differed in their levels of fitness and weight. Glass and Chvala (15) employed average to highly fit, low-body fat men and women, while Lind et al. (20) studied less fit, high-weight women. Despite the differences in fitness and body composition, subjects from both studies selected similar intensities during a 20-min walk that fall slightly lower to within the intensity recommendations set forth by the ACSM for maintenance or improvement of cardiorespiratory fitness. In a study by Murtagh et al. (23), normal-weight men and women of average fitness walked at a pace that elicited physiological and perceptual values that were consistent with those found by Glass and Chvala (15) and Lind et al. (20). Comparing these three studies appears to suggest that there would be no combined effects of aerobic fitness and body weight on preferred walking intensities. However, the methodology across the three studies varies with a) subjects in the Glass and Chvala study (15) not viewing their speed during 20 min of walking, b) subjects in the Lind et al. study (20) viewing their speed during 20 min of walking, and c) those in the Murtagh et al. study (23) walking for only 18.56 m.

Therefore, the purpose of this investigation was to determine the individual and combined effects of aerobic fitness and body weight on physiological responses, RPE, and speed variables during preferred, steady-state treadmill (TM) walking in college-age women. It was hypothesized that overweight women and those with lower levels of aerobic fitness separately and with these combined characteristics would comparatively prefer walking intensities that resulted in lower oxygen uptake (\(\text{VO}_2\)), \%\(\text{VO}_{2\text{max}}\), HR, %\(\text{HR}_{\text{max}}\), RPE, and EE.

METHODS

Subjects. Seventy-six women between 18 and 30 yr of age were recruited for the study through fliers posted around campus. During an initial screening session, subjects read and signed a written informed consent to participate. The consent and experimental procedures were approved by the University of Pittsburgh’s institutional review board for human subject experimentation. In addition, all subjects completed the Physical Activity Readiness Questionnaire (PAR-Q) prior to participation. Individuals were excluded if they responded positively to any of the questions on the PAR-Q indicating the presence of heart disease, chest pain, orthopedic limitation, or other contraindications for physical activity participation. Subjects who confirmed that they were either pregnant or participated in a regular walking program as their only form of exercise \(\geq 3 \text{ d}\cdot\text{wk}^{-1}\) were also excluded from the study. Regular walkers were excluded from the study because the authors thought that the use of nonhabitual exercise walkers represents the general population more accurately than previous studies. In addition, Cunningham et al. (7) suggested that participants may choose a different relative intensity because of their familiarity with a given mode. We wanted to eliminate this possibility.

Experimental design. Seventy-six women completed both a maximal exercise test and body composition analysis. Sixteen of these subjects did not fall into one of the four predetermined categories and were eliminated from the study. Testing continued until 15 women fit the requirements of each of the four experimental groups: (a) lower fitness, normal weight; (b) lower fitness, overweight; (c) higher fitness, normal weight; and (d) higher fitness, overweight; the total sample size was 60 subjects. A maximal oxygen uptake of 33.8 mL/kg\(^{-1}\cdot\text{min}^{-1}\) or lower falls at or below the 40th percentile for maximal aerobic power for women aged 20–29 yr and was considered lower fitness for this study (1). A \(\text{VO}_{2\text{max}}\) of 36.7 mL/kg\(^{-1}\cdot\text{min}^{-1}\) or higher falls at or above the 60th percentile for women aged 20–29 yr and was considered higher fitness for this study (1). Overweight was established as a body mass index (BMI) between 25.0 and 29.9 kg/m\(^2\), while normal weight was considered 18.5–24.9 kg/m\(^2\) (1).

