Journal of Physical Education and Sport ® (JPES), Vol. 21 (5), Art 352, pp. 2641 - 2649, September 2021
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

Effects of a hybrid multi-professional intervention on morphological and cardiorespiratory parameters in overweight or obese females

GABRIELA GASPAROTTO SANGIROLAMO[1], ISABELLA CAROLINE SANTOS[2] HENRIQUE BROIO DE SOUZA[3], CYNTHIA GOBBI ALVES ARAÚJO[4], ISABELA RAMOS MARIANO[5], PABLO VALDES-BADILLA[6], BRAULIO HENRIQUE MAGNANI BRANCO[7]
[1,2,3,4,5,7]Universidade Cesumar (UniCesumar), BRAZIL
[1,2,4,7]Instituto Cesumar de Ciência, Tecnologia e Inovação (ICETI), BRAZIL
[1,2,3,4,5,7]Laboratório Interdisciplinar de Intervenção em Promoção da Saúde (LIIPS/UniCesumar), BRAZIL
[6]Department of Physical Activity Sciences. Faculty of Education Sciences. Universidad Católica del Maule. Talca, CHILE.
[6]Carrera de Entrenador Deportivo. Escuela de Educación. Universidad Viña del Mar, CHILE.

Published online: September 30, 2021
(Accepted for publication September 15, 2021)
DOI:10.7752/jpes.2021.05352

Abstract:
Background: Obesity is a chronic, non-communicable, multifactorial disease that different governmental and non-governmental organizations consider a pandemic. It has even been reported as the disease to be combated in the 21st century. **Purpose:** This study aimed to investigate the effects of a multi-professional intervention with an online component (hybrid – some activities were performed in person, and others were conducted on the internet) on the morphological and cardiorespiratory parameters of overweight or obese females after 6 and 12 weeks of intervention. **Methods:** Seventeen females between 40 and 59 years of age were included in the final analyses. Data were gathered at 6 and 12 weeks. The interventions were performed for 12 weeks by a team made up of physical education professionals (3x a week), physical therapists (3x a week), nutritionists (1x a week), and psychologists (1x a week). Physical exercises by physical education professionals and physical therapists were conducted in person. In addition, nutritional and psychological group therapy sessions were conducted online through Google Meet. **Results:** There was a significant reduction ($p<0.05$) in body fat mass and body fat percentage. The Bruce test with direct spirometric (metabolic gas analyzer) analysis indicated a significant increase ($p<0.05$) in distance and duration after 12 weeks of intervention. However, there were no observed differences for peak oxygen consumption, blood pressure, body mass, and body mass index ($p>0.05$) after the training program. **Conclusion:** The proposed intervention model (i.e., exercises using body weight and accessories, together with nutritional and psychological interventions online) effectively reduced body fat and improved health-related physical fitness parameters in overweight or obese females after 12 weeks.
Keywords*:* **Interdisciplinary Health Team, Health; Health promotion; Public Health, Female Health Issues; Woman's health.**

Introduction

Overweight and obesity are alarming public health problems (Han et al., 2019). Obesity, which is defined as an excessive accumulation of body fat, is known to cause damage to the population's health (Dada et al., 2018). Therefore, multidisciplinary approach is needed to effectively control and treat obesity (Bolognese et al., 2020; Branco et al., 2019; Magnani Branco et al., 2020). Tambasco et al. (2017) pointed out that multi-professional teams can treat different pathologies that present with multifactorial characteristics. This multifactorial disease encompasses genetic and environmental factors related to lifestyle, including inadequate and unbalanced eating habits and insufficient physical activity (Tauqeer et al., 2018). Regarding obesity management strategies, physiotherapists, nutritionists, physical education professionals, psychologists, and medical doctors all participate in the research and interventions that promote healthy weight loss, improving health-related quality of life in males and females.

In the United States of America, obesity affects more females than males (Tauqeer et al., 2018). Although no differences were observed in body mass index (BMI) between male and female adults in Brazil, an average of ~20.3% of the population had a BMI of 30.0 kg/m² or greater (Brazil, 2020). Research on specific strategies for controlling and treating this significant public health problem suggests that multi-professional interventions that consider gender differences may aid in treating the specific health conditions of obese females (Bolognese et al., 2020). There is also a need to incorporate interventions that consider the inherent characteristics of females through discussions and meetings on female health issues (McCuen-Wurst et al., 2017). The performance of activities with homogeneous groups (i.e., with either female who is overweight or obese), within the same or similar age groups (same health problems), tends to reduce the patient's resistance to

Corresponding Author: BRAULIO HENRIQUE MAGNANI BRANCO, E-mail: brauliohmagnani@gmail.com

combatting and controlling the pathology; self-acceptance tends to increase, and generalized anxiety tends to decrease (Bolognese et al., 2020). Therefore, the treatment model centered on specific groups tends to be more effective in interventions.

Eating disorders, family dynamics, and physical inactivity are significant factors in the etiology of overweight (Al-Khudairy et al., 2017). Among the pillars for the non-pharmacological treatment of obesity, the following stand out: physical activity, food re-education, and stress control. These interventions are based on lifestyle changes (Solmi et al., 2018). Interventions using body weight and accessories, food re-education, and group psychotherapy are considered cost-effective strategies to combat obesity (Bolognese et al., 2020; Branco et al., 2019; Magnani Branco et al., 2020). Among the different physical training programs, concurrent exercise (CE) is an exercise strategy in which strength exercises are performed concomitantly with aerobic exercises or with an interval of a few hours between the two, and vice versa (Coffey & Hawley, 2017). CE is potentially an effective strategy for treating obesity because stimuli are provided to maintain and/or increase musculoskeletal mass and cardiorespiratory fitness (Coffey & Hawley, 2017). The combination of the two types of stimuli, for example, the neuromuscular and cardiorespiratory component, via exercises that mimic activities of daily living (ADLs), commonly referred to as "functional exercises" (Da Silva-Grigoletto et al., 2014), may improve health-related physical fitness.

