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Research Article

Intermittent Exercise is Beneficial to Obese Women Independently of Obesity Class

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Abstract

Introduction: Physical exercise is recommended to tackle obesity. However, obese individuals often do not closely adhere to training programmes. Intermittent exercise might be a means to improve compliance, although little is known about the effects of this type of exercise according to obesity class.

Objective: The aim of this study was to examine the effects of an intermittent exercise programme on obese women according to their obesity class.

Method: Fifty-three obese and sedentary women were divided into two groups: a training group (moderate obesity, n = 4; severe obesity, n = 14; morbid obesity, n = 13) and a control group (moderate obesity, n = 5; severe obesity, n = 9; morbid obesity, n = 8). The training group performed 32 min of intermittent exercise 3 days per week for 10 weeks, whereas the control group was untrained. Before and after the intervention period, anthropometric and physiological data were collected and 6-min walking test performance was assessed for between-group comparisons.

Results: The main results showed that after the programme, the training group had significantly reduced body mass (103.9 ± 14.6 *vs* 101.1 ± 14.4 Kg), body mass index (39.5 ± 4.8 *vs* 38.5 ± 4.8 $Kg.m^{-2}$), resting heart rate (75 ± 8 *vs* 70 ± 7 bpm), and systolic blood pressure (135 ± 13 *vs* 130 ± 10 mmHg). Moreover, the maximal 6-min walking distance after the intervention period was significantly increased in the training group (389 ± 63 *vs* 436 ± 61 m). However, these beneficial effects did not depend on obesity class.

Conclusion: A training programme based on intermittent exercise has beneficial effects on anthropometric and physiological measures and 6-min walking test performance. However, these effects do not depend on the obesity class.

Key words: Physical Exercise; Interval Training; Moderate; Severe and Morbid obesity

Introduction

Regular physical exercise is widely acknowledged to have potential health benefits [1]. The evidence suggests that it reduces the risk of cardiovascular diseases, cancers and even metabolic diseases like obesity [2]Numerous studies have thus attempted to identify the optimal exercise strategy to tackle the obesity epidemic. Based on these studies, [3]. Revised the previous recommendations of the American College of Sports Medicine [4]. And proposed at least 150 to 250 min.wk^{-1} of moderate-intensity exercise to provide and maintain modest weight loss. However, to obtain clinically significant weight loss, a greater exercise volume is needed (≥ 250 min.wk^{-1}). Yet the literature indicates that the long-term beneficial effects of exercise are often disappointing, mainly because of poor patient adherence to exercise programmes. Indeed, overweight individuals who begin a training programme rarely continue it or only participate on an irregular basis, and the exercise volume consequently remains low [5,6].

As suggested by [7], the poor adherence to physical exercise programmes might be explained by the monotony of the prescribed exercises. The exercise prescribed in rehabilitation centres is often performed in continuous fashion (*i.e.* pedalling continuously at the same exercise intensity), which may quickly become monotonous and thus is not always very motivating. To limit this phenomenon and increase the adherence to exercise programmes, other types of exercise, like intermittent exercise (*i.e.* during which the exercise intensity varies regularly) may be more appropriate. [7] reported that the obese women in their study perceived intermittent exercise as less difficult than the continuous exercise (a perception that may improve exercise adherence), and the intermittent exercise programme produced beneficial effects on obesity. However, the authors did not study the beneficial effects of intermittent exercise according to obesity class.

Recently, a meta-analysis [8] examined, among other factors, the impact of obesity severity on the effectiveness of lifestyle interventions (in which physical exercise was proposed) from 11 studies. Seven of the studies found that the obese individuals with a higher initial body mass index (BMI) reduced their BMI significantly more after the interventions compared with those individuals with lower BMI. However, other studies (n = 4) found no difference or no association between baseline obesity class and weight loss. These discrepant results preclude definitive conclusions about the effects of obesity class on the effectiveness of lifestyle interventions. The authors of the meta-analysis[8] thus suggested further studies to better identify responders and non-responders in order to better adapt the physical exercises included in intervention programmes. To our knowledge, no study has yet compared the effects of intermittent exercise programmes according to obesity class. Therefore, the aim of the present study was to examine the effects of an intermittent exercise programme on obese women according to their obesity class.

Materials and Methods

Participants

Fifty-three obese and sedentary women volunteered to take part in this study. From this sample, two groups were composed: a training group (n = 31) and a control group (n = 22). All participants signed informed consent forms concerning the investigation purposes and procedures. Moreover, this study was approved by the ethics committee for participants' protection in clinical research and by the technical committee for clinical research of the hospital.

