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Multidisciplinary approach to obesity: Aerobic or resistance physical exercise?

Mohamed Ahmed Said [a, *], Mohamed Abdelmoneem [a], Abdullah Almaqhawi [b], Ahmad Abdel Hamid Kotob [a], Mohammed Chaab Alibrahim [a], Iheb Bougmiza [b]

[a] Physical Education Department, College of Education, King Faisal University, Al-Hasa, Saudi Arabia
[b] Department of Family and Community Medicine, College of Medicine, King Faisal University, Saudi Arabia

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ABSTRACT

Background: An integrated treatment based on dieting, physical training and cognitive-behavioural psychotherapy is an effective tool to reduce obesity and its consequences. However, the feasibility of this approach is problematic. This study aims to compare two multidisciplinary programs used to improve weight loss.

Methods: Fifty-two obese individuals were subjected to an Enhanced Lifestyle Counselling associated with, according to their own choice, dieting (N = 11), or dieting + aerobic training (n = 18), or dieting + resistance training program (n = 23). The study experiment spanned 16 weeks divided into two phases. The first phase lasted 04 weeks and was oriented to enhance motivation and establishing changes in behaviours related to dietary and sedentary lifestyle. The second phase lasted 12 weeks and was oriented to add aerobic or resistance training. Body compositions, cardiovascular disease risk factors, and cardio-respiratory fitness were assessed.

Results: Data demonstrated that all obesity treatment programs were able to improve all studied variables. Weight loss levels were -6.03 ± 2.08, -10.5 ± 2.33, and -9.37 ± 1.99 kg in Dieting, DAT and DRT groups, respectively. Our results noted also that exercise training could play an important role in reducing obesity and its consequences. Nevertheless, modifications were more important in DRT at the explosivity and muscle strength and in DAT at fat percentage, aerobic capacity, SA, and CVR factors.

Conclusion: The current evidence noted that both multidisciplinary weight loss programs were efficient in the treatment of obesity and its comorbidity. Moreover, the use of aerobic exercises was more effective in reducing body fat and improving cardiorespiratory fitness. However, using resistance exercises appeared to be more appropriate to enhance the muscle potential.

Introduction

Weight loss is an urgent public health around the world. Several reports have noted that metabolic disorders, cancers, and various diseases increase steadily with the rise of the body mass in general, and the fat mass in particular. Worldwide, at least 2.8 million per year of mortalities, and around 35.8 million of global DALYs (Disability-Adjusted Life Year) result of being overweight or obese.[1] However, despite the large number of studies done in this area using various techniques to combat this epidemic, the prevalence of overweight and obesity continues to rise dramatically each year, with uncertain impact on the risks of illness and death. Additionally, evidence-based guidelines for the treatment of overweight and obesity noted that standard behavioural treatments have shown poor long-term maintenance. Due to that nearly 95% of individuals fail in their initial attempt to diet and regain the lost weight within one to five years.[2]

According to these authors, this may be mainly due to a lack of psychological tools necessary for strengthening weight-control behaviours against the powerful, innate countervailing drives. They noted that the act to restrain eating, like the inhibition of any other pleasurable activity, entails a self-regulation based on the substitution of a normal response by a competing response. Consequently, the individual in diet is always under a pressure of,

* Corresponding author.
E-mail address: masaid@kfu.edu.sa (M.A. Said).

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as described in 1890 by William James,[3] "a battle between impulsions and inhibitions that resulted in either the "explosive" or the "obstructed" will.

Thus, control-based strategies of weight management appear to be not sufficient so we have to work in addition to that on the psychological aspects of weight gain. According to Forman et al.,[2] an acceptance-based behavioural strategy can overcome the psychological problems that prevent the achievement of the weight loss intervention and, consequently, promote behaviours that lead to the incarnation of the desired goal. Such weight loss programs generally incorporate nutritional intervention and physical reconditioning program, to which a cognitive-behavioural psychotherapy have been added.[4]

Several studies suggested that aerobic exercise is the most effective strategy to prevent and treat obesity and its co-morbidities.[5] However, published research noted that resistance training is also safe and efficacious for overweight and obesity treatment mainly in increasing lean body mass and physical fitness components related to muscle strength.[6] Furthermore, recently published studies have shown that ludic activities such as team sports seem to be more effective in improving psychological and socio-affective dimensions than aerobics or resistance training programs.[7]

For all these reasons, we believe it would be interesting to analyse, on the same group of obese individuals, if a multidisciplinary weight reduction program using aerobic exercise is more effective than that using resistance exercise or inversely.

Materials and methods

Subjects

Sixty-nine sedentary male students aged 19–24 years were evaluated for potential participation. Exclusion criteria included BMI less than 30 kg m^{-2}, heart disease, diabetes requiring insulin treatment, orthopaedic or joint problems that restrict physical exercise, and the use of medications that could affect weight loss. A compliance with the study protocol of 80% was also set as a criterion for completing the study. Fifty-two students who met the eligibility criteria and agreed to participate in this experiment were subjected to an Enhanced Lifestyle Counselling associated to, according to their own choice, dieting program (D group, N = 11), or dieting + aerobic training program (DAT, n = 18), or dieting + resistance training program (DRT group, n = 23). All participants were informed about the possible risks and benefits of the protocol, and signed consent before the beginning of the study.

Study design and ethics

This is a randomized, controlled intervention trial conducted between October 2016 and March 2017. The study protocol is in conformity with the U.S. Department of Health & Human Services recommendations and reports according to the International Compilation of Human Research Standards.[8] Ethical approval was obtained from the Ethical Committee of the Deanship of Scientific Research of King Faisal University, Saudi Arabia (project number 160140).

