# Effects of functional training and two interdisciplinary interventions on VO2max and weight loss of women with obesity: a randomized clinical trial

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<td>Interdisciplinary therapy provided more comprehensive adaptations, including morphological variables and cardiorespiratory fitness, Functional training increased cardiorespiratory fitness but reduced only abdominal obesity., Interdisciplinary education provided benefits on morphological variables, but it doesn't increase cardiorespiratory fitness.</td>
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Effects of functional training and two interdisciplinary interventions on VO\(_2\max\) and weight loss of women with obesity: a randomized clinical trial

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Abstract

Our aim was to analyze and compare functional training (FT), interdisciplinary therapy (IT) and interdisciplinary education (IE) on cardiorespiratory fitness (CF) and anthropometric characteristics of women with obesity. Forty-four women (age=39.7±5.9 years, BMI=35.5±2.8 kg/m²) completed 30 weeks of intervention randomly assigned to three groups: FT (n=14), IT (n=19) and IE (n=11). The FT participated in training program (3x/wk), the IT received the same training intervention plus nutrition- (1x/wk), psychology-advice (1x/wk) and physical therapy (1x/wk). The IE participated in interdisciplinary lectures on topics related to health promotion (1x/month). CF (ergospirometry), anthropometry and body composition (electrical bioimpedance) were measured pre- and post-intervention. CF increased (p≤0.05) significantly (pre- vs. post-) in FT (7.5%) and IT (10.8%), but not in IE (1.8%). Body mass (BM), body mass index (BMI), relative fat mass (FM) and waist circumference (WC) significantly (p≤0.05) decreased (pre- vs. post-) in IT (-4.4%, -4.4%, -2.3% and -5.1%, respectively). IE showed a significant decrease in BM (-3.7%), in BMI (-3.7%) and in WC (-3.5%), whereas FT promoted significant decrease in WC (-3.4%). In conclusion, FT increased CF but only interdisciplinary interventions improved the anthropometric profile of women with obesity.

Clinical Trial Registration Number: NCT02573688

Novelty bullets

- Interdisciplinary therapy provided more comprehensive adaptations in women with obesity, including morphological variables and cardiorespiratory fitness.
- Functional training increased cardiorespiratory fitness but reduced only abdominal obesity.
• Interdisciplinary education provided benefits on morphological variables, but it doesn't increase cardiorespiratory fitness.

Keywords: obesity; overweight; integrated training; combined training; multimodal training; interdisciplinary therapy; multicomponent training
Introduction

Obesity is a serious fast-growing global public health problem. According to the World Health Organization (World Health Organization 2000), more than 300 million people worldwide are obese, of which over 1/3 suffer from obesity-related health problems.

Excessive accumulation of adipose tissue compromises the balance in the production of pro- and anti-inflammatory adipokines, creating a state of chronic subclinical inflammation that favors the development of heart, metabolic, musculoskeletal and mental comorbidities (Schelbert 2009). Thus, there is a growing interest in strategies that promote weight- and fat mass-loss, including physical exercises (Thompson 2018), and multi- or interdisciplinary interventions (Donini et al. 2009; Sanches et al. 2016).

Considering that obesity is a multifactorial disease, interventions that address more than one factor (e.g., physical exercise + nutrition) generally provide better results for weight loss than isolated physical exercise programs (Johns et al. 2014). In this sense, studies using face-to-face multi- or interdisciplinary therapy for obesity treatment - combination of interventions in different areas - observed significant weight loss in patients with obesity (Carvalho-Ferreira et al. 2011; Leite et al. 2017). Other studies using interventions from different areas but based on information sharing through obese patient education programs (e.g., interdisciplinary education), were also effective in promoting weight loss in people with obesity (Lagger et al., 2010).

In isolated exercise programs, the weight loss is discrete and sometimes nonexistent (Swift et al. 2014). However, exercise can help in maintaining lean body mass and resting metabolic rate in weight loss programs (Donnelly et al. 2009). Additionally, physical exercise has benefits on cardiorespiratory fitness in people with obesity (Sanches et al. 2016) and, regardless of changes in body mass, provides reduction in viscera/abdominal fat (Verheggen et al. 2016). It is noteworthy that both low cardiorespiratory fitness and excess
visceral/abdominal fat are independently associated with the risk of early mortality (Ekelund et al., 2015; McAuley et al. 2010).

Regarding the type of physical exercise, aerobic and resistance exercises are already widely investigated (Ismail et al. 2012; Wewege et al. 2018), but there are few studies analyzing the effects of functional training (FT) in people with obesity, and there is a gap regarding the comparison of this “new” type of training being performed by itself or with interdisciplinary therapies in patients with obesity.

