Inter-Modal Comparisons of Acute Energy Expenditure during Perceptually Based Exercise in Obese Adults

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Summary Previous studies have suggested that if exercise intensity is established by perceived effort, the metabolic demand varies among exercise machines and the treadmill optimizes energy expenditure (EE). However, these studies have been completed utilizing young people with normal body fat percentages. Therefore, the purpose of this study was to assess whether there was a difference in acute EE when obese people used different exercise modes at a self-selected intensity (ratings of perceived exertion 11–12) commonly recommended for overweight individuals. Twelve obese subjects (7 male; 5 female; BMI > 29 kg/m2), aged 37–71 years completed two familiarization trials on four machines: treadmill (TM), stationary cycle (C), body tree elliptical arm/leg (BT), and air dyne (AD). On separate days, subjects then completed a 15 min trial on each machine at a self-selected intensity corresponding to a target RPE of 11–12 on the Borg 15-point scale. Machine order was randomly assigned, and subjects were blinded to the workload throughout each trial. Workload was self-adjusted during the first 5 min and then remained stable for the rest of the trial. Physiological data were obtained during the last 5 min of each trial. The BT produced the highest rate of EE among exercise machines and C the lowest. These results suggest that perceptually-based exercise prescriptions are not reliable across modes typically found in a fitness center environment, and that weight-bearing arm/leg exercise optimizes EE during self-selected exercise of moderate intensity in obese subjects.

Key Words energy expenditure, ratings of perceived exertion, obesity, exercise mode

Exercise intensity is prescribed as a percentage of an individual’s maximum oxygen uptake (VO2max). An appropriate exercise training intensity is usually monitored by heart rate (HR) determined from a graded exercise testing (GXT). Ratings of perceived exertion (RPE) can also be used as a valid tool for exercise prescription, especially in cases where HR corresponds to exercise is changed due to medication, and individuals have difficulty with palpation (1). The target RPE for exercise training can be assessed during graded exercise treadmill or bicycle ergometer test (1). Following this test, the RPE value that corresponds to the appropriate target HR may be given to individuals as a target RPE for exercise training (1).

In order for RPE to be an effective means for intensity regulation, there would need to be consistent matching between the RPE number and the relative physiological intensity (e.g., limited inter-individual variability in relative exercise intensity at any given RPE). Previous studies have investigated the reliability and validity of perceptual-physiological relationship (2–6). These studies reported that the relationship between RPE and HR or RPE and oxygen uptake (VO2) was valid and reliable across exercise training conditions. Dunbar et al. (7) investigated whether perceptual responses obtained during graded exercise testing on a treadmill and cycle could be used to accurately regulate exercise intensity across exercise training setting. Their results indicated that RPE could accurately regulate intensity across exercise modes at 50% but not at 70% of mode-specific VO2max. Even though RPE could not accurately regulate exercise intensity at the higher intensity, the authors suggested that RPE is a valid tool for monitoring intensity. However, recent studies have yielded mixed results and indicated significant differences in RPE at any given relative physiological intensity across exercise conditions (8–12). For example, Whaley et al. (11) compared the psychological and physiological responses between a modified Balke and the Bruce protocol and suggested that perceptual-physiological relationship varied between these protocols. Thus, the relationship between RPE and physiological responses across a variety of exercise conditions needs to be investigated further.

Various exercise modes are used for fitness programs, cardiac rehabilitation programs, and exercise testing. Few studies have been conducted for exercise mode comparisons of the aerobic and energy demands relative to the level of perceived exertion (13–15). Recent research focused on investigating submaximal metabolic responses to different exercise modes. Differences in the cardiovascular and metabolic responses to these modes may be important considerations for exercise.

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prescription, especially for those individuals with weight reduction goals. While some studies reported that there was no difference in energy expenditure (EE) at similar HR (16), others have found different EE during self-selected submaximal exercise (13–15). Thomas et al. (16) compared oxygen consumption at similar HR across several exercise machines. These investigators found that there was no significant difference in EE for stationary cycling, rowing, ski simulator exercise, or treadmill jogging. However, the sample size of the study was too small to test EE differences at similar heart rates across exercise modes. On the other hand, a comparison of six exercise modes, at a given RPE (i.e., 11, 13, 15), has shown that treadmill results in greater EE than other exercise machines (14, 15). The authors suggest that if exercise intensity is established by perceived effort, the metabolic demand varies considerably among exercise machines and the treadmill is the optimal indoor exercise machine for enhancing EE. Thus, the metabolic demand varies significantly among exercise machines during submaximal exercise. However, most previous research on this topic has been completed utilizing a group of young, fit people with normal body fat percentage (13–16). More studies are needed comparing EE across machines at exercise intensities (RPE 11–12) recommended for obese adults due to lack of research on submaximal physiological responses to different exercise modes.

