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ORIGINAL ARTICLE

Exercise does not feel the same when you are overweight: the impact of self-selected and imposed intensity on affect and exertion

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Objective: The lower rates of adherence to physical activity commonly found among overweight adults compared to their normal-weight counterparts might be due to the activity being experienced as more laborious and less pleasant, particularly when its intensity is prescribed (or imposed) rather than self-selected.
Design: Within-subject design, with two 20-min sessions of treadmill exercise, one at self-selected speed and one at imposed speed, 10% higher than the self-selected.
Subjects: A total of 16 overweight (BMI: 31 kg/m^2) and 9 normal-weight (BMI: 22 kg/m^2) previously sedentary but healthy women (age: 43 years).
Measurements: Heart rate, oxygen uptake relative to body weight, and ratings of perceived exertion and pleasure–displeasure were assessed every 5 min.
Results: The overweight women showed higher oxygen uptake and perceived exertion than the normal-weight women during both sessions. Although the two groups did not differ in ratings of pleasure–displeasure during the session at self-selected speed, only the overweight women showed a significant decline when the speed was imposed.
Conclusions: Imposing a speed that is just 10% higher than what overweight women would have self-selected led to a significant decline in reported pleasure. Over time, this could diminish the enjoyment of and intrinsic motivation for physical activity, reducing adherence.
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Keywords: exercise prescription; self-determination theory; theory of planned behavior

Introduction

Regular physical activity is an essential component of effective weight loss programs, particularly during the first 6 months, and helpful for avoiding weight regain thereafter.[1] However, data from the United States[2] indicate that, although approximately two-thirds of overweight adults (body mass index (BMI), equal to or higher than 25 kg/m^2) report using leisure-time physical activity as a weight loss strategy (66.6% of men and 62.2% of women), only one-fifth (22.2% of men and 19.0% of women) report that they perform the minimum recommended amount of activity (i.e., at least 30 min of moderate-intensity activity on 5 or more days per week). The problem is even more pronounced among obese adults (BMI equal to or higher than 30 kg/m^2), with only 18.8% of men and 16.1% of women reporting that they meet the guidelines. To date, several studies have provided evidence that high body weight, BMI, or adiposity are associated with lower levels of physical activity participation and lower adherence to activity programs.[3–8]

The reasons why overweight individuals seem even less willing than normal-weight ones to participate in and adhere to physical activity remain largely unknown despite the obvious practical importance of this question. In the general population, the problem of adherence and dropout is typically approached from the perspective of conceptual models originating in social psychology and general health behavior, none of which take the uniqueness of the physical activity stimulus into account. However, it is reasonable to assume that, particularly in the case of overweight individuals, the interaction between physical activity and excess body weight would create some unique challenges. Therefore, the role of the physical activity stimulus itself in

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shaping motivational tendencies among overweight participants warrants closer research attention.

As a general principle, participants must perform enough activity to substantially raise total energy expenditure since frustration due to unmet weight-loss expectations (which are often unrealistically high) is one of the principal reasons for dropout.[9,10] This increase in total energy expenditure can be accomplished either by prolonging the duration of activity or by raising its intensity.[11] For example, Schoeller *et al.*[12] showed that weight gain can be avoided by either 80 min/day of moderate-intensity activity or 35 min/day of vigorous-intensity activity. However, finding the right balance between duration and intensity is a challenging task, since both factors have the potential to negatively impact adherence.

Regarding duration, recent recommendations aimed at weight reduction and maintenance either call for at least 60 min/day of moderate physical activity[13,14] or state that individuals should start with at least 30 min and gradually progress to 60 min or more per day.[15,16] These figures, if seen as too high, might discourage participation, given that perceived lack of time is consistently rated as the primary barrier to physical activity participation among adults.[17,18]

Consequently, within the time constraints considered acceptable by an individual, intensity must be as high as possible without increasing the risk of adverse consequences. The intensity of physical activity has been found to be negatively related to adherence in several studies,[19–21] including some, though not all, studies involving overweight participants.[6,22,23] This could be due to the fact that higher intensity entails increased risk of musculoskeletal injuries, particularly among the overweight.[24–26] Alternatively, given that people generally tend to do what makes them feel good and avoid what makes them feel bad,[27] the lower adherence could also be attributed to the fact that high intensity is typically experienced as unpleasant.[28] Although this latter possibility remains untested, the few relevant published studies permit two important observations. First, overweight individuals exhibit low tolerance to high intensity,[29,30] report higher perceived exertion,[31,32] and seem willing to trade a longer duration for a lower intensity.[17] Second, overweight adults exhibit better adherence when physical activity is unsupervised and self-determined rather than supervised and prescribed.[33,34] We believe that these observations are related. Specifically, we theorize that a causal chain exists, linking (a) the intensity of physical activity (not only its level but also whether it is imposed or self-selected), (b) affective responses (pleasure vs displeasure) and perceived exertion, and, finally, (c) adherence.