Weight loss is a long process that can take months or even years (Jensen et al., 2014). However, in one study, after 6 weeks of aerobic training without nutritional prescription, reductions of 34% were observed for free fatty acids, 9.6% were observed for fasting blood glucose, and 28.7% were observed for homeostasis model assessment of insulin resistance. However, no significant differences were found in body weight or fat mass. The other intervention group presented a significant reduction of 1.5% of body weight in the same study, but no significant differences were found for biochemical markers when the only nutritional prescription was used (Nordestgaard et al., 2013). Therefore, exercise-based interventions reduced cardiometabolic risk, whereas nutritional interventions reduced body weight in the above study (Nordestgaard et al., 2013). In addition, Lee et al. (2014) observed significant reductions in body weight, free fatty acids, and serum triglycerides in obese people after a 12-week intervention.

Thus, a study that employs theoretical-practical strategies to treat obesity in females, with the participation of professionals of different backgrounds (considering that obesity is a multifactorial disease), could add to the evidence on the efficacy of non-pharmacological treatment of chronic non-communicable diseases in females. Accordingly, this study aimed to investigate the effects of a multi-professional intervention with a hybrid component (activities performed in university installations and other online activities, with live discussions about health) on the morphological and cardiorespiratory parameters of overweight or obese females after 6 and 12 weeks. As a hypothesis, it is believed that the intervention will promote significant improvements in the different areas of health-related physical fitness, emphasizing the effectiveness of interventions conducted over 12 weeks.

Methods

Sample, Variables, and Research Design

The present research is a quantitative study of pre-experimental, interventional, repeated measures (pre-intervention, after 6 weeks of intervention, and after 12 weeks of intervention). The study was carried out from April 2019 to August 2019. Seventeen females between 40 and 59 years of age were included in the final analyses. The inclusion criteria were as follows: ***i)*** middle-aged adult females (between 40-59 years old); ***ii)*** BMI indicating overweight or obesity (≥ 25 kg/m²); ***iii)*** the ability to participate in interventions four times a week (three practical classes [in person] and one theoretical class [online]), over 12 weeks of multi-professional interventions, and ***iv)*** a medical approval to participate in physical activites. The exclusion criteria were as follows: ***i)*** females who were using psychotropic or corticosteroid drugs; ***ii)*** presence of musculoskeletal lesions that could limit the practice of physical activity; ***iii)*** being on some type of diet (received nutritional planning); and ***iv)*** undergoing hormone replacement therapy. All participants were informed about the project's objectives and were invited to sign the informed consent form. The study was approved by the ethics research committee, under number: 063060/2019, and was conducted following 466/2012 of the Brazilian Ministry of Health and the Helsinki Declaration.

Participants underwent a series of tests to evaluate body composition, cardiorespiratory, and physical fitness anthropometric variables. The tests were as follows: ***i)*** anthropometric variables, including body weight (BW), height, and BMI calculation; ***ii)*** body composition, with the estimation of musculoskeletal mass (MME), body fat mass (BF), and body fat percentage (%BF); and ***iii)*** cardiorespiratory test, with the measurement of heart rate peak (HRpeak), systolic blood pressure (SBP) before and after the test, via the Bruce protocol (pre- and post-SBP), diastolic blood pressure (DBP) pre- and post-Bruce test (SBPpre and SBPpos), Bruce test speed, Bruce test duration, Bruce test distance, and Bruce test stage achieved. The entire recruitment process, evaluations, and reassessments are depicted in Figure 1.

