Public Health

The mysterious case of the public health guideline that is (almost) entirely ignored: call for a research agenda on the causes of the extreme avoidance of physical activity in obesity

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Summary

Physical activity and exercise guidelines for weight management call for at least 60 min of daily activity. However, these documents fail to acknowledge that almost no obese adults meet this target and that non-adherence and dropout are even higher among obese individuals than the general population. The reasons for this level of activity avoidance among obese individuals remain poorly understood, and there are no evidence-based methods for addressing the problem. Opinions among exercise scientists are polarized. Some advocate moderate intensity and long duration, whereas others call for high intensity and shorter duration. The latter approach attributes the inactivity and high dropout to limited discretionary time and the slow accrual of visible benefits. However, higher intensity has been associated with non-adherence and dropout, whereas longer duration has not. A conceptual model is then proposed, according to which obesity interacts with intensity, causing physical activity and exercise to be associated with reduced pleasure among obese individuals. We theorize that, in turn, repeated experiences of reduced pleasure lead to avoidance. On this basis, we call for a research agenda aimed at identifying the causes of activity-associated and exercise-associated displeasure in obesity and, by extension, the causes of the extreme physical inactivity among obese individuals.

Keywords: Adherence, affect, dropout, duration.

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In 1994, at the conclusion of a satellite symposium of the 7th International Congress on Obesity, which focused on the benefits of exercise, nutritionist John Garrow (1), speaking as a discussant, presented an assessment of the role of exercise that stood in stark contrast to the optimistic tone of previous talks. He argued that 'the contribution of exercise to the treatment of obesity is trivial' (p. S126), mainly because 'really obese people are unable to do much exercise' (p. S128). In the more than two decades that passed since then, the number of studies and literature reviews detailing the benefits of exercise for obese individuals have multiplied. So have the calls for increased levels of physical activity for the prevention and treatment of obesity from governmental agencies and scientific bodies around the world. On the other hand, the issue raised by Garrow has received surprisingly little attention among obesity experts. However, by most indications, Garrow's gloomy assessment was correct. Obese individuals are advised to do more physical activity than the general population but do even less. In fact, physical activity guidelines for obese individuals arguably represent a rare case in the annals of public health, in that they are followed by nearly none of the people they are supposed to help.

In this article, we describe the phenomenon of the extreme avoidance of physical activity and exercise in obesity, as reflected in very low rates of participation and high rates of non-adherence and dropout. Subsequently, we call for a research agenda aimed at investigating the (still largely unknown) causes of this phenomenon. The hedonic theory provides the conceptual framework for this review. According to this intuitive and time-honoured idea, people generally tend to do what makes them feel better and tend to avoid what makes them feel worse. We propose that under most circumstances, physical activity and exercise make obese individuals feel worse. In turn, we theorize that over time, experiences of reduced pleasure translate to diminished participation.

Coming to terms with the extent of the problem

The importance of physical activity and exercise for obese individuals must be disentangled from the controversial question of the role that energy expenditure plays in energy balance. The evidence shows that when exercise is combined with dietary restriction, weight loss and long-term maintenance are improved substantially compared with diet alone (2,3). Moreover, regardless of the contribution of physical activity and exercise to weight loss, their benefits for overall health remain irrefutable (4). Authors have argued that physical activity may function as a buffer against the harmful effects of obesity (5), although more studies on this issue are needed (6).

How much physical activity is recommended for weight management?

Despite the potential benefits that obese adults could accrue from physical activity and exercise, their level of engagement is low, especially when compared with the levels presently recommended for effective weight management. As shown in Table 1, most current guidelines call for the accumulation of at least 60 min of moderate-intensity physical activity daily for the prevention of weight gain and at least 60–90 min for the prevention of weight regain in individuals who were previously obese but have lost weight. However, obesity experts have warned that guidelines calling for 60 or 90 min of daily physical activity may be ‘too daunting’ (7) (p. 769) or ‘too ambitious’ (8) (p. 2264) and may, therefore, prove to be unrealistic, and perhaps discouraging, as goals. Indeed, the discrepancy between what is recommended and what is achieved is striking.

Surveys show that nearly all obese individuals would like to weigh less (e.g. 95.9% of women and 89.8% of men) (9). Approximately, two-thirds report actively trying to lose weight. In the USA, for example, data from the National Health and Nutrition Examination Survey (NHANES) showed that the percentage of those who reported trying to lose weight was 61.8% overall in 1999–2002 (10), and 69.2% among women and 56.0% among men in 2003–2008 (9). Data from the Behavioral Risk Factor Surveillance System (BRFSS) showed that the figures were 70.1% and 70.0% for obese women and 60.4% and 62.8% for obese men in 1996 (11) and 2000 (12), respectively.

Of those individuals who are trying to lose weight, physical activity is reported as a strategy less frequently among obese adults than their normal-weight and overweight counterparts. For example, in the 1996 BRFSS, 60.6% of obese men and 55.5% of obese women who were trying to lose weight reported using physical activity as part of their efforts (11). These figures were considerably lower than the 72.3% of normal-weight men, 73.7% of normal-weight women, 69.6% of overweight men and 64.5% of overweight women trying to lose weight who reported using physical activity (11). Dieting was overwhelmingly the most prevalent strategy in all categories, but the difference between the rates of dieting and physical activity was largest among obese adults (the reported prevalence of dieting was 33.3% and 37.8% higher than the prevalence of physical activity among obese men and women trying to lose weight, respectively) (11).

How much physical activity do obese adults do?

The extent of the avoidance of physical activity among obese adults becomes more clearly apparent in population studies assessing the amount of physical activity that obese individuals do, especially when these assessments are based on objective methods (e.g. accelerometers). Even when considering the less stringent guideline for health promotion (i.e. at least 150 min of moderate-intensity activity per week), rather than for weight management, the percentage of obese individuals who fail to meet the guideline approaches 80% according to self-reports and 100% according to objective measures. Specifically, in the 1990–2002 NHANES, compared with 71.7% of the general population who reported being inadequately active (defined as fewer than 600 min of moderate or vigorous activity in the last month), the figure for obese adults was 78.4% (10). In some US states, the figure exceeded 80%, even among obese adults who reported trying to lose weight (13,14). Similarly, in the 2000 BRFSS, only 15.9% of obese women and 21.3% of obese men trying to lose weight reported combining eating fewer calories with at least 150 min of physical activity per week (12).

