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VIEWPOINT

Is high-intensity exercise better than moderate-intensity exercise for weight loss?

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Motivation

Abstract This viewpoint debates the state-of-the-art research focusing on the optimal intensity of the exercise programs for inducing a sustained weight or fat-mass loss in overweight/obese people. In our demanding society, the most attractive messages in the popular press are those promising the best results in a short time. This might explain the emphasis given by media to those scientific articles that report the efficacy on weight loss of exercise programs by their shorter duration and higher intensity.

However, in the literature on overweight or obese people, there is little conclusive evidence for more favorable effects with high-intensity training than with continuous moderate-intensity exercise on body weight or fat mass loss. Since both exercise protocols have been demonstrated as useful to reduce body weight, the decision on the intensity of exercise prescription should be individualized and based on outcomes different from fat or weight loss. In this regard, there are pro and contra arguments for the prescription of high-intensity aerobic exercise in obese people. Among the pro arguments, is the demonstration that, in several studies, high-intensity training appears to induce superior improvements in aerobic fitness. Among the contra arguments to prescribe high-intensity exercise is the demonstration that prescribing a higher-intensity exercise decreases adherence and results in the completion of less exercise. Thus, a successful exercise program should be proposed at a moderate intensity and a low perceived effort because obese subjects who have low self-efficacy, poor mood status, and are not familiar with high-intensity workouts could easily drop out.

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Introduction

The pandemic distribution of being overweight and obesity has resulted in the growth in interest by the media in communicating different nutritional and exercise strategies to the general population to achieve weight loss. Certainly, regular exercise is an effective way to prevent weight gain and promote weight loss [1]. However, in our demanding society, the most attractive messages in the popular press are those promising the best results in a short time. This might explain the emphasis given by media to those scientific articles that report the efficacy on weight loss of exercise programs by their shorter duration and higher intensity. This opinion view debates the state-of-the-art research focusing on the optimal intensity of the exercise programs for inducing a sustained weight or fat-mass loss in overweight/obese people.

Theoretically, an optimal exercise program for weight loss should be feasible and attractive for patients, lead to tangible health outcomes, and consequently be adopted by patients as definite lifestyle behavior. According to Bandura's social learning theory, the major determinants that influence a person in adopting a new behavior are consciousness and self-esteem [2]. Thus, a sedentary obese person before starting a regular exercise program should be convinced that the positive results outweigh his/her negative expectations and that he/she will be able to perform the exercise [3]. Qualitative analysis of obese patients' views on barriers to start a lifestyle intervention program, in which exercise represents the core strategy, shows that the decision-making process is strongly influenced by the expectations of significant weight loss and other health outcomes that are counterbalanced by the views of exercise as a sacrifice, a time demanding, difficult, or impossible task [4].

In the last two decades, a growing number of studies have tested the efficacy of exercise programs with different structures regarding the type (aerobic, resistance, and mixed), the weekly frequency, the volume, the intensity (moderate or high), and the duration. Based on these results, many national and international health organizations or scientific societies have published position statements and guidelines on the promotion of physical activity or the use of exercise as a therapeutic tool for obesity, diabetes, and prevention of cardiovascular diseases that take into account the expected health outcomes and the patients' compliance [5–11]. In order to better clarify the matter of the present opinion view, it is necessary to clearly distinguish the terms physical activity and exercise, sometimes inaccurately or interchangeably used, and to share a definition of exercise intensity (Table 1). Physical activity can be defined as any bodily movement, produced by skeletal muscles, that results in energy expenditure beyond resting expenditure [12]. Exercise is a subset of physical activity that is planned, structured, repetitive, and purposeful in the sense that improvement or maintenance of physical fitness is the objective [12]. A clear differentiation between moderate- and high-intensity exercises is also relevant to discuss the results of the exercise studies performed in obese populations because in the methodological sections of some of these studies the range of the exercise effort is used to define moderate- or high-intensity exercise is sometimes overlapping and not well standardized. This opinion view adopts the definition of the American College of Sports Medicine, which states that the intensity for moderate-intensity exercise ranges between 40% and 60% of maximal capacity, whereas that for high-intensity exercise is above 65% of the maximal capacity [12]. However, it should be outlined that in most of studies in which volunteers performed exercise at high-intensity, the intensity prescribed was above 80–85% of peak power output or maximal velocity. Below 80% of peak power output, we should not consider generally this as high-intensity training.