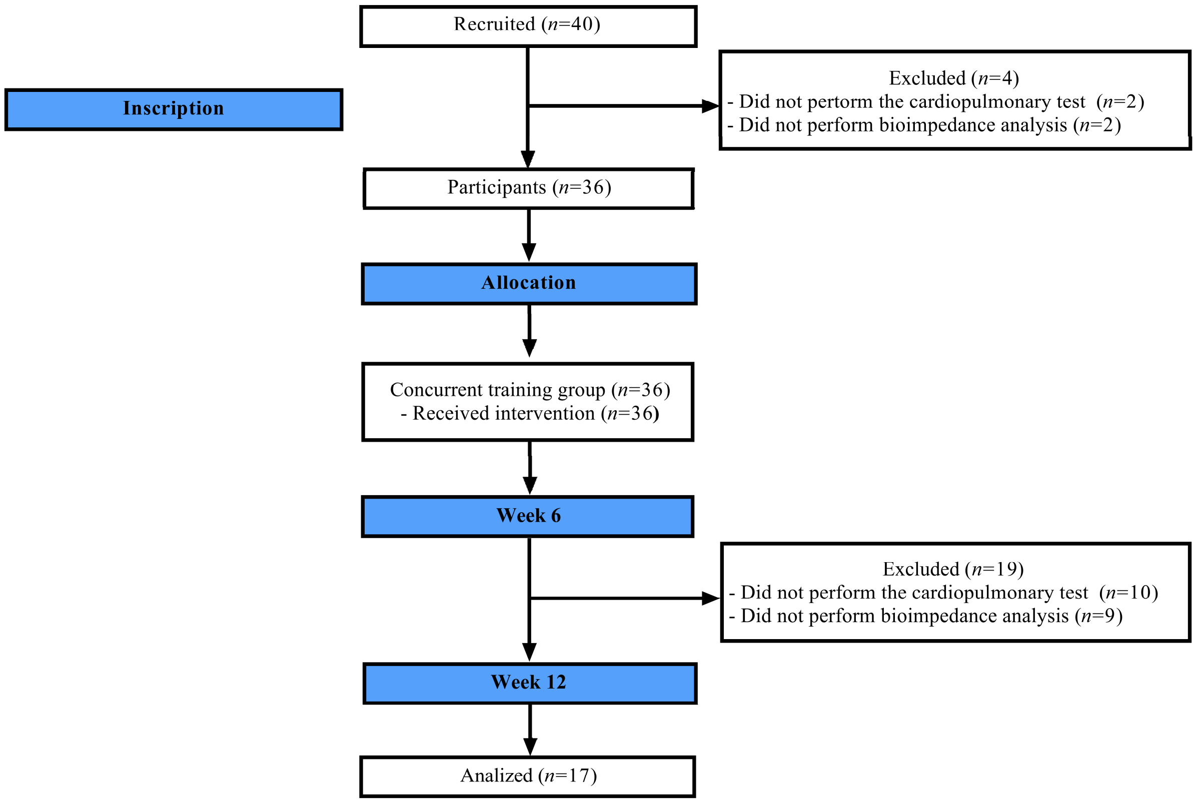

Figure 1. Flowchart of the study.

Procedure

The preliminary clinical evaluation involved a medical consultation about identifying possible health risk factors. In the assessment, an anamnesis was performed to determine the patient's family history, personal history, history of the previous diseases, history of the current illness, primary complaint, medication, surgeries, recent laboratory tests, the current level of physical activity, and availability of time for physical activity. Data on pulmonary auscultation, cardiac auscultation, blood pressure, and peripheral oxygen saturation were also collected. The participants were informed on each technique's positioning and procedure. All exercises were performed in a calm and pleasant environment, in which the positioning was adopted, free of clothes in the foci of auscultation and using a standard stethoscope. Participants were asked not to consume alcoholic beverages or caffeinated drinks (12 hours after measurement), not to smoke (1 hour after measurement), and not to engage in physical activity (24 hours after measurement). A standard sphygmomanometer and stethoscope were used for blood pressure measurement. The participants were seated with the forearm supported and their palm facing upward, cuff 2 cm above the antecubital fossa on the brachial artery, and bell below. Radial artery palpation was used to measure cuff inflation (Cavasin, 2016). Peripheral oxygen saturation was measured using an AT101C - Bioland portable finger oximeter. Pulmonary and cardiac auscultation and blood pressure measurement at rest were performed by a single researcher, with an intraclass coefficient of 0.99.

Anthropometry and body composition

Body composition analysis was performed via tetrapolar electric bioimpedance of eight InBody 570® electrodes (InBody, Biospace, Seoul, South Korea). Body weight was obtained using an electronic scale with a stadiometer with 250 kg capacity and 0.1 kg accuracy (Welmy, Santa Bárbara do Oeste, Brazil), and height was subsequently measured following Dettwyler et al. (1993). The requirements were as follows: fasting for 4 hours (not ingesting any liquids or solids), wearing light and comfortable clothes, being without props and metals in the body, urinating 30 minutes before, not exercising lightly or intensely in the 24 hours before the measurement, not taking diuretic medications in the last 24 hours, and not drinking caffeinated drinks 12 hours before the test (Branco et al., 2018).

Cardiorespiratory test

The Bruce test was used on the treadmill Inbramed (ATL model, Porto Alegre, Brazil) to evaluate cardiorespiratory fitness (Bruce et al., 2004). Direct analysis of gas exchange was performed using the metabolic gas analyzer VO2000 (Medgraphics®, Saint Paul, USA), using peak oxygen consumption (VO_2peak), and heart rate was measured using a Polar cardio frequency meter (model FT1, Kempele, Finland). The equipment was calibrated to the manufacturer's specifications. SBP and DBP were measured before and after interventions by the same researcher, which presented an intraclass coefficient of 0.99.

Physical training, food re-education, and psychological intervention

The physical training period was divided into two mesocycles, divided into series A and B, which were performed alternately, 3 times a week for 12 weeks. The first mesocycle used an effort: pause ratio of 30" by 30" and the second mesocycle used an effort: 40" by 20". The repetitions of the exercises were not counted. It was decided to use the time in seconds for the effort and pause actions. All physical exercises were performed in person, in a group, and guided by a team of physical education professionals. Table I presents the exercises developed in the first mesocycle (1st to the 6th week) and the second intervention mesocycle (7th to the 12th week) of interdisciplinary interventions.

Table I. Physical exercises of the first and second mesocycle for the women participating in this study.