Not surprisingly, objective data from accelerometers show even lower levels of activity. Specifically, according to data from a nationally representative sample of adults from the 2005–2006 NHANES, fewer than 3.0% of obese men and 1.5% of obese women averaged 30 min of

Table 1 Physical activity guidelines for weight management issued by governmental agencies and major scientific and professional organizations

Organization(s)	Year	Physical activity guidelines
International Association for the Study of Obesity (131)	2003	45–60 min of moderate physical activity per day to prevent the transition to overweight or obesity 60–90 min·day^{-1} to prevent weight regain in formerly obese individuals (or lesser amounts of vigorous-intensity activity)
Department of Health, Physical Activity, Health Improvement and Prevention (UK) (132)	2004	45–60 min of moderate-intensity activity per day to prevent weight gain 60–90 min day^{-1} to avoid weight regain
Department of Health and Human Services, Department of Agriculture (USA) (133)	2005	60 min of moderate-to-vigorous physical activity per day to prevent weight gain 60–90 min·day^{-1} to sustain weight loss for individuals who were previously overweight
Institute of Medicine of the National Academies (USA) (134)	2005	Average of 60 min of daily moderate-intensity physical activity (or shorter periods of vigorous activity) to maintain a body mass index within the normal range
European College of Sport Science (75)	2006	250–300 min of moderate-intensity physical activity per week for initial weight loss >60 min·day^{-1} for the maintenance of reduced body weight
Canadian Medical Association (135)	2007	Moderate-intensity physical activity of 30 min·day^{-1}, with a progression to 60 min·day^{-1} as soon as this becomes possible
American College of Sports Medicine (74)	2009	>250 min of physical activity per week for meaningful weight loss (5.0 to 7.5 kg) Minimum of 60 min of moderate-intensity daily activity to prevent weight regain
Chief Medical Officers (UK) (136)	2011	For those who are overweight or obese, achieving a healthy weight will likely require more than 150 min of physical activity per week and should be accompanied by dietary changes to reduce calorie intake
American College of Cardiology, American Heart Association, The Obesity Society (137)	2014	>150 min of moderate-intensity physical activity per week as part of a comprehensive lifestyle intervention for the management of adult overweight and obesity (along with a reduced-calorie diet and behaviour therapy) 200 to 300 min·week^{-1} are recommended for the maintenance of weight loss or the minimization of weight regain

moderate-to-vigorous physical activity per day (15). Based on the same data, obese adults average 17.3 ± 0.7 min of moderate and 3.2 ± 0.4 min of vigorous physical activity per day. According to a recent reanalysis, obese men average 23.4 min of moderate and 36.0 s of vigorous physical activity daily, while obese women average 13.8 min and 10.8 s, respectively (16). Similarly, in a nationally representative sample of British adults, obese men averaged 41% less (28.7 to 48.7 min in total) and obese women averaged 48% less (17.2 to 33.3 min in total) combined moderate-and-vigorous physical activity daily compared to their normal-weight counterparts (17).

Given that compliance with the (less demanding) physical activity guidelines for health promotion is below 3.0% among obese adults, it is unsurprising that compliance with the (more demanding) guidelines for weight management is also close to zero. According to self-reports, among obese adults trying to lose weight, only 6.4% of men and 3.0% of women reported combining eating fewer calories with at least 420 min of physical activity per week (or 60 min·day^{-1} on average) (12). In an accelerometry-based study of 1,297 adults, including both overweight and obese individuals, only 1.7% were found to be active at least at a moderate intensity for at least 60 min·day^{-1} (18).

To put this level of non-compliance with guidelines in perspective, it is instructive to compare it with rates of other health behaviours that commonly evoke fears of pain, discomfort, or embarrassment. In 2003, the percentage of adults who reported at least one dental visit within the previous year was 72.0% (19). In 2005, the percentages of women and men over 50 years of age who reported having had colorectal endoscopy during the previous 3 years were 19.8% and 23.7%, respectively (20). The percentage of women aged 40 years or older who reported having had a mammogram within the previous 2 years was 67.0% (20). The percentage of those aged 25 years or older who reported having had a cervical smear within the past 3 years was 78.4% (20).

The 'reverse causation' phenomenon and the obesity-inactivity 'vicious cycle'

Cross-sectional studies showing inverse correlations between physical activity and body mass index (BMI) or body fat are ubiquitous in the literature. Usually, these are assumed to indicate that physical activity protects against weight gain or, conversely, that the absence of adequate amounts of physical activity results in weight gain. In other words, most researchers and practitioners are accustomed to thinking of the relationship between physical activity and obesity as unidirectional. The possible causal path linking obesity to reduced physical activity or exercise is, thus, often overlooked. However, this pathway, also referred to as the 'reverse causation' hypothesis (21,22), has strong empirical support.

Epidemiologic evidence

Longitudinal studies, in which both physical activity and body mass indices were assessed in a time-lagged fashion, have consistently shown that obesity is a significant predictor of reduced physical activity at a later point in time. Such studies with adults have been conducted in Australia (23,24), Denmark (25–27), Finland (28,29), Greece (30), the UK (31–34), Canada (35,36) and the USA (37–41). Furthermore, studies with children have been reported from Denmark (42), the UK (43,44) and the USA (45).

Experimental evidence

In a study with a unique design, the movements of 10 lean and 12 obese adults were initially monitored with multiple sensors (four inclinometers and two triaxial accelerometers) twice per second for 10 consecutive days (46). The participants exhibited between 46 and 62 bouts of walking per day, which were mostly short (85% lasted fewer than 15 min) and slow (88% were below 2 $\text{mi}\cdot\text{h}^{-1}$). The researchers determined that the obese participants, despite being free of joint pain and chronic diseases, walked one-third less distance per day than the lean participants (approximately 3.5 mi or 2 $\text{h}\cdot\text{day}^{-1}$). Although the number of walking bouts and the mean velocity of walking did not differ between the two groups, the obese participants covered one-third less distance per bout compared with their lean counterparts. The amount of body fat (in kg, measured by dual X-ray absorptiometry) exhibited a significant negative correlation with the distance walked per day ($r = -0.61$). Following the initial 10-day observation, the participants were then overfed for 8 weeks (by 1,000 $\text{kcal}\cdot\text{day}^{-1}$ above weight-maintenance needs), which resulted, on average, in a gain of 3.6 kg of body mass and 2.8 kg of body fat. These gains were accompanied by similar decreases in walking in both the lean (-1.4 $\text{mi}\cdot\text{day}^{-1}$) and the obese ($-1.6$ $\text{mi}\cdot\text{day}^{-1}$) participants (46).

This body of evidence, while still developing, is strong enough to support the conclusion that the relationship between physical activity and obesity is, in fact, bidirectional. In other words, an initial caloric imbalance created by a combination of excess intake and inadequate expenditure leads to obesity, but once obesity sets in, it becomes a significant barrier to physical activity. Because inactivity contributes to obesity and obesity, in turn, contributes to inactivity, the relationship can be best described as a vicious cycle (29). This is the crux of the rationale for preventing childhood obesity. Evidence consistently demonstrates that once obesity sets in during childhood, it tracks reliably into adulthood (47). At least in part, this 'tracking' may be due to a persistent attenuating effect of obesity on energy expenditure through physical activity and exercise.

Non-adherence and dropout

Published data on dropout from exercise programs probably have limited external validity and are difficult to interpret. This is because of considerable sampling bias (the individuals who volunteer for exercise interventions are unlikely to represent a random sample of the population) and because most intervention trials include components specifically designed to improve adherence and prevent dropout. Moreover, the full extent of the problem of dropout from exercise interventions was difficult to appreciate in the past because this information was not always reported, and statistical analyses were based on only those participants who successfully completed the programs. However, reporting guidelines for randomized controlled trials that were implemented in biomedical journals since the late 1990s have made it possible for researchers and practitioners to obtain a more accurate picture. It is now apparent that dropout from exercise trials is substantial. It is estimated that between 9% and 87% of exercise intervention participants (not limited to obese individuals) drop out (48).