Maximal TM exercise test. A graded TM (TrackMaster Treadmill; Carrollton, TX) test using the standard Bruce protocol with 3-min stages was administered to assess \(\text{VO}_{2\text{max}}\). A standard set of scaling instructions and scale anchoring procedures for the Borg 15 category (6–20) RPE scale were read to the subject prior to TM testing. These instructions followed an established format used in previous investigations (24). The low and high rating standards (i.e., perceptual scale anchors) were established during this continuous maximal exercise test. A rating of 7 (low anchor) was assigned to the lowest exercise intensity and 19 (high anchor) was assigned to the highest exercise intensity. Subjects were verbally encouraged to continue to exercise until exhausted. The criteria to achieve a \(\text{VO}_{2\text{max}}\) required subjects to meet two of the following three criteria: 1) plateau in \(\text{VO}_2\), as indicated by a difference in values between the
highest two contiguous test stages of < 2.1 mL·kg$^{-1}$·min$^{-1}$; 2) RER > 1.1; or 3) HR within 10 beats of their age-predicted HR$_{max}$.

Respiratory metabolic measures were determined every 30 s throughout the graded TM exercise test. A monitor (Polar Advantage™, Port Washington, NY) was worn to record HR during the last 15 s of each 3-min exercise stage. Oxygen uptake, carbon dioxide production ($\text{VO}_2$), pulmonary ventilation (STPD; $\text{VE}_{\text{STPD}}$), and the RER were measured every 30 s throughout the TM test (Ametek; Pittsburgh, PA). Prior to each test, the respiratory analyzers were calibrated with standard gases of known concentration.

**Anthropometric measures.** BMI (kg·m$^{-2}$) was calculated from weight (kg) and height (m) as measured by a Detecto physician’s scale and attached stadiometer. The percentage of body fat was determined by bioelectrical impedance analysis (BIA) (Valhalla Scientific Industries, San Diego, CA). In addition to refraining from exercise, alcohol, tobacco, and caffeine for 48 h and food for 4 h, the women were also instructed to not drink within 4 h and to urinate within 30 min of the BIA test (17). A summary of their physical characteristics is provided in Table 1.

**Familiarization trial.** Once the 60 subjects were established into one of four groups, subjects underwent a trial to familiarize them with walking on a TM. Subjects were asked to refrain from exercise, alcohol, tobacco, and caffeine for 48 h and food for 4 h prior to the familiarization trial. Resting HR was measured with the subject in a seated position. During the trial, each subject was oriented to the TM protocol and the process of selecting a preferred walking intensity. The familiarization trial consisted of walking at a constant 2.5% grade for 5 min at the subject’s preferred speed. Preferred speed was defined as a speed that the subject considered comfortable for the stipulated duration of the activity. Instructions to the subject regarding intensity preference for this trial and the experimental trial were adapted from Dishman et al. (10) and read as follows: “Select a walking intensity that you prefer. This should be an intensity that you would choose for a 15-min workout if you were attempting to get a good workout. The intensity should be high enough so that you would get a good workout, but not so high that exercising daily or every other day would be objectionable. It should be an intensity that feels appropriate to you.” The speedometer, initially set at 3.22 km·h$^{-1}$ (2.0 mph), was covered so that subjects were masked to the actual TM belt speed. However, the faster and slower indicator arrows for speed control were kept visible so that subjects could titrate the speed during the first 30 s of the 5-min session. At the 30-s time point, the subject selected speed, viewed only by the investigator, was recorded. Following this 5-min walk, subjects sat for 10 min or until their HR was within 10 bpm of their resting HR. This procedure to identify the preferred walking speed was then repeated. The average preferred speed (km·h$^{-1}$) selected during the two 5-min walking segments was used as the beginning speed during the experimental trial. A grade of 2.5% was selected to provide the subjects with biomechanical speed/grade combinations that allowed a greater opportunity to self-select metabolic walking intensities. The authors thought that a level gradient would more likely result in inefficient jogging from subjects looking to exercise at a faster pace.