Therefore, the purpose of this study was to investigate whether there was a difference in EE when obese people used different exercise modes (stationary cycle (C), air-dyne (AD), treadmill (TM), and body tree (BT)) at self-selected (RPE 11–12 “fairly light”), steady-state exercise. It was hypothesized that rates of EE at a given rating of perceived exertion would vary among four different indoor exercise machines during self-selected submaximal exercise.

METHODS

Twelve obese subjects (7 males and 5 females) participated in the study. These subjects were recruited from members of the Adult Physical Fitness Program of Ball State University. Subjects ranged in age from 37 to 71 y. All subjects took part in a regular exercise program consisting primarily of endurance exercise training. Subjects were informed of the possible risks and benefits before participating in this study. Subjects reviewed and signed a written informed consent approved by the University’s Institutional Review Board for Human Subjects. All subjects were free of known cardiovascular disease and pulmonary or musculoskeletal disorders that might have prevented the safe completion of a maximal graded exercise test.

Preliminary tests. As members of the Adult Physical Fitness Program (APFP), most subjects completed a battery of resting tests as part of the program screening. If their APFP testing was within 3 mo of participation in the study, data for body composition status were retrieved from the data collected for the program screening. If the APFP testing records exceeded the 3-mo period, they were scheduled for additional lab assessment of body composition. Subjects reported to the APFP Exercise Testing Laboratory to complete a health history questionnaire, resting heart rate and blood pressure. The subject’s height, weight, and percent body fat were measured. Jackson and Pollock (17) seven-site skinfold equations (chest, abdomen, thigh, triceps, subscapular, suprailliac, and midaxillary) for males and three sites (triceps, supraillium, and thigh) for females were used to predict body density and then converted to percent body fat using the Siri equation (18). The waist-to-hip circumference ratio was calculated by dividing the waist circumference, taken in the horizontal plane at the smallest circumference in the abdominal region, by the hip circumference, measured as the maximum gluteal diameter. Subjects who met two out of three criteria qualified for this study (BMI: >27 kg/m² for men and >30 kg/m² for women; percent body fat: >25% for men and >33% for women; waist-to-hip ratio: >0.90 for men and >0.80 for women). Five subjects (1 male and 4 female) met all three criteria.

Incremental (or graded) peak oxygen uptake tests. Subjects completed four peak oxygen uptake (V02peak) tests, one on each mode of equipment. Subjects were encouraged to exercise to volitional fatigue during each of these exercise tests. These data were used to determine the relative exercise intensity of the submax trial for each machine. Each V02peak test was completed at the same day of the week, separated by 48 h. The four exercise machines investigated in this study were TM (The Trotter 540 Supertrainer, United Medical Company, Medway, Mass), C (Cybex Metabolic 100 cycle, Division of Lumex Inc., Ronkonkoma, NY), Schwinn AD (Schwinn Bicycle Company, Chicago, Ill), BT (Cross-Condition’s Systems, Reebok, Broomfield, CO). The TM test was completed in the Human Performance Laboratory, and data for V02peak was retrieved from archived test recorded when testing was completed within 3 mo; otherwise they were scheduled for V02peak tests and given pretest guidelines. Subjects completed the V02peak test to determine maximal physiological responses and perceptual responses during graded exercise on the treadmill. A motorized treadmill (Quinton Instruments, Seattle, Wa) was used for all subjects. The BSU/Bruce Ramp protocol (19) which employed speed and grade increases every 20 s was used for participants. Prior to each exercise test, standardized instructions for the use of the 15-point Borg scale RPE were read to subjects (20). During the test, ventilation (V̇e), oxygen, and carbon dioxide production were collected by a metabolic cart (SensorMedics 2900, Yorba Linda, Ca). The HR was measured via ECG (Marquette CASE 16). The RPE values were recorded every minute and blood pressure was measured every 3 min.

The three other V02peak tests were completed in the APFP Fitness Center. The individualized protocols were developed for each exercise mode. All individualized protocols were incremental in nature and the workload was increased every 1 or 2 min depending on the protocol and mode. Machine order was randomly assigned.