FT has been understood as the use of strength training (and other techniques) to promote multisystem adaptations (e.g. strength, balance, coordination, agility, among others), using multiarticular, multisegmental, multiplanar, integrated, unstable and acyclic exercises. Some previous studies have shown beneficial effects of this type of training on anthropometric variables and body composition with overweight women (BMI<30kg/m²) (Neves et al. 2014; Neves et al., 2017). Additionally, it should be considered that FT, as it presents itself as one of the main fitness worldwide trends (Thompson 2018) and as it uses high complexity exercises that seem to increase energy expenditure (La Scala Teixeira et al. 2019), has attracted people with obesity, justifying this research.

Thus, the aim of the study was to analyze and compare the effects of FT with two distinct formats of interdisciplinary interventions on cardiorespiratory fitness and anthropometric characteristics and body composition of women with obesity. We hypothesized that three interventions would produce beneficial health outcomes (including anthropometric variables and cardiorespiratory fitness), but at different magnitudes.

Materials and methods

Experimental design
The present study had a randomized clinical trial format. In order to verify and compare the effects of 3 different obesity treatments on cardiorespiratory fitness and anthropometric profiles, 44 women with obesity were randomly (through Microsoft Excel specific function) assigned to 3 groups: Functional training (aerobic + functional resistance training - 3x/wk), Interdisciplinary therapy (aerobic + functional resistance training - 3x/wk; nutrition - 1x/wk; psychology - 1x/wk; physical therapy - 1x/wk) and, Interdisciplinary education (lectures on topics related to general health promotion - 1x/month). Before and after 30 weeks of intervention, all volunteers underwent VO$_2$max, anthropometry and body composition assessments. Results were compared within and between groups. The study was conducted at the Interdisciplinary Laboratory of Metabolic Diseases of the Federal University of São Paulo, Santos, Brazil.

**Subjects**

The invitation to participate was made through social media, institutional websites, and local newspapers. Inclusion criteria were: woman, aged between 30 and 50 years, BMI between 30.0 and 39.9 kg/m$^2$ and having a recent medical certificate and electrocardiogram. Volunteers were excluded if they had any skeletal muscle restrictions to practice resistance and aerobic exercises, were using ergogenic, stimulant substances and/or weight loss substances, were pregnant or had already undergone bariatric surgery. Volunteers who presented comorbidities were not excluded because it is a common condition for people with obesity. In total, 78 adult women with obesity were randomized into three groups: Functional Training group (FT, n=28), Interdisciplinary Therapy group (IT, n=24), and Interdisciplinary Education group (IE, n=26). After 30 weeks, 44 women (FT=14; IT=19; IE=11) reached the minimum number of interventions (70%) and were included in the analyses. The reasons reported for drop-out or non-inclusion in the data analysis were as follows: pregnancy (n=1),
surgery (n=1), job opportunities (n=2), non-attendance at reevaluations (n=12), personal reasons (n=8), insufficient attendance (n=12). The study was previously approved by the UNIFESP Research Ethics Committee (CAAE: 57101616.6.0000.5505).

**Cardiorespiratory fitness assessment – VO\textsubscript{2}max**

For the aerobic fitness assessment, an ergospirometric test of increasing loads on a treadmill (TRX 600 – Total Health®) was performed until exhaustion, protocol adapted from previous studies of our group (Cerrone et al., 2017. Sanches et al. 2018). The protocol used to perform the ergospirometric test had an initial speed of 3 km/h and inclination set at 1%, with speed increasing 1 km/h every two minutes until the volunteer’s exhaustion. Volunteers were verbally encouraged to continue the exercise for as long as possible. The test was interrupted when subjects reported inability to continue the activity. During the test, a facemask connected to Gas Analyzer (FITMATE-PRO – COSMED®) was used. For safe test execution, heart rate and blood pressure were measured during each stage. Concomitantly, the rating of perceived exertion (RPE) (Borg 1998) was reported at the end of each stage and test results that showed RPE≥18 and heart rate compatible with the expected maximum at the time of discontinuation, were considered valid. The relative VO\textsubscript{2}max (absolute VO\textsubscript{2}max / body mass) and the intensity (km/h) corresponding to VO\textsubscript{2}max (\textit{iVO\textsubscript{2}max}) were recorded.