Obesity and body mass index as moderators of adherence and dropout

Importantly, non-adherence to the prescribed regimens and dropout from the programs are even more prevalent among obese individuals than among their non-obese counterparts. In fact, these problems are often discussed as the main possible reasons behind lower-than-anticipated weight loss or health-related outcomes from exercise interventions (49–53). A higher body weight, BMI or percentage of body fat at baseline has been found to be a significant predictor of non-adherence and dropout in several studies. For example, in early studies of men, Dishman *et al.* (54,55) found that both body fat ($r = -0.49$) and body weight ($r = -0.28$) were significantly related to the number of days participants remained in the 20-week exercise program and strongly discriminated between dropouts and adherers.

Similarly, Kriska *et al.* (56) reported that women who complied with a prescribed regimen ($7\,\text{mi}\cdot\text{week}^{-1}$) over a 2-year period had, on average, lower weight and BMI than women who did not comply. King *et al.* (57) found that among the men and women who were assigned to a group exercise program, those with a baseline BMI of 27 or lower were considerably more likely to be successful at adhering to the exercise prescription (i.e. attending at least two-thirds of sessions) during the second year of a program (28.0%) than participants with a higher BMI (7.7%).

In the 3-year-long National Exercise and Heart Disease Project (58), male myocardial infarction patients who failed to attend at least 14 of the possible 18 sessions during the initial low-intensity run-in period were excluded from the study. Nevertheless, session attendance fell to 55.1% by the 6th month and to 13% by the 36th month. Men with a BMI below $25.75\,\text{kg}\cdot\text{m}^{-2}$ (median) showed significantly higher compliance throughout the 36-month period than men with a BMI of $25.75\,\text{kg}\cdot\text{m}^{-2}$ or higher (58).

In the Diabetes Prevention Program (59), having a lower baseline BMI was significantly associated with the likelihood of reaching the physical activity goal ($150\,\text{min}\cdot\text{week}^{-1}$) at both the end of the 16-session core curriculum (median duration of 24 weeks) and at the final visit (median of 3.25 years). Bautista-Castaño *et al.* (60) studied a large sample ($N = 1{,}018$) of overweight or obese men and women, who were enrolled in an outpatient weight-loss program involving structured exercise and daily physical activity, in addition to dietary guidance. Most enrollees (70.4%) abandoned the program before reaching their agreed upon weight-loss goal (5–10% of initial body weight) after an average period of 4.3 months. Each additional baseline BMI unit was associated with 21% lower probability of reaching the weight-loss goal. The percentage of those who reached their goal decreased across BMI categories (57.5% of overweight, 29.2% of class 1 obese, 9.6% of class 2 obese and 3.7% of class 3 obese).

In the Arthritis, Diet and Activity Promotion Trial (61), men and women with diagnosed osteoarthritis of the knee and BMI of at least $28\,\text{kg}\cdot\text{m}^{-2}$ exercised for 18 months. They attended 65.6% of the prescribed sessions during the first 6 months and 53.7% overall. Both their initial BMI ($r = -0.29$) and gains in BMI ($r = -0.27$) over the course of the study were significantly associated with adherence (61).

Colley *et al.* (62) investigated 16-week adherence to prescribed exercise ($1{,}500\,\text{kcal}\cdot\text{week}^{-1}$) in a sample of obese women under free-living conditions, using heart rate monitors. Twenty five of the 29 women failed to reach the prescribed amount of activity. The average exercise-associated energy expenditure of $768\,\text{kcal}\cdot\text{week}^{-1}$ represented only 51.2% of the amount prescribed. Baseline percentage of body fat was significantly correlated ($r = -0.44$) with exercise-associated energy expenditure. The researchers commented on the implications of this finding:

> To improve the success rate of lifestyle interventions aimed at reducing obesity and its complications, it is important to increase the understanding of why adherence to exercise prescription is so modest. Obese individuals may have different determinants of exercise adherence behavior compared to their leaner counterparts, and it may be helpful to identify these factors in order to successfully promote physical activity (p. 842) (62).

The figures that have been reported in the literature suggest that dropout becomes more severe as the length of interventions is extended. Some representative figures include 26% dropout over 8 weeks (63), 24% over 26 weeks (64) and 40% over 32 weeks (65). However, in longer programs, more than half of overweight or obese participants have been found to drop out. Examples include the 53% dropout over 16 months reported by Donnelly *et al.* (66) and the 58% dropout over 18 months reported by Jacobsen *et al.* (67)

Important caveats

As noted earlier, data on adherence and dropout should be evaluated with caution. One reason is that many participants may not abandon the program entirely but may instead exhibit very low attendance or adherence to the prescription. For example, Wing *et al.* (68) reported that although most of their participants remained in the program (89% over the first 6 months and 76% from 6 to 12 months), attendance of the prescribed group meetings and supervised walks declined from 57% to 16%. Similarly, Shah *et al.* (69) found that five of the 21 (24%) participants in a high-volume exercise prescription quit the 12-week study, but only half of the remaining participants were adhering to the $>2{,}000\,\text{kcal}\cdot\text{week}^{-1}$ exercise prescription.

Another reason to be sceptical of reported dropout figures is that they might have been influenced, to an unknown extent, by parallel behavioural interventions specifically designed to improve adherence and prevent dropout. Although most clinical trials include such intervention components, in an effort to preserve statistical power and increase cost-efficiency, these are not always explicitly described in published reports. This non-disclosure may give researchers and practitioners the false impression that low dropout or high adherence rates were achieved naturally, when in actuality these might have been the result of intensive and costly behavioural interventions.

It is interesting to point out that clinical trials with relatively low dropout included quite vigorous parallel behavioural intervention components. For example, Irwin *et al.* (70) observed a dropout of only 3% over a 12-month period among postmenopausal, overweight and low-active women. However, in their report, the authors described offering individualized attention, behaviour-change education classes, weekly telephone calls and individual meetings at regular intervals to discuss goals and provide feedback on progress, incentives, newsletters and group activities. Jeffery *et al.* (71) observed a dropout rate of only 20% over an 18-month period among overweight participants. This may be attributed to the fact that (i) participants were strongly encouraged to recruit friends or family members to participate in the study with them; (ii) exercise coaches were used, who reviewed exercise progress with each participant individually and provided encouragement, support and problem-solving strategies and (iii) monetary incentives were offered for each week the participants achieved or exceeded the energy-expenditure goal. Church *et al.* (72) found that dropout over a 6-month period was less than 9% among postmenopausal, low-active, overweight or obese women. As the authors noted, to reduce dropout and maintain adherence, they offered a 2-week 'run-in' period, behavioural contracts, consistent support from staff, and hundreds of dollars per participant in financial incentives.