**Experimental trial.** Within 24–72 h of completion of the familiarization trial, subjects underwent the experimental trial. This trial consisted of continuous walking at a constant 2.5% grade for 15 min. The subjects were given the same instructions regarding the selection of a preferred walking intensity as those provided during the familiarization trial. As in the familiarization trial, the speedometer was covered while the faster and slower arrows for speed control were visible. In this manner, the subjects were masked to the actual speed of the TM. During the first 2 min of the 15-min trial, subjects were allowed to increase, decrease, or maintain the speed selected during the familiarization trial. They were permitted to manipulate the speed by pressing the faster or slower arrows on the TM control panel ad libitum. Ultimately, the subjects gave a “thumbs up” signal to indicate they were at their preferred speed. Subjects were made aware that at the end of the initial 2 min, the speed selected was to be maintained for the next 13 min. Subjects were told in 15-s intervals how much time they had remaining to make a final speed determination. At the 2-min time point, the subject-selected speed, viewed only by the investigator, was recorded. After this point, there were no more opportunities to change the TM belt speed and the speed remained constant throughout the remaining 13 min of the test. Using the same equipment, instruments, and procedures as in the maximal exercise test, respiratory metabolic measures and HR were determined every 30 s throughout the trial. Physiological data (i.e., HR and $\text{VO}_2$) were averaged for the final two 30-s intervals to derive a

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**TABLE 1. Subject characteristics.**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>All Subjects (N = 60)</th>
<th>Higher Fitness, Normal Weight (N = 15)</th>
<th>Higher Fitness, Overweight (N = 15)</th>
<th>Lower Fitness, Overweight (N = 15)</th>
<th>Lower Fitness, Normal Weight (N = 15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>20.72 ± 2.25</td>
<td>20.53 ± 1.55</td>
<td>19.4 ± 1.45</td>
<td>21.07 ± 3.04</td>
<td>21.87 ± 2.03</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>67.71 ± 13.73</td>
<td>59.91 ± 5.70</td>
<td>75.71 ± 10.72</td>
<td>77.59 ± 15.20</td>
<td>57.73 ± 8.57</td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.65 ± 0.09</td>
<td>1.64 ± 0.06</td>
<td>1.67 ± 0.06</td>
<td>1.65 ± 0.14</td>
<td>1.64 ± 0.07</td>
</tr>
<tr>
<td>Body mass index (kpg$^{-3}$)</td>
<td>24.79 ± 4.03</td>
<td>22.35 ± 1.97</td>
<td>27.10 ± 2.82</td>
<td>28.26 ± 3.83</td>
<td>21.46 ± 2.14</td>
</tr>
<tr>
<td>Lean body mass (kg)</td>
<td>40.41 ± 1.74</td>
<td>48.88 ± 5.58</td>
<td>52.20 ± 4.10</td>
<td>50.74 ± 10.59</td>
<td>46.04 ± 7.14</td>
</tr>
<tr>
<td>Body fat (%)</td>
<td>25.21 ± 5.92</td>
<td>19.86 ± 2.31</td>
<td>28.45 ± 5.09</td>
<td>30.93 ± 4.57</td>
<td>21.58 ± 2.15</td>
</tr>
</tbody>
</table>

Data are means ± SD.

$^a$ High fitness, high fat significantly different from low fitness, normal weight (P < 0.05).

$^b$ High fitness, high fat significantly different from high fitness, normal weight (P < 0.05).

$^c$ Low fitness, high fat significantly different from high fitness, normal weight (P < 0.05).

$^d$ Low fitness, high fat significantly different from low fitness, normal weight (P < 0.05).
single data point for each variable. RPE for the overall body were determined by the subjects' pointing to the corresponding numbers on a poster-sized scale placed directly in front of them. Subjects were instructed to make their subjective assessments of RPE relative to the low and high perceptual anchors established during the maximal exercise test. Overall RPE values were recorded every 5 min throughout the trial and reported as an average over the 15-min trial. The caloric equivalent of steady-state absolute VO₂ was corrected for differential substrate utilization using the RER and expressed as total kilocalories for the 15-min trial (26).

Experimental variables. The independent variables for this investigation were aerobic fitness (mL·kg⁻¹·min⁻¹) and BMI (kg·m⁻²). The dependent variables for the self-selected speed were 1) oxygen uptake (mL·kg⁻¹·min⁻¹); 2) HR (bpm); 3) %VO₂max; 4) %HRmax; 5) RPE for the overall body (6-20); 6) TM belt speed (km·h⁻¹); and 7) total EE (kcal).