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Subjects completed VO_{peak} tests on a stationary cycle. One of three protocols was used. For seven tests, the first protocol increased 25 W every minute. For two tests, the second protocol increased 25 W every 2 min. For three tests, the third protocol increased 50 W every minute.

Subjects completed VO_{peak} tests on a AD. One of three protocols was used. For five tests, the first protocol increased one level every 2 min. For four tests, the second protocol increased one half (0.5) every minute. For three tests, the third protocol increased one level every minute.

Subjects completed VO_{peak} tests on a BT. One of four protocols was used. For nine tests, the first protocol increased two levels every 2 min. For three tests, the second protocol increased one level every 2 min. If subjects exceeded level 10, the subject was told to increase the rate of climb. All tests were terminated when the subjects indicated they could no longer continue due to fatigue.

During each exercise test, the subjects breathed through a Hans Rudolph 2700 series, two-way non-rebreathing valve while wearing a nose clip. Expired respiratory gases were collected by the Aerosport TEEM 100 with 20-s measurement intervals throughout the tests. The RPE values were recorded during the last 5 s of each minute and peak RPE was recorded immediately following the test. Heart rates (HRs) were recorded every minute via HR telemetry (Polar Electro, Oy, Finland).

**Submaximal exercise trials.** All participants completed a submaximal steady-state exercise trial on each of four machines. A summary of the design for these trials is presented in Fig. 1. Prior to the submaximal exercise trial, subjects completed ≥2 familiarization trials for 10 min on each machine. Subjects performed all exercise tests at the same time of day, separated by at least 24 h and were given pre-exercise trial guidelines.

Machine order was randomly assigned.

**Trial design:** Subjects reported to the APFP Fitness Center, and the investigator asked for information about last meal and time and recorded it. The subjects were fitted with a Polar HR telemetry monitor (Polar Electro). Resting heart rate and blood pressure measurements were taken prior to beginning each trial. Prior to each exercise test, instructions for the submaximal trial were read to each subject. When using TM, subjects were asked not to use the rails throughout the trial. With the BT, subjects selected their most comfortable climbing rate to yield a comfortable distribution of work between the upper and lower body and then adjusted workloads corresponding to RPE levels of 11–12 (fairly light) (Step 2), and kept these speeds and workloads consistent throughout testing (Step 3). The work rates for the BT were expressed by speed (the rate of climb) and levels (the resistance setting). Work rates with the leg cycle ergometer were measured by watts. Subjects selected their power output (pedaling rates and load) on the cycle ergometer during step 2 and then maintained a steady number of revolutions per minute (RPM) throughout testing (Step 3). Work rates with the AD were measured by RPM. Subjects adjusted their RPM to yield the appropriate workload corresponding to RPE levels of 11–12 (fairly light). Subjects then maintained the same RPM throughout testing.

**Data collection:** During the submaximal exercise trials, rating of perceived exertion (RPE) was assessed every 5 min. The HRs were recorded via HR telemetry every minute throughout the trial. The HRs during the last 2 min of each trial were averaged and used for data analysis. Physiological data were obtained by the TEEM 100 portable oxygen uptake measurement system (Aerosport, Ann Arbor, MI) with 20-s measurement intervals during step 3. The last minute values of these 5 min was averaged for each mode and used for data analysis. Calculated VO_{2} values were later converted to rates of EE (21). Blood lactate was also sampled immediately following exercise (Step 4).

**Statistical analysis.** Group means were compared using a one-way repeated measures ANOVA to assess exercise mode differences (TM, C, BT, and AD) for EE (kcal/min), V_{O2}, HR, VO_{2}, mode-specific percent maximal

![Fig. 1. Submaximal trial design. Machine order was randomly assigned.](image-url)
TABLE 2. Submaximal exercise test data across exercise modes.