Procedure

During a preliminary session, height was measured in the morning using a wall stadiometer (model 222, Seca®, Hamburg, Germany) with the patient scantily dressed and without shoes. In the same conditions, body mass and the percentage of body fat were assessed with a calibrated bioelectronical impedance scale (TBF 543, Tanita®, Tokyo, Japan). From these data, BMI was calculated as body mass (Kg) divided by the square of height (m). From the BMI, participants were determined to be moderately (*i.e.* $30 \leq BMI < 35$ Kg.m^{-2}), severely (*i.e.* $35 \leq BMI < 40$ Kg.m^{-2}), or morbidly (*i.e.* $BMI \geq 40$ Kg.m^{-2}) obese.

The waist-to-hip ratio (WHR) was used as an index of abdominal fat distribution. Waist circumference was measured at the midpoint between the lower part of the ribcage and the iliac crest, with the patient standing and breathing normally. Hip circumference was measured with the same tape at the level of the greater trochanter. The average of three readings, obtained using a non-elastic measuring tape, was taken as the measurement of each circumference.

Resting systolic and diastolic blood pressures (*i.e.* SBP and DBP, respectively) were determined from the left arm of the seated participant after 5 min of resting, using an electronic device (BP 3AC1-1, Microlife®, Berneck, Switzerland). Three separate measurements were taken at 1-min intervals, and the mean of these three readings was recorded.

Resting heart rate (HR) represented the minimal value of HR measured in the last 30 s after a seated 5-min rest period, using a cardiotachometer (Accurex$^+$, Polar®, Kempele, Finland).

The maximal distance performed during the 6-min walking test was measured in a vacant corridor in the hospital basement.

During another session, all participants performed a graded exercise test on an electromagnetically braked cycle ergometer (Ergometrics 800, Ergoline®, Blitz, Germany). During this exercise test, the initial power output was set at 10 W and was increased by 10 $W.min^{-1}$ until volitional exhaustion (pedalling rate < 60 rpm). HR and alveolar gas exchanges were continuously recorded with a 12-lead electrocardiogram (Medcard, Medisoft®, Sorinnes, Belgium) and an ergospirometry system (Ergocard, Medisoft®, Sorinnes, Belgium), respectively. The ventilatory threshold was identified using the v-slope method of [9]. This reference method divides the carbon dioxide production *vs* oxygen uptake curve into two regions, each of which is fitted by linear regression. The intersection between the first two regression lines is considered as the ventilatory threshold. At the ventilatory threshold, the power output was measured.

The participants were then assigned to a training group or control group. Whatever the group, all participants were instructed to maintain their lifestyle and usual diet throughout the study. The training group women followed a 10-week training programme, which consisted of three sessions of intermittent exercise per week on an electromagnetically braked cycle ergometer (Ergometrics 800, Ergoline®, Blitz, Germany). During the intermittent exercise, the women alternated 80 and 120% power output at the ventilatory threshold every 2 min for 32 min. Each session began with a 4-min warm-up and ended with a 3-min cool-down. During these periods, the exercise intensity increased or decreased linearly. At the tenth and twentieth sessions, the exercise intensity could be readjusted (*i.e.* increase of 10% power output when the HR at the ventilatory threshold was decreased by 5 bpm).

As at baseline, anthropometric and physiological data were collected after the intervention period in each group. These included body mass, the percentage of body fat, BMI, WHR, resting SBP and DBP, resting HR and maximal 6-min walking distance.

Statistical analysis

A two-way (2 groups × 3 obesity classes) ANOVA was conducted to check that the groups were homogenous in age and height before the intervention.

A two-way (2 groups × 3 obesity classes) ANOVA for repeated measures (before *vs* after intervention) was performed to examine the intervention effect. If significant differences were obtained, a Tuckey *post-hoc* test was conducted.

Statistical significance was set at $P < 0.05$ and all analyses were performed with Statistica software (version 10.0, Statsoft®, Tulsa, USA).

Results

The training group included four women with moderate obesity, 14 with severe obesity and 13 with morbid obesity. In the control group, five women were moderately obese, nine were severely obese, and eight were considered as morbidly obese.

Age and height were not significantly different between groups at baseline, independently of obesity class ($P > 0.05$, Table 1).

The results revealed significant differences in body and fat mass between all obesity classes ($P < 0.05$, Table 1).