The study experiment spanned 16 weeks divided into two phases. The first phase lasted 04 weeks and was oriented to enhance motivation and establishing changes in behaviours related to dietary and sedentary lifestyle, a minimum of 5000 steps/day was recommended.[9] The second phase lasted 12 weeks and was oriented to add a supervised physical activity to changes already established. All participants were prescribed the same goals with respect to diet but were assigned to the aerobic or resistance training program and they were scheduled for monthly lifestyle counselling sessions conducted by lifestyle coaches. At the first session, all participants were instructed about how to record food and calorie intake in diaries provided by the Saudi Ministry of Health. Each session began with a weight control and then a review of participants' recording calories intake, and to adjust the prescribed program, if necessary. At the beginning and during the two days that followed immediately the end of the intervention, body composition, cardiovascular disease (CVD) risk factors, and cardiorespiratory fitness was assessed. In addition, a WhatsApp group to which all participants were added was launched.

Outcomes and assessments

Anthropometric measurements

Height was assessed with a stadiometer (Holtain, Crymich, UK) with an accuracy of 0.1 cm. Weight was evaluated using a platform beam balance (Seca, Germany) to the nearest 0.02 kg; subjects were nude or wearing only underwear. Waist and hip circumferences were measured using a stretch-resistant tape that provides a constant tension of 100 g, and the Skinfolds thicknesses (bicipital, tricipital, supra-iliac, and suprascapular) were assessed using a Harpenden Skinfold Callipers (Harpenden Caliper, UK). All measurements were defined according to the Organization's data gathering protocol on the right side, and the body mass index (BMI) was determined using the formula: BMI = body weight x height^{-2}. Waist-to-hip ratio (WHR) was calculated, and the body fat percent (%F) and fat mass (FM) were determined using a prediction equation specific for adult.[10]

Physical fitness

Components of physical fitness related to health were evaluated for each participant. Aerobic fitness (AF) was assessed according to the American Thoracic Society statement using the Six-Minute Walk Test.[11] Speed and agility (SA) were measured through the 10 × 5m sprint test[12] using two pairs of photocells and reflectors connected with an electronic timer (Tag Hewer, Marin, Switzerland). The vertical-jump distance (VJ) was evaluated by the countermovement jump test using an Optojump dispositive (Microgate SRL, Italy) connected to a computer.[13] The abdominal muscles endurance (AME) was measured using the 1-min Sit Up test and the flexibility (F) of the lower back and hamstrings were assessed using the Sit and Reach Flexibility test.[14] A standardized warm-up proceed the testing period including five minutes of jogging followed by ten minutes of exercises of stretching, coordination, jumping and accelerations. During the CMJ test, each participant performed three trials with 60 s of rest between trials, and the best performance was recorded. Between every two tests, 3-min rest was accorded for participants, and the AF was assessed last.

Blood sample analysis

Arriving at the laboratory after a minimum of 12 h fasting, participants were asked to sit back and relax for 10–15 min. Then, the heart rate (HR), systolic blood pressure (SBP) and diastolic blood pressure (DBP) were obtained from the right arm by auscultation using a Wireless Blood Pressure Monitor (iHealth Labs Inc. FDA, CE, TGA, Health Canada). Glucose concentrations were also assessed through capillary sampling from a finger and using a blood glucose monitor (OneTouch Verio® meter, LifeScan, Inc. Milpitas, CA). In addition, approximately 10 ml of venous blood were collected in tubes without anticoagulant. The coagulum was centrifuged at 3000 rpm for 15 min at 4 °C and the serum was withdrawn and stored at −80 °C until analyses were performed at the Laboratory of King Faisal University Medical Centre. Lipid profile and its extension were assessed using Vitros commercial kits

(Ortho-Clinical Diagnostics, CA) including total cholesterol (TC), triglyceride (TG), high-density lipoprotein-cholesterol (HDL-C), and low-density lipoprotein-cholesterol (LDL-C).

Interventions

Enhanced lifestyle counselling

Details of the Enhanced Lifestyle Counselling have been previously described.[15] Briefly, each participant was offered one education session/month with 30–60 min in length and conducted by lifestyle coaches, who were trained and certified in an intervention before the experiment began. Participants were encouraged to produce a weight loss between 0.5 and 1%/week of the own weight by reducing calorie intake and increasing energy expenditure. Coaches act to reinforce motivation and sustain the weight reduction programs by resolving problems derived from self-monitoring, behavioural modifications, controlling stimulus, physical training, and appearance. At each session, the lifestyle coach acts in a way to achieve four behavioural goals: (1) strengthening the desire to lose weight based on determining the monthly weight loss, and some anthropometry modifications. The body mass, fat percentage and abdominal circumference were measured to assess the immediate effects of the weight loss programs; (2) cultivating an identity as a successful weight loser by discussing actions that they had taken to improve eating habits, increasing weight loss and time spent in physical training. Data, videos, and photos were published in the WhatsApp group; (3) eliciting autonomous motivation for a weight loss program and supporting the self-monitoring by eliciting the personal reasons for changes and supporting the congruence between their personal values and weight reduction; and (4) creating an array of non-food by encouraging participants to be engaged in daily pleasurable activities to reward themselves and reduce stress.

Dietary protocol

At the beginning of the first period, an initial dietary assessment (times and amounts of food and fluid consumed for a week) was performed by all individuals in order to define the daily amount of calories consumed, dietary compositions, and related diet behaviours that may improve weight gain. Then, for each subject, our dietician team members established a balanced and personalized dietary restriction program. No specific meals were imposed; each individual's diet was designed using the subject's dietary habits and other selected foods. The targeted daily caloric intake deficit was around 500 kcal/day, and diet was composed approximately of 15–20% proteins, 25–30% lipids and the rest from carbohydrates.[15,16] Each subject recorded the amount of food and the time at which it was consumed (4 times a week). A specifically designed notebook and a computerized database that calculates the food intake and composition were used (SCDA Nutrsoft, Cerelles, France). Participants should pay attention to consuming low fat and foods that have low glycaemic index mainly fruits, vegetables, and whole grains. However, fast food, sugar-sweetened drinks, energy drinks, French fries and potato chips, Cake and donuts, and sweets should be avoided. One open day per week was awarded for all subjects.