In the present study, we focused on the critical first link in this chain, namely the relationship of intensity to affect and exertion. Based on the aforementioned observations, we hypothesized that overweight women would rate physical activity as inducing less pleasure and higher levels of perceived exertion than their nonoverweight counterparts, particularly when the intensity was imposed rather than self-selected. The sample consisted of middle-aged women who were just starting an activity program after having remained sedentary for at least 1 year prior to participation. Treadmill exercise (20 min) was performed under two conditions: (a) self-selected speed and (b) imposed speed, which exceeded the self-selected level by a minimal amount (just 10%).

Methods

Subjects

Through posted fliers and messages sent through electronic mail to the faculty and staff of a large university, we recruited 16 overweight (BMI equal to or higher than 25 kg/m^2) and 9 normal-weight women (BMI less than 25 kg/m^2). The participants were between the ages of 35 and 53 years and had all been physically inactive for at least 1 year prior to their involvement in this study. The demographic and anthropometric data of these 25 women are shown in Table 1.

Before being included in the sample, the women (a) responded to a 7-day physical activity recall interview,[35] to ensure that they expended less than the recommended 200 kcal[36] or participated in less than 30 min of moderate physical activity per day on most days of the week,[37,38] (b) reported that they had not changed their physical activity habits in the past 12 months (and, thus, based on the 7-day physical activity recall, they were sedentary), (c) certified that they had a physical examination in the previous 12 months that revealed no contraindications to vigorous physical activity, (d) gave negative responses to all the questions of the Physical Activity Readiness Questionnaire,[39] indicating that they were apparently healthy, (e) had no history of cardiovascular, respiratory, musculoskeletal, or metabolic conditions, (f) were not suffering from any injuries or other ailments, (g) were not taking any medication, and (h) were nonsmokers. One of the participants was a Pacific Islander and the rest were all Caucasian (according to the 2000 census, 88% of the residents of the local community are Caucasian). All were native English speakers. The participants received no monetary compensation, but were given the results of their fitness assessment and an

Table 1 Demographic, anthropometric, and physiological characteristics of the participants

	Normal-weight (n = *9*) *M* ± *s.d.*	*Overweight* (n = *16*) *M* ± *s.d.*
Age (years)	43.67 ± 4.24	43.00 ± 5.40
Height (m)	1.65 ± 0.07	1.66 ± 0.06
Body mass (kg)***	60.54 ± 6.68	86.13 ± 12.92
Body mass index (kg/m^2)***	22.34 ± 1.82	31.06 ± 4.91
Estimated body fat (%)***	21.63 ± 2.71	30.61 ± 4.11
VO_2peak (l/min)	1.55 ± 0.38	1.77 ± 0.39
VO_2peak (ml/kg/min)*	25.80 ± 6.07	20.82 ± 4.54

*: $P < 0.05$; ***: $P < 0.001$.

individualized physical activity prescription upon the completion of the study. Before starting the first session, all participants read and signed an informed consent form approved by the university's Institutional Review Board.

Measures

Body mass was measured with a mechanical beam medical scale (Health-o-meter, Boca Raton, FL, USA). Body adiposity was estimated (for descriptive purposes only) by skinfolds, using a Lange caliper (Beta Technology Incorporated, Cambridge, MD, USA) and a three-site (thigh, triceps, suprailiac) formula.[37]

Heart rate was assessed with a heart rate monitor (Polar Electro Oy, Finland), consisting of a stretchable chest band and a radio transmitter interface to a computerized metabolic analysis system (see below). Validation studies have shown correlations between this method and heart rate measured by electrocardiography typically in the 0.94–0.99 range and differences between 1 and 12 beats/min.[40–42]

