Case Report

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Impact of eight weeks of concurrent training on obesity-related biochemical parameters and cardiometabolic risk factors: a case report

Abstract

Objective: evaluate the impact of concurrent training (CT) on biochemical parameters and obesity-related cardiometabolic risk factors.

Methods: case report of a sedentary 23-year-old male, classified as class 1 obese. Blood sample collected: glucose (GLU), glycated hemoglobin (HbA1c), total cholesterol (TC), triglycerides (TG), HDL-cholesterol fraction (HDL), LDL-cholesterol fraction (LDL), tumor necrosis factor alpha (TNF-α), C-reactive protein (CRP), interleukin-6 (IL-6), leptin (LEP) and adiponectin (ADP). In addition, VO2max, resting heart rate (HR), resting systolic and diastolic blood pressure (SBP and DBP), body mass (BM), height (HT), waist circumference (WC) and hip circumference (HC) were measured. The body mass index (BMI) and body adiposity index (BAI) were obtained by anthropometric measurements. All variables were evaluated before and after eight weeks of TC with progressive intensity, performed in three non-consecutive weekly sessions.

Results: a reduction was observed in blood GLU (Δ%=-5.56), HbA1c (Δ%=-13.46), TC (Δ%=-19.05), TG (Δ%=-9.64), LDL (Δ%=-32.98), TNF-α (Δ%=-23.2), CRP (Δ%=-67.03), IL-6 (Δ%=-21.2) and LEP (Δ%=-37.5). The variables HDL (Δ%=10.5) and ADP (Δ%=152.73) exhibited an increase. A decline was observed in BM (Δ%=-1.69), WC (Δ%=-9.55), HC (Δ%=-9.17), BMI (Δ%=-1.7), BAI (Δ%=-14.24), SBP (Δ%=-4.96) and HR (Δ%=-18.67). The VO$_2$max showed an increase (Δ%=16.83).

Conclusion: a concurrent 8-week training program had beneficial effects on biochemical parameters and obesity-related cardiometabolic risk factors.

Keywords: obesity, concurrent training, metabolic syndrome, prevention, treatment

Túlio Monteiro-Lago,[1,2] Marlon da Silva Cardoso,[1] Ighor Henriques,[2,3] Danielli Braga de Mello,[2,4] Marcos de Sá Rego Fortes,[7] Rodrigo Gomes de Souza Vale,[5,6] Guilherme Rosa[1–3]

[1]Castelo Branco University UCB, Rio de Janeiro, Brazil
[2]Research Group in Physical Exercise and Health Promotion GEPS, Brazil
[3]Bezerra de Araújo College FABA, Brazil
[4]Physical Education College of the Brazilian Army (EsEFEx, EB), Brazil
[5]Laboratory of Exercise Physiology LAFIEX, Estácio de Sá University, Brazil
[6]Institute of Physical Education and Sports (IEFD), Graduate Program in Exercise and Sport Sciences (PPGCEE), State University of Rio de Janeiro (UERJ), Brazil
[7]Research Institute of Brazilian Army Physical Capacitation (IPCFEx, EB, Brazil)

Correspondence: Danielli Braga de Mello, Physical Education College of Brazilian Army (EsEFEx, EB, Brazil),
Email danielli.mello@gmail.com

Received: July 16, 2019 | **Published:** August 05, 2019

Abbreviations: HT, height; BM, body mass; WC, waist circumference; HC, hip circumference.

Introduction

Obesity, characterized by excessive accumulation of body fat,[1] is considered a chronic and progressive disease due to associated comorbidities.[2,3] These include metabolic syndrome (MS), a complex disorder characterized by cardiometabolic risk factors such as abdominal obesity, insulin resistance, glucose intolerance and dyslipidemia.[4] Individuals with MS are at increased risk of developing type II diabetes, coronary artery disease, arterial hypertension, atherosclerosis, some types of cancer and early death.[3,5] Because it is strongly associated with obesity, the prevalence of MS has increased rapidly in both developed and developing countries.[6] In a systematic review, Vidigal et al.,[7] found a prevalence of MS in the Brazilian adult population between 28.9 and 29.6%, according to the criteria used to define it.