First mesocycle			
Order	**Exercises - Serie A**	**Order**	**Exercises - Serie B**
1	Walking / Quick Walk / Trot 8 min	1	Walking / Quick Walk / Trot 8 min
2	Marches with the change of direction: right and left	2	Marches with the change of direction: right and left
3	Half Squat Jump	3	Half Squat Jump
4	Slalom Jump (with agility ladder)	4	Slalom Jump (with agility ladder)
5	Medicine Ball Squat and Overhead Throw	5	Medicine Ball Squat and Overhead Throw
6	Active rest: trot	6	Active rest: trot
7	Push-up (on knees)	7	Pull tire and naval rope
8	Active rest: trot	8	Step-up
9	Stiff leg dead lifts with medicine ball	9	Active rest: trot
10	Active rest: trot	10	Tire flip
11	Rope twist and naval rope	11	Active rest: trot
12	Trot / quick walk / walk	12	Sit-up
13	Stretching	13	Trot / quick walk / walk
		14	Stretching
Second mesocycle			
Order	**Exercises - Serie A**	**Order**	**Exercises - Serie B**
1	Walking / quick walk and trot	1	Walking / quick walk and trot
2	Trotting up between the sides of the cones and running hard between the tips	2	Trotting up between the sides of the cones and running hard between the tips
3	Skipping stopped picking up the cone	3	Skipping stopped picking up the cone
4	Skipping in motion: front and back	4	Skipping in motion: front and back
5	Shoulder tap push-up	5	Shoulder tap push-up
6	Single leg declines rear bridge	6	Single leg declines rear bridge
7	Lateral displacement agility ladder	7	Lateral displacement agility ladder
8	Active rest: trot	8	Active rest: trot
9	Push-up	9	Beat ropes: Twist Rope and in the rest interval: up and down the tire
10	Active rest: trot	10	Active rest: trot
11	Medicine ball wall shot	11	Medicine ball trunk rotation throw on the floor
12	Trot / quick walk / walk	12	Active rest: trot
13	Advance with a medicine ball pitch	13	Half knees rotating alternating side
14	Trot / quick walk / walk	14	Trot / quick walk / walk
15	Stretching	15	Stretching

Food re-education and group psychotherapy sessions were held online via the Google Meet platform (Google, Mountain View, CA, USA). The sessions were led by nutritionists and psychologists and discussed the following topics: ***i)*** self-monitoring and prevention of compulsive episodes of eating; ***ii)*** reduction of anxiety symptoms and negative emotions; ***iii)*** stress control; ***iv)*** self-acceptance of body image; ***v)*** food re-education based on increased consumption of natural and minimally processed foods and reduced consumption of processed and ultra-processed foods, and ***vi)*** discussion of food topics mentioned by the study participants. Twelve meetings were held each week, lasting approximately 1 hour each.

Statistical analysis

The data were presented as means and standard deviations. The Shapiro-Wilk test was used to verify the data's normality, and the Levene test was used to verify the homogeneity of the data. The parametric data were compared by a variance analysis (one-way analysis of variance) of repeated measures, applying the Bonferroni correction if a significant difference was detected. The non-parametric data were analyzed via Friedman's analysis of variance, with Dunn's post-hoc test. The significance level for all statistical comparisons was $p<0.05$.

The effect size was calculated using Cohen's *d*, as proposed by Rhea (2004), classified as: < 0.50 (*trivial*); ≥ 05.0-1.25 (*small*); > 1.25-1.9 (*moderate*), or ≥ 2.0 (*large*). The absolute and relative deltas (Δ) were also calculated, considering time difference (after 6 weeks and after 12 weeks, less pre-intervention values). All statistical analyses were performed using GraphPad Prism version 5.0 (GraphPad, San Diego, CA, USA).

Results

For body composition, significant reductions were observed in BF and %BF ($p<0.05$) when comparing pre- and post-intervention, as shown in Table II. No significant differences were observed for BW, BMI, and MME between the different time measurements ($p>0.05$). Table II presents the data on the anthropometric variables and body composition at the three-time measurements.

Table II. Anthropometry and body composition in the three moments of evaluation.

(*n*=17)	Pre	6 weeks	d^a	Δabs^a	Δ%^{a}	12 weeks	d^b	Δabs^b	Δ%^{b}
BW (kg)	81.4 ± 14.9	81.0 ± 14.4	0.0	-0.4	-0.49	80.6 ± 14.3	0.0	-0.8	-1.0
BMI (kg/m²)	31.0 ± 5.4	30.7 ± 4.9	0.0	-0.3	-0.96	30.6 ± 4.7	0.0	-0.4	-1.3
MME (kg)	25.4 ± 3.3	25.7 ± 3.4	0.0	0.3	1.18	26.2 ± 5.5	0.2	0.8	3.1
BF (kg)	35.3 ± 11.2	34.3 ± 10.7	0.0	-0.9	-2.83	**34.0 ± 10.2***	-0.1	-1.3	-3.7
% BF	42.5 ± 6.4	**41.6 ± 6.6***	-0.1	-0.9	-2.11	**41.4 ± 6.2***	-0.2	-1.1	-2.6

Note: Values expressed by mean and (±) standard deviation; * = significant difference ($p<0.05$) in relation to pre; BW = body weight; BMI = body mass index; MME = musculoskeletal mass; BF = body fat; %G = body fat percentage; a = comparison between the pre-intervention time and, after 6 weeks of intervention; b = comparison between the pre-intervention time and, after 12 weeks of intervention; Δ = delta (post minus pre values); abs = absolute values; % = relative values. *d* = Cohen´s *d*; For more information on the effect size's magnitude, see the methods.

For physical fitness, significant differences were observed for Bruce test duration, with higher values after 6 and 12 weeks compared with the pre-intervention values ($p<0.05$). It was also found that the values for Bruce test distance were greater after 12 weeks when compared with the values obtained after 6 weeks and in the pre-intervention period ($p<0.05$). Similarly, higher values were obtained for Bruce test distance after 6 weeks than the pre-intervention period ($p<0.05$). There were no statistical differences between other variables of the Bruce test ($p>0.05$). Table III presents the physical fitness values obtained at the three-time measurements.

Table III. Physiological and mechanical responses to Bruce's test.