Oxygen uptake (VO_2) was assessed with an open-circuit computerized spirometry system (model TrueMax 2400, ParvoMedics, Salt Lake City, UT, USA). Before each test, this system was calibrated for oxygen and carbon dioxide using a certified mixture of these two gases and for ventilation using a 3-l syringe and a standard 15-stroke calibration procedure. A validation study of this system found that the differences compared to the gold-standard Douglas bag method were 'so small as to be not physiologically significant'.[43]

The affective dimension of pleasure–displeasure during exercise was assessed with the Feeling Scale (FS).[44] The FS is an 11-point, single-item, bipolar rating scale commonly used for the assessment of affective responses during exercise. The scale ranges from -5 to $+5$. Anchors are provided at zero ('Neutral') and at all odd integers, ranging from 'Very Good' ($+5$) to 'Very Bad' (-5). Hardy and Rejeski[44] have provided evidence of significant correlations between the FS and other self-report measures of pleasure.

Perceived exertion was assessed with the Rating of Perceived Exertion (RPE).[45] The RPE is a 15-point single-item scale ranging from 6 to 20, with anchors ranging from 'Very, very light' to 'Very, very hard'. A meta-analysis of validity data has shown that the RPE exhibits the following weighted mean validity coefficients with physiological indices of intensity: 0.62 for heart rate, 0.57 for blood lactate, 0.64 for percentage of maximal aerobic capacity, 0.63 for oxygen consumption, 0.61 for ventilation, and 0.72 for respiratory rate.[46]

Procedures

Participation in the study required three visits to the laboratory. The first session involved an incremental treadmill test to volitional exhaustion, to determine peak oxygen uptake (VO_{2peak}) and peak heart rate (HR_{peak}). The second session involved a 20-min bout of treadmill exercise at a self-selected speed. The third session involved a 20-min bout of treadmill exercise during which the speed was imposed by the experimenters and adjusted to be 10% higher than the self-selected level. There was a minimum of 48 h between sessions (mean $\pm$ s.d. $= 8.23 \pm 4.31$ days between the first and second sessions and 7.00 ± 4.77 days between the second and third sessions). Furthermore, to control for possible diurnal effects, all tests for each participant were conducted at the same time of day.

At the beginning of each session, the participants were fitted with a nasal and mouth breathing face mask (model 8920/30, Hans Rudolph, Kansas City, MO, USA) equipped with an ultralow-resistance, T-shaped, two-way, nonrebreathing valve (model 2700, Hans Rudolph), which was, in turn, connected to the spirometry system via plastic tubing (3.5 cm in diameter). A gel sealant (model 7701, Hans Rudolph) was applied to the face mask to prevent leaks.

The incremental treadmill test performed during the first visit consisted of an initial walk at a speed of 1.11 m/s and 0% grade for 2 min, followed by increases in speed by 0.18 m/s every second min (while maintaining the grade at 0%). This was continued until each participant reached the point of volitional exhaustion. The highest 60-s average value of oxygen uptake was designated VO_{2peak} and the highest 60-s average value of heart rate was designated HR_{peak}.

For the second session, the women were told that they were to engage in a 20-min bout of treadmill exercise, during which they would be able to select the speed that they preferred. After again being fitted with the heart rate monitor and face mask following the same procedures described above, each participant was allowed to warm up by walking for 5 min at 1.11 m/s and 0% grade. After the warm-up, each participant set the speed that she preferred (0:00 min) and was allowed to make adjustments (faster or slower, but with the grade always fixed at 0%) every 5 min of the 20-min bout (min 5:00, 10:00, and 15:00). RPE and pleasure–displeasure (FS) were obtained at min 0:00, 4:45, 9:45, 14:45, and 19:45 by displaying a poster-size version of the scales and asking the participant to indicate her response either verbally or by pointing to a number. After the 20-min session, the participants were allowed to cool down by walking for 5 min at 1.11 m/s and 0% grade. They were released after a 20-min seated recovery and observation period.

An identical procedure was followed during the third and final session, with the exception that the speed of the treadmill was imposed by the experimenters and was adjusted (at 0:00, 5:00, 10:00, and 15:00) to be 10% higher than the speed that the participants self-selected during the second session. All the participants were able to complete the entire 20-min session without stopping.