After the intervention period, body mass (103.9 ± 14.6 *vs* 101.1 ± 14.4 Kg before and after the training programme) and BMI (39.5 ± 4.8 *vs* 38.5 ± 4.8 $Kg.m^{-2}$ before and after the training programme) were significantly decreased only in the training group ($P = 0.002$, Table 1).

Similarly, resting HR (75 ± 8 *vs* 70 ± 7 bpm before and after the training programme, $P = 0.001$, Table 1) and SBP (135 ± 13 *vs* 130 ± 10 mmHg before and after the training programme, $P = 0.001$, Table 1) were significantly reduced after the intervention period in the training group.

Resting DBP (77 ± 9 *vs* 82 ± 5 mmHg before and after the training programme, $P = 0.044$, Table 1) was significantly increased after the intervention period in the control group.

The maximal distance covered during the 6-min walking test after the intervention period was significantly increased only in the training group (389 ± 63 *vs* 436 ± 61 m before and after the training programme, $P < 0.001$, Table 1).

Discussion

The aim of the present study was to examine the effect of an intermittent exercise programme on obese women, according to their obesity class. The main results show that this type of programme has beneficial effects on several anthropometric and physiological measures and 6-min walking test performance. However, these beneficial effects do not depend on obesity class.

According to several studies [10, 7,11], intermittent exercise programmes significantly decrease body mass (-2.7%) and BMI (-2.5%). Therefore, these programmes should be considered as a potential therapeutic and non-pharmacological strategy to combat obesity. However, to enhance the beneficial effects (*i.e.* greater reduction in body mass and BMI), nutritional therapy (*i.e.* a caloric restriction) should be combined with regular exercise to produce a greater energy imbalance in favor of reduced body mass and thus BMI.

Body fat loss especially at the visceral level may be an important benefit of exercise, as reduction in abdominal obesity leads to significant improvement in metabolic indices [12]. Moreover, an excess of visceral fat (measured from WRH) is a major predictor of cardiovascular disease and coronary heart disease mortality [13]. Thus, decreasing abdominal obesity is essential in obese individuals. Nevertheless, our study revealed a

Table 1. Anthropometric and physiological data and 6-min walking test performance (mean and standard deviation) before and after the intervention period in training and control groups, according to obesity class.

	Moment	Training group				Control group			
		moderate obesity (n = 4)	severe obesity (n = 14)	morbid obesity (n = 13)	all obesity class (n = 31)	moderate obesity (n = 5)	severe obesity (n = 9)	morbid obesity (n = 8)	all obesity class (n = 22)
Age (y)	before	51.5 ± 5.4	49.1 ± 10.6	46.0 ± 10.8	48.1 ± 10.1	57.6 ± 7.5	52.4 ± 6.3	51.0 ± 7.9	53.1 ± 7.3
Height (m)	before	1.62 ± 0.04	1.62 ± 0.09	1.63 ± 0.07	1.62 ± 0.07	1.63 ± 0.04	1.62 ± 0.04	1.60 ± 0.06	1.61 ± 0.05
Body mass (Kg)	before	85.1 ± 5.9	99.7 ± 13.0	114.2 ± 9.3	103.9 ± 14.6	88.0 ± 7.1	98.9 ± 7.6	109.0 ± 13.8	100.1 ± 12.7
	after	83.4 ± 3.9	96.2 ± 11.4	112.4 ± 10.0	101.1 ± 14.4	90.1 ± 8.9	101.8 ± 8.6	111.5 ± 18.1	102.3 ± 14.7
Body mass index ($Kg.m^{-2}$)	before	32.6 ± 1.4	38.0 ± 1.7	43.2 ± 4.6	39.5 ± 4.8	33.2 ± 1.7	37.7 ± 1.6	42.7 ± 3.3	38.5 ± 4.3
	after	32.0 ± 1.6	37.1 ± 1.5	42.2 ± 4.7	38.5 ± 4.8	34.0 ± 2.6	38.4 ± 1.8	43.3 ± 4.8	39.0 ± 4.8
Body fat (%)	before	44.2 ± 2.3	46.3 ± 2.5	49.6 ± 2.4	47.4 ± 3.1	44.1 ± 2.9	44.8 ± 2.9	49.1 ± 1.8	46.1 ± 3.3
	after	41.9 ± 2.5	44.4 ± 4.0	48.9 ± 3.6	45.9 ± 4.5	44.9 ± 4.2	46.0 ± 2.7	49.9 ± 3.2	47.1 ± 3.8
Waist-to-hip ratio	before	0.97 ± 0.07	0.96 ± 0.05	0.99 ± 0.11	0.97 ± 0.08	0.95 ± 0.05	0.91 ± 0.10	0.95 ± 0.13	0.93 ± 0.10
	after	0.94 ± 0.05	0.96 ± 0.08	0.99 ± 0.10	0.97 ± 0.09	0.94 ± 0.06	0.98 ± 0.10	0.94 ± 0.13	0.96 ± 0.10
Resting heart rate (bpm)	before	74 ± 5	75 ± 9	76 ± 9	75 ± 8	71 ± 11	76 ± 11	72 ± 12	74 ± 11
	after	69 ± 3	70 ± 8	70 ± 8	70 ± 7	72 ± 11	75 ± 10	77 ± 13	75 ± 11
Systolic blod pressure (mmHg)	before	135 ± 11	136 ± 15	134 ± 12	135 ± 13	134 ± 4	127 ± 12	137 ± 14	132 ± 12
	after	131 ± 9	131 ± 9	130 ± 11	130 ± 10	136 ± 4	129 ± 11	144 ± 15	136 ± 13
Diastolic blood pressure (mmHg)	before	80 ± 10	83 ± 10	84 ± 8	83 ± 9	78 ± 11	74 ± 10	79 ± 7	77 ± 9
	after	74 ± 9	83 ± 6	81 ± 8	81 ± 8	83 ± 3	81 ± 6	83 ± 6	82 ± 5
Maximal distance during a 6-min walking test (m)	before	401 ± 63	395 ± 61	378 ± 68	389 ± 63	416 ± 28	391 ± 58	398 ± 65	400 ± 54
	after	464 ± 47	442 ± 60	420 ± 67	436 ± 61	421 ± 25	387 ± 65	406 ± 75	402 ± 61