In general, well-funded trials may offer expert support that is typically absent in free-living conditions and most ordinary clinical settings. This creates a considerable degree of artificiality in the adherence and dropout rates that are reported in the literature. Thus, to gain a more realistic perspective, critical readers should turn to more ecologically valid investigations. In one observational study involving individuals who had been referred to an 'exercise on prescription' scheme in the UK for being overweight or obese (with a BMI of 29 to 58 $kg{\cdot}m^{-2}$), the dropout was 27% in the first month and an additional 18% in the second month. After 3 months, 51% of the original sample were still exercising in accordance with the prescription and another 4% were still exercising but below prescribed levels (73). It is interesting to point out that although the study included assessments of a wide range of crucial motivational variables (such as perceived autonomy, self-efficacy, affect, commitment and intention), none of these were significantly different at baseline between participants who dropped out and those who did not. This finding, although preliminary, suggests that perhaps dropout may be influenced primarily by factors inherent to the exercise program rather than by psychological characteristics of the participants. The authors commented that after the first month, during which the participants were shown how to perform the prescribed exercises and how to use the equipment, the exercise advisors turned their attention primarily to new program enrollees, because the influx of new referrals was continuous. Thus, this observational study is a useful reminder of the differences between clinical trials and real-world exercise settings that are subject to logistical constraints.

Clash of paradigms: tortoise versus hare revisited

It is striking that official statements by major American (74) and European (75) scientific and professional organizations detailing the current physical activity and exercise guidelines for weight management contain no mention of the problems of non-adherence and dropout among obese participants. These documents are strictly prescriptive (telling people what they should be doing and why) but contain little or no specific information on how these behavioural goals are to be achieved. Presumably, this is not because the problems of non-adherence and dropout are unknown, inconspicuous or underappreciated but rather because so little is presently known about their causes and possible remedies.

The challenge in designing physical activity and exercise programs for obese individuals lies in maximizing energy expenditure while striking the 'right' balance between intensity and duration. Intensity can only be increased so much before the experience becomes intolerable for participants or the activity becomes unsafe because of the heightened risk of cardiovascular and musculoskeletal adverse events. Likewise, duration can only be prolonged so much before the daily time commitment is seen as too daunting or overwhelming. Identifying the intensities and durations that offer the best compromise is exceedingly difficult, and the inability to devise a universally applicable formula may be one of the main reasons behind the problems of non-adherence and dropout described in the previous sections.

In the continued absence of reliable empirical evidence, two 'schools of thought' have emerged, with strikingly contrasting views on the subject. On one side of the debate, there are experts who advise that 'the training intensity should be moderate (55-65% of maximal aerobic capacity), while the training session duration should be long (>1 hour)' (76) (p. 43). On the other side, there is an increasing number of experts who propose that high-intensity exercise is not only feasible but also necessary, either as a supplement to (77–79) or as a replacement of (80) moderate-intensity activity. For example, the American Heart Association, while recognizing that moderate-intensity activity can yield significant benefits for individuals with type 2 diabetes, notes

> Caution should be applied to prescribing walking, because it can easily be performed at lower intensities. In such cases, the intensity must be brisk and must be

> regarded as an exercise walk rather than simply as a walk. Vigorous intensities should be targeted if tolerated and with consideration of contraindications (81) (p. 3253).

Arguments for the 'tortoise' approach

Experts in the former camp believe that obese individuals are prone to dropout because, as a consequence of their increased body mass and adiposity, exercise becomes exceedingly laborious and tiring. These experts typically advocate a conservative approach to exercise prescription, especially during the critical early stages of participation (82). The assumption behind this approach is that asking people to do 'too much, too soon' will cause them to feel overwhelmed and develop an aversion to exercise. For example, the members of the expert panel who compiled the physical activity-related targets in the Healthy People 2010 program wrote that

> each person should recognize that starting out slowly with an activity that is enjoyable and gradually increasing the frequency and duration of the activity are central to the adoption and maintenance of physical activity behavior (83) (p. 22/4).

Reviewers have similarly noted that 'because compliance to a continuous high-intensity exercise training program is generally lower than lower-intensity exercise intervention regimens, selecting higher intensities during early stages of such interventions is not advised' (84) (p. 930). Consistent with this approach, the American College of Sports Medicine (85) recommends that for obese participants, 'initial exercise training intensity should be moderate,' defined as 40–60% of oxygen uptake or heart rate reserve (p. 320). Progression to intensities over 60% should be attempted only if participants are 'capable and willing' (p. 320).

Preliminary evidence supports the notion that lower intensity (especially early on) may promote adherence. For example, Fogelholm *et al.* (86) studied 82 women with BMIs between 30 and 45 $kg{\cdot}m^{-2}$. After an initial 12-week weight-reduction period, the women were randomly assigned either to a walking group aiming to expend 4.2 $MJ{\cdot}week^{-1}$ or to a walking group aiming to expend 8.4 $MJ{\cdot}week^{-1}$ over a 40-week maintenance period. This was followed by two years of unsupervised follow-up. The women in both walking groups were free to 'trade' duration and intensity as they preferred, as long as they reached their respective energy-expenditure goals. Consistent with the prescription, the women in the 8.4 $MJ{\cdot}week^{-1}$ group were taking more steps per day at the end of the maintenance period. After this, however, they showed a larger decline and were found to take fewer steps than the 4.2 $MJ{\cdot}week^{-1}$ group after 1 year of unsupervised follow-up (the differences had dissipated by the final 2-year follow-up). According to the authors, 'key issues in exercise prescription for obese subjects are moderate intensity, moderate volume, and individuality' (86) (p. 2183).

In another study with similar results, Brock *et al.* (87) examined 113 women who were previously overweight but had undergone a weight-loss program. At the end of the program, the women completed a 5-min treadmill walk at a speed of 3 $mi{\cdot}h^{-1}$, at the conclusion of which they reported their perceived exertion. After a 1-year unsupervised follow-up period, it was found that perceived exertion during the short walk predicted weight regain and (marginally, $p = 0.068$) the amount of physical activity performed, as measured by a 7-day physical activity recall. Each half-unit increase in perceived exertion (on a 15-point scale) during the walk predicted 1-kg weight regain 1 year later.

Arguments for the 'hare' approach

Experts on the opposite side of the debate evaluate the effectiveness of exercise programs by whether they induce meaningful and rapid weight loss, in addition to a host of muscular, cardiovascular and metabolic adaptations characteristic of physical conditioning (77–80). These experts also tend to believe that the main reason why obese individuals abandon physical activity and exercise programs is that they do not experience noticeable changes in their weight early on. This belief is usually accompanied by the suspicion that the aforementioned conservative approach, instead of facilitating adherence, slows down the accrual of visible changes, thus impeding motivation. For example, Winett (88), while acknowledging that current physical activity and exercise guidelines 'represent a reasonable starting point for a predominately sedentary population' (p. 209), lamented guidelines focusing on moderate-intensity activity, stating that they amount to 'a grand waste of time and effort' (pp. 216–217). According to Winett (88), 'because these behavioral prescriptions are at best minimally effective, nonmaintenance becomes a predictable outcome' (p. 209). Other advocates for the application of high-intensity exercise in the domain of public health have echoed this argument, noting, for example, that 'given the lack of discernible outcomes, … nonmaintenance is a rational decision' (89) (p. 434).