(*n*=17)	Pre	6 weeks	d^a	Δabs^a	Δ%^{a}	12 weeks	d^b	Δabs^b	Δ%^{b}
HRpeak (bpm)	172.6 ± 13.5	172.3 ± 8.0	0.0	-0.3	-0.2	174.1 ± 13.0	0.1	1.5	0.9
SBP pre-test (mmHg)	122.9 ± 10.5	120.6 ± 6.6	-0.2	-2.30	-1.9	124.1 ± 10.0	0.1	1.2	1.0
SBP post-test (mmHg)	168.8 ± 18.7	158.2 ± 22.7	-0.6	-10.6	-6.3	177.6 ± 27.7	0.4	8.8	5.2
DBP pre-test (mmHg)	81.2 ± 4.9	77.6 ± 9.0	-0.7	-3.6	-4.4	78.2 ± 9.5	-0.6	-3.0	-3.7
DBP post-test (mmHg)	84.7 ± 8.0	78.2 ± 15.1	-0.8	-6.5	-7.7	82.9 ± 11.0	-0.2	-1.8	-2.1
VO_2peak (mL/kg/min)	34.2 ± 4.2	33.7 ± 4.8	-0.1	-0.5	-1.5	33.6 ± 5.3	-0.1	-0.6	-1.7
Speed (km/h)	5.9 ± 1.0	6.7 ± 0.7	0.8	0.8	13.6	7.1 ± 0.7	1.2	1.2	20.3
Length (min)	9.1 ± 1.7	**10.0 ± 1.6***	0.5	0.9	9.9	**10.8 ± 1.8***	1.0	1.7	18.7
Distance (km)	0.6 ± 0.2	0.7 ± 0.2	0.5	0.1	16.7	**0.8 ± 0.2*#**	1.0	0.2	33.3
Stage (n)	3.4 ± 0.8	3.9 ± 0.6	0.6	0.5	14.0	4.3 ± 0.6	1.1	0.9	26.5

Note: Values expressed by mean and (±) standard deviation; * = statistical difference ($p<0.05$) in the twelfth week when compared to pre-intervention time; # = statistical difference ($p<0.05$) in relation to measurement conducted in the sixth week; HRpeak = peak heart rate; SBP pre-test = Bruce's pre-test systolic blood pressure; SBP post-test = Bruce's post-test systolic blood pressure; DBP pre-test = Bruce's pre-test diastolic blood pressure; DBP post-test = Bruce's post-test diastolic blood pressure; VO_2peak = peak oxygen consumption.

The variables speed, duration, distance, and stage are related to the Bruce test; a = comparison between the pre-intervention time and after 6 weeks of intervention; b = comparison between the pre-intervention and after 12 weeks of intervention. Δ = delta (post values minus pre values); abs = absolute values; % = relative values; *d* = Cohen´s *d*; For more information on the effect size's magnitude, see the methods.

Discussion

The main aim of this study was to investigate the effects of a multi-professional intervention on morphological and cardiorespiratory parameters in overweight or obese females after 6 and 12 weeks of hybrid intervention; the following results were identified: ***(1)*** a significant reduction in BF and %BF after 12 weeks of intervention and ***(2)*** a significant increase in Bruce test duration and distance after 12 weeks of intervention. No significant differences were found in BW, BMI, MMI, VO_2peak, HRpeak, and BP after 6 or 12 weeks. Given this, it is considered that the study hypothesis has been confirmed.

The BF and %BF changes observed in the present study are in line with the results of a study by Donnelly et al. (2009) that indicated that the inclusion of 150 to 250 minutes of moderate physical activity a week provides energy expenditure between 1000 and 2000 kcal. According to Donnelly et al. (2009), this energy expenditure would be sufficient to avoid BW gain greater than 3% in most adults and may also result in a slight weight loss in some cases. In the present study, on average, BF decreased by 3.7% after the interventions, and %BF decreased by an average of 3.4%. The decrease of BF and %BF is fundamentally positive for reducing the impacts caused by adiposity, since, for example, for every 1 kg lost and maintained, some favorable changes are seen, such as: -1.0% of total cholesterol, +0.68% of HDL cholesterol, -0.5% diastolic pressure, and -0.2% in fasting glycemia (Anderson & Konz, 2001).

When a decrease in BF and %BF occurs in a planned way, it is expected that MME loss will occur simultaneously (Gallagher et al., 2017). Recent research has suggested that menopausal transition decreases muscle mass through positive MME catabolism changes or reduced muscle response to anabolic stimuli, such as resistance training (Cheng et al., 2018). However, there was no increase in this variable or significant losses of the MME in the present study, which is already a great advantage, considering the unfavorable physiological processes. In that sense, the present study results support Bolognese et al. (2020), who observed MME preservation concomitantly with reduced BW, BMI, BF, and %BF after 12 weeks of multi-professional interventions. Maintenance of MME is essential for conserving the resting metabolic rate because MME is one of the main factors that explains the magnitude of basal metabolism (Stiegler & Cunliffe, 2006). Thus, physical exercises that aid in the maintenance and/or gain of MME reduce %BF and BF significantly affect total energy expenditure (Stiegler & Cunliffe, 2006). Physiologically, the reduction of MME is related to aging, mainly after the age of 50, becoming greater around the age of 60 (Deschenes, 2004). However, it is emphasized that the maintenance of MME is relevant, since sarcopenic obesity can generate different harmful effects on the individual's health, such as difficulties in performing daily activities, reduction in the speed of walking, reduction in mobility, long-term disability, increased risk of dyslipidemia, and increased inflammatory adipokines that may alter insulin sensitivity (Batsis & Villareal, 2018).