Statistical analysis. A 2 (higher fitness and lower fitness) × 2 (overweight and normal weight) factor ANOVA was used to test for differences for VO₂, HR, %VO₂max, %HRmax, RPE, TM speed, and total EE between the four cohorts. In addition, two-way ANOVA (fitness × weight) was used to test for differences for body weight (kg), height (m), BMI (kg·m⁻²), lean body mass (kg), and percentage of body fat. An alpha level of 0.05 was used for all statistical analyses. Using an alpha level of 0.05, power of 0.70, and a moderately large effect size (0.35 from Cohen (6)), 14 subjects were required for each of the four cells. Data were analyzed using the Statistical Package for the Social Sciences (SPSS 11.0).

RESULTS

Body composition. Body composition for the four groups is listed in Table 1. Two-way ANOVA (fitness × weight) confirmed that there were no significant group differences (P > 0.05) in height or lean body mass. Body weight, BMI, and percentage of body fat were all greater (P < 0.05) in both overweight groups compared with the other two groups.

Aerobic fitness. The physiological responses to the maximal graded exercise test for each of the four groups are provided in Table 2. There was a significant fitness main effect (F(1,56) = 127.91, P < 0.0005) such that VO₂max was higher in the higher (43.33 mL·kg⁻¹·min⁻¹) than lower-fit (30.76 mL·kg⁻¹·min⁻¹) groups when averaged across weight. However, there were no significant fitness × weight interactions, nor were there any significant weight main effects for any variables.

The physiological, perceptual, and TM speed values during 15-min of preferred walking exercise are listed in Table 3. When averaged across body weight, %VO₂max was greater (F(1,56) = 20.16, P < 0.0005) for the lower (52.40%) than higher-fitness (39.56%) subjects during the 15-min walk. However, there were no interactions between fitness and weight nor were there any significant weight main effects for any of the dependent variables listed in Table 3 (i.e., %VO₂max, %HRmax, RPE, TM speed, and total EE).

DISCUSSION

The primary purpose of this investigation was to examine the influence of aerobic fitness, body weight, and the combined effect of fitness and weight on physiological, perceptual, and TM speed responses at preferred TM walking speeds in college-age women. The present findings indicated that the lower the maximal aerobic power was, the higher the %VO₂max was at preferred TM walking intensities independent of body weight. In contrast, neither

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**TABLE 2. Maximal physiological responses.**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>All Subjects (N = 80)</th>
<th>Higher Fitness, Normal Weight (N = 15)</th>
<th>High Fitness, Overweight (N = 15)</th>
<th>Low Fitness, Overweight (N = 15)</th>
<th>Lower Fitness, Normal Weight (N = 15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VO₂max (mL·kg⁻¹·min⁻¹)</td>
<td>37.04 ± 7.70</td>
<td>43.99 ± 4.72*</td>
<td>42.82 ± 3.29*</td>
<td>30.94 ± 4.95</td>
<td>30.42 ± 4.27</td>
</tr>
<tr>
<td>VO₂ (L·min⁻¹)</td>
<td>2.44 ± 0.50</td>
<td>2.54 ± 0.35</td>
<td>3.00 ± 0.35</td>
<td>2.25 ± 0.54</td>
<td>1.88 ± 0.53</td>
</tr>
<tr>
<td>HR (bpm)</td>
<td>189.00 ± 9.76</td>
<td>192.33 ± 5.51</td>
<td>189.60 ± 7.11</td>
<td>185.67 ± 14.87</td>
<td>187.87 ± 8.57</td>
</tr>
<tr>
<td>RPE</td>
<td>1.09 ± 0.08</td>
<td>1.09 ± 0.00</td>
<td>1.09 ± 0.09</td>
<td>1.07 ± 0.09</td>
<td>1.12 ± 0.07</td>
</tr>
<tr>
<td>VE (L·min⁻¹)</td>
<td>64.28 ± 15.26</td>
<td>63.33 ± 13.98</td>
<td>76.76 ± 7.43</td>
<td>58.82 ± 12.94</td>
<td>53.41 ± 14.77</td>
</tr>
</tbody>
</table>

Data are means ± SD.
* P < 0.05.