Intensity of aerobic and resistance exercises and weight loss

There is enough evidence that suggests that aerobic and resistance exercises are beneficial for patients with obesity and related morbidities. For this reason, all scientific guidelines recommend that at least 150 min per week of moderate aerobic exercise should be combined with three weekly sessions of resistance exercise to increase muscle strength [5–11]. However, if we limit the discussion to the outcome "weight loss" or "fat mass loss", only aerobic exercise has solid evidence supporting its efficacy in the literature; whereas conflicting data regarding the effects of resistance exercise have been produced [13]. Very recently, Willis et al. specifically examined the effects of the type of exercise on body mass and fat mass in overweight adults and, in a randomized approach, compared similar amounts of aerobic and resistance training and a combination of the two [13]. Primary outcomes included total body mass, fat mass and lean body mass [13]. The aerobic training and aerobic/resistance training groups reduced the total body mass (TBM, aerobic -1.8 ± 3.0, aerobic/resistance -1.6 ± 3.1 kg, mean ± SD) and fat mass (FM, aerobic -1.7 ± 2.7, aerobic/resistance -2.4 ± 3.0 kg) more than that of the resistance training (TBM 0.8 ± 2.3, FM -0.3 ± 2.1 kg, $p < 0.05$), but they were not different from each other. Resistance training and aerobic/resistance training increased the lean body mass more than that of the aerobic training ($p < 0.05$). Thus, while requiring double the time commitment, a program of combined aerobic/resistance training did not result in significantly more fat mass or body mass reductions over aerobic training alone. The authors conclude that in balancing time commitments against health benefits, it appears that aerobic training is the optimal mode of exercise for reducing fat mass and body mass while a program including resistance training is needed for increasing lean mass in middle-aged and overweight/obese individuals [13]. In my opinion, these results do not mean that resistance training should be reduced because people lose muscle mass when they grow older, and stronger muscles can prevent possible injuries caused by aerobic exercise. However, owing to the poor efficacy of resistance training on fat mass loss, the following discussion will be limited to the effects of high-intensity compared to moderate-intensity aerobic exercise on weight loss.

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Table 1 Definitions of physical activity, exercise, and of moderate or high exercise intensities.

Physical activity can be defined as any bodily movement, produced by skeletal muscles, that results in energy expenditure beyond resting expenditure.
Exercise is a subset of physical activity that is planned, structured, repetitive, and purposeful in the sense that improvement or maintenance of physical fitness is the objective.
Moderate-intensity exercise ranges between 40% and 60% of maximal capacity.
High-intensity exercise is above 65% of the maximal capacity.
Generally, high intensity exercise is considered that performed over 80% of maximal power output.

Weight loss and aerobic exercise intensity

High-intensity exercise (above 80–85% of peak power output) can be performed only for few minutes. For this reason, it is proposed in practice as high-intensity interval training (HIIT). HIIT involves exercising repeatedly at a high intensity for 30 s to several minutes, separated by 1–5 min of recovery (either no- or low-intensity exercise) [14]. A particular HIIT intervention used in studies is the Wingate protocol developed in the 1970s [15]. This involves 30 s of cycling at maximum effort (at an intensity of over 90% of the maximal oxygen uptake, also known as 90% of $VO_{2\ max}$) separated by 4 min of recovery, repeated 4–6 times per session, with three sessions per week. Wingate tests require a specialized cycle ergometer and the 'all-out' maximal effort necessitates an extremely high level of subject motivation. The bout of exercise is until exhaustion, and the principle of HIIT is spent a long time at a high percentage of peak VO_2, as proposed for athletes by Dupont et al. [16], Millet et al. [17]. Therefore, it may not be safe or practical to implement this form of training in the general overweight or obese population. Two weeks of HIIT using Wingate protocol or a more practical model of low-volume HIIT [18] was a sufficient stimulus to increase skeletal muscle oxidative capacity and GLUT4 protein content. At present, no data on the effects on body weight or fat mass in response to long-term use of HIIT in obese people has been published. Tremblay and colleagues, in 1994, were the first to explore the impact of exercise intensity by using a 15–20-week ergocycle exercise program in two groups of non-obese young adults on body fatness and skeletal muscle metabolism [19]. Body weight did not change after the moderate or HIIT period, however, a significantly greater reduction in subcutaneous fat (measured by skin folds) was observed in the HIIT group [19]. More recently, several studies have examined the effects of HIIT for a period of training ranging from 12 to 24 weeks [20] and demonstrated significant reductions of weight or fat mass [21–24]. However, these studies were not designed to compare the efficacy of HIIT versus moderate aerobic-exercise intensity on weight or fat mass loss in obese subjects as the major outcome. Trapp et al. compared the effects of HIIT versus steady-state exercise, but, in a group of young healthy women with a BMI of 23.2 ± 2.0 kg/m^2 and demonstrated that HIIT exercise induced a significant reduction in total body mass, fat mass, and trunk fat whereas steady-state exercise had no effect [21]. Tiønna et al. examined the effects of moderate- versus high-intensity exercise with regard to variables associated with cardiovascular function and prognosis in 32 patients with the metabolic syndrome [23]. The two exercise programs were equally effective at lowering the mean arterial blood pressure and reducing fat mass and body weight (-2.3 and -3.6 kg in high-intensity exercise and continuous moderate-intensity exercise, respectively) [23].