Physical activity

The program involved three sessions/week of, according to the own participant's choice, Low Impact Aerobics or strength training exercises. Each session started with 5–10-min warm-up, followed by the session routine, and concluded with 5–10-min cooldown. Warm-up compound walking and stretching exercises for the major muscles of the upper and lower limbs, and the session routine load was gradually increased according to the American College of Sports Medicine recommendations.[14] The DAT group was subjected to continuous rhythmic exercises performed without any jumping at 50–55% of the subject's maximum heart rate (220- age) for 30 min at weeks 1–4, at 55–60% for 35 min at weeks 5–8, and at 65–70% for 40 min at weeks 9–12. However, the DRT group underwent strength training sessions composed of muscle-strengthening exercises conducted on machines (Abdominal curl, sit-ups, leg extension, leg flexion, lateral pulldown, bench press, shoulder press, triceps extension, and biceps curl). After measuring the dynamic force using the *one repetition maximum tests*, strength exercises were performed at 40–50% of the personal recorded values for 2–3 sets of 8–12 repetitions each one with 1-min rest between sets and 3-min rest between exercises. The intensity of the exercises was increased by 10% each month. To make sure that the exercise programs were carried out as equal as possible, professional trainers supervised all training sessions and a Polar Analyser (Polar Electro Oy, Finland) was used to maintain the heart rate at the fixed interval throughout the session.[17]

Statistical analysis

For all analysis, the Statistical Package for the Social Sciences (SPSS 16.0) was used. Data distributions were checked for normality by the Kolmogorov-Smirnov test. Changes in all independent variables were calculated as *Final - Initial value*, and percentage of changes as *(Pre-value - Post-value)/Pre-value*. Student's T-test for Paired Sample was used to compare all assessment measures (baseline - follow-up). For studying the effectiveness of the weight loss program between groups, a one-way analysis of variance (ANOVA) was performed. A Pearson's correlation test was used to assess the relationship between parameters. Results were presented as mean ± SD, and statistical significance was set at $p < 0.05$.

Results

Anthropometric parameters

The initial values differ significantly between all groups in all parameters (Table 1). The DAT group was the most corpulent, and the DRT group was the thinner. At the end of the weight management program, significant changes were noted in all groups at all variables ($p < 0.01$ at WC and $p < 0.01$ at WHR for the Dieting group, and $p < 0.001$ for the rest). The relative changes differed significantly between trained and untrained subjects at weight ($p < 0.05$ for all), BMI ($p < 0.05$ for all), Fat percentage ($p < 0.05$ for all), FM ($p < 0.05$ for D vs DAT, $p < 0.01$ for D vs. DRT), WC ($p < 0.05$ for all), and WHR ($p < 0.01$ for D vs. DAT, $p < 0.001$ for D vs. DRT). A significant difference was also noted in DAT vs. DRT at FM ($p < 0.05$) and WHR ($p < 0.001$). The losing fat level depends on the initial WC level ($r = 0.3$, $p < 0.05$), and the basal percentage of fat ($r = 0.277$, $p < 0.05$).

Physical parameters

Before training, the intergroup comparisons noted that the DAT group was less performing than the other two groups in all fitness tests and the DRT participants were the most. After training, a significant improvement was noted in all groups across all physical variables, except the Dieting group at speed and agility ($p < 0.001$ for all). The relative changes differed significantly in DAT compared to the other two groups at all variables (Table 2). A significant difference was also recorded in D vs. DRT at VJ ($p < 0.05$), HJ ($p < 0.05$), AME ($p < 0.05$), and Push Up ($p < 0.01$). The relative values noted that, compared to the other two groups, the improvement was more important in DAT at the aerobic capacity ($p < 0.05$ for D, and

Table 1
The anthropometric parameters of Dieting (D), Dieting associated with aerobic training (DAT), and Dieting associated with resistance training (DRT) group before and after 16 weeks of intervention.