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**TABLE 3. Physiological, metabolic, and mechanical values for self-selected speeds during 15 min of walking.**

<table>
<thead>
<tr>
<th>Physiological Parameter</th>
<th>Higher Fitness, Normal Weight (N = 15)</th>
<th>Higher Fitness, Overweight (N = 15)</th>
<th>Lower Fitness, Overweight (N = 15)</th>
<th>Lower Fitness, Normal Weight (N = 15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>%VO₂max*</td>
<td>40.59 ± 9.5</td>
<td>37.43 ± 9.8</td>
<td>51.47 ± 12.4</td>
<td>54.4 ± 15.4</td>
</tr>
<tr>
<td>Oxygen uptake</td>
<td>17.73 ± 3.9</td>
<td>15.09 ± 5.1</td>
<td>15.83 ± 4.6</td>
<td>16.2 ± 4.6</td>
</tr>
<tr>
<td>(mL·kg⁻¹·min⁻¹)</td>
<td>64.09 ± 0.23</td>
<td>63.15 ± 7.39</td>
<td>70.24 ± 11.57</td>
<td>67.5 ± 11.07</td>
</tr>
<tr>
<td>%HRmax</td>
<td>123.40 ± 10.6</td>
<td>120.20 ± 15.88</td>
<td>125.53 ± 17.09</td>
<td>127.20 ± 20.70</td>
</tr>
<tr>
<td>HR (bpm)</td>
<td>9.90 ± 1.1</td>
<td>9.40 ± 2.1</td>
<td>10.07 ± 1.6</td>
<td>10.39 ± 2.35</td>
</tr>
<tr>
<td>RPE overall (6-20)</td>
<td>5.60 ± 0.88</td>
<td>4.94 ± 1.21</td>
<td>5.07 ± 1.08</td>
<td>5.15 ± 1.1</td>
</tr>
<tr>
<td>TM speed (km·h⁻¹)</td>
<td>75.73 ± 16.7</td>
<td>79.47 ± 21.8</td>
<td>85.33 ± 28.7</td>
<td>74.06 ± 32.5</td>
</tr>
</tbody>
</table>

Data are means ± SD.
* Fitness main effect as determined by marginal means.

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weight alone nor an interaction between fitness and weight affected any of the physiological, perceptual, or speed variables at the preferred TM intensity.

Weight Main Effect

Physiological responses. Both normal-weight and overweight subjects selected a preferred walking intensity that elicited a similar %\(\text{VO}_{2\text{max}}\) (~46%), \(\text{VO}_{2}\) (~16.5 mL·kg\(^{-1}\)·min\(^{-1}\)), %HR\(_\text{max}\) (~66%), and HR (~125 bpm) for the 15-min trial. These results are in agreement with those of Bar-Oz et al. (2), who reported lean and overweight subjects selected preferred walking paces that elicited similar HR of 128 and 123 bpm, respectively. However, the present data are in contrast to those of Mattsson et al. (22), who found that when obese subjects self-selected a walking pace, the %\(\text{VO}_{2\text{max}}\) (56%\(\text{VO}_{2\text{max}}\)) was significantly higher than %\(\text{VO}_{2\text{peak}}\) of normal-weight subjects (36%\(\text{VO}_{2\text{peak}}\)) as reported in a reference text. A potential reason for the discrepancy between the results of Mattsson et al. and those of the present study could be the difference in subjects’ body weight between the two studies. The mean BMI for the present overweight group was comparatively lower (27.68 kg·m\(^{-2}\)) than that reported for the obese (BMI = 37.1 kg·m\(^{-2}\)) group in the Mattsson et al. (22) study. The present results are generalizable to individuals with a BMI ≤ 29.9 kg·m\(^{-2}\). The results cannot be generalized to individuals classified as clinically obese, defined by a BMI ≥ 30.0 kg·m\(^{-2}\).