Positive changes were also observed in some variables of the cardiopulmonary test, such as Bruce test duration and distance. Similarly, in a study by Paavolainen et al. (1999), runners who used concurrent training presented an improvement in running time, although VO_2peak values did not improve. Enhanced performance without increased VO_2peak can be explained by increased capillarization of muscles, mitochondrial biogenesis, the economy of movement, and increased oxidative enzymatic activity responses promoted by concurrent training (Slentz et al., 2004). In addition to these responses, concurrent training becomes effective for hypertrophy, strength, and power (to a lesser extent than isolated strength training), attenuating these variables compared with endurance training. The muscles are subjected to different contractile stimuli during concurrent training, altering the adaptive responses, favoring the variables' increased (Coffey & Hawley, 2017). Adenosine triphosphate (ATP) should be produced quickly as it is used during exercise through oxidative phosphorylation (Wilson, 2017). For this reason, the rate of uptake of oxygen during exercise serves as a measurement of the rate at which ATP is generated. Moreover, it has been found that the amount of oxygen used is directly linked to endurance race performance, as performed in the Bruce protocol. It is known that the rate of ATP production through oxidative phosphorylation is related to the individual's ability to convert energy during the performance so that an "energy-saving execution" can occur during the race, given the adaptations suffered by the organism (Coyle, 1995). The term "energy-saving execution" is used to express the uptake of oxygen needed to run at a certain speed or even the energy required per unit mass to cover a horizontal distance (Bassett, 2000). In the present study, although no changes were observed in the VO_2peak values, which is an indicator of aerobic fitness, there were improvements in the mechanical efficiency, resistance, and performance of the participants, given the adaptations suffered in the process of "energy savings of execution" on account of the applied training.

It is also worth noting that although no changes in VO_2max have been observed, there is a clear benefit in adding strength training to endurance training (Coffey & Hawley, 2017). The absence of differences in VO_2peak can be explained by the fact that VO_2peak is a variable that presents a late adaptation in this training style. Concurrent stimuli may cause a delay in the development of VO_2peak, which, according to Brum et al. (2004), begin to show significant improvements after 11 weeks of training. Thus, the absence of modifications of HRpeak, SBP, and DBP before and after the intervention has the possibility of being justified because of their connection with the cardiorespiratory fitness represented as VO_2peak (Nauman et al., 2012). The improvement in duration and distance in the test demonstrates a tendency to increase VO_2peak with the continuity of training, which is highly positive. Thus, the increase in cardiorespiratory fitness is linked to preventing cardiovascular morbidity and mortality (Al-Mallah et al., 2018). Therefore, the BF and %BF values reductions also indicate a positive characteristic. In addition to decreasing the prevalence of obesity, these changes can strengthen metabolic syndrome treatment. These excess tissues may be related to endocrine-level inflammation, causing secondary damage to several tissues and preventing the risk of developing type 2 diabetes mellitus (Klöting & Blüher, 2014).

It is necessary to consider that discrete body composition changes may be related to the end of productive age (around 45 years old). According to a recent study by Greendale et al. (2019), the fat mass gain during pre-menopause is two to four times greater than in fertile ages. The decrease in estrogen concentration justifies this change due to the decline of ovarian functionality concomitant with increased androgen secretion due to these hormonal profile changes, especially in the abdominal region (Dmitruk et al., 2018). This study had two significant limitations: ***i)*** this study did not measure food control (food records), which may interfere with the response to body composition; ***ii)*** this study did not use a control group. However, in studies on weight loss, the control group's use could be problematic because the participants may not receive the benefits of the intervention method (Hecksteden et al., 2018). Regarding the absence of the control group in this research, it is essential to emphasize that the benefits of the intervention would not be obtained by it. Therefore, in line with Hecksteden et al. (2018), in interventions that will undoubtedly present benefits for health, health-related quality of life, and food, the absence of the control group is justified.

Conclusions

Although no changes were observed in VO_2peak, HRpeak, and BW, the interventions efficiently reduced the participants' %BF and BF. There were also significant improvements in the cardiopulmonary test variables, such as Bruce test distance and duration after 12 weeks of intervention. Finally, we highlighted the effectiveness of online strategies (food re-education and group psychotherapy) performed once a week as supplementary tools in treating obesity. The proposed intervention model (i.e., exercises using body weight and accessories and nutritional and psychological interventions online) effectively reduced body fat and improved health-related physical fitness parameters in overweight or obese females after 12 weeks.

Conflicts of interest

The authors declare that they have no conflicts of interest.

Acknowledgement

The authors thank Master student Fabiano Mendes de Oliveira for developing the flowchart diagram. The authors also thank medicine student, Lovro Pendić, for English grammar review. Finally, the authors thank PPSUS of "Fundação Araucária" and Cesumar Institute of Science, Tecnology and Innovation, in order for providing the grants for the conduction of this study.

References

Alberti, K. G., Zimmet, P., & Shaw, J. (2006). Metabolic syndrome--a new world-wide definition. A Consensus Statement from the International Diabetes Federation. *Diabetic Medicine, 23*(5), 469-480.

Al-Khudairy, L., Loveman, E., Colquitt, J. L., Mead, E., Johnson, R. E., Fraser, H., Olajide, J., Murphy, M., Velho, R. M., O'Malley, C., Azevedo, L. B., Ells, L. J., Metzendorf, M.-I., & Rees, K. (2017). Diet, physical activity and behavioural interventions for the treatment of overweight or obese adolescents aged 12 to 17 years. *Cochrane Database of Systematic Reviews*, 22(6), CD012691.

Al-Mallah, M. H., Sakr, S., & Al-Qunaibet, A. (2018). Cardiorespiratory Fitness and Cardiovascular Disease Prevention: an Update. *Current Atherosclerosis Reports*, *20*(1), 1.