The regional distribution of fat plays an important role in the etiology of adiposity-related diseases in several populations.[8] A number of studies suggest that adipose tissue stored in specific body areas can differentially affect metabolic health.[9] In this respect, the literature reports an adverse risk of metabolic disorder with visceral adiposity,[10] although femoral adiposity is associated with a decreased risk of having two or more cardiometabolic risk factors in African American and white adults.[11] Thus, besides acting as a risk factor for the onset of MS, the excessive deposit of adipose tissue can be harmful to health for other reasons. Historically considered only a fat storage site, adipose tissue (AT) has been classified as an endocrine organ due to its bioactive substances.[13,14] These substances, known as adipokines or adipocytokines,[14,15] are involved in a wide variety of physiological processes, including insulin action, endothelial function, and energy balance regulation.[16,17] However, the increase in some proinflammatory adipocytokines is related to the immune system and increased inflammatory response, prompting some researchers to view obesity as a chronic state of systemic inflammation.[18]

Obesity and its comorbidities should not be treated separately. Treatment involves a lifestyle change and multidisciplinary intervention in the areas of internal medicine, physical education, nutrition and psychology.[19] Cardiorespiratory and strength training performed successively during the same training session is

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characterized as concurrent training (CT),[20,21] and is an important strategy for weight loss in overweight and obese individuals. Reducing total body fat, increasing lean body mass and basal metabolic rate,[22,23] and lowering proinflammatory adipocytokine levels[24] result in positive responses. Thus, both types of training induce adaptations in skeletal muscles that will combat a range of disorders affecting functional capacity and metabolic health, including sarcopenia, type II diabetes and obesity.[25] As such, the present study aimed to evaluate the impact of concurrent training on biochemical parameters and obesity-related cardiometabolic risk factors.

Case report

Design

The present investigation is a case report.[26] The study described and interpreted data with the primary purpose of assessing the merit of a physical exercise program.

Sample

The criterion-based sample[26] consisted of an individual who did not engage in regular physical exercise, had no history of osteomyoarticular lesions that could interfere with their participation, did not use ergogenic / nutritional / pharmacological resources that could interfere with the dependent variables, and were in the class 1 obesity range.[3]

Ethics

The volunteer gave his informed consent in accordance with the Declaration of Helsinki,[27] and Resolution 510 of the National Health Council, Brazil (2016). The project was approved by the Research Ethics Committee of the Federal University of the State of Rio de Janeiro under protocol number 983.976/15.

Data collection

Body composition

The following pre- and post-intervention body composition variables were measured: total body mass (BM), height (HT), waist circumference (WC), and hip circumference (HC). To assess total body mass and height, we used a mechanical balance with capacity of 150kg and accuracy of 100 g and a Filizola® stadiometer (Brazil) respectively. Waist and hip circumference were measured with a Sanny® anthropometric tape (Brazil). The procedures followed International Society for the Advancement of Kinanthropometry (ISAK) guidelines.[25,28]

Body mass index (BMI) and body adiposity index (BAI) were calculated using the anthropometric measures obtained. BMI was obtained by the ratio of body mass in kilograms to height in meters squared.[3] BAI was calculated using the WC and HP measurements in centimeters, and HT in meters in the following formula:

$$BAI = \left[WC - to - HC\ ratio / \left(HTx \sqrt{HT} \right) \right] - 18 \,.[29]$$

Blood pressure

Systolic and diastolic blood pressure (SBP and DBP) were measured on the day anthropometric measurements were collected using an OMRON HEM-7200 digital electronic sphygmomanometer.

Strength test

With a view to measuring the maximum load and determining training intensity, the 1RM tests[30] were performed in the following exercises: chest-supported row, 45° leg press, supine straight leg raise, knee flexion (flexor table), high pulley elbow extension and low pulley elbow flexion. A lower limb and upper limb exercise were performed on each strength testing day. There was an interval of at least 48h between each test session.