Statistical analysis

The 1-min averages were calculated for heart rate and oxygen uptake and converted to percentages of peak values (VO_{2peak}

and HR_{peak}). Five time points were considered for subsequent analyses for both physiological (%VO_{2peak} and %HR_{peak}) and self-reported data (RPE and FS): (a) the end (last min) of the warm-up, (b) min 5, (c) min 10, (d) min 15, and (e) min 20 of the 20-min treadmill bout. Change was examined using 2 (weight groups: normal-weight, overweight) by 2 (exercise intensity conditions: self-selected, imposed) by 5 (time points: end of warm-up, min 5, 10, 15, and 20) mixed-model analyses of variance (ANOVA) with repeated measures on the last two factors. Whenever the sphericity assumption was violated, the Greenhouse-Geisser adjustment of the degrees of freedom was applied and the adjusted values are reported. When the weight group or intensity condition main effect was significant, no follow-up tests were necessary (since each factor had only two levels). When a significant intensity condition by time interaction was found, its decomposition superceded the analysis of main effects. In such cases, separate repeated-measures ANOVAs were conducted within each intensity condition (with the two weight groups collapsed) and followed up by multiple pairwise comparisons to identify significant changes between time points. The least significant difference (LSD) procedure was used to protect against the inflation of the Type I error rate due to the multiple pairwise comparisons. In the case of significant three-way interactions (weight group by intensity condition by time), separate repeated-measures ANOVAs were conducted for each weight group and each intensity condition. These were also followed up by multiple pairwise comparisons to identify significant changes between time points, using the LSD procedure. Effect sizes ($d=(M_i-M_j)/SD_{pooled}$) are also reported for selected contrasts.

Results

Physiological responses

At the conclusion (min 20) of the bout, the normal-weight women exercised at an average (±s.d.) of 1.81±0.55 m/s under the self-selected and 1.98±0.61 m/s under the imposed-intensity condition. On the other hand, the overweight women exercised at an average (±s.d.) of 1.53±0.31 m/s under the self-selected and 1.73±0.30 m/s under the imposed-intensity condition. Although the main effects of exercise intensity and time were significant, the effect of weight group was not.

The %HR_{peak} data are shown in Figure 1a and b. The ANOVA showed significant main effects for exercise intensity, F (1, 21) = 40.80, $P<0.001$, and time, F (2.19, 46.05) = 38.85, $P<0.001$, and a significant intensity by time interaction, F (2.54, 53.37) = 11.92, $P<0.001$. With the data from the two weight groups collapsed, %HR_{peak} was significantly higher in the imposed-intensity condition than the self-selected intensity condition at min 10 ($d=0.53$), 15 ($d=0.53$), and 20 ($d=0.51$; for all comparisons, $P<0.001$). In the self-selected intensity condition, %HR_{peak} was significantly higher at all time points compared to the end of the warm-up (from $d=0.57$ at min 5 to $d=1.25$ at min 20; for all comparisons, $P<0.001$). Of the point-to-point comparisons, however, only the increase from the warm-up to min 5 reached significance. On the other hand, in the imposed-intensity condition, not only was %HR_{peak} higher at all time points compared to the end of the warm-up (from $d=0.98$ at min 5 to $d=1.96$ at min 20; for all comparisons, $P<0.001$), but also the increases from warm-up to min 5, from min 5 to 10 ($d=0.62$; $P<0.001$), and from min 15 to 20 ($d=0.18$; $P<0.05$) were also significant.

The %VO_{2peak} data are shown in Figure 1c and d. The ANOVA showed that all three main effects were significant: weight group, F (1, 23) = 4.90, $P<0.05$; exercise intensity, F (1, 23) = 51.84, $P<0.001$; and time, F (1.81, 41.62) = 40.03, $P<0.001$. Overall, the overweight group showed higher values than the normal-weight group. Likewise, significantly higher values were recorded during the imposed-intensity condition than the self-selected intensity condition. Furthermore, the intensity by time interaction was also significant, F (3.12, 71.69) = 20.87, $P<0.001$. With the data from the two weight groups collapsed, %VO_{2peak} was significantly higher in the imposed-intensity condition than the self-selected intensity condition, continuously from min 5 to 20 ($d=0.52$ at min 5, $d=0.32$ at min 10, $d=0.36$ at min 15, $d=0.29$ at min 20; for all comparisons, $P<0.001$). In the self-selected intensity condition, %VO_{2peak} was significantly higher at all time points compared to the end of the warm-up (from $d=0.24$ at min 5 to $d=0.55$ at min 20; for all comparisons, $P<0.001$). Of the point-to-point comparisons, there were significant increases from the end of the warm-up to min 5, from min 5 to 10 ($d=0.13$; $P<0.05$), and from min 10 to 15 ($d=0.14$; $P<0.01$). In the imposed-intensity condition, %VO_{2peak} was also higher at all time points compared to the end of the warm-up (from $d=0.48$ at min 5 to $d=0.89$ at min 20; for all comparisons, $P<0.001$). Of the point-to-point comparisons, significant increases occurred from the end of the warm-up to min 5, from min 5 to 10 ($d=0.29$; $P<0.001$), and from min 10 to 15 ($d=0.16$; $P<0.01$).