<table>
<thead>
<tr>
<th>Variable</th>
<th>TM</th>
<th>C</th>
<th>AD</th>
<th>BT</th>
</tr>
</thead>
<tbody>
<tr>
<td>VO2peak (mL/kg/min)</td>
<td>32.3±9.1a</td>
<td>24.6±9.4</td>
<td>26.6±9.4</td>
<td>27.6±9.1</td>
</tr>
<tr>
<td>VO2 (L/min)</td>
<td>1.355±0.42a</td>
<td>1.097±0.42</td>
<td>1.271±0.42</td>
<td>1.652±0.39b</td>
</tr>
<tr>
<td>VO2 (mL/kg/min)</td>
<td>13.5±4.6a</td>
<td>10.7±4.1</td>
<td>12.8±4.6</td>
<td>16.4±4.0b</td>
</tr>
<tr>
<td>HR (bpm)</td>
<td>110±14</td>
<td>109±14</td>
<td>118±21</td>
<td>128±22c</td>
</tr>
<tr>
<td>O2 pulse (mL/beat)</td>
<td>12.4±3.7d</td>
<td>10.1±3.9</td>
<td>10.9±3.4</td>
<td>13.2±3.4d</td>
</tr>
<tr>
<td>VE (L/min)</td>
<td>30.8±8</td>
<td>29.7±14</td>
<td>31.2±9</td>
<td>39.7±10d</td>
</tr>
<tr>
<td>EE (kcal/min)</td>
<td>6.6±2.1a</td>
<td>5.3±2.1</td>
<td>6.3±2.0a</td>
<td>8.0±2.0b</td>
</tr>
<tr>
<td>RER</td>
<td>0.82±0.05</td>
<td>0.84±0.06</td>
<td>0.85±0.08</td>
<td>0.84±0.06</td>
</tr>
<tr>
<td>BL (mM)</td>
<td>2.82±1.33</td>
<td>3.35±1.19</td>
<td>3.67±1.63</td>
<td>3.97±1.77</td>
</tr>
</tbody>
</table>

Values are presented as the mean±SD.


* >C, b >TM, C & AD; c >TM & C, d >C & AD, p<0.05 (a, b, c, d).

RESULTS

The purpose of this study was to assess intermodal differences in EE during self-selected exercise of moderate intensity in obese subjects. For this study, 12 obese subjects completed a 15 min trial on each machine at a self-selected intensity corresponding to a target RPE of 11–12 on the Borg 15 point scale. Subjects were acquainted with the RPE scale prior to submaximal bouts. Descriptive data for males and females are presented in Table 1. The male subjects were considered as cardiorespiratory “good” and the women subjects were considered as cardiorespiratory “poor” according to the norms of the American College of Sports Medicine (1). Subjects maintained stable body weight throughout the study. One subject was dropped from the study due to difficulty in performing the tests, but another person replaced the original subject. One submaximal trial was repeated due to lost data. One subject repeated a submaximal trial on the BT because she felt she was working at a higher than the target RPE (14 vs. 11–12) at the end of data collection.

Physiological responses during the submaximal exercise trials are presented in Table 2. The average EE ranged from a low of 5.3 kcal/min (stationary cycle) to a high of 8.0 kcal/min (BT). Exercise on the BT resulted in higher (p<0.05) EE compared to other exercise machines (BT>TM, AD, and C: 21, 27, and 51%, respectively). The average EE for both TM and AD were significantly greater (p<0.05) than C (TM>C: 35%; AD>C: 19%). No significant mean difference was observed when comparing TM and AD. The average VO2 for subjects was the greatest (p<0.05) for BT among machines with similar RER. The average VO2 for TM was significantly higher (p<0.05) than C. No difference was observed between TM and AD. These results indicated that there were intermodal differences in EE and VO2 during self-selected exercise of moderate intensity in obese subjects.

Mean HR was significantly different across exercise modes. The average HR was significantly higher (p<0.05) for BT than both TM and C, but there were no significant mean differences among TM, AD, and C. The average O2 pulse was significantly higher (p<0.05) during both TM and BT than during C and AD. No significant mean differences were observed between C and AD. Mean ventilation was significantly different across exercise modes, with BT yielding the highest (p<0.05) average ventilation. No significant mean differences were observed among TM, AD, and C. HRs and VO2 were statistically higher for BT compared to TM, but O2 pulse was not. Mean blood lactate was not significantly different across exercise modes, but the spread was very large.

Relative physiological responses at self-selected intensity were compared across exercise modes. Mode-spe-
Exercise Mode and Energy Expenditure Comparisons

Fig. 3. Comparisons of mode-specific %MHRR at an RPE 11–12 across exercise modes. TM: treadmill, C: stationary cycle, AD: aridyne, BT: body tree elliptical arm/leg. Values are expressed as mean±SD.