group		Weight (kg)	BMI (kg.m^{-2})	Fat (%)	FM (kg)	WC (cm)	WHR
Dieting group (N = 11)	before	108.69 ± 16.14**†	36.47 ± 4.97*†	36.46 ± 3.53*†	40.07 ± 9.14*††	111.72 ± 14.13**††	1.03 ± 0.16*†
	After	102.63 ± 15.75**†	33.69 ± 4.67**††	32.2 ± 3.37†	35.85 ± 8.45*††	106.78 ± 13.27**††	0.99 ± 0.13†
	Dif.	−6.03 ± 2.08 (5.38 ± 2.04%)*†	−2.87 ± 0.75 (7.22 ± 2.15%)*†	−4.26 ± 0.65 (11.24 ± 1.95%)*†	−4.22 ± 1.21 (10.09 ± 3.82%)*††	−5.08 ± 3.24 (4.35 ± 2.95%)*†	−0.23 ± 0.09 (21.84 ± 8.76%)†††**
	t	−7.988	−7.606	−11.468	−11.54	−4.813	−2.856
	Sign.	.000	.000	.000	.000	.001	.017
DAT (N = 18)	before	126.97 ± 15.65$^{\dagger\dagger\dagger\clubsuit\clubsuit}$	39.98 ± 4.02$^{\dagger\clubsuit}$	40.39 ± 4.9$^{\dagger\dagger\clubsuit}$	51.95 ± 12.44$^{\dagger\dagger\dagger\clubsuit}$	127.64 ± 13.72$^{\dagger\dagger\dagger\clubsuit\clubsuit}$	1.16 ± 0.17$^{\dagger\clubsuit}$
	After	117.58 ± 15.73$^{\dagger\dagger\dagger\clubsuit\clubsuit}$	35.36 ± 4.01$^{\clubsuit\clubsuit}$	32.06 ± 4.11†	44.65 ± 11.44$^{\clubsuit\dagger\dagger}$	118.28 ± 14.02$^{\clubsuit\clubsuit\dagger\dagger\dagger}$	1.01 ± .19†
	Dif.	−10.5 ± 2.33 (8.18 ± 1.98%) $^{\clubsuit}$	−4.62 ± 1.76 (11.27 ± 4.14%) $^{\clubsuit}$	−7.94 ± 1.4 (18.6 ± 3%) $^{\clubsuit}$	−6.75 ± 2.57 (12.51 ± 4.8%) $^{\clubsuit\dagger}$	−9.41 ± 4.75 (7.16 ± 2.17%) $^{\clubsuit}$	−0.17 ± 0.07 (13.83 ± 6.21%) $^{\clubsuit\clubsuit\dagger\dagger\dagger}$
	t	−15.837	−14.544	−10.105	−12.46	−7.487	−7.484
	Sign.	.000	.000	.000	.000	.000	.000
DRT (N = 23)	before	96.28 ± 5.65$^{\clubsuit***}$	31.98 ± 1.82$^{\clubsuit*}$	30.94 ± 2.34$^{\clubsuit**}$	29.88 ± 3.64$^{***\clubsuit\clubsuit}$	100.78 ± 6.97$^{***\clubsuit\clubsuit}$	0.88 ± 0.08$^{*\clubsuit}$
	After	87.89 ± 6.01$^{\clubsuit***}$	27.18 ± 1.85$^{\clubsuit\clubsuit}$	24.31 ± 2.62$^{\clubsuit*}$	25.25 ± 3.67$^{\clubsuit\clubsuit**}$	94.27 ± 7.11$^{\clubsuit\clubsuit***}$	0.83 ± 0.09$^{\clubsuit*}$
	Dif.	−9.37 ± 1.99 (9.27 ± 2.15%) $^{\clubsuit}$	−3.9 ± 0.69 (12.07 ± 1.92%) $^{\clubsuit}$	−6.34 ± 1.12 (19.82 ± 4.12)$^{\clubsuit}$	−5±1.27 (15.94 ± 4.14%)$^{*\clubsuit\clubsuit}$	−6.28 ± 3.54 (6.13 ± 3.44%) $^{\clubsuit}$	−0.04 ± 0.02 (4.25 ± 2.12%) $^{\clubsuit\clubsuit\clubsuit***}$
	t	−20.36	−19.401	−11.283	−12.14	−13.337	−4.192
	Sign.	.000	.000	.000	.000	.000	.000

Notes: Values are presented as mean ± SD. $^{\clubsuit}$ *p < 0.05,* $^{\clubsuit\clubsuit}$ *p < 0.01,* $^{\clubsuit\clubsuit\clubsuit}$ *p < 0.001 compared to D;* *p < 0.05, **p < 0.01, ***p < 0.001 compared to DAT; †p < 0.05, ††p < 0.01, †††p < 0.001 compared to DRT.

Table 2
Physical fitness level of Dieting (D), Dieting associated with aerobic training (DAT), and Dieting associated with resistance training (DRT) group before and after 16 weeks of intervention.