Anderson, J. W., & Konz, E. C. (2001). Obesity and Disease Management: Effects of Weight Loss on Comorbid Conditions. *Obesity Research*, *9*(S11), 326S-334S.

Bassett, D. R. (2000). Limiting factors for maximum oxygen uptake and determinants of endurance performance. *Medicine & Science in Sports & Exercise*, 32(1), 70-84.

Batsis, J. A., & Villareal, D. T. (2018). Sarcopenic obesity in older adults: etiology, epidemiology and treatment strategies. *Nature Reviews Endocrinology*, *14*(9), 513–537.

Bolognese, M. A., Franco, C. B., Ferrari, A., Bennemann, R. M., Lopes, S. M. A., Bertolini, S. M. M. G., Júnior, N. N., & Branco, B. H. M. (2020). Group Nutrition Counseling or Individualized Prescription for Women With Obesity? A Clinical Trial. *Frontiers in Public Health*, *8*, 1-13.

Branco, B. H. M., Bernuci, M. P., Marques, D. C., Carvalho, I. Z., Barrero, C. A. L., Oliveira, F. M. de, Ladeia, G. F., & Júnior, N. N. (2018). Proposal of a normative table for body fat percentages of Brazilian young adults through bioimpedanciometry. *Journal of Exercise Rehabilitation*, *14*(6), 974–979.

Branco, B. H. M., Carvalho, I. Z., Oliveira, H. G., Fanhani, A. P., Santos, M. C. M., Oliveira, L. P., Boni, S. M., & Nardo, N. (2020). Effects of 2 Types of Resistance Training Models on Obese Adolescents' Body Composition, Cardiometabolic Risk, and Physical Fitness. *Journal of Strength and Conditioning Research*, *34*(9), 2672–2682.

Branco, B. H. M., Valladares, D., de Oliveira, F. M., Carvalho, I. Z., Marques, D. C., Coelho, A. A., de Oliveira, L. P., & Bertolini, S. M. M. G. (2019). Effects of the Order of Physical Exercises on Body Composition, Physical Fitness, and Cardiometabolic Risk in Adolescents Participating in an Interdisciplinary Program Focusing on the Treatment of Obesity. *Frontiers in Physiology*, *10*, 1-11.

Bruce, R. A., Blackmon, J. R., Jones, J. W., & Strait, G. (2004). Exercising Testing in Adult Normal Subjects and Cardiac Patients*. *Annals of Noninvasive Electrocardiology*, *9*(3), 291–303.

Brum, P. C., Forjaz, C. L. de M., Tinucci, T., & Negrão, C. E. (2004). Adaptações agudas e crônicas do exercício físico no sistema cardiovascular. *Revista Paulista de Educação Física*, 18(1), 21-31.

Buemann, B., & Tremblay, A. (1996). Effects of exercise training on abdominal obesity and related metabolic complications. *Sports Medicine, 21*(3), 191-212

Cavasin, S. B. P. (2016). 7ª Diretriz Brasileira de Hipertensão Arterial. *Sociedade Brasileira de Cardiologia*.

Cheng, C.-C., Hsu, C.-Y., & Liu, J.-F. (2018). Effects of dietary and exercise intervention on weight loss and body composition in obese postmenopausal women: a systematic review and meta-analysis. *Menopause*, *25*(7), 772–782.

Coffey, V. G., & Hawley, J. A. (2017). Concurrent exercise training: do opposites distract? *The Journal of Physiology*, *595*(9), 2883–2896.

Coyle, E. F. (1995). Integration of the Physiological Factors Determining Endurance Performance Ability. *Exercise and Sport Sciences Reviews*, *23*, 25-63.

Da Silva-Grigoletto, M. E., Brito, C. J., & Heredia, J. R. (2014). Treinamento funcional: funcional para que e para quem? *Revista Brasileira de Cineantropometria e Desempenho Humano*, *16*(6), 714-719.

Dada, R. P., Branco, B. H. M., Terra, C. M. de O., Lazarin, S. P. B., Hintze, L. J., & Nardo Junior, N. (2018). Nutritional status and cardiometabolic risk in women: relationship with usual and non-usual components of body composition. *Journal of Physical Education*, *29*, e2935.

Deschenes, M. R. (2004). Effects of Aging on Muscle Fibre Type and Size. *Sports Medicine*, *34*(12), 809–824.

Dettwyler, K. A. (1993). Anthropometric standardization reference manual, abridged edition. Edited by Timothy G. Lohman, Alex F. Roche, and Reynaldo Martoll. Champaign, Illinois: Human Kinetic Books. 1991. 90 pp. *American Journal of Physical Anthropology*, *92*(2), 239–241.

Dmitruk, A., Czeczelewski, J., Czeczelewska, E., Golach, J., & Parnicka, U. (2018). Body composition and fatty tissue distribution in women with various menstrual status. *Roczniki Panstwowego Zakladu Higieny*, *69*(1), 95–101.

Donnelly, J. E., Blair, S. N., Jakicic, J. M., Manore, M. M., Rankin, J. W., & SMITH, B. K. (2009). Appropriate Physical Activity Intervention Strategies for Weight Loss and Prevention of Weight Regain for Adults. *Medicine & Science in Sports & Exercise*, *41*(2), 459–471.

Gallagher, D., Kelley, D. E., Thornton, J., Boxt, L., Pi-Sunyer, X., Lipkin, E., Nyenwe, E., Janumala, I., & Heshka, S. (2017). Changes in skeletal muscle and organ size after a weight-loss intervention in overweight and obese type 2 diabetic patients. *The American Journal of Clinical Nutrition*, *105*(1), 78–84.