**Anthropometry**

Body mass (BM) was measured using a digital scale (Toledo) with 200 kilograms as maximum capacity and 50 grams of accuracy, with the volunteers wearing light clothes and standing with their backs to the scales. Height was measured by a professional stadiometer (Sanny), accurate to one mm. Body mass index (BMI) was calculated by the ratio of body mass (in kg) to the square of height (in m).
Anthropometric tape (Sanny) with a precision of one mm was used to measure waist circumference. Waist circumference was measured with the tape being placed horizontally over the midpoint between the iliac crest and the last costal arch at the end of normal exhalation (Kaminsky and American College of Sports Medicine 2013). The median of 3 measurements was considered. To calculate waist-to-height ratio (WHtR), the waist circumference value (in cm) was divided by height (in cm).

**Body Composition**

Participants were submitted to the bioelectrical impedance protocol using tetrapolar equipment (Maltron BF-906) to evaluate body fat percentage, equipment that has been used in some previous studies with women with obesity (Carroll et al. 2012; Steckling et al. 2016). The assessment was made after four hours of fasting period, following the manufacturer’s recommendations. To calculate body composition by calculating fat-free mass, an equation was used, previously proposed by Segal et al. (1988) specific for women with obesity.

**Physical activity level**

To estimate physical activity level, the International Physical Activity Questionnaire (IPAQ) was applied in its short version (Matsudo et al., 2001), comprising four questions about the weekly time of sedentary, mild, moderate and vigorous physical activities. In this study, the five possible IPAQ classifications were divided into two physical activity levels: unsatisfactory = "sedentary" + "irregularly active A" + "irregularly active B"; satisfactory = "active" + "very active".

**Functional training**

The functional training group (FT) underwent a face-to-face training protocol which
consisted of performing exercises to enhance different physical capacities in an integrated, synergistic and balanced approach, as suggested by La Scala Teixeira et al. (2017). The intervention was conducted in a climate-controlled environment (~20 to 22 ºC) and equipped with ergometers (bicycle and treadmills), and equipment and accessories for resistance training. The volunteers underwent an FT program three times a week (Monday, Wednesday and Thursday), including aerobic and functional resistance exercises. The training session lasted 60 minutes and was structured as follows: 5 minutes of warm-up, followed by 25 minutes of aerobic exercise plus 25 minutes of functional resistance exercises (not necessarily in this order), ending with 5 minutes of relaxation.

Aerobic exercises were performed on an ergometer (treadmill or bicycle) at an intensity equivalent to the rating of perceived exertion (RPE) of 13-14 on the Borg scale (Borg 1998). Resistance training was performed in a circuit scheme, with 3 passes in 8 stations. Each pass consisted of execution for 40 seconds interleaved with 20 seconds of passive rest interval. Table 1 shows intensity control by the rating of perceived exertion, using the CR-10 scale (Borg 1998). In total, four different circuits were elaborated, which were rotated in monthly cycles. For overload, the exercises used free weights (FW – bars, plates, dumbbells, poles), elastic bands (EL) and bodyweight (BW), except for the fourth circuit, which was based on manual resistance training (MRT), as suggested by La Scala Teixeira (2017) (Table 2).
The Interdisciplinary Therapy (IT) group underwent a training program identical to the FT group. However, on each physical training day, interventions were added in the fields of Nutrition (once a week, Tuesday), Psychology (once a week, Thursday) and Physical Therapy (once a week, Friday) based on an interdisciplinary approach. Furthermore, once a month an intervention was developed between two or more fields to strengthen the interdisciplinary character of the proposed treatment.

The nutrition interventions were conducted with the main objective of raising awareness about diet and eating behavior, allowing volunteers to make positive changes in their lifestyles, helping to reduce obesity and its comorbidities. The interventions were based on the dietary guide for the Brazilian population (Brasil 2014) and the principles of behavioral nutrition (Alvarenga et al. 2015), as well as specific knowledge of nutrition, food and dietetics. These were structured in weekly themes and lasted 60 minutes, during which mainly expository and talking methods were used to convey the contents covered. Moreover, practical classes in experimental cooking were held every 2 months to enrich the practical knowledge of participants, and so they could live some experiences in the area of gastronomy and nutrition. At the beginning of the therapy, an individualized dietary plan was also proposed for each volunteer according to their energetic and nutritional needs, seeking to serve as a guide for those who had greater difficulty regarding the quantities and portion sizes of food, thus helping in the daily food choices.