group		6min. walk (m)	SA (s)	VJ (cm)	HJ (cm)	F (cm)	AME (Unit)	Push Up (Unit)
Dieting group (N = 11)	before	408.64 ± 95.5†	68.36 ± 27.58††	27.09 ± 16.91†**	140 ± 69.57††	−11.6 ± 9.54†	21.55 ± 8.89††	15 ± 6.13††
	After	446.36 ± 102.5	57 ± 12.01††	30.27 ± 22.39††	149.09 ± 65.98††	−4.56 ± 7.37†	24.27 ± 8.16††	16.55 ± 6.15††
	Dif.	37.73 ± 16.64 (**8.4**1 ± 4.24%)*	−11.37 ± 18.18 (**16.1**3 ± **31**.52%)*	3.18 ± 1.83 (**10**.98 ± **6**.3%)**†	9.09 ± 6.25 (5.84 ± 4.**2**6%)*†	6.4 ± 3.9 (**52**.3 ± **33**.7%) *	2.73 ± 1.19 (**11**.8 ± 6.06%)**†	1.55 ± 0.82 (**9**.5 ± 5.**0**3%)***††
	t	7.521	−2.073	5.754	4.822	5.786	7.596	6.249
	Sign.	.000	.065	.000	.000	.000	.000	.000
DAT group (N = 18)	before	356.22 ± 75.63††	89.67 ± 33.19†††	17 ± 9.37$^{\clubsuit\clubsuit\dagger\dagger\dagger}$	125.11 ± 57.29†	−12.02 ± 11.12†	18.56 ± 9.76†††	11.83 ± 9.62††
	After	433.4 ± 96.82††	67.17 ± 21.24†††	22.39 ± 9.07†	140.61 ± 57.45††	−4.54 ± 9.87†	23.56 ± 9.5††	15.94 ± 9.64††
	Dif.	71.61 ± 39.78 (**18**.98 ± 8.29%) $^{\clubsuit\dagger\dagger}$	−23.11 ± 22.66 (**23**.4 ± **2**7.87%) $^{\clubsuit\dagger\dagger}$	5.39 ± 1.97 (**30**.8 ± 10.26%) $^{\clubsuit\clubsuit\dagger}$	15.5 ± 7.89 (10.28 ± 5.34%) $^{\clubsuit\dagger}$	7.24 ± 4.5 (32.4 ± 7**8**.8%) $^{\clubsuit\dagger}$	5.11 ± 2.27 (**25**.84 ± 11.87%) $^{\clubsuit\clubsuit\dagger}$	4.11 ± 2.14 (**32**.56 ± 18.7%) $^{\clubsuit\clubsuit\clubsuit\dagger}$
	t	7.542	−4.574	11.579	8.334	6.24	8.835	8.154
	Sign.	.000	.000	.000	.000	.000	.000	.000
DRT group (N = 23)	before	488.26 ± 60.58$^{\clubsuit**}$	38.83 ± 3.66$^{\clubsuit\clubsuit***}$	38.65 ± 7.18$^{\clubsuit***}$	196.74 ± 27.21$^{\clubsuit\clubsuit*}$	2.57 ± 8.74$^{\clubsuit*}$	32.52 ± 6.39$^{\clubsuit\clubsuit***}$	26 ± 5.6$^{\clubsuit\clubsuit**}$
	After	518.7 ± 68.18**	34.17 ± 3.19$^{\clubsuit\clubsuit***}$	46.74 ± 6.92$^{\clubsuit\clubsuit*}$	224 ± 27.53$^{\clubsuit\clubsuit**}$	4.62 ± 6.87$^{\clubsuit*}$	40.26 ± 7.34$^{\clubsuit\clubsuit**}$	32.13 ± 6.39$^{\clubsuit\clubsuit**}$
	Dif.	30.87 ± 15.78 (5.62 ± 3.**1**%)**	−4.65 ± 1.75 (**10.54** ± 5.**1**8%)**	8.04 ± 2.84 (**18**.64 ± 8.34%) $^{\clubsuit*}$	27.26 ± 7.71 (13.32 ± 4.5%) $^{\clubsuit*}$	1.64 ± **4**.89 (**59**.8 ± **5**4.8%)*	7 ± 2.37 (**19**.84 ± 7.65%) $^{\clubsuit*}$	6.17 ± 1.97 (21.52 ± **8**.45%) $^{\clubsuit\clubsuit*}$
	t	9.152	−12.764	13.959	16.966	0.76	14.796	15.172
	Sign.	.000	.000	.000	.000	.465	.000	.000

Notes. SA, speed and agility; VJ, vertical jump; HJ, horizontal jump; F, flexibility; AME, abdominal muscles endurance.
Values are presented as mean ± SD. $^{\clubsuit}$ p < 0.05, $^{\clubsuit\clubsuit}$ p < 0.01, $^{\clubsuit\clubsuit\clubsuit}$ p < 0.001 compared to D; *p < 0.05, **p < 0.01, ***p < 0.001 compared to DAT; †p < 0.05, ††p < 0.01, †††p < 0.001 compared to DRT.

p < 0.01 for DRT), SA (p < 0.05 for D, and p < 0.01 for DRT), VJ (p < 0.01 for D, and p < 0.05 for DRT), AME (p < 0.01 for D, and p < 0.05 for DRT), and Push Up (p < 0.001 for D, and p < 0.05 for DRT), and in DRT at HJ and the flexibility (p < 0.05 for all).

Cardiovascular risk factors biomarkers

The paired-Samples T test noted that, excepting the diastolic blood pressure in dieting individuals, all CVR factors biomarkers were significantly improved in all participants at the end of the weight loss program (Table 3). The data suggested that individuals presenting a higher degree of obesity were more vulnerable; significant correlations were noted between the body weight and all CVR factors biomarkers (unpublished results). Additionally, the ANOVA test demonstrated that relative changes were significantly more important in DAT compared to the other two groups at all variables (p < 0.01 for DAT vs. D at TG, TC, HDL-c and LDL-c; DAT vs. DRT at TG and LDL-c, and p < 0.05 for the rest). A significant difference was also noted in D vs. DRT at TC (p < 0.05).

Discussion

In the present study, an Enhanced Lifestyle Counselling was added to the standard behavioural treatments for obesity in order to improve the motivation and getting over the psychological problems that, generally, prevent the achievement of weight management processes. In addition, all sessions were conducted by lifestyle coaches that acted in a way to prevent the influence of any substantial intergroup differences at the initial level of motivation and which could affect the degree of weight loss.[18] Consequently, all participants who were engaged in this experiment achieved the study protocol with compliance more than 80%. They were satisfied with the achieved results and desire to continue their own weight loss program. The subjects' determination to maintain their weight reduction programs reflects the successful completion of the experiment and means the integration of each participant in one's

Table 3
CVR factors biomarkers concentrations in Dieting (D), Dieting associated with aerobic training (DAT), and Dieting associated with resistance training (DRT) group before and after 16 weeks of intervention.