Greendale, G. A., Sternfeld, B., Huang, M., Han, W., Karvonen-Gutierrez, C., Ruppert, K., Cauley, J. A., Finkelstein, J. S., Jiang, S.-F., & Karlamangla, A. S. (2019). Changes in body composition and weight during the menopause transition. *JCI Insight*, *4*(5) e124865.

Han, L., You, D., Zeng, F., Feng, X., Astell-Burt, T., Duan, S., & Qi, L. (2019). Trends in Self-perceived Weight Status, Weight Loss Attempts, and Weight Loss Strategies Among Adults in the United States, 1999-2016. *JAMA Network Open*, *2*(11), e1915219.

Hecksteden, A., Faude, O., Meyer, T., & Donath, L. (2018). How to Construct, Conduct and Analyze an Exercise Training Study? *Frontiers in Physiology*, *9*, 1-15.

Jensen, M. D., Ryan, D. H., Apovian, C. M., Ard, J. D., Comuzzie, A. G., Donato, K. A., Hu, F. B., Hubbard, V. S., Jakicic, J. M., Kushner, R. F., Loria, C. M., Millen, B. E., Nonas, C. A., Pi-Sunyer, F. X., Stevens, J., Stevens, V. J., Wadden, T. A., Wolfe, B. M., & Yanovski, S. Z. (2014). 2013 AHA/ACC/TOS Guideline for the Management of Overweight and Obesity in Adults. *Circulation*, *129*(25 suppl 2), S102–S138.

Klöting, N., & Blüher, M. (2014). Adipocyte dysfunction, inflammation and metabolic syndrome. *Reviews in Endocrine and Metabolic Disorders*, *15*(4), 277–287.

Lee, A., Jeon, K. J., Kim, H.-K., & Han, S. N. (2014). Effect of a 12-week weight management program on the clinical characteristics and dietary intake of the young obese and the contributing factors to the successful weight loss. *Nutrition Research and Practice*, *8*(5), 571–579.

McCuen-Wurst, C., Culnan, E., Stewart, N. L., & Allison, K. C. (2017). Weight and Eating Concerns in Women's Reproductive Health. *Current Psychiatry Reports*, *19*(10), 68.

Ministério da Saúde. (2020). Vigitel Brasil 2019. In *Vigitel Brasil 2019 : vigilância de fatores de risco e proteção para doenças crônicas por inquérito telefônico : estimativas sobre frequência e distribuição sociodemográfica de fatores de risco e proteção para doenças crônicas nas capitais dos 26 estados*.

Nauman, J., Aspenes, S. T., Nilsen, T. I. L., Vatten, L. J., & Wisløff, U. (2012). A Prospective Population Study of Resting Heart Rate and Peak Oxygen Uptake (the HUNT Study, Norway). *PLoS ONE*, *7*(9), e45021.

Nordestgaard, B. G., Chapman, M. J., Humphries, S. E., Ginsberg, H. N., Masana, L., Descamps, O. S., Wiklund, O., Hegele, R. A., Raal, F. J., Defesche, J. C., Wiegman, A., Santos, R. D., Watts, G. F., Parhofer, K. G., Hovingh, G. K., Kovanen, P. T., Boileau, C., Averna, M., Boren, J., & Tybjaerg-Hansen, A. (2013). Familial hypercholesterolaemia is underdiagnosed and undertreated in the general population: guidance for clinicians to prevent coronary heart disease: Consensus Statement of the European Atherosclerosis Society. *European Heart Journal*, *34*(45), 3478–3490.

Paavolainen, L., Häkkinen, K., Hämäläinen, I., Nummela, A., & Rusko, H. (1999). Explosive-strength training improves 5-km running time by improving running economy and muscle power. *Journal of Applied Physiology*, *86*(5), 1527–1533.

Rhea, M. R. (2004). Determining the Magnitude of Treatment Effects in Strength Training Research Through the Use of the Effect Size. *The Journal of Strength and Conditioning Research*, *18*(4), 918-920.

Slentz, C. A., Duscha, B. D., Johnson, J. L., Ketchum, K., Aiken, L. B., Samsa, G. P., Houmard, J. A., Bales, C. W., & Kraus, W. E. (2004). Effects of the Amount of Exercise on Body Weight, Body Composition, and Measures of Central Obesity. *Archives of Internal Medicine*, *164*(1), 31-39.

Solmi, M., Köhler, C. A., Stubbs, B., Koyanagi, A., Bortolato, B., Monaco, F., Vancampfort, D., Machado, M. O., Maes, M., Tzoulaki, I., Firth, J., Ioannidis, J. P. A., & Carvalho, A. F. (2018). Environmental risk factors and non-pharmacological and nonsurgical interventions for obesity: An umbrella review of meta-analyses of cohort studies and randomized controlled trials. *European Journal of Clinical Investigation*, *48*(12), e12982.

Stiegler, P., & Cunliffe, A. (2006). The Role of Diet and Exercise for the Maintenance of Fat-Free Mass and Resting Metabolic Rate During Weight Loss. *Sports Medicine*, *36*(3), 239–262.

Tambasco, L. de P., Silva, H. S. da, Pinheiro, K. M. K., & Gutierrez, B. A. O. (2017). A satisfação no trabalho da equipe multiprofissional que atua na Atenção Primária à Saúde. *Saúde Em Debate*, *41*(spe2), 140–151.

Tauqeer, Z., Gomez, G., & Stanford, F. C. (2018). Obesity in Women: Insights for the Clinician. *Journal of Women's Health*, *27*(4), 444–457.

Wilson, D. F. (2017). Oxidative phosphorylation: regulation and role in cellular and tissue metabolism. *The Journal of Physiology*, *595*(23), 7023–7038.