Psychology interventions were performed once a week, lasting 60 minutes per session. The theoretical approach that guided psychological intervention was Cognitive Behavioral Therapy (CBT). In this model, the cognition has an important role in expression of feelings and behavior. The individual learns how to identify and respond to dysfunctional thoughts in a more realistic and adaptive perspective, which leads to feeling better emotionally and to behave more adaptively to one’s environment. The CBT emphasizes the
importance of collaborative relation and active participation in solving problems (Beck 2011). The cognitive behavioral model was adopted to help individuals modify the way they deal with eating, physical activity and exercise.

Physical therapy interventions aimed to improve the volunteers’ functional capacity. Each session lasted 60 minutes involving postural exercises, lumbopelvic stabilization (core training), dynamic balance and flexibility exercises.

Interdisciplinary education

The protocol adopted in the interdisciplinary education group (IE) was conducted as monthly lectures. Volunteers received guidance on lifestyle changes through seven lectures on the following key topics: (1) motivation to behavior change; (2) emotional eating; (3) healthy eating; (4) physical therapy care in obesity and in the weight loss process; (5) obesity-associated diseases; (6) physical exercise in promoting health and weight loss; and (7) bariatric surgery. During the investigation, group members were connected to each other by social networks (WhatsApp® group chat) to share information about therapy and feedback on lectures/meetings.

Statistical Analysis

Data normality was verified using the Shapiro-Wilk test. Data are presented as mean and standard deviation for the analyzed variables pre- and post-intervention. Baseline characteristics were compared by one-way ANOVA test. Inferential analysis to verify interaction in time (pre- vs. post-) and the relationship between time and intervention (FT vs. IT vs. IE) was performed using mixed ANOVA for repeated measures with Bonferroni’s post hoc application for multiple pairwise comparison. In order to correct any statistical problems, nonparametric data were transformed into logarithms prior to ANOVA analysis of repeated
measures. The significance level considered was 5% \((p \leq 0.05)\). Additionally, percentage changes \((\Delta \%)\) and effect size \((ES)\) by Cohen's \(d\) were calculated. Inferential analysis of categorical variables of physical activity level was performed using chi-square test. The analyses were performed using the SPSS v.20 program.

**Results**

Table 3 presents the characteristics of subjects who completed the interventions in the three groups.

**Cardiorespiratory fitness – \(VO_2\text{max}\)**

In \(VO_2\text{max}\), ANOVA showed interaction in the time factor \((F=12.441, p=0.001)\), but not in the relationship between time and intervention \((F=1.841, p=0.172)\). The post-hoc test showed a significant increase in \(VO_2\text{max}\) in FT \((p=0.014, 95\%CI=0.469 \text{ to } 3.902, \Delta\%=7.5\pm10.7, ES=0.47)\) and IT \((p=0.001, 95\%CI=1.169 \text{ to } 4.115, \Delta\%=10.8\pm14.1, ES=0.74)\) interventions, with no change in IE \((p=0.699, 95\%CI=-1.564 \text{ to } 2.309, \Delta\%=1.8\pm9.8, ES=0.12)\) (Table 4).

In \(iVO_2\text{max}\), ANOVA showed interaction in the time factor \((F=56.843, p<0.001)\), but not in the relationship between time and intervention \((F=1.414, p=0.255)\). The post-hoc test showed a significant increase in all interventions (IE: \(p=0.014, 95\%CI=0.007, \Delta\%=9.1\pm14.7, ES=0.65\) to \(0.062\); FT: \(p<0.001, 95\%CI=0.038\) to \(0.087, \Delta\%=15.7\pm8.0, ES=1.22\); IT: \(p<0.001, 95\%CI=0.038\) to \(0.079, \Delta\%=15.1\pm12.3, ES=1.45\)), with no difference between groups (Table 4).
Anthropometric variables and body composition

For both BM and BMI, mixed ANOVA showed interaction in time (BM: $F=17.719$, $p<0.001$; BMI: $F=18.708$, $p<0.001$), but not in the relationship between time and intervention (BM: $F=1.218$, $p=0.306$; BMI: $F=1.274$, $p=0.291$). The post-hoc test showed a significant decrease in BM and BMI in IE (BM: $p=0.029$, 95%CI=0.363 to 6.228, Δ%=−3.7±6.1, ES=0.85; BMI: $p=0.022$, 95%CI=0.197 to 2.347, Δ%=−3.7±6.1, ES=1.62) and IT (BM: $p<0.001$, 95%CI=2.145 to 6.608, Δ%=−4.4±5.3, ES=1.44; BMI: $p<0.001$, 95%CI=0.812 to 2.448, Δ%=−4.4±5.3, ES=2.67) interventions, without change in FT (BM: $p=1.187$, 95%CI=−0.871 to 4.288, Δ%=−1.8±2.2, ES=0.49; BMI: $p=0.183$, 95%CI=−0.314 to 1.592, Δ%=−1.8±2.2, ES=0.86) (Table 5).