RPE and pleasure–displeasure

The RPE data are shown in Figure 1e and f. The ANOVA showed that all three main effects were significant: weight group, F (1, 23) = 7.02, $P<0.05$; exercise intensity, F (1, 23) = 13.00, $P<0.001$; and time, F (1.84, 42.23) = 76.86, $P<0.001$. Overall, the overweight group reported higher RPE values than the normal-weight group. Also, participants, regardless of weight, reported higher RPE values in response to the imposed-intensity condition than the self-selected intensity condition. Furthermore, the intensity by time interaction was also significant, F (2.54, 58.33) = 13.61, $P<0.001$. RPE rose continuously in both conditions (self-selected intensity: $d=1.51$, 0.95, 0.65, and 0.52; imposed intensity: $d=2.26$, 1.40, 0.83, and 0.52; for all comparisons between time points, $P<0.001$). However, the ratings were

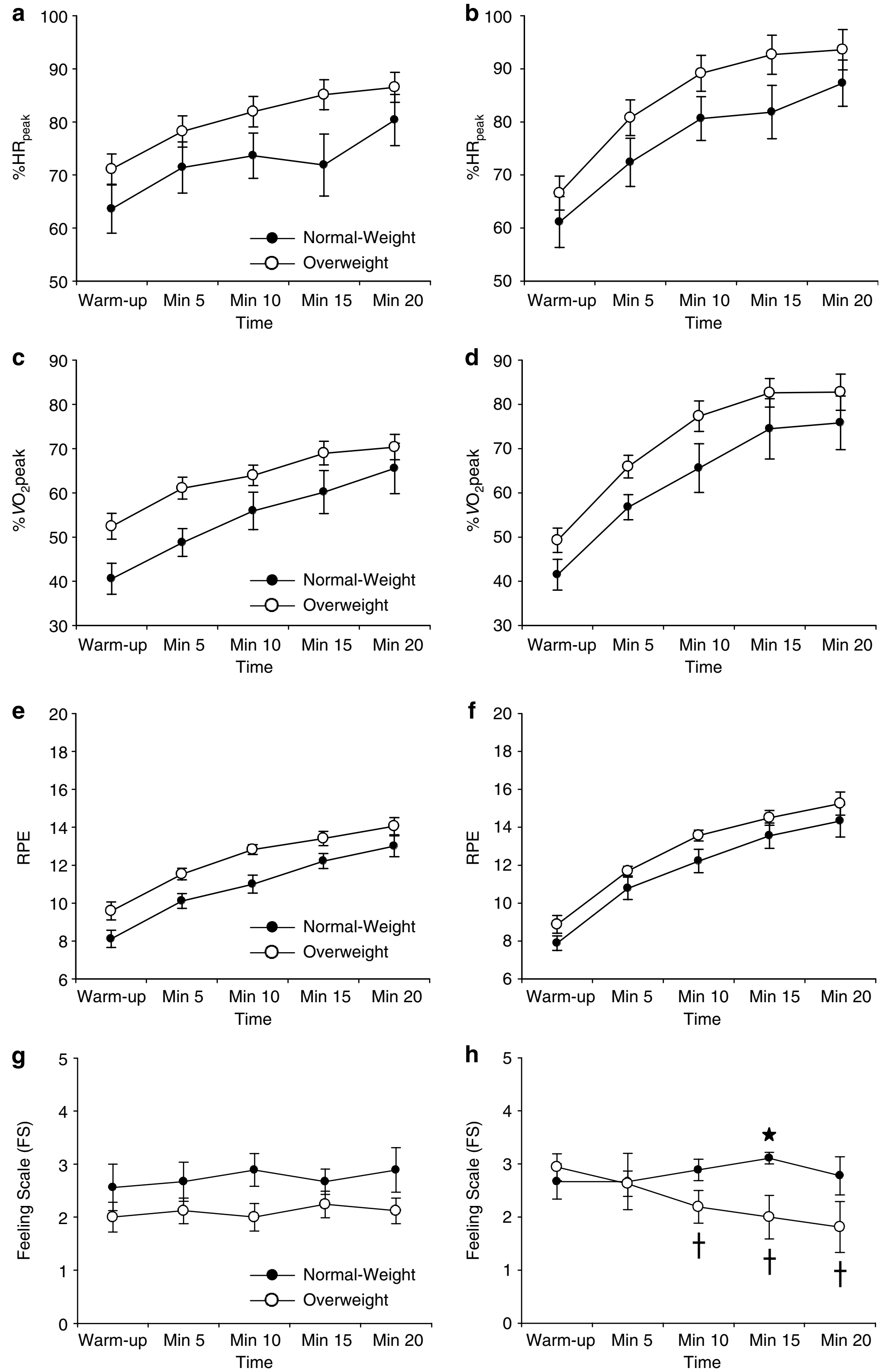

Figure 1 Responses (M ± s.e.m.) of heart rate (%HR_{peak}; **a** and **b**), oxygen uptake (%VO_{2peak}; **c** and **d**), Ratings of Perceived Exertion (RPE; **e** and **f**), and Feeling Scale (FS; **g** and **h**) during the treadmill exercise sessions at self-selected (left-side panels) and imposed (right-side panels) intensity. Note: *: significant difference between normal-weight and overweight groups ($P<0.05$); †: significant difference from warm-up and min 5 ($P<0.05$) in the overweight group. See Results for other statistically significant differences.

significantly higher in the imposed-intensity condition compared to the self-selected intensity condition only at min 10:00 ($d = 0.71$), min 15 ($d = 0.89$), and min 20 ($d = 0.82$; for all three comparisons, $P < 0.001$).

The FS data (pleasure–displeasure) are shown in Figure 1g and h. The ANOVA showed only a significant three-way interaction, F (2.74, 63.06) = 3.18, $P < 0.05$. Follow-up analyses showed that there were no significant changes in FS ratings during the 20-min exercise bouts, except when the overweight participants exercised in the imposed-intensity condition. In this condition, FS ratings showed a steady decline. Compared to the end of the warm-up and min 5, the decline was significant at