Additionally, because, as in the general population, 'lack of time' is presented by obese individuals as the top perceived barrier to physical activity and exercise participation (90), arguments in favour of high-intensity exercise typically revolve around the fact that when the intensity is high, the same level of energy expenditure can be achieved in a shorter amount of time. For example, according to Gibala and McGee (91),

> given that lack of time is such a common barrier to exercise participation, exercise prescription innovations that yield benefits with minimal time commitments represent

a potentially valuable approach to increasing population activity levels and population health (p. 61).

Similarly, commenting on a study comparing the effects of exercise at 60% versus 80% of maximal aerobic capacity among inactive middle-aged men, O'Donovan *et al*. noted that

the high-intensity group was able to expend 1,200 kcal/week with three 30- to 40-min visits to the gym, [whereas], to achieve the same energy expenditure while walking briskly, these men would have to walk for 30 min/day, 7 days/week (92) (p. 1623).

Critical appraisal of the 'hare' approach

At this point, the debate between the proponents of the 'tortoise' and the 'hare' approaches has become heated and polarized (93,94). At first, the high-intensity approach, by promising larger benefits and more time-efficiency, seems like a compelling proposition. However, the value of this approach may be undermined by an issue that is conspicuously underemphasized in writings extolling the benefits of high intensity. Even the proponents of high-intensity training have expressed scepticism about the prospect of applying this approach to large segments of the general population. According to Winett, 'it is granted that it is unlikely that large numbers of people in the immediate future will embark on very systematic, very high intensity interval training' (88) (p. 217). Similarly, Gibala and McGee acknowledged that high-intensity training programs require 'an extremely high level of subject motivation' (91) (p. 62). Therefore, 'given the extreme nature of the exercise, it is doubtful that the general population could safely or practically adopt the model' (p. 62).

Arguments that a high-intensity approach may even facilitate, rather than discourage, adherence compared with a more conservative approach lack empirical support at this stage. No relevant data are available for obese individuals. Gibala and McGee (91) cited an earlier study by King *et al*. (95) as a basis for the claim that 'a low-frequency high-intensity approach to training is associated with greater long-term adherence as compared with a high-frequency low-intensity program' (p. 62). This assertion, however, is unfounded for two reasons. First, the study by King *et al*. (95) compared a high-frequency low-intensity program (five 30-min sessions per week at 60–73% of peak heart rate, performed at the participants' homes) with two (not one) low-frequency high-intensity programs (three 40-min sessions per week at 73–88% of peak heart rate), one performed at the participants' homes and another performed in a group setting under the guidance of an exercise instructor. Adherence was not higher for *both* high-intensity groups (home and group) but only for the home-based exercise group; the adherence of the high-intensity group-based exercise group was, in fact, lower than that of the low-intensity home-based group.

Second, as revealed in another report from the same study (96), heart rate recordings showed that the participants tended to ignore the prescribed intensities, with those in the low-intensity group exercising at the high end of their target range and, conversely, those in the high-intensity groups exercising at the low end of their target range. The researchers interpreted these observations as evidence that formerly low-active adults (50–65 years of age) show 'a preference for moderate-intensity exercise' (96) (p. 1541).

A meta-analysis of studies in the general adult population found a near-zero ($d = 0.02$) standardized mean difference between the effects of moderate and high levels of exercise intensity on adherence, leading the authors to conclude that 'intensity does not appear a critical behavioral adherence factor' (97) (p. 367). However, this result should be interpreted with caution due to (i) the aforementioned inclusion in some studies of parallel intervention components designed to improve adherence and prevent dropout and (ii) the presence of multiple methodological limitations in most studies, including the imprecise quantification of intensity, non-adherence to intensity prescriptions, the use of varied ecological settings and social conditions and the confounding effect of intensity that was externally prescribed (e.g. instructor-guided) versus self-regulated (e.g. in-home exercise or 'lifestyle' physical activity).

Studies that directly compared the effects of different levels of exercise intensity on adherence, and were adequately powered to detect differences, have consistently shown that adherence is lower in higher-intensity programs. For example, in the 6-month study by Perri *et al*. (98), 63% of the participants were overweight or obese, 75% had an aerobic capacity below the 25th percentile and all were initially low-active. Those who were assigned to a higher intensity condition (65–75% of heart rate reserve) showed lower adherence to the exercise prescription (58% vs. 66%), a lower amount of exercise completed (72 vs. 85 $min \cdot week^{-1}$), and a higher rate of exercise-related injuries (19% vs. 8%) than those assigned to a lower intensity condition (45–55% of heart rate reserve). Interestingly, the authors speculated that to some extent, the injuries in the high-intensity condition might have been 'excuses' devised in order to avoid 'an activity that entailed a relatively high degree of subjective discomfort' (98) (p. 457).

Similarly, in an 18-month study of low-active but healthy women, whose BMI averaged over 25 $kg \cdot m^{-2}$, Cox *et al*. (99) found that a moderate-intensity (40–55% of heart rate reserve) exercise group retained 81% of its participants compared with 62% in a high-intensity group (65–80% of heart rate reserve). Throughout the trial, the participants in the moderate-intensity group also completed a higher percentage of prescribed sessions (75.9%, 77.5% and

78.7% at 6, 12 and 18 months, respectively) than the participants in the high-intensity group (71.3%, 63.6% and 72.4%), with the difference reaching statistical significance during the 6- to 12-month period. Furthermore, the participants in the moderate-intensity group tended to exercise at a higher-than-prescribed range and those in the high-intensity group tended to exercise at a lower-than-prescribed range. Because the participants in the high-intensity group completed fewer sessions and at a lower-than-prescribed intensity, ultimately the two groups did not differ significantly in terms of gains in aerobic fitness or in energy expenditure.

Finally, in a 2-year study of men with evidence of cardiovascular disease, 41% of whom had a BMI of 27.8 kg·m^{-2} or higher, Lee *et al.* (100) found that, after the first 6 months, attendance was consistently higher in the low-intensity group (50% of maximal aerobic capacity) than the high-intensity group (85% of maximal aerobic capacity). For the first year, the low-intensity group averaged 64.0%, whereas the high-intensity group averaged 55.5%. A higher BMI was negatively associated with attendance only in the high-intensity group. Furthermore, as was the case in other studies, the participants in the low-intensity group tended to exceed their prescribed heart rate range, whereas those in the high-intensity group tended to fall short.

The debate between proponents of the moderate-intensity and vigorous-intensity approaches is reminiscent of Aesop's fable of the tortoise and the hare. Although the hare is, undoubtedly, capable of running faster and reaching the goal first, it is often the slower, albeit steady and persistent, pace of the tortoise that proves more reliable and, ultimately, effective. One point on which it is easy for most experts to agree is that above all else, the prime objective of physical activity and exercise interventions must be to establish a stable, ideally lifelong, activity habit. A program that is discontinued after a while, no matter how effective it might have been initially, is of limited or no value from a public-health standpoint. To quote Fabricatore and Wadden, 'the optimal exercise prescription is likely that which can be maintained long-term' (101) (p. 365). In other words, the merit of the two approaches that were discussed in this section must be evaluated not solely on the basis of the weight-loss or other health-related benefits that they produce in the short term (all of which are quickly reversible upon drop-out) but rather on the basis of their potential for long-term maintenance (102).