For WC and WHtR, mixed ANOVA showed interaction in time (WC: $F=31.534$, $p<0.001$; WHtR: $F=32.264$, $p<0.001$), but not in the relationship between time and intervention (WC: $F=0.757$, $p=0.476$; WHtR: $F=0.749$, $p=0.479$). The post-hoc test showed significant decrease in WC and WHtR in IE (WC: $p=0.022$, 95%CI=0.538 to 6.407, Δ%=−3.5±4.4, ES=1.25; WHtR: $p=0.014$, 95%CI=0.003 to 0.028, Δ%=−3.5±4.4, ES=0.40), FT (WC $p=0.007$, 95%CI=1.084 to 6.287, Δ%=−3.4±3.8, ES=1.54; WHtR: $p=0.009$, 95%CI=0.004 to 0.026, Δ%=−3.4±3.8, ES=0.40) and IT (WC $p<0.001$, 95%CI=3.157 to 7.622, Δ%=−5.1±5.0, ES=2.57; WHtR: $p<0.001$, 95%CI=0.014 to 0.033, Δ%=−5.1±5.0, ES=1.00) (Table 5), with no difference between the groups.

In the body composition analysis, the relative body fat (BF) showed interaction in time ($F=11.192$, $p=0.002$) but not in the relationship between time and intervention ($F=1.644$, $p=0.206$). In the post-hoc test, relative BF significantly reduced only in IT ($p=0.001$, 95%CI=0.451 to 1.662, Δ%=−2.3±2.9, ES=0.68), with no changes in IE ($p=0.065$, 95%CI=−
0.048 to 1.544; $\Delta%=-1.7\pm4.1$, ES=0.54) and FT ($p=0.527$, 95%CI=-0.483 to 0.928, $\Delta%=-0.5\pm1.3$, ES=0.11). Similarly, absolute BF presented interaction in time ($F=14.849$, $p<0.001$), but not in the relationship between time and intervention ($F=1.384$, $p=0.262$), showing significant decrease only in IT ($p<0.001$, 95%CI=1.394 to 4.460, $\Delta%=-7.3\pm10.0$, ES=0.38), tendency to decrease in IE ($p=0.052$, 95%CI=-0.022 to 4.007, $\Delta%=-3.7\pm14.7$, ES=0.33) and no changes in FT ($p=0.269$, 95%CI=-0.794 to 2.777, $\Delta%=-0.4\pm1.0$, ES=0.11). Relative fat free mass (FFM) showed interaction in time ($F=11.192$, $p=0.002$) but not in the relationship between time and intervention ($F=1.644$, $p=0.206$) (Table 5). IT was the only intervention that showed a significant increase in relative FFM ($p=0.001$, 95%CI=0.451 to 1.662, $\Delta%=-1.9\pm2.5$, ES=0.68), without changes in IE ($p=0.065$, 95%CI=-0.048 to 1.544, $\Delta%=-1.3\pm3.2$, ES=0.54) and FT ($p=0.527$, 95%CI=-0.483 to 0.928, $\Delta%=-0.4\pm1.0$, ES=0.11). Regarding absolute FFM, there was interaction in time ($F=22.470$, $p<0.001$), but not in the relationship between time and intervention ($F=0.851$, $p=0.434$). The post-hoc test showed a significant decrease in absolute FFM in IT ($p=0.001$, 95%CI=0.714 to 2.185, $\Delta%=-2.7\pm3.3$, ES=0.21) and in IE ($p=0.009$, 95%CI=0.336 to 2.269, $\Delta%=-2.6\pm3.1$, ES=0.24), but not in FT ($p=0.090$, 95%CI=0.120 to 1.594, $\Delta%=-1.4\pm1.9$, ES=0.12) (Table 5).

<<<INSERT TABLE 5 ABOUT HERE>>>

**Physical activity level**

Based on the percentage of subjects distributed in the IPAQ classifications, physical activity levels increased in all groups. In the IT group, the number of subjects with satisfactory physical activity level ("active" + "very active") increased from 5 to 14 ($\Delta%=180.2\%$). In FT, it increased from 3 to 11 ($\Delta%=267.3\%$). In the IE, it increased from 4 to 7 ($\Delta%=74.7\%$). The chi-square test revealed an association between physical activity level
(unsatisfactory and satisfactory) and intervention both pre- ($\chi^2=5.830, p=0.054$) and post-intervention ($\chi^2=5.830, p=0.054$).