min 10 ($d = 0.69$ and 0.41), min 15 ($d = 0.80$ and 0.54), and min 20 ($d = 0.90$ and 0.66; for all comparisons, $P < 0.05$). The difference between the normal-weight and overweight groups reached significance at min 15 ($d = 0.99$; $P < 0.05$) and approached significance at min 10 ($d = 0.68$; $P = 0.07$) and min 20 ($d = 0.73$; $P = 0.12$). An analysis of the FS data collected postexercise (during the 20-min observation period) showed only a significant main effect of time (i.e., FS ratings gradually increased in both conditions and weight groups).

Discussion

Overweight adults exhibit lower levels of adherence to physical activity than their normal-weight counterparts. However, the causes of this problem remain elusive. The present study was based on the assumption that this phenomenon might be due to a causal chain linking (a) exercise intensity, (b) exercise experiences (pleasure–displeasure and perceived exertion), and (c) adherence. Furthermore, we theorized that being overweight might influence this causal chain, such that, compared to normal-weight individuals, overweight ones would operate at a higher relative level of intensity, experience exercise as less pleasant and more laborious, and, as a result, exhibit lower adherence.

The results were consistent with this idea. The overweight women did exercise at a higher percentage of their peak aerobic capacity than their normal-weight counterparts, both when the intensity was self-selected and when it was imposed. Interestingly, the overweight and normal-weight groups did not differ at any time point in terms of the speed of the treadmill that they selected (and, of course, nor did they differ when the speed was set at a level 10% higher). However, to perform the same amount of work, the overweight women had to utilize a higher percentage of their peak aerobic capacity, since their peak aerobic capacity (per kg of body weight) was significantly lower than that of the normal-weight women. This is consistent with previous findings.[30] A difference in physiological intensity between the two groups was also evident in the heart rate data, although it did not reach statistical significance.