group		Blood sugar (mg/dL)	DBP (mmHg)	SBP (mmHg)	TG (mg/dL)	TC (mg/dL)	HDL-c (mg/dL)	LDL-c (mg/dL)
Dieting group (N = 11)	before	106.91 ± 11.99*	88.91 ± 9.94†	133.45 ± 15.53††	170.1 ± 47.31	216.15 ± 28.04*††	41.85 ± 2.86†	140.66 ± 23.78*††
	After	105.82 ± 11.16b*	88.64 ± 9.27†	131.91 ± 14.26††	168.44 ± 43.98	215.01 ± 27.02*††	42.38 ± 2.9†	138.7 ± 23.03*††
	Dif.	−1.09 ± 1.2 (**0.92** ± 0.95%)*	−0.27 ± 1.19 (0.38 ± 1.04%)*	−1.34 ± 1.29* (0.**86** ± 0.79%)*	−1.65 ± 0.86 (**0.92** ± 0.**38**%)**	−1±1.18 (0.4 ± 0.5**3**%)**†	0.45 ± 0.57 (1.**01** ± 0.**8**%)**	−1.89 ± 1.4 (1.28 ± 0.**9**%)**
	t	−2.963	−0.76	−2.924	−6.315	−2.857	2.353	−4.474
	Sign.	.014	.465	.015	.000	.017	.04	.001
DAT group (N = 18)	before	121 ± 14.68$^{\clubsuit\dagger}$	91.61 ± 11.19†	133.89 ± 8.74††	192.22 ± 48.29†	238.43 ± 23.3$^{\clubsuit\dagger\dagger}$	39.74 ± 2.31†	160.31 ± 18.59$^{\clubsuit\dagger\dagger}$
	After	117.94 ± 13.2$^{\clubsuit\dagger}$	89.72 ± 10.24†	130.78 ± 7.89††	186.44 ± 47.09†	232.71 ± 22.84$^{\clubsuit\dagger\dagger}$	41.34 ± 1.9†	153.67 ± 18.52$^{\clubsuit\dagger\dagger}$
	Dif.	−3±2 (2.**24** ± **1**.87%) $^{\clubsuit\dagger}$	−1.89 ± 1.4 (2.**01** ± 1.32%) $^{\clubsuit\dagger}$	−3.11 ± 1.45 (2.23 ± 1.12%) $^{\clubsuit\dagger}$	−5.22 ± 1.98 (2.6**1** ± 1.**02**%) $^{\clubsuit\clubsuit\dagger\dagger}$	−5.84 ± 3.76 (2.38 ± 1.**4**7%) $^{\clubsuit\clubsuit\dagger}$	1.4 ± 0.76 (3.26 ± 2.08%) $^{\clubsuit\clubsuit\dagger}$	−6.74 ± 2.13 (3.95 ± 1.**2**5%) $^{\clubsuit\clubsuit\dagger\dagger}$
	t	−6.533	−5.524	−9.098	−8.818	−6.302	12.22	−12.893
	Sign.	.000	.000	.000	.000	.000	.000	.000
DRT group (N = 23)	before	104.22 ± 7.21*	80.26 ± 5.72$^{\clubsuit*}$	119.61 ± 5.11$^{\clubsuit\clubsuit**}$	146.43 ± 43.94*	186.86 ± 4.7$^{\clubsuit\clubsuit***}$	49.05 ± 4.38$^{\clubsuit*}$	107.65 ± 6.92$^{\clubsuit\clubsuit***}$
	After	102.96 ± 6.35*	79.71 ± 4.726$^{\clubsuit*}$	118.39 ± 4.84$^{\clubsuit\clubsuit**}$	145.13 ± 25.94*	185.55 ± 4.82$^{\clubsuit\clubsuit**}$	49.54 ± 4.03$^{\clubsuit*}$	106.31 ± 6.62$^{\clubsuit\clubsuit**}$
	Dif.	−1.17 ± 1.27 (1.**02** ± 1.**1**7%)*	−0.85 ± 0.74 (0.98 ± **0.8**8%)*	−1.2 ± 1.78 (0.97 ± 1.**2**8%)*	−1.36 ± 0.85 (0.**8**6 ± 0.**8**1%)**	−2.78 ± 3.24* (1.38 ± 1.64%) $^{\clubsuit*}$	0.63 ± 0.83* (1.17 ± 1.53%)*	−1.42 ± 0.76** (1.27 ± **0.6**8%)**
	t	−4.354	−5.567	−6.137	−8.334	−6.263	2.562	−7.527
	Sign.	.000	.000	.000	.000	.000	.018	.000

Notes. Values are presented as mean ± SD. $^{\clubsuit}$ $p < 0.05$, $^{\clubsuit\clubsuit}$ $p < 0.01$, $^{\clubsuit\clubsuit\clubsuit}$ $p < 0.001$ compared to D; $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$ compared to DAT; $^{\dagger}p < 0.05$, $^{\dagger\dagger}p < 0.01$, $^{\dagger\dagger\dagger}p < 0.001$ compared to DRT.

true 'sense of self' which becomes the basis of autonomous regulation.[19] Autonomous reasons for participation, associated with a tendency of the participant to be autonomy-oriented, may improve weight reduction and reinforce the long-term completion of the weight management program.[20]

Our findings demonstrated also that the weight loss levels in Dieting, DAT and DRT groups were 5.38 ± 2.04, 8.18 ± 1.98, and 9.27 ± 2.15% of the initial weight, respectively. This indicates that the objective of this study (weight loss from 0.5 to 1%/week of the initial weight over the 16-week time period) was not reached only by the dieting group, and outcomes are better when the intervention is based on a multidisciplinary approach including simultaneously lifestyle consoling, dieting, and physical activity than dieting alone.[21]

The effects of diet on the energy balance likely mediate the relationship between dietary quality and adiposity through several mechanisms that influence satiety, and consequently provides significant changes in weight and waist circumference,[22] lean body mass,[23] triglycerides, TC, HDL-c and LDL-c concentrations,[16] and longevity and oxidative stress.[24] Nevertheless, and in line with several weight loss trials, our results suggested that interventions involving caloric restriction alone were less performing in reducing obesity and its co-morbidity, and multidisciplinary interventions including diet, physical activity, sedentary behaviours, and psychological aspects can deliver better outcomes.[22] In a systematic review carried out on 28 studies focused on evaluating measures of success in a weight loss process using diet and physical activity, Millstein[25] affirmed that physical activity is a key driver of changes in fat mass and fat-free mass, however, the ideal intervention was that including components of both diet and physical activity, to reduce weight, BMI, body fat and maintain or increase fat-free mass.