### Discussion

To the best of our knowledge, this is the first study to investigate FT effects on people with obesity, as well as being the first to compare it with IT (gold standard) and an IE program. Our main finding was that while IT was the only intervention that improved all parameters evaluated, FT and ES promoted positive changes in some variables, which confirms our hypothesis in part.

As expected, IT promoted positive changes in all variables investigated, including a decrease in body mass, body mass index, relative and absolute fat mass, waist circumference and waist-to-height ratio, as well as an increase in cardiorespiratory fitness and relative fat free mass. These findings confirm the results of previous studies (Bischoff et al. 2012; Leite et al. 2017; Sanches et al. 2016) and corroborate what the literature suggests as the “gold standard” for obesity treatment (Jensen et al. 2014; Tsigos et al. 2008). Moreover, the drop-out rate over the 30 weeks was low for IT (~20%), confirming the effectiveness of the intervention.

However, considering the high cost of long-term interdisciplinary therapy for both the subject with obesity (end-user) and health services, this study analyzed the effects of cheaper interventions and thus accessible to large populations. Although these data were not presented in the results, the cost of INT was approximately 5 and 14 times higher than the cost of FT and IE, respectively. This information needs to be considered in view of the possibility of practical application of these therapy models for obesity treatment.

Regarding the IE program, the results showed a positive effect on several anthropometric variables in the sample that remained until the end of the intervention. As
observed in the results, the number of subjects with satisfactory physical activity level in the IE group increased by 74%, which may have helped, in part, in the reduction of anthropometric measurements. Moreover, although the specific procedures adopted by each volunteer that aimed to lose weight during the intervention period were not recorded, it is possible that the information shared in the lectures motivated attitudes related to behavior changes – mainly regarding the adoption of a healthier eating pattern, eating behavior and physical activity level. This is a hypothesis that must be confirmed in future studies.

In a study that considered 35 systematic reviews and meta-analyses results (covering 360 studies in total), Lagger et al. (2010) found that 64% of the studies showed positive effects related to programs based on education of the patient with obesity (similar to group IE), corroborating our findings. Although the IE group had a positive effect on anthropometry, the drop-out rate over the intervention period was high (58%), which classifies the strategy as effective for weight loss for those who remain until the end of the study but the probability of permanence is small (~42% of users).

The FT program provided a decrease only in waist circumference and waist-to-height ratio, without changes in body mass, body fat and fat free mass. Although some previous studies have observed a positive effect of functional training on anthropometric variables and body composition of overweight postmenopausal women (Neves et al. 2014; Neves et al. 2017), some of the literature shows that training-based interventions of physical exercise in subjects with obesity is little or not effective for weight loss (Johns et al. 2014; Swift et al. 2014). However, even without observing weight loss, studies suggest that physical training can reduce visceral fat (Verheggen et al., 2016), a fact that has been confirmed in this study. We must note that abdominal obesity is considered an isolated risk factor for morbidity and death (Ekelund et al. 2015), and its reduction is important for reducing cardiometabolic risk.
In addition to FT providing positive changes in waist circumference and WHtR, cardiorespiratory fitness also improved significantly in this group. Considering that (1) low cardiorespiratory fitness is associated with high mortality rate in overweight and subjects with obesity, (2) its improvement alters the obesity paradox (McAuley et al. 2010), and (3) physical inactivity kills at least two times more than obesity (Ekelund et al. 2015), FT presents itself as another physical exercise option and can be encouraged for women with obesity. However, given the low efficacy in promoting positive changes on anthropometric variables and body composition, in addition to the high drop-out rate over the intervention period (50%), its association with Nutrition, Psychology and Physical therapy interventions is necessary, especially in an interdisciplinary approach. However, it should be emphasized that although FT did not promote significant weight loss, the results observed at post-intervention did not present significant differences between the groups.