As a consequence of these physiological differences, the overweight women reported different levels of perceived exertion and pleasure–displeasure. First, as others have noted,[31,32] the overweight group reported higher exertion ratings during both intensity conditions. Second, and perhaps more interestingly, although both the normal-weight and the overweight group maintained steady and not significantly different ratings of pleasure–displeasure during the exercise at self-selected intensity, the pattern during the imposed-intensity condition was different. In that situation, although the normal-weight women were able to again maintain stable ratings of pleasure–displeasure (at levels very close to those during the self-selected intensity condition), the overweight women responded with a gradual decrease in pleasure over time. Given the fact that the intensity of physical activity is prescribed (i.e., imposed) in most studies that have reported lower adherence rates for overweight and obese participants, it is reasonable to speculate that the lower adherence might be attributed, at least in part, to the decline in pleasure found under such conditions in the present study.

The reasons behind this differential pattern of pleasure–displeasure ratings between normal-weight and overweight participants are not known at this point. Previous studies have shown that (a) when participants are allowed to select their preferred intensity, they intuitively tend to gravitate toward a level that approximates the point of transition from an intensity that can be maintained through aerobic metabolism to an intensity that requires anaerobic supplementation, operationalized as a threshold in blood lactate accumulation or gas exchange[47,48] and (b) a systematic decrease in self-ratings of pleasure begins once the intensity exceeds the level of the aerobic–anaerobic transition.[49–52] In analyses not detailed here, we found that normal-weight and overweight participants did not differ in terms of the level of oxygen uptake they utilized in relation to their gas exchange threshold (used as an indirect, noninvasive marker of the aerobic–anaerobic transition) in either the self-selected or the imposed-intensity condition. In the self-selected intensity condition, the intensity remained below the gas exchange threshold for the entire duration of the bout (78, 85, 93, and 97% of the oxygen uptake at the gas exchange threshold at min 5, 10, 15, and 20, respectively). In the imposed-intensity condition, however, the intensity clearly exceeded the gas exchange threshold during most of the bout (88, 102, 115, 115% of the oxygen uptake at the gas exchange threshold at min 5, 10, 15, and 20, respectively). It seems that normal-weight women were able to tolerate this intensity well (i.e., without a drop in pleasure), whereas overweight women were not.

These findings suggest that the proximity to the gas exchange threshold is not an adequate explanation for the affective decline, since normal-weight and overweight women did not differ in this respect. Therefore, we offer two alternative explanations, one cognitive and one physiological. First, it is possible that an overweight and chronically inactive adult will approach exercise and the exercise environment with a tendency for negative cognitive self-appraisals. These could take several forms. In the present study (data not shown), the overweight women did not have a lower self-efficacy for vigorous exercise but did report significantly higher levels of social physique anxiety,[53] the negative emotion resulting from the perception that one's body is being evaluated by critical observers. When the intensity is self-selected, a sense of control can be maintained, overt signs of poor physical conditioning can be avoided, the situation is likely to be perceived as relatively innocuous, and, therefore, social physique anxiety is unlikely to manifest itself. Conversely, when the intensity is imposed, control is taken away, overt signs of fatigue and discomfort become unavoidable, the situation is likely to be perceived as posing a potential evaluative threat, and, therefore, social physique anxiety might manifest itself in the form of reduced pleasure. Second, it is possible that the culprit is a physiological reason other than a difference in cardiorespiratory function (heart rate or oxygen uptake) or metabolic balance (aerobic vs anaerobic metabolism). One possibility is that overweight individuals might have compromised thermoregulatory ability, resulting in higher core or brain temperatures.[54–57] These are known to be associated with reduced ratings of pleasure and comfort during exercise.[58] Another possibility, supported by anecdotal reports collected during the present study, is that, as the intensity increases, overweight adults tend to experience more skeletal and muscular aches and pains than normal-weight adults.[30,59] These could also lead to a less pleasant or more unpleasant affective experience.