Thus, at present, it has not been demonstrated that in overweight or obese people HIIT is better than moderate-intensity exercise in inducing weight loss. In 2003, Jakicic and coworkers published the results of a randomized trial that compared the effects of four exercise-training programs that differed in terms of intensity and duration, in sedentary and overweight women with body weight, cardiorespiratory fitness, and exercise participation as the main outcome measures [25]. Participants were randomly assigned to 1 of 4 exercise groups (vigorous intensity/high duration; moderate intensity/high duration; moderate intensity/moderate duration; or vigorous intensity/moderate duration) based on estimated energy expenditure (1000 kcal/week versus 2000 kcal/week) and exercise intensity (moderate versus vigorous). Vigorous exercise was performed on treadmills and prescribed by using the Borg's scale (13–15/20 of rate of perceived exertion) and age-predicted maximal heart rate. The vigorous-exercise protocol used by Jakicic and coworkers was at about 75% of the maximal capacity and thus, less demanding in comparison to the maximal effort required by HIIT. The results of this well-conducted randomized study demonstrated that significant weight loss and improved cardiorespiratory fitness were achieved through the combination of exercise and diet during 12 months, although no differences were found based on different exercise durations and intensities [25]. This conclusion has been subsequently confirmed by Chambliss who using a quite similar study design demonstrated that sedentary overweight women lost weight and improved cardiorespiratory fitness in a year-long combined dietary and exercise regimen and that the duration of exercise (at least 150 min/week of walking) was more important than vigorous versus moderate intensity in achieving these goals [26]. Finally, in 2005, Duncan et al. compared the effects of walking at different intensities on cardiorespiratory fitness and lipid profile in sedentary adults [27]. The four different exercise conditions: moderate intensity–low frequency, moderate intensity–high frequency, hard intensity–low frequency, and hard intensity–high frequency did not differentially affect body weight ($p = 0.78$), which was not an outcome of this randomized study [27].

At present, based on the limited number of available studies, we can conclude that there is no convincing

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evidence of the superiority of high-intensity exercise in inducing weight loss in an overweight or obese population.

Exercise intensity and substrate utilization

The recent availability of stable isotope techniques and of nuclear magnetic resonance spectroscopy, along with the classic studies made with indirect calorimetry and tissue biopsy, has permitted to establish the contribution of glucose and FFA to ATP production in exercising humans [28].

A main conclusion that can be drawn from these studies is that energy flux is determined by relative exercise intensity [29]. At rest, most of energy (about 60%) for non-contracting skeletal muscle derives from lipid oxidation [29]. During moderate intensity exercise (40–50% of $VO_{2\ max}$), both fuels lipid and glucose are equally oxidized by working muscles. At greater exercise intensities carbohydrate become the primary energy source whereas FFA flux and oxidation are inversely related to exercise intensity. The rate of FFA utilization declines below the basal values at high (>80%) exercise intensities; under these conditions the energy supply of working skeletal muscle becomes strictly dependent on muscle glycogen and blood glucose [29,30]. Muscle glycogen depleted because of high intensity exercise must be restored in the hours following the exercise session and this elicits greater lipid oxidation rates in the 24 h period following intense exercise in comparison to moderate exercise [28].

The different rates and types of substrate utilization during moderate or high intensity exercise have clear implications for exercise mediated fat loss. In theory, high intensity exercise allows patients/subjects to lose more fat mass than moderate intensity exercise, considering that it induces increased oxidation of lipids after the session. In addition, the principal interest of high intensity exercise is the possibility to maintain high-intensity exercise for far longer periods than during continuous exercise. Therefore, high intensity exercise elicits a greater training stimulus, which further increase the total active caloric expenditure [3]. On the other hand, several obese persons refer that they do not feel confident with high rates of perceived exertion and naturally prefer to exercise at moderate intensities [4]. For these patients the optimal strategy to promote fat loss are open air group exercise sessions at moderate intensity but for many hours, using socialization and pleasant surroundings as elements for long term adherence. Under these conditions trained obese subjects will predominantly use lipid oxidation for their physical activity [28].