*Significantly different from TM, C, and AD.

cific VO_{peak} (mL/kg/min) was TM (32.3±9.1), C (24.6±9.4), AD (26.6±9.4), and BT (27.6±9.1) (TM >BT, AD, and C: 17, 21, and 31%, respectively). Figure 2 indicates mode-specific %VO_{peak} at an RPE 11–12 on each machine. BT elicited higher (p<0.05) mean %VO_{peak} than other modes. No significant mean differences in %VO_{peak} were observed among TM, C, and AD. Mode-specific peak HRs across the modes were TM (173±19), C (153±16), AD (163±17), and BT (164±14) (TM >BT, AD, and C: 5.5, 6.1, and 13%, respectively). Figure 3 presents mode-specific %MHRR at each machine at an RPE 11–12. BT had higher (p<0.05) %MHRR than other machines. No significant mean differences in %MHRR were observed among TM, C, and AD.

DISCUSSION

Several researchers compared physiological responses at a given RPE during submaximal exercise across exercise modes (3, 13–15). Results of these studies indicated that physiological data were different at a given RPE during steady-state submaximal exercise among exercise machines. However, because previous studies (3–15) utilized a group of young, fit people with normal body fat percentage, it is questionable whether the results apply to a population with obese adults. Thus, this study was designed to investigate the perceptual-physiological relationship across exercise modes when obese adults perform steady-state submaximal exercise at a moderate self-selected intensity (RPE 11–12 “fairly light”).

Exercise mode comparisons of EE during moderate intensity exercise in obese adults are unique to the present study. The major findings from the study were significant differences in physiological responses at an RPE 11–12 across exercise modes. BT yielded the highest EE and VO_{2}, followed by the TM, AD, and C modes. This finding is consistent with previous studies (3, 13–15, 22) that suggested perceptual-physiological relationship differed across exercise modes and supports that the TM exercise induces higher EE at matched RPE when compared with leg only and arm and leg cycling (13–15). Based on previous studies that reported differences in the psycho-physiological relationship across exercise modes (13–15), the RPE method for intensity regulation may be inappropriate for prescriptive purpose, and based on significant differences in physiological responses when obese adults used different exercise modes at self-selected, steady-state exercise, this present study would advise caution in the use of generalized RPE recommendation in training setting.

The differences in physiological responses at an RPE 11–12 across different modes could be explained by muscle mass differences. The size of muscle mass influences the relationship of metabolic demand with RPE. Ekblom and Goldbarg (23) reported that RPE was higher for a given level of VO_{2} during use of a small muscle mass than during exercise with a large muscle mass. These results imply that use of a larger muscle mass seems to allow a greater absolute VO_{2} for a given RPE than use of a smaller muscle mass. The present study is fairly consistent with those of Ekblom and Goldbarg in that subjects produced higher VO_{2} and EE during BT and AD (arm and leg) and TM exercise (large muscle mass) than during C (leg only) exercise (small muscle mass).

Another factor that may explain the physiological difference is that obese adults consumed more oxygen for the weight bearing (BT and TM) when compared with non-weight bearing (AD and C) modalities. Kravitz et al. (13) reported that the weight bearing [TM and cross-country skiing (XC)] exercises produced more EE as compared with non-weight bearing (cycle ergometry and aerobic riding) modes at a self-selected intensity (RPE=13–13.5). The physiological literature on exercise modes suggests that performing weight-bearing exercise yields higher EE than performing non-weight bearing exercise because weight bearing activity requires a larger muscle mass, hence a higher VO_{2} (21). This conception is supported by the results of this present study.

This study showed that exercise at an RPE 11–12 resulted in significant differences among exercise modes in EE. The VO_{2} data indicated that exercise at an RPE 11–12 produced substantially higher EE during BT exercise than during other modes of exercise. These findings would suggest that if exercise intensity is established by perceived effort (RPE 11–12), obese adults select a higher level of EE while performing BT as compared to other modes. However, previous researchers suggested that when upper body exercise is added to lower body exercise, individuals tend to select a lower workload than during only lower body exercise (13–15). For example, Kravitz et al. (13) found that TM exercise yielded greater EE at a self-selected intensity (RPE=13–13.5) than XC exercise. This discrepancy may be due to different RPE. The intent of the present study was designed to use RPE 11–12 in contrast to a higher RPE (i.e., 13–15) used by previous studies (12, 13, 16). Zeni et al. (15) reported no differences in EE
between TM and XC at matched RPE 11. It is possible that in the previous studies (13–15) local fatigue and discomfort associated with additional upper muscle mass during XC exercise might have contributed to higher perceived exertion, and individuals might select lower energy expenditure intensity. It is conceivable that at an RPE 11–12, individuals would self-select a higher exercise intensity during BT exercise due to less perceived strain from upper body as compared to those (at RPE 13–15) observed within previous studies (13–15), and engage in large muscle mass and produce the highest EE.