Although the overall drop-out rate seems high (~ 44%), it is similar or lower than rates observed in previous studies of our group with long-term interventions in people with obesity (Sanches et al. 2016; Leite et al. 2017). The highest drop-out rates were observed in the ES and FT groups. Specifically in the ES, the low frequency of lectures may have contributed to the higher drop-out rates, because another study that used a similar format, but more frequently at the beginning of the intervention, observed a low drop-out rate (~ 16%) after 6 months of treatment (Minniti et al. 2007). In the FT, the results corroborate a previous study that showed Brazilians with obesity have a drop-out rate close to 50% in isolated physical training programs (Costa et al. 2009). In the INT group, the interdisciplinary character of therapy, with the purpose of promoting behavior change, associated with the high frequency of interventions (3x / week) may have contributed to attenuate the drop-out rate.
Our results obviously have to be interpreted in light of some limitations. The main limitation of this study was the large sample drop-out rate over the intervention period, especially in the IE and FT groups. However, as mentioned, previous studies show that the drop-out rate of overweight and people with obesity in exercise programs and other interventions for weight loss is high, being higher than that of nonobese individuals (Burgess et al. 2017; Costa et al. 2009); thus, this is a challenge that requires greater attention from investigators and professionals dealing with this population. Another important limitation is the method used to evaluate body composition, although it was highly correlated with the gold standard method in the study (Segal et al. 1988) that proposed the equation used in the present. Also, the analysis of the physical activity level through a questionnaire also has limitations and questions.

Finally, it is important to highlight that, although the interventions applied in the present study provided statistically significant changes in several of the analyzed variables, some observations should be considered. IT and ES provided significant weight loss, but percentage reductions did not reach 5-10% of initial weight, which is recommended by the World Health Organization and other entities (World Health Organization 2000). Similarly, VO2 increased significantly in FT and IT, but post-intervention mean ratings were "regular" according to parameters for Brazilian women (Herdy and Caixeta 2016).

In conclusion, isolated functional training promotes improvement in cardiorespiratory fitness, but only interdisciplinary therapy improved both cardiorespiratory fitness and anthropometric profile of women with obesity. Considering that concomitant improvement in anthropometric variables and cardiorespiratory fitness is desirable in these women, FT should be encouraged, but whenever possible, associated with Nutrition, Psychology and Physical therapy interventions, preferably in an interdisciplinary approach.
Acknowledgements

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Conflict of interest

The authors have no conflicts of interest to report.

References


La Scala Teixeira, C.V., Evangelista, A.L., Novaes, J.S., Da Silva-Grigoletto, M.E., Behm, D.G. 2017. "You're only as strong as your weakest link": a current opinion about the


<table>
<thead>
<tr>
<th>Variable</th>
<th>Characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activities conducted</td>
<td>Integrated resistance exercises including simultaneous upper and lower limb, multiplanar movements, high demand for core stability, motor coordination and balance.</td>
</tr>
<tr>
<td></td>
<td>Weeks 1 to 10: RPE 6–7 (0–10)</td>
</tr>
<tr>
<td>Intensity</td>
<td>Weeks 11 to 20: RPE 7–8 (0–10)</td>
</tr>
<tr>
<td></td>
<td>Weeks 21 to 30: RPE 8–9 (0–10)</td>
</tr>
<tr>
<td>Volume/duration/method</td>
<td>Circuit with 8 stations (exercises), 40 seconds of execution, 20 seconds apart, 3 passes, totaling 25 minutes</td>
</tr>
<tr>
<td>RPE: Rating of perceived exertion</td>
<td></td>
</tr>
</tbody>
</table>
Table 2. Circuit protocol adopted in monthly functional training cycles

<table>
<thead>
<tr>
<th>Week</th>
<th>Exercise (Means)</th>
</tr>
</thead>
</table>
| 1, 5, 9, 13, 17, 21, 25, 29 | 1. Sit to stand with elbow flexion (FW, BW)  
2. Push-ups (BW)  
3. Crunches with rotation (BW)  
4. Dumbbell Swing (FW)  
5. Front pulldown with squat (EL)  
6. “Good morning” (FW)  
7. Side-lying Hip Abduction (FW)  
8. Airplane (BW) |
| 2, 6, 10, 14, 18, 22, 26, 30 | 1. Upright row with sumo squat (FW)  
2. Dumbbell fly with pelvic elevation (FW)  
3. Elastic trunk rotation (EL)  
4. Front raise with side lunge (FW, BW)  
5. Suspended row (BW)  
6. Knee flexion with elbow flexion (FW)  
7. Trunk lateral flexion (FW)  
8. Single leg balance with eyes closed (BW)  
1. Squat Thruster (FW)  
2. Hip flexion with elbow flexion (PL)  
3. Ball crunch (BW) |
| 3, 7, 11, 15, 19, 23, 27 | 4. Side lateral raise with lunge (FW, BW)  
5. Horizontal row (EL)  
6. Stiff leg deadlift (FW)  
7. Bench Press (FW) |
8. Single leg balance with eyes closed (BW)