Contrary to popular belief, time may not be the most important barrier

The field of obesity research should place the 'lack of time' that is often reported as the main barrier to physical activity under a critical light. Specifically, it may be time to contemplate whether this is nothing more than a cover for other, underlying factors contributing to physical activity and exercise avoidance.

Time-allocation and media-usage data

There are several reasons why 'lack of time' should be treated with scepticism and not accepted *prima facie* as a real barrier to physical activity. First, extensive research on human decision-making processes supports the principle of 'duration neglect,' (103) according to which, even though people may remember how long a certain episode lasted, this duration has minimal influence on how pleasant or unpleasant the episode is subsequently remembered or the likelihood that people will opt to repeat the experience in the future. Instead, what appears to be influential in forming memories of past episodes is how pleasant or unpleasant people felt during those episodes.

Second, 'lack of time' is inconsistent with objective data. Longitudinal time-use surveys in the USA show that leisure time increased by 6.2 h·week^{-1} for men and by 4.9 h·week^{-1} for women between 1965 and 2003 (104). According to the American Time Use Survey (ATUS) conducted by the Bureau of Labor Statistics of the United States Department of Labor on a sample of 11,400 individuals aged 15 years or older, nearly all Americans (95.3%) participate in leisure, averaging 5.26 h daily (excluding such activities as doing household chores or taking care of children) (105). The evidence indicates that the increase in leisure time is fully (over 100%) accounted for by the increase in the time spent watching television (104). ATUS data show that 79.4% of Americans watch television daily, averaging approximately 3.5 h. The Nielsen Company data (106), which are derived from a combination of objective and observational methodologies, raise the estimated time of live-television watching among American adults (18+ years of age) to 4 h and 36 min·day^{-1}. The discrepancy may be due to the fact that in ATUS, TV viewing is recorded only when it is the focal activity during a particular time period, whereas in the Nielsen Company data, the TV viewing might have occurred concurrently with another activity. Nevertheless, it is interesting to point out that the 4 h and 36 min of live-TV viewing are in addition to 31 min of recorded TV, 9 min of watching video from a digital video disc, 11 min of using a video game console, 1 h and 7 min of browsing the Internet, 1 h and 25 min of smartphone usage, 2 h and 45 min of listening to the radio and 3 min of using a multimedia device. Together, these figures add up to nearly 11 h of media usage per day.

Understanding time-allocation decisions

Data from a 2006 random-digit-dial telephone survey of US residents (N = 3,982; age 15 years or older) help to put the relative time allocation to television watching and physical activity into perspective (107). American women allocated 0.84% of their awake time to exercise and sports, 0.26% to walking, 0.02% to cycling, and 0.04% to physical activity and sports with a child (total of 1.16%). American men allocated 1.36%, 0.22%, 0.07%, and 0.07%, respectively (total of 1.72%). By comparison, women allocated 14.68% of their awake time to watching television and video (13-fold more than physical activity), and men allocated 17.25% (10-fold more than physical activity). While time allocated to TV and video has been on a steady upward trajectory, time allocated to physical activity has changed very little since 1965 (Fig. 1).

Given these data, deconstructing the statement 'I do not have time to exercise' could prove enlightening. Although a complete lack of discretionary time may be a reality for an unfortunate minority, what most adults probably mean by 'I do not have time to exercise' is 'I do not have time *for exercise*' – or '*I prefer* to allocate my leisure time to something else.' Time-use research is based on the fundamental principle, first articulated by Juster (108), that time allocation tends to be proportional to the 'set of satisfactions generated by activities themselves' (p. 333) or, in other words, the pleasure and enjoyment individuals derive from each activity. Once this point is fully appreciated, it places physical activity and exercise guidelines under a fundamentally different light. Researchers and practitioners should not look for ways to make physical activity and exercise shorter. Instead, they should look for ways to make them more pleasant and, therefore, stronger competitors in the fierce contest of leisure time allocation.

Are obese adults more intolerant of time commitment or high intensity?

In the study of obese (BMI 30 to 45 kg·m^{-2}) low-active women (aged 30 to 45 years) by Fogelholm *et al.* (86), the researchers fixed weekly energy expenditure but allowed participants to 'trade' the intensity and duration (e.g. reduce intensity but extend the duration or vice versa). As the investigators reported, 'more subjects requested a reduction, rather than an increase, of walking intensity' (86) (p. 2182). Although the authors did not provide additional details or statistical comparisons, this is an insightful observation because it shows that obese women are willing to accept a longer duration as long as the intensity is kept low. This finding is consistent with other evidence that session duration and frequency, both of which raise the total time commitment, are not consistently associated with adherence (97).

In fact, none of the large randomized trials in which the weekly exercise duration was manipulated have shown differences in adherence or dropout. Perri *et al.* (98) and Duncan *et al.* (109) reported the results of a 6-month investigation of adherence for a large sample of healthy but low-active women and men ($N = 379$, 30–69 years), 63% of whom were overweight or obese (average BMI of 28.6 kg·m^{-2}). The participants were assigned to treatment groups combining moderate (45–55% of heart rate reserve) and high (65–75% of heart rate reserve) intensity, and low (3–4 days·week^{-1}) and high (5–7 days·week^{-1}) frequency. Session duration was constant across groups, at 30 min. Although, as noted earlier, the moderate-intensity groups had higher adherence (65.8%) than the high-intensity groups (57.8%), frequency (which also entailed a lower or higher weekly time commitment) did not make a difference (62.7% for the low-frequency and 60.9% for the high-frequency group). Thus, the authors concluded that 'the prescription for a higher frequency of exercise significantly increased the accumulation of exercise without a deleterious effect on adherence' (98) (p. 456).

Jakicic *et al.* (110) assigned 201 low-active women (21–45 years), with a BMI between 27 and 40 kg·m^{-2}, to one of the four groups: (i) vigorous intensity and high duration (perceived exertion 13–15, 200 min·week^{-1}); (ii) moderate intensity and high duration (perceived exertion 10–12, 300 min·week^{-1}), (iii) moderate intensity and moderate duration (perceived exertion 10–12, 200 min·week^{-1}),