Many other previous studies have also demonstrated an association between physical activity training and weight management. In a systematic review carried out on seventeen studies classified as 'high-quality' studies (range 6–8 in the PEDro scale score), and seven as 'low-quality' studies (range 4–5 in the PEDro scale score), Vasconcellos et al.[26] noted that physical activity is associated with significant and beneficial effects on body composition and physical fitness of overweight and obese adolescents. Interventions including physical activity programs are very likely to make greater changes in fat mass, WC, SBP, insulin, LDL-c, and TC, as well as smaller changes in DBP, glucose, and HDL-c. In contrast, Gondim et al.[27] affirmed that moderate regular exercise, 2 times a week, for 12 months had no effect on anthropometric parameters and body composition; however, beneficial effects were recorded on low-grade inflammatory state and cardiovascular disease biomarkers in overweight and obese individuals. Johnston et al.[28] indicated in this way that physical education duration is the cornerstone in the improvement of health-related biomarkers among youth obese individuals, while the Physical Activity Guidelines Advisory Committee[29] suggested that 300 min/week of moderate to vigorous physical activity, complemented by strength activities performed three times per week, appeared to be effective in reducing weight and improving health in youth obese individuals.

Evidence suggests also that aerobic exercise is the most effective strategy to prevent and treat obesity and its co-morbidities. Wei et al.[5] reported that aerobic exercise performed five times per week over 6 weeks period at an intensity of approximately 75% of HRmax significantly modify BMI (from 33.27 ± 5.63 to 30.07 ± 5.30), triglyceride (from 1.46 ± 0.53 to 1.04 ± 0.53 mmol/L), total cholesterol (from 5.08 ± 0.70 to 4.10 ± 0.36 mmol/l), and insulin sensitivity (HOMA-IR went from 4.24 ± 0.46 to 2.73 ± 0.49). Nevertheless, published research to date suggested that resistance training is safe and efficacious for overweight and obesity treatment mainly in increasing lean body mass and physical fitness components related to muscle strength.[6] Atashak et al.,[30] using strengthening exercises on machines performed three days per week for ten weeks, noted significant decreases in WC, WHR, Fpercentage, FM, TC, and a significant increase in fat free mass. Normandin et al.[31] investigating the impact of resistance training associated with caloric restriction on CVR factors noted a significant reduction in body weight (−5.67% loss of initial mass), SBP (−8.3 ± 15.9 mmHg), DBP (−3.3 ± 8.9), VLDL-c (−4.8 ± 9.8 mg dL^{-1}) and TG (−23.7 ± 49.1 mg dL^{-1}), and a significant increase in HDL-c (1.8 ± 6.8). Additionally, Kang et al.[32] demonstrated that lifestyle education associated with resistance training program, offered 5 d wk^{-1} for 8 months to obese adolescents, had more favourable changes than a lifestyle education alone in plasma triacylglycerol, TC/HDL-c, and DBP. Changes levels were −0.22 ± 0.06 mmol l^{-1}, 0.05 ± 0.14, and −5.92 ± 1.79 mmHg, respectively. These authors affirmed also that individuals who had the least favourable baseline values showed the most beneficial impact of the resistance training.

Nonetheless, current evidence suggested that the combination

of aerobic training and strengthening exercises might be the most efficient exercise training modality for weight loss.[33] Our results, in line with several findings, demonstrated that interventions based on dieting associated with supervised physical activity has a lot of benefits and is more effective in improving weight, increasing fat mass loss, and preserving lean body mass than dieting alone.[34]

The current study is subject to some limitations that deserve attention and should be addressed in the future. First, some patterns presented in this cross-sectional study need confirmation through longitudinal and experimental studies; the long-term success of this weight loss program should be approved in a longer follow-up period. Interventions were only 16 weeks in duration, we are not sure if participants were able to continue the weight loss process after the program ended. Second, interventions used involved a Lifestyle Counselling added to standard weight loss programs in order to enhance autonomous motives and getting over some psychological problems. Unfortunately, the motivation controls and personal values which were manipulated during this study derived from previous studies and were not tested directly. Due to their important attribute to such interventions, they should be assessed prior initiating the weight loss program in order to identify those who are most effective in producing behaviour changes among participants.[18]

Conclusions

In conclusion, these data demonstrate that enhanced lifestyle counselling associated with dieting alone, or dieting combined with aerobic or strengthening exercises over a 16- week period time are able to improve body compositions, physical fitness, and cardiovascular health state. Nevertheless, the intervention involving lifestyle behaviour changes associated with energy restriction alone appears to be less performing in reducing obesity and its co-morbidity, and multidisciplinary interventions including dieting, physical activity, and lifestyle behaviours changes can deliver better outcomes. Specifically, results demonstrated that adding aerobic training was more effective in improving fat mass, aerobic capacity, and cardiovascular health state than strengthening exercises. Later, this, may better improve muscle strength conditioning.