It is also interesting to note that increasing perceived exertion was accompanied by decreasing pleasure only under conditions of imposed intensity in the overweight women. Although perceived exertion was also higher in the overweight than the normal-weight women under conditions of self-selected intensity, this did not seem to entail significantly lower pleasure. These data suggest that exertion and pleasure maintain some independence up to a certain point but develop a reciprocal relationship thereafter. Specifically, exertion ratings between 11 and 14 (i.e., in normal-weight women under conditions of both self-selected and imposed intensity, as well as in overweight women under conditions of self-selected intensity, from min 10 to 20), were accompanied by stable, positive ratings of pleasure. On the other hand, when exertion ratings reached 14–15 (i.e., in the overweight women under conditions of imposed intensity, from min 10 to 20), ratings of pleasure were reduced. At the final min of the imposed-intensity bout among overweight women, when the highest ratings of exertion and lowest ratings of pleasure were recorded, the correlation between RPE and FS was the strongest ($r = -0.55$; $P < 0.05$).

The possible consequences of the present findings for adherence are still unknown. However, several theories of health behavior offer reasonable frameworks from which to draw inferences. Self-determination theory,[60] for example, suggests that the lack of autonomy inherent in an externally imposed exercise prescription could limit intrinsic motivation for future exercise participation. Studies have shown a link between intrinsic motives, such as enjoyment, and adherence.[61,62] Likewise, the theory of planned behavior[63] suggests that the affective component of attitude (e.g., liking or enjoying exercise), which could be influenced by the positive or negative nature of affective responses experienced during exercise, exerts an important influence on the intention to remain physically active and, by so doing, could increase or decrease the likelihood of future participation. Studies have again shown a link between the affective component of attitude and exercise participation.[64,65]

In evaluating the results of the present study, researchers and practitioners should take into account its inherent limitations. First, the study involved a relatively small and narrowly defined sample. This does not appear to have caused problems with inadequate statistical power to investigate its core hypotheses, since significant effects were observed, but it does limit the generalizability of the findings. Therefore, before assuming that the results are applicable to other populations (e.g., men, adults who are younger or older, or patients suffering from exercise-limiting conditions), one must await studies that replicate and extend the results reported here. Second, due to the design of the present study, in which one type of intervention (i.e., imposed-intensity exercise) follows another (i.e., self-selected intensity exercise), there is a possibility that the results, particularly those pertaining to the pleasure–displeasure responses, might reflect an order effect. However, we should point out that it is highly unlikely that the order would have influenced only the overweight participants, since normal-weight women responded to both the self-selected and the imposed-intensity conditions in a similar manner.

Finally, the findings do have some intriguing practical implications for exercise interventions involving overweight adults. It is clear that overweight adults have lower aerobic capacity, relative to their body weight, than their normal-weight counterparts. Consequently, they utilize a higher percentage of their peak capacity to perform the same absolute amount of work. Therefore, exercise practitioners must adjust what they consider a mild or moderate exercise stimulus. In some case, this adjustment might have to be substantial. It is noteworthy that the overweight women in this sample, at only 43 years of age, averaged a peak oxygen uptake of less than 21 ml/kg/min, a level just six times higher than the standard resting metabolic rate. Although this low number might not represent an accurate measure of the *maximal* capacity of their cardiorespiratory system, it does represent their *peak* functional capacity once all relevant factors, including physical (e.g., knee pain) and cognitive (e.g., social physique anxiety, fear of unfamiliar somatic sensations), are taken into account. When the overweight women were allowed to self-select the speed of the treadmill, their physiological intensity during the last 10 min of the

20-min bout averaged 69–70% of their peak aerobic capacity or 85–87% of peak heart rate. This is clearly a strenuous stimulus, exceeding the range of intensity that the American College of Sports Medicine[15] considers 'adequate' for the effective management of body weight (i.e., 55–69% of maximal heart rate). If the perception of the health practitioner (exercise or weight management specialist) about what constitutes an adequate treadmill speed is just 10% higher than what the participant herself finds preferable, the physiological intensity could be set as high as 83% of peak oxygen uptake or 93–94% of peak heart rate (as was the case here). In the present study, the consequence of this was a significantly lower rating of pleasure during the imposed-intensity condition in the overweight sample compared to the normal-weight one. In a clinical setting, it could also increase the risk of cardiovascular complications or musculoskeletal injuries. Therefore, we are inclined to conclude that, in the case of overweight and chronically sedentary women, it might be advisable to encourage the self-selection rather than the imposition of exercise intensity (refocusing external monitoring to the avoidance of extremes in either direction). More broadly, it seems clear that exercise recommendations for overweight adults should take into account not only what is safe and effective from a physiological standpoint but also what is tolerable and enjoyable from a psychological perspective.[66–68]

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