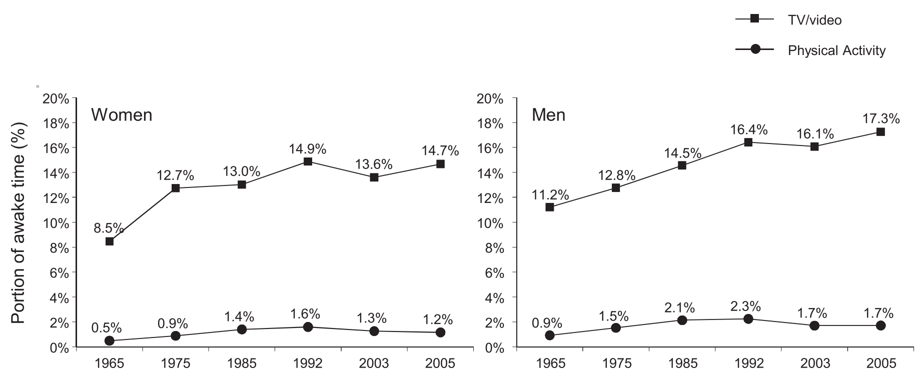

Figure 1 Comparison of time allocation to television/video and physical activity, according to data from the American Heritage Time Use Studies project (as reported in Krueger (107), Table A1, pp. 209–214). 'Physical activity' includes walking, cycling, physical activity and sports and physical activity/sports with child.

and (iv) vigorous intensity and moderate duration (perceived exertion 13–15, 150 min·week^{-1}). Participants were instructed to exercise 5 days·week^{-1} for 12 months. Because exercise was carried out at home and was unsupervised, the participants did not follow the prescriptions closely. Intensities, in particular, converged to within a 1-unit difference on a 15-point scale of perceived exertion. Nevertheless, there were substantial differences in weekly duration, from 144.3 min·week^{-1} for the vigorous intensity and moderate duration group to 210.8 min·week^{-1} for the moderate intensity and high duration group. However, neither dropout nor the number of sessions performed per week over the 12-month period differed significantly between groups. Accordingly, neither weight loss nor gains in cardiorespiratory fitness were different.

Church *et al.* (72) assigned low-active, postmenopausal, overweight or obese women (BMI 25–43 kg·m^{-2}, 45–75 years) to a 4 kcal·kg^{-1}·week^{-1} (N = 155), an 8 kcal·kg^{-1}·week^{-1} (N = 104) or a 12 kcal·kg^{-1}·week^{-1} (N = 103) group. All the women exercised at 50% of their maximal aerobic capacity for 6 months, but the three exercise conditions placed substantially different demands on their time, with the 4 kcal·kg^{-1}·week^{-1} group averaging 72.2 min·week^{-1} over 2.6 sessions, the 8 kcal·kg^{-1}·week^{-1} group averaging 135.8 min·week^{-1} over 2.8 sessions and the 12 kcal·kg^{-1}·week^{-1} group averaging 191.7 min·week^{-1} over 3.1 sessions. Although the adherence data in this study are hard to evaluate because of the multiple methods that were applied to encourage adherence (as described earlier), it is worth noting that adherence did not differ between groups (94.6%, 89.0% and 93.3%) and the 12 kcal·kg^{-1}·week^{-1} group (which required the largest time commitment) had the lowest number of dropouts.

Integrative conceptual framework: the centrality of pleasure

There is presently no hypothesis-generating framework that could serve as the impetus for investigations aimed at deciphering the causes of the extreme avoidance of physical activity and exercise in obesity. To help fill this critical void, we propose that a crucial contributor to the low rates of participation and adherence and the high rates of dropout among obese individuals is that obesity, acting through various mechanisms, makes the experience of physical activity and exercise less pleasant. We further propose that intensity interacts with obesity to exacerbate the unpleasantness of the experience.

Although suggestions that are in line with these proposals have appeared in the literature, displeasure has remained in the subtext instead of being articulated as a crucially important variable. For example, speculating on the reasons why a higher body mass may be associated with lower levels of physical activity, Petersen *et al.* (26) wrote

> It seems likely that a given level of physical activity elicits on average more discomfort, for example as musculoskeletal complaints, dyspnea, exhaustion and sweating, the greater the overweight. This may reduce the motivation for physical activity and eventually reduce the actual physical activity (p. 111).

Similarly, focusing their remarks on children, Kwon *et al.* (45) expressed the view that

> a high level of adiposity may negatively influence [physical activity] participation by children, presumably through psychological, societal, and physical functioning, such as low self-efficacy, poor body image, fear of being teased by peers, low athletic proficiency, and discomfort from heaviness (p. 443).

The ‘hedonic’ conceptual model upon which the present proposals are based is shown in Fig. 2. We propose that the inverse relationship between exercise intensity and adherence is mediated by affective responses (107). This mediational relationship has been shown to apply to the general population, but we hypothesize that the link is particularly strong among obese individuals. A host of physiological (111–113), biomechanical (114,115) and psychological factors (116,117) associated with obesity combine to broaden the range and intensify the severity of aversive somatic symptoms generated by physical activity and exercise (Fig. 3). Examples include (but are not limited to) stronger sensations of dyspnoea (from the physiological domain), heavier impacts on the joints

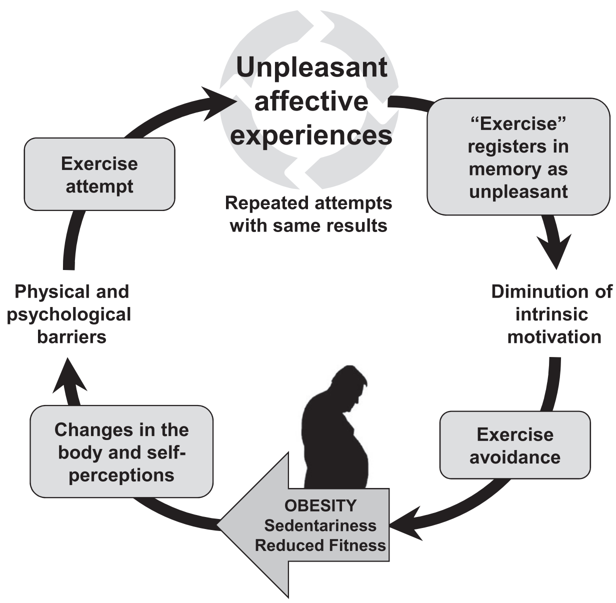

Figure 2 Conceptual model illustrating the ‘vicious cycle’ of obesity and physical inactivity, assigning a central role to experiences of displeasure from exercise.

(from the biomechanical domain), and more profound worry about being negatively evaluated by critical observers (from the psychological domain). In turn, these and many other aversive stimuli contribute to an overall experience that is less pleasant or more unpleasant for obese individuals than for their normal-weight and even their overweight counterparts. Importantly, the higher exercise intensity further exacerbates these differences (116,118). Consequently, obese adults typically describe exercise as being unpleasant, uncomfortable and unenjoyable (119). The fear of aversive bodily cues appears to be an especially salient feature (120).

It should be noted that although the relevant literature focuses mostly on obese adults, similar observations have been reported in obese children. Epstein *et al*. (121) gave children (10–11 years of age) a choice between a highly liked sedentary activity (watching cartoon or comedy videos) or a moderately liked physical activity (riding an exercise bicycle). To gain access to these activities, the children had to earn points by playing a tedious computer game. The investigators kept the 'cost' of exercise constant but varied the 'cost' of the sedentary activity. As the 'cost' of the sedentary activity rose, non-obese (first) and moderately obese children (later) switched their preference to the physical activity. However, 'very obese' children (defined as more than 80% above average weight) never did. The authors concluded that 'activity will not become reinforcing until the very obese become at least moderately obese' (121) (p. 314).