Conflicts of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

1. World Health Organization (WHO). *Global Health Observatory Data: Overweight and Obesity*; 2016. . Accessed February 12, 2018.
2. Forman EM, Butryn ML, Juarascio A, et al. The mind your health project: a randomized controlled trial of an innovative behavioral treatment for obesity. *Obesity*. 2013;21:1119–1126.
3. James W. *Principles of Psychology*. New York: Holt; 1890.
4. Tapper K, Shaw C, Ilsley J, Hill AJ, Bond FW, Moore L. Exploratory randomized controlled trial of a mindfulness-based weight loss intervention for women. *Appetite*. 2009;52:396–404.
5. Wei C, Yukuo W, Hebei Z. Aerobic exercise improves insulin sensitivity and lipid metabolism are associated with reduced BMI in obese adolescents. *Heart*. 2011;97:105–106.
6. Watts K, Jones TW, Davis EA, et al. Exercise training in obese children and adolescents: current concepts. *Sports Med*. 2005;35(5):375–392.
7. Drake KM, Beach ML, Longacre MR, et al. Influence of sports, physical education, and active commuting to school on adolescent weight status. *Pediatrics*. 2012;130(2):296–304.
8. Office for Human Research Protections (OHRP). *International Compilation of Human Research Standards*. Rockville: U.S. Department of Health and Human Services; 2016.
9. Davison KK, Birch LL. Childhood overweight: a contextual model and recommendations for future research. *Obes Rev*. 2001;2:159–171.
10. Duren DL, Sherwood RJ, Czerwinski SA, et al. Body composition methods: comparisons and interpretation. *J Diabetes Sci Technol*. 2008;2(6):1139–1146.
11. American Thoracic Society (ATS). ATS statement: guidelines for the six-minute Walk test. *Am J Respir Crit Care Med*. 2002;166:111–117.
12. Boddington MK, Lambert MI, St Clair Gibson A, Noakes TD. Reliability of a 5-m multiple shuttle test. *J Sports Sci*. 2001;19:223–228.
13. Dao HH, Frelut M-L, Peres G, Bourgeois P, Navarro J. Effects of a multidisciplinary weight loss intervention on anaerobic and aerobic aptitudes in severely obese adolescents. *Int J Obes*. 2004;28:870–878.
14. American College of Sports Medicine (ACSM). ACSM position stand. Progression models in resistance training for healthy adults. *Med Sci Sports Exerc*. 2009;41(3):687–708.
15. Wadden TA, Sheri Volger DB, Sarwer ML, et al. A two-year randomized trial of obesity treatment in primary care practice. *N Engl J Med*. 2011;365:1969–1979.
16. Hu M, Wang S, Wang D, et al. Combined moderate and high intensity exercise with dietary restriction improves cardiac autonomic function associated with a reduction in central and systemic arterial stiffness in obese adults: a clinical trial. *Peer J*. 2017;(5), e3900.
17. Said M, Lamya N, Olfa N, Hamda M. Effects of high-impact aerobics vs. low-impact aerobics and strength training in overweight and obese women. *J Sports Med Phys Fit*. 2015;57(3):278–288.
18. Reed JR, Struwe P, Bice MR, Yates BC. The impact of self-monitoring food intake on motivation, physical activity and weight loss in rural adults. *Appl Nurs Res*. 2017;35:36–41.
19. Georgiadis MM, Biddle SJH, Stavrou NA. Motivation for weight-loss diets: a clustering, longitudinal field study using self-esteem and self-determination theory perspectives. *Health Educ J*. 2006;65(1):53–72.
20. Williams GC, Grow VM, Freedman ZR, Ryan RM, Deci EL. Motivational predictors of weight loss and weight-loss maintenance. *J Pers Soc Psychol*. 1996;70(1):115–126.
21. Ranucci C, Pippi R, Buratta L, et al. Effects of an intensive lifestyle intervention to treat overweight/obese children and adolescents. *BioMed Res Int*. 2017: 1–12.
22. Romieu I, Dossus L, Barquera S, et al. Energy balance and obesity: what are the main drivers? *Cancer Causes Control*. 2017;28:247–258.
23. Varady KA. Intermittent versus daily calorie restriction: which diet regimen is more effective for weight loss? *Obes Rev*. 2011;12:e593–e601.
24. Johnson JB, Summer W, Cutler RG, et al. Alternate day calorie restriction improves clinical findings and reduces markers of oxidative stress and inflammation in overweight adults with moderate asthma. *Free Radic Biol Med*. 2007;42:665–674.
25. Millstein RA. Measuring outcomes in adult weight loss studies that include diet and physical activity: a systematic review. *J Nutr Metab*. 2014, 421423, 13 pages.
26. Vasconcellos F, Seabra A, Katzmarzyk PT, Kraemer-Aguiar LG, Bouskela E, Farinatti P. Physical activity in overweight and obese adolescents: systematic review of the effects on physical fitness components and cardiovascular risk factors. *Sports Med*. 2014;44(8):1139–1152.
27. Gondim OS, de Camargo VT, Gutierrez FA, et al. Benefits of regular exercise on inflammatory and cardiovascular risk markers in normal weight, overweight and obese adults. *PloS One*. 2015 Oct 16;10(10), e0140596.
28. Johnston CA, Tyler C, Fullerton G, et al. Effects of a school-based weight maintenance program for Mexican-American children: results at 2 years. *Obesity*. 2010;18(3):542–547.
29. Physical Activity Guidelines Advisory Committee report. To the secretary of health and human Services. Part A: executive summary. *Nutr Rev*. 2008;67(2): 114–120, 2009.
30. Atashak S, Peeri M, Azarbayjani MA, Stannard SR, Haghighi MM. Obesity-related cardiovascular risk factors after long-term resistance training and ginger supplementation. *J Sports Sci Med*. 2011;10(4):685–691.
31. Normandin E, Chmelo E, Lyles MF, Marsh AP, Nicklas BJ. Effect of resistance training and caloric restriction on the metabolic syndrome. *Med Sci Sports Exerc*. 2017;49(3):413–419.
32. Kang HS, Gutin B, Barbeau P, et al. Physical training improves insulin resistance syndrome markers in obese adolescents. *Med Sci Sports Exerc*. 2002;34(12): 1920–1927.
33. Schwingshackl L, Dias S, Strasser B, Hoffmann G. Impact of different training modalities on anthropometric and metabolic characteristics in overweight/obese subjects: a systematic review and network meta-analysis. *PloS One*. 2013;8(12), e82853.
34. Miller CT, Fraser SF, Levinger I, et al. The effects of exercise training in addition to energy restriction on functional capacities and body composition in obese adults during weight loss: a systematic review. *PloS One*. 2013;8(11), e81692.