non-significant loss in percentage of body fat and WHR after the intervention period for the training group, which might be explained by the exercise intensity. Indeed, to optimize training programmes for patients with metabolic disease (*e.g.* obesity, metabolic syndrome or type 2 diabetes), theoretically, the maximal fat oxidation rate point ($Fatox_{max}$) might be recommended[14]. As $Fatox_{max}$ corresponds to the exercise intensity that elicits the maximum oxidation of lipids [15], it seems that it would be optimal to reduce body fat and thus especially well-suited for obese individuals. However, some authors have demonstrated that although $Fatox_{max}$ is theoretically the optimal exercise intensity to reduce body, in practice this exercise intensity presents several limitations (*e.g.* $Fatox_{max}$ depends on the last meal) [16].

Our results revealed that a sedentary lifestyle (control group) increases blood pressure (significantly for DBP), while an intermittent exercise programme (training group) decreases blood pressure (significantly for SBP). The drop in blood pressure observed in the training group could be explained by modifications in blood vessel morphology and function for improved blood flow[17]. Indeed, the training programme may have induced angiogenesis (*i.e.* an expansion of the capillary network by the formation of new blood vessels) and arteriogenesis (*i.e.* an enlargement of existing vessels) [18], both of which would reduce blood pressure.

The significant reduction in resting HR (-7%) and the increase in 6-min walking distance (+12%) after the intervention period in the training group indicate an improvement in physical fitness. These results are similar to the findings of a previous study [7] that used the same training programme (32 min of cycle ergometer exercise 3 days per week for 10 weeks) and suggest that the changes in physical fitness induced by intermittent training on a cycle ergometer may be transferred to walking. However, to obtain better 6-min walking test performance, it may be preferable to propose walking exercise. Indeed, [19 reported that obese women showed a significant increase of +18% in performance during a 6-min walking test after a walking programme.

In their meta-analysis, [8] reported discrepancies in the studies that examined weight loss according to obesity class. Although four studies found no difference or association between baseline obesity class and reduction in body mass, most of them (*n* = 7) showed significantly greater weight loss in those individuals with higher BMI after a lifestyle intervention programme including physical exercise. Our results confirm these discrepancies, because the beneficial effects in our study do not depend on obesity class. However, this results may be explained from low sample size, especially in the groups of patients with moderate obesity (n = 4 versus 5 participants). Consequently, further studies must be performed to better explain the divergences in the studies.

Conclusion

The present study revealed that a training programme based on intermittent exercise has beneficial effects on several anthropometric and physiological measures and 6-min walking test performance. However, these beneficial effects do not depend on the obesity class.

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