The consequence of repeated experiences of reduced pleasure is that exercise registers in the memory of obese individuals as a negatively laden activity. Over time, the concept of exercise elicits an inherent tendency to avoid this activity, particularly when an individual has the freedom to choose among options considered more pleasant. A growing body of evidence suggests that responding to bouts of exercise with pleasure versus displeasure is significantly and meaningfully associated with physical activity, both concurrently and prospectively (122,123).

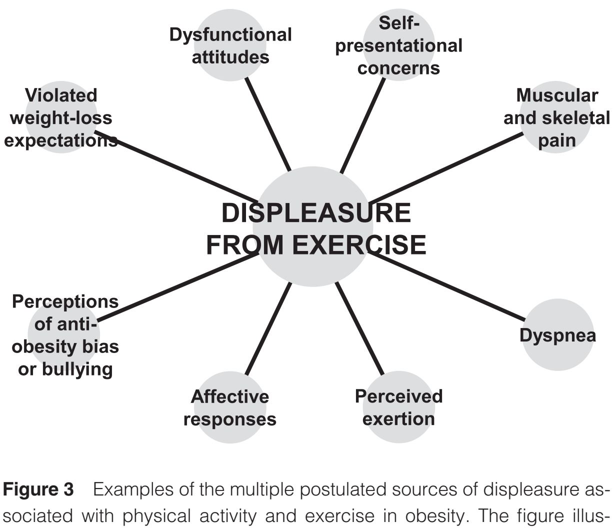

Figure 3 Examples of the multiple postulated sources of displeasure associated with physical activity and exercise in obesity. The figure illustrates how displeasure can serve as the organizing principle in integrating relevant data from exercise physiology (e.g. causes of dyspnoea), biomechanics (e.g. causes of muscular and skeletal pain) and psychology.

Research in the fields of neurology and affective neuroscience has begun to sketch the possible biological mechanisms underpinning the avoidance of a previously unpleasant behaviour. Studies in patients with focal brain damage in areas presumed to be involved in the encoding and experience of affect (i.e. ventromedial prefrontal cortex and amygdala) have provided indications that events are stored in memory in conjunction with the pleasure or displeasure, as well as the configuration of somatic states, which accompanied them. Damasio (124,125) has termed this type of memory trace a 'somatic marker.' Somatic markers are 'a special instance of feelings,' which 'have been connected by learning to predicted future outcomes of certain scenarios' (124) (p. 174). According to the somatic marker hypothesis, when the thought of a certain behaviour is accompanied by a positive somatic marker, it acts as an inducement, increasing the possibility that the individual will choose to engage in that behaviour again. On the contrary, when a behaviour was experienced as unpleasant and has thus been linked to a negative somatic marker, repeating that behaviour or even thinking about repeating that behaviour reenacts the unpleasant state and serves as a deterrent.

A process by which past affective experiences (via a 'somatic marker' or similar mechanism) influence behaviour is presumed to operate within a dual-process decision-making system, combining reflective and impulsive pathways (126), the latter strongly influenced by affect. In the case of physical activity and exercise in obesity, it is possible that these two processes yield conflicting behavioural tendencies (122). While the reflective system may enumerate the health benefits of physical activity, resulting in the desire or intention to be active, past experiences of displeasure may result in a 'valence-laden association … within the impulsive system' (127) (p. 139) resulting in avoidance of this behaviour. Miller and Miller (128) similarly noted an elusive 'disconnect between past exercise behaviors and future promises to exercise' (p. 2) among obese adults. This disconnect is reflected in the seemingly paradoxical co-occurrence of a strong appreciation of the benefits of physical activity and a strong intention for future participation with very low levels of past and present activity. Because of their presumed automaticity and effortlessness, impulsive processes are often relied upon as the default pathway leading to behavioural decisions. Thus, depending on the severity of unpleasant past experiences, it is possible that interventions targeting only rational deliberative processes (e.g. attempting to strengthen the belief of obese individuals in the health benefits of exercise or their appraisal of physical self-efficacy) may prove ineffective. Instead, a parallel effort should be directed toward replacing the unpleasant past experiences with pleasant ones. At this stage, however, no relevant knowledge is available on how to achieve this goal.

Necessity of a research agenda

Obesity is a persistent problem for the industrialized world, with no signs of imminent abatement (129). It is estimated that more than a half billion people globally are obese (130). In this review, we summarized evidence that obese individuals are not only less physically active than the general population, but their rate of compliance with current physical activity for health and weight management is nearly zero. Moreover, obesity is a significant predictor of non-adherence and dropout from exercise programs. A substantial body of evidence indicates that the path from obesity to physical inactivity is stronger and more reliable than the path from physical inactivity to obesity (21,22). Meanwhile, it is striking that physical activity and exercise guidelines for weight management issued by major organizations do not acknowledge the problem of the extreme avoidance of physical activity and exercise among obese individuals, opting instead to follow a purely prescriptive approach.

At this point, there is a nearly absolute lack of information on the causes of the extreme avoidance of physical activity and exercise in obesity. This has resulted in a sense of inevitability among public health professionals; the near-zero rates of compliance with the physical activity and exercise guidelines have come to be considered as unalterable facts. There are presently no evidence-based interventions that can reliably and sustainably increase the level of physical activity among obese adults or improve their adherence to exercise. Consequently, available guideline documents offer no solution other than recommending a slow start and a cautious progression. Consequently, global practice norms in gymnasia and bariatric clinical settings remain not only stagnant but also possibly vulnerable to transitory trends of unproven effectiveness and sustainability.

We call for the urgent initiation of a research agenda focused on pinpointing the causes of the extreme avoidance of physical activity and exercise in obesity and developing evidence-based approaches for addressing this problem. To facilitate this process and the establishment of a cohesive knowledge base, we propose the construct of pleasure /displeasure as the central element that characterizes the experience of physical activity and exercise for obese individuals. While this call does not imply that research on cognitive constructs and deliberative processes (e.g. perceived benefits, self-efficacy and perceived social support) is superfluous or must cease, we do submit that the present dearth of knowledge on the contributors to the displeasure associated with physical activity and exercise in obesity is especially problematic.

Although pleasure may be seen as a psychological construct, and therefore strictly within the scope of psychological research, in the research agenda we are envisioning, the study of pleasure should be integrated into all lines of research focusing on obesity-related exercise and physical activity. For example, exercise interventions with obese adults, besides focusing on energy balance and weight loss, should incorporate components aiming to understand the causes of non-adherence to and dropout from the prescribed exercise regimens. It is remarkable that despite the fact that dozens such interventions have been conducted, the experience of exercise for obese individuals remains so poorly understood. Similarly, biomechanical studies on how obesity influences the kinematics of gait should highlight the implications for discomfort, overexertion or joint pain and, by extension, for the potential for avoidance or dropout. Likewise, physiological research on proposed exercise methods, such as high-intensity interval training, should address not only the implications for metabolic rate or glucose regulation but also for pleasure, enjoyment and adherence.

Conflict of interest statement

All authors have completed ICMJE COI forms and have no conflicts to report.

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