Perceptual responses. Both normal-weight and overweight subjects selected a preferred walking intensity that resulted in the selection of a similar RPE (~10) for the 15-min trial. This value is lower than that selected by previously sedentary overweight women in a study by Jakicic et al. (18). Women in this study were randomized to one of four groups based on intensity (moderate or high) and duration (moderate or high). TM walking was encouraged as the primary mode of exercise. Regardless of duration, the moderate-intensity groups were instructed to exercise at an RPE of 10–12, while the high-intensity subjects were to exercise in the 10–12 range for the first 12 wk and 13–15 for the duration of the yearlong study. Over the 12 months, the women in the moderate-intensity groups selected an average RPE of 12, while the high-intensity groups selected a significantly higher average value of 13. Despite the higher RPE selected by the Jakicic et al. subjects (12,13), compared with our group of overweight, lower-fitness subjects (RPE = 10.07), the Jakicic et al. subjects were exercising at a lower absolute HR (118.5 bpm) than our subjects (129.53 bpm). It is possible that our subjects selected a lower RPE because of the shorter duration of the exercise sessions in our study (15 min) versus those in the Jakicic et al. study (> 30 min). In addition, our subjects were masked to the speed of the TM and were not given a specific target RPE or HR to achieve. It is possible that viewing the speed and having knowledge of their HR influenced RPE selection.

Preferred speeds. In the present investigation, no significant differences were found between preferred TM speeds of normal-weight subjects (5.33 km·h\(^{-1}\) or 3.13 mph) and overweight subjects (5.04 km·h\(^{-1}\) or 3.13 mph). In contrast, Procari et al. (28) found that the percentage of body fat was the best predictor of self-selected walking speed in a combined sample of men and women (\(r = -0.69; P < 0.05\)).

The preferential selection of similar TM speeds between normal and overweight subjects in the present investigation is possibly the result of similar %\(\text{VO}_{2\text{max}}\) values of the normal-weight (37.20 mL·kg\(^{-1}\)·min\(^{-1}\)) and overweight (36.88 mL·kg\(^{-1}\)·min\(^{-1}\)) groups when collapsed across fitness. These groups subjectively perceived the exertion at preferred speeds to be similar and expended a comparable amount of energy. It is possible that body weight, although significantly different, was not sufficiently diverse to find between group differences in the dependent variable.

Fitness Main Effect

Physiological and perceptual responses. Although fitness level had no influence on RPE or TM speed at a preferred walking intensity, lower-fitness subjects exercised at a significantly higher %\(\text{VO}_{2\text{max}}\) than higher-fitness subjects. Dishman et al. (10) reported that highly active subjects selected a higher power output than less active subjects for a 20-min steady-state cycle performance. Similar to the present findings, results of the Dishman et al. (10) study also revealed identical RPE values for both activity cohorts. However, these investigations differed in that subjects were permitted to alter their speed every 5 min in the Dishman et al. study (10) and only during the first 2 min of the 15-min trial in the current study. Interestingly, the Dishman et al. less active subjects also exercised at a higher %\(\text{VO}_{2\text{peak}}\) than the highly active subjects during the first 10 min (10). However, the %\(\text{VO}_{2\text{peak}}\) at the end of the 20-min trial were equal between the groups (10). When absolute HR (bpm) was examined, there was no significant difference (\(P > 0.05\)) between lower (121 bpm) and higher-fitness (131 bpm) individuals in the current study. Similarly, Bar-Oz et al. (2) found that sedentary and active subjects selected TM speeds that resulted in HR equal to 125 and 128 bpm, respectively. These HR values were not significantly different.