Another finding within the present study was the observation of inter-individual variability in blood lactate concentration (BLC) at an RPE 11–12. It has been suggested that exercise below lactate threshold (LT) may be considered RPE 10–13 (24). The data for BLC on the BT within the present study was 3.89 ± 2.34 mm. At an RPE 11–12, some of individuals reported BLC that were considerably above or below expected LT based on American College Sports Medicine (ACSM) Position Stand (24). The results observed within this study would not support the notion of relationship published by ACSM Position Stand. This present study would not also support the study of Hetzler et al. (25) that suggested a strong relationship exists between RPE and BLC.

Ventilation was significantly different at an RPE 11–12 across exercise modes. Nobel et al. (26) reported that ventilation was a central factor for perceived effort. However, the same RPE across exercise modes would not explain the higher VE during BT exercise. The changes of blood lactate concentration are not similar to VE changes. Thus, although it is known that a close relationship exists between VE and RPE (4, 20), the present study would suggest that VE is not a strong signal at moderate exercise. HR was significantly different across exercise modes. This study is in disagreement with previous studies that suggested the relationship between RPE and HR is valid and reliable across a variety of exercise training conditions (3, 5, 6), but consistent with other studies (13, 15) that reported HR:RPE is not valid across exercise machines. Such findings indicate that the target heart rates may be different across exercise modes when exercise intensity is prescribed by perceived exertion.

Data analysis of the submaximal O2 pulse demonstrated that both TM and BT at matched RPE were significantly higher than AD and C. Oxygen pulse is calculated by dividing oxygen uptake (mL/min) by heart rate (beats/min) (27). This ratio means the work of the heart when compared to total body oxygen uptake (14). Previous investigators reported a lower O2 pulse with small muscle mass (28). It is possible that BT and TM in the present study use large muscle mass.

Another important finding from this study was considerable inter-individual variability in relative physiological responses at matched RPE across exercise machines. If the RPE method to represent a %MHRR or %VO2peak is accurate across exercise modes, RPE could be a useful method for monitoring exercise intensity. These results indicated that higher %VO2peak during arm and leg exercise (BT) resulted when compared with other exercises, and BT had the highest %MHRR among machines. Similarly, Londeree et al. (29) reported variability in the %VO2max/%HRmax relationship between exercise modalities. The results observed within this study do not support previous reports (3) that suggested cross-modal prescription of exercise intensity using RPE is valid when exercise is performed at the same mode-specific %VO2peak. Data from the present study would suggest that generalized target RPE (i.e., 11–12) yield less reliable relative physiological data during arm and leg exercise (BT) compared to other exercise modes and may not result in expected intensities (%VO2 and %MHRR) during exercise training.

In conclusion, the major findings of this study would suggest that physiological responses are different among exercise machines during self-selected exercise of moderate intensity in obese subjects. From data analysis of the present study, BT exercise produced the highest EE among machines and C the lowest. This study also demonstrates that obese adults who performed weight-bearing arm/leg exercise (BT) and TM at an RPE 11–12 selected higher intensity and expended more calories as compared with non-weight-bearing exercise (AD and C). This investigation is consistent with previous studies (13–15) that showed differences in physiological responses for a given RPE across exercise modes and the highest rate of energy expenditure during weight-bearing exercise and extends to obese adults. Thus, in the development of the exercise prescription for the obese adults, weight-bearing exercise at self-selected intensity may be beneficial to achieving a greater training effect. This study suggests that generalized RPE targets (i.e., 11–12) produce less reliable relative physiological data during arm and leg exercise compared to leg only exercise and may not result in expected intensities (i.e., %VO2peak and %MHRR) during exercise training. Based on this study, as well as previous studies (13–15), mode differences should be considered when exercise intensity is established by perceived exertion, and BT and TM (weight bearing exercise) are the optimal exercise machines to optimize energy expenditure of obese adults during self-paced moderate intensity.

Implications

These results have important implications for those who use RPEs for exercise prescription. Obese people who can perform weight bearing exercise will self-select a higher exercise intensity on the BT, consuming more calories compared with alternative exercise modes. Although differences in EE observed within this present study may be minimal [(i.e., BT (8 kcal/min) vs. C (5.3 kcal/min)], when accumulated over months and years of exercise training, the energy difference could significantly impact weight loss.

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REFERENCES