Strenuous exercise and appetite

Exercise-induced weight loss is the result of the balance between the effects of exercise on energy expenditure and appetite. Exercise is often considered as an unsuccessful form of weight control because of the possible concomitant compensation of food intake. However, this belief is not supported by several studies that show that exercise induces a brief suppression of hunger [31–33], even if this does not necessarily translate into a decrease in subsequent food intake [31,32]. Post-exercise energy intake might also be influenced by exercise intensity [34]. In this regard, scientific literature reports conflicting results. Some studies have demonstrated that high-intensity exercise favors a negative energy balance to a greater extent than does low-intensity exercise [34,35]. Another study performed in normal weight women reached the opposite conclusion that high-intensity exercise increases energy intake [36]. In 1990, Kissileff and coworkers compared post-exercise food intake in a small number of obese ($n = 9$) or non-obese ($n = 9$) women after strenuous or moderate exercise [35]. Obese women ingested the same amount of the liquid test meal after moderate or strenuous exercise in contrast to non-obese women who ingested fewer calories after intense exercise [35]. It is hypothesized that the absence of an increase in energy intake when increasing expenditure in obese subjects is based on their excess energy stores in the form of adipose tissue [35].

Thus, according to this limited experience high-intensity exercise should not significantly modulate hunger or appetite in obese people and favor weight loss through a better control of food intake.

Conclusions

In the literature on overweight or obese people, there is little conclusive evidence for more favorable effects with high-intensity training than with continuous moderate-intensity exercise on body weight or fat mass loss. Since both exercise protocols have been demonstrated as useful to reduce body weight, the decision on the intensity of exercise prescription should be individualized and based on outcomes different from fat or weight loss. In this regard, there are pro and contra arguments for the prescription of high-intensity aerobic exercise in obese people. Among the pro arguments for high-intensity aerobic exercise, is the demonstration that, in several studies, high-intensity training appears to induce superior improvements in aerobic fitness and similar improvements in some cardio-metabolic risk factors in comparison to continuous moderate-intensity exercise when performed by healthy subjects or clinical patients for at least 8–12 weeks [37]. Certainly, a greater improvement in cardio-respiratory fitness is a valuable outcome because the results of several prospective studies have shown a significant inverse relationship between cardio-respiratory fitness and all causes of risk of death in obese or type 2 diabetes subjects [38,39]. In addition, for some patients introducing sub-maximal short repeats in the exercise schedule might represent a mental stimulus that mitigates the boring aspects of a constant exercise session and augments the long-term adherence to regular exercise [40]. The game-like nature of interval training makes it an attractive alternative [41]. In theory, it could be incorporated into every phase of rehabilitation adjusted according to each subject's medical history and functional status. Among the contra arguments to prescribe high-intensity exercise is the consideration that sedentary and obese people usually view exercise as a "sacrifice" or "something impossible" [4]. Thus, a successful exercise program should be proposed at a moderate intensity and a low perceived effort because obese subjects who have low self-efficacy, poor mood

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status, and are not familiar with high-intensity workouts could easily drop out [42]. Perri et al. have already shown that prescribing a higher frequency of exercise to sedentary adults increases the accumulation of exercise without a decline in adherence, whereas prescribing a higher-intensity exercise decreases adherence and results in the completion of less exercise [43]. Furthermore, before prescribing high-intensity exercise the potential risk of injuries or acute cardiovascular events should also be carefully considered. In this regard, the physiological effects of exercise on joints, tendons, and the cardiovascular system at sub-maximal or maximal rates raise some concerns for the specific target of the obese population. However, it should be noticed that, a systematic review demonstrated no cardiac or other potentially lethal events across seven HIIT studies in patients with coronary artery disease suggesting that HIIT is safe when performed in a controlled environment, although prescription of such exercise must be considered on an individual patient basis [44].

Our advice, based on the personal experience with obese people attending our Healthy Lifestyle Institute, is to begin the indoor exercise program at a moderate intensity (50% of maximal aerobic capacity) and increase by 5% of exercise intensity every six training sessions to up to 65% of the maximal capacity [45]. After at least three months of training, once patients have significantly improved their aerobic capacity and skills, in selected and motivated cases, it is better to insert short repeats of interval training at sub-maximal intensity, which is monitored and supervised by an exercise physiologist.

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