Cardio respiratory test

Cardio respiratory fitness was evaluated using the 12-minute Cooper test, which consists of the subject walking/running as far as possible in 12 min. Maximum oxygen consumption (VO_{2max}) is then calculated based on the distance traveled. The Cooper test was performed on a 400-meter athletics track. The course was demarcated by cones every 50 meters and controlled by the research team to evaluate the distance traveled in 12 minutes. Thus, it was possible to predict maximum VO_2 using Cooper's equation.[31] Prior to the test, the volunteer rested in a quiet environment for 10 minutes to measure resting heart rate (HR) using a Polar® FT1 digital heart monitor.

Biochemical variables

After a 12-hour fast and eight hours sleep, blood samples were collected to analyze the following parameters: glucose (GLU); glycated hemoglobin (HbA1c); (LDL), tumor necrosis factor-alpha (TNF-α), C-reactive protein (CRP), interleukin-6 (IL- 6), leptin (LEP) and adiponectin (ADP). The biochemical parameters HbA1c and CRP were analyzed using the turbidimetry method. TC, TG, HDL, LDL, and GGT were analyzed by the enzymatic colorimetric method. Glucose was determined by the enzymatic method. The chemiluminescence method was applied to analyze TNF-α and IL-6, the kinetic-UV method to determine ALT and AST and the enzyme immunoassay technique to assess LEP and ADP.

LDL concentration was estimated using the Friedewald formula: LDL=TC-HDL- (TG/5).[32] Blood sample collection, biochemical parameter analysis and disposal of the biological material were carried out by qualified personnel from the Sérgio Franco laboratory in Rio de Janeiro, Brazil.

Food frequency questionnaire (QFA)

In order to ascertain the volunteer's dietary habits, he completed the food frequency questionnaire (FFQ)[33] in the week prior to the beginning of the intervention and in the following eight weeks.

Intervention

The intervention involved eight weeks of physical exercise, totaling 24 sessions of concurrent training (CT), performed on three nonconsecutive days per week, in the following order: strength training (ST) followed by aerobic training (AT). The ST started with a warm-up of 15 repetitions and overload of approximately 50%, which was used for the first series in the different exercises of the program. The weekly characteristics of the ST phase are presented in Table 1. Immediately after strength training, aerobic training was performed using continuous treadmill walking, with the characteristics presented in Table 2. The intensity of aerobic training was controlled by a Polar FT1 digital cardiac monitor, and the target training zone was calculated using heart rate reserve (HRR).[30]

Table 1 Strength training protocol

Weeks	Sets	Repetitions	Intensity	Interval	Speed
1	3	Until exhaustion	60% 1RM	1'-2'	2" x 2"
2	3	Until exhaustion	60% 1RM	1'-2'	2" x 2"
3	3	Until exhaustion	60% 1RM	1'-2'	2" x 2"
4	3	Until exhaustion	65% 1RM	1'-2'	2" x 2"
5	3	Until exhaustion	65% 1RM	1'-2'	2" x 2"
6	3	Until exhaustion	65% 1RM	1'-2'	2" x 2"
7	3	Until exhaustion	70% 1RM	2'-3'	2" x 2"
8	3	Until exhaustion	70% 1RM	2'-3'	2" x 2"

RM, 1 maximum repetition; Speed, velocity of each repetition; 2"x2", 2 seconds in the concentric phase and 2 seconds in the eccentric phase.

Table 2 Aerobic training protocols

Phase	Time (min)	Intensity (% HR_{rest})
Warm-up	0-5	45-55
Specific exercise	5-35	65-70
Cool down	35-40	45-55

Data analysis

The difference between the measures was calculated as well as the percentage difference between pre-intervention (Baseline) and post-intervention (Post). Data were processed in Microsoft Excel software, 2007.