Consistent with previous reports (2,10), the present findings indicated there were no significant differences (\(P = 0.34\)) in overall body RPE as measured by the Borg 6–20 category scale between the lower (RPE = 10.10) and higher-fit (RPE = 9.60) groups when performing at preferred walking intensities. In contrast, both Hassmen (16) and Marsh and Martin (21) indicated that fitness level influences RPE responses during cycling and running. However, in these investigations, preferred exercise intensities were not employed; rather subjects exercised at specified sub-maximal intensities. As such, the high-fitness subjects exercised at comparatively lower relative exercise intensities,
consequently estimating lower exertional perceptions. Interestingly, the average RPE selected by our subjects (RPE = 10) is lower than other studies in which self-selected exercise intensity produced a higher RPE (~12–13). It is likely that the preferred intensity selected by subjects in the present study was just below their lactate/ventilatory threshold. If this assumption is correct, then the RPE values would be in accordance with those of other studies that indicate preferred intensities often fall just below the lactate/ventilatory threshold (29).

**Preferred speeds.** Relatively few studies have examined the influence of fitness on preferred walking speed. Of the studies conducted, Bassey et al. (3) determined that aerobic fitness did not influence the selected speed of walking. Results from the current investigation are in agreement with those of Bassey et al. (3) in that lower-fitness women did not self-select a TM speed that differed from the self-selected speed of higher-fitness women (5.09 vs 5.28 km·h⁻¹ or 3.16 vs 3.28 mph, respectively; \( P = 0.51 \)). A lack of differences in the self-selected speeds despite fitness disparities could possibly be explained by the narrow range of self-selected speed for TM walking before the subjects would engage in inefficient jogging. Only walking was permitted in this study.

**Total EE.** Total EE was also not significantly different (\( P = 0.59 \)) between the higher (78.10 kcal) and lower-fitness (79.70 kcal) women when values were averaged across weight categories. To date, no other study has compared total EE between higher- and lower-fitness individuals when performing at preferred walking speeds on a TM. However, EE has been determined in habitual walkers while walking at preferred TM speeds (33). In the Spelman et al. (33) study, female subjects self-selected a comparatively faster pace (6.41 km·h⁻¹ or 3.98 mph) than that selected in the current investigation (5.19 km·h⁻¹ or 3.22 mph). The difference in pace resulted in a higher energy expenditure (6.1 ± 2.3 kcal·min⁻¹) than observed presently. Extrapolated to a comparable 15-min session, the Spelman et al. (33) walkers would expend approximately 91.5 versus 79 kcal among the current subjects. In the Spelman et al. (33) investigation, the %\( \text{V}O_2 \text{max} \) at which the subjects walked was generally similar to those of the present subjects. Furthermore, the average \( \text{V}O_2 \text{max} \) and BMI were also similar. One possible reason for the differences in EE between the two studies may be that Spelman et al. (33) examined habitual walkers while the current study excluded anyone who walked for exercise on a regular basis. It is possible that habitual walkers select a faster pace, thus resulting in a greater EE than those who do not primarily walk for exercise.

**Combined Effects of Fitness and Weight**

The present study is the first to explore the combined effect of varying fitness levels and body weight on preferred exercise intensities among women while walking on a TM. There were no significant combined effects of fitness level and body weight on any of the metabolic and perceptual variables. However, because of the greater body mass, the lower-fitness, overweight subjects expended more total calories (85.33 kcal), on average, than any of the other groups. This occurred despite similar preferred TM speeds and RPE as observed in the other three groups. This finding may be important from a public health perspective. The segment of the population that may derive the greatest benefit from regular exercise participation (i.e., lower fitness, overweight) may expend a greater number of calories when compared with women who are more fit and/or of normal weight when walking at the same speeds. This greater rate of caloric expenditure could facilitate a comparatively faster rate of weight loss, especially when coupled with other lifestyle changes. In addition, the average total energy expenditure for all four groups was 78.90 kcal for the 15-min walk. At this rate of caloric expenditure, the subjects would only need to walk at their preferred intensities for approximately 30–60 min to expend the recommended 150–400 kcal·d⁻¹ (1).