1. Standing Bench Press (MRT)

2. Sumo Squat (MRT)

3. Horizontal Row (MRT)

4. Crunch (BW)

5. Push Forward (MRT)

6. Hips Extension (MRT)

7. Shoulder abduction / adduction (MRT)

9. Trunk Rotation (MRT)

FW: free weights; EL: elastic bands; BW: bodyweight (calisthenic exercises); MRT: manual resistance training
Table 3. Sample characterization of subjects who completed the interventions. Values shown as mean and standard deviation

<table>
<thead>
<tr>
<th>Variable</th>
<th>IE</th>
<th>FT</th>
<th>IT</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>11</td>
<td>14</td>
<td>19</td>
</tr>
<tr>
<td>Age (years)</td>
<td>41.0±6.3</td>
<td>39.7±6.6</td>
<td>39.0±5.5</td>
</tr>
<tr>
<td>BMI (Kg/m²)</td>
<td>36.3±2.7</td>
<td>34.5±2.6</td>
<td>35.8±3.0</td>
</tr>
<tr>
<td>Frequency of participation (%)</td>
<td>77.9±11.7</td>
<td>78.0±9.3</td>
<td>75.7±10.7</td>
</tr>
</tbody>
</table>

IE: interdisciplinary education; FT: functional training; IT: interdisciplinary intervention
Table 4. Maximum oxygen uptake (VO₂max) and VO₂max intensity (iVO₂max) at pre- and post- moments in different interventions. Values shown as mean and standard deviation

<table>
<thead>
<tr>
<th>Variable</th>
<th>IE</th>
<th>FT</th>
<th>IT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-</td>
<td>Post-</td>
<td>Pre-</td>
</tr>
<tr>
<td>VO₂max</td>
<td>25.9±3.4</td>
<td>26.3±3.5</td>
<td>28.8±4.7</td>
</tr>
<tr>
<td>(ml.Kg.min⁻¹)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>iVO₂max</td>
<td>7.8±1.0</td>
<td>8.5±0.9*</td>
<td>7.5±0.9</td>
</tr>
<tr>
<td>(km/h)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

IE: interdisciplinary education; FT: functional training; IT: interdisciplinary intervention; *: 
\( p \leq 0.05 \) vs. pre
Table 5. Anthropometric variables pre- and post- the different interventions. Values shown as mean and standard deviation

<table>
<thead>
<tr>
<th>Variable</th>
<th>IE</th>
<th>Post-</th>
<th>FT</th>
<th>Pre-</th>
<th>Post-</th>
<th>IT</th>
<th>Pre-</th>
<th>Post-</th>
</tr>
</thead>
<tbody>
<tr>
<td>BM (kg)</td>
<td>97.5±3.9</td>
<td>94.2±4.1*</td>
<td>91.2±3.5</td>
<td>89.5±3.6</td>
<td>95.9±3.0</td>
<td>91.6±3.1*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>36.3±0.8</td>
<td>35.0±1.0*</td>
<td>34.5±0.7</td>
<td>33.9±0.9</td>
<td>35.8±0.6</td>
<td>34.2±0.7*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BF (%)</td>
<td>45.4±1.4</td>
<td>44.6±2.8</td>
<td>44.3±2.0</td>
<td>44.1±1.8</td>
<td>45.2±1.6</td>
<td>44.2±1.8*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BF (kg)</td>
<td>44.3±6.0</td>
<td>42.3±8.6</td>
<td>40.6±6.8</td>
<td>39.6±6.4</td>
<td>43.6±7.6</td>
<td>40.6±7.6*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FFM (%)</td>
<td>54.7±1.4</td>
<td>55.4±2.8</td>
<td>55.7±2.0</td>
<td>55.9±1.8</td>
<td>54.8±1.6</td>
<td>55.8±1.8*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FFM (kg)</td>
<td>53.2±5.4</td>
<td>51.9±6.2*</td>
<td>50.6±6.1</td>
<td>49.9±5.9</td>
<td>52.4±6.8</td>
<td>50.9±6.6*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WC (cm)</td>
<td>101.9±2.8</td>
<td>98.4±2.8*</td>
<td>103.9±2.4</td>
<td>100.2±2.5*</td>
<td>105.2±2.1</td>
<td>99.8±2.1*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WHtR</td>
<td>0.62±0.05</td>
<td>0.60±0.06*</td>
<td>0.64±0.05</td>
<td>0.62±0.04*</td>
<td>0.65±0.04</td>
<td>0.61±0.05*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

IE: interdisciplinary education; FT: functional training; IT: interdisciplinary intervention; BM: body mass; BMI: body mass index; BF: body fat; FFM: fat free mass; WC: waist circumference; WHtR: waist-to-height ratio; *: p≤0.05 vs. pre-