The nonhabitual walkers employed in this study, regardless of fitness level and weight, rated their perceived exertion to be about 10 on the 6–20 Borg category scale. As such, this investigation is the first to establish an average group-normalized perceptual response that is associated with walking at self-selected speeds. A group-normalized perceptual response is defined as a stable RPE or RPE range that corresponds to a target physiological outcome during exercise and that is common to a specified cohort of individuals (30). This group-normalized perceptual response indicates that the individuals studied at present (i.e., college-age women who were nonhabitual walkers) perceived the exertion associated with preferred TM walking to be just below “light.” It is possible that this perceptual intensity has exertional properties that would promote adherence, as described by Dishman (8). Furthermore, it can be speculated that preferred TM walking speeds that fall within this “group-normalized zone” are in part mediated by perception of exertion (i.e., RPE). However, RPE in this preferred context is independent of relative metabolic rate and, by extension, maximal aerobic power. This is contrary to one line of reasoning that holds that self-selected preferred walking speed is determined by a level of perceived exertion that is indexed to an efficient or acceptable relative metabolic cost (24).

In summary, preferred intensities produce exertional perceptions that are consistent with adoption of a physical activity program independent of fitness level and body weight. This suggests that walking programs involving self-selected speeds could be perceptually similar in level of effort for college-age women of various levels of fitness and body weight, thus facilitating group exercise prescriptions. Furthermore, the self-selected speeds were within the range (~3–4 mph) considered to be moderate-intensity activity regardless of fitness and weight of the participants. In addition, the self-selected pace elicited a percentage of HR\( \text{max} \) within the range (55–90%) recommended by the ACSM to increase or maintain cardiorespiratory fitness. The pace, however, resulted in a percentage of \( \text{V}O_2 \text{max} \) that
was within the recommended range (50–85%) for lower-fitness participants but suboptimal for improvement or maintenance of fitness in higher-fitness participants regardless of weight.

CONCLUSION

Understanding how aerobic fitness and body weight influence the self-selection of moderate-intensity activities and their associated exertional perceptions has public health implications. Specifically, these findings may increase the understanding of how individuals interpret and ultimately adhere to general exercise recommendations designed to promote health and fitness. The current findings suggest that self-selected preferred walking speed and corresponding exertional perceptions are independent of both fitness and weight. However, fitness, and not weight, influences aerobic metabolic responses to preferred exercise intensity during TM walking in college-age women. More specifically, lower-fitness women exercised at a higher %\(\text{VO}_2\text{max}\) than higher-fitness women at preferred intensities. However, this intensity, as determined by %\(\text{VO}_2\text{max}\), is considered suboptimal by ACSM guidelines (1) to enhance cardiorespiratory fitness among the higher-fitness groups, regardless of weight. More importantly, however, the results of this study suggest that walking that is self-regulated at a preferred intensity is likely to promote adherence and occurs at intensities that have been shown to produce health benefits, particularly for less fit individuals. For instance, the women selected a walking pace that elicited an average submaximal oxygen consumption of 16.46 mL·kg\(^{-1}\)·min\(^{-1}\) or 4.7 METs at a normalized RPE zone of 10 (Borg 6–20 scale). Activity undertaken at this metabolic and perceptual level is considered moderate intensity and is sufficient for most people to achieve health benefits. These results, however, are not generalizable to women with BMI values < 18.5 kg·m\(^{-2}\). In addition, the results are not generalizable to clinically obese women with BMI values > 30 kg·m\(^{-2}\), who require more clinical supervision and are less likely to undertake preferred walking intensities for exercise.

Limitations of this study include narrow age and BMI ranges of the study population. Future research should use the same research paradigm to determine whether a group-normalized perceptual response exists in an obese population. In addition, a normalized zone may be affected by both physiological and psychological mediators. Physiological mediators such as the lactate inflection point were not measured in this study, but may be influential because a lower pH may affect fatigue. Furthermore, future studies should examine psychological mediators such as self-efficacy and total mood scores to determine what impact, if any, they have on a normalized zone of preferred intensity. A final interesting aspect would be the examination of the effects of habitation on the process of self-selecting exercise intensity.

REFERENCES