Results

The results of cardiometabolic risk factors at baseline and post-intervention are presented in Table 3. BM, WC, HC, BMI, BAI, SBP and HRrest decreased, VO2max increased and HT and DBP remained unchanged. The biochemical parameter results at pre-intervention (Baseline) and post-intervention (Post) are presented in Table 4. With respect to biochemical markers, a decline was observed in all parameters analyzed, except for HDL and ADP, which showed an increase. In relation to the food frequency questionnaire, no change was found in the volunteer's eating habits throughout the intervention period.[31–33]

Table 3 Cardiometabolic risk

	Baseline	Post	Δ	Δ%
HT (m)	1.73	1.73	-	-
BM (Kg)	100.5	98.8	-1.7	-1.69
WC (cm)	99.5	90	-9.5	-9.55
HC (cm)	114.5	104	-10.5	-9.17
BMI	33.58	33.01	-0.57	-1.70
BAI	32.66	28.01	-4.65	-14.24
SBP (mmHg)	121	115	-6	-4.96
DBP (mmHg)	80	80	-	-
HRrest (bpm)	75	61	-14	-18.67
VO_2max (ml/kg/min)	31.19	36.44	5.25	16.83

HT, height; BM, body mass; WC, waist circumference; HC, hip circumference, BMI, body mass index; BAI, body adipose index; SBP, systolic blood pressure; DBP, diastolic blood pressure; HRrest, resting heart rate; VO_2max, cardiorespiratory fitness.

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Table 4 Biochemical values

	Baseline	Post	Δ	Δ%
GLU (mg/dL)	90	85	-5	-5.56
HbA1c (%)	5.2	4.5	-0.7	-13.46
TC(mg/dL)	147	119	-28	-19.05
TG(mg/dL)	83	75	-8	-9.64
HDL(mg/dL)	38	42	4	10.53
LDL(mg/dL)	94	63	-31	-32.98
LEP (ng/dL)	17.6	11.0	-6.6	-37.50
ADP(mcg/mL)	5.5	13.9	8.4	152.73
TNF-α(pg/mL)	12.5	9.6	-2.9	-23.20
CRP(mg/dL)	0.91	0.30	-0.61	-67.03
IL-6(pg/mL)	3.30	2.60	-0.7	-21.21

GLU, glucose; HbA1c, glycated hemoglobin; TC, total cholesterol; TG, triglycerides; HDL, high-density lipoprotein cholesterol; LDL, low-density lipoprotein cholesterol; LEP, leptin; ADP, adiponectin; TNF-α, tumor necrosis factor alpha; CRP, C-reactive protein; IL-6, interleukin 6.

Discussion

The results of the present study showed a positive impact on the variables studied as a result of concurrent training in a 23-year-old man with grade 1 obesity. All the biochemical, hemodynamic and anthropometric parameters related to cardiometabolic risk improved with the training used. The choice of strength training followed by aerobic exercise in concurrent training is due to literature reports suggesting that aerobic exercise performed first alters the molecular events that regulate muscle proteins during subsequent resistance exercise, impairing strength gain. In this respect, activation of the tuberous sclerosis complex 2 (TSC2) acts negatively on the mTOR signaling pathway, blocking proteins from binding with their respective receptors, which, in turn, prevents hypertrophy.[34]

Results similar to those obtained here were reported in a systematic review involving 12 trials with 555 young people, where the authors investigated whether the combination of aerobic and resistance exercise (concurrent training) was better than aerobic exercise alone for the health of obese children and adolescents. Compared with aerobic exercise alone, concurrent training resulted in greater reductions in body mass ($\bar{x}$ =-2.28kg), fat ($\bar{x}$ =-3.49%) and LDL cholesterol ($\bar{x}$ =-10.20mg/dL), and an increase in both lean body mass ($\bar{x}$ =2.20kg) and ADP levels ($\bar{x}$ =2.59μg/mL). However, it is important to underscore that the differences were greater for long-term programs (>24 weeks). In the present study, there was a decline in LDL cholesterol (Δ%=-32.98) and a rise in ADP (Δ%=152.73). With respect to the other variables, there was a decrease in BM (Δ%=-1.69) and BAI (Δ%=-14.24).[35]

A study of sixteen patients with type II diabetes (DM2) investigated the effects of a concurrent training program on inflammatory status and metabolic parameters. The patients were randomly assigned to an experimental group (EG; n=8), who underwent a concurrent aerobic and resistance program (3 times a week for 16 weeks) or a control group (CG; n=8) who followed the traditional model of diabetes care. The EG significantly improved body composition, blood pressure, total cholesterol, and overall fitness level. After training, plasma leptin levels (-33.9%), pro-inflammatory markers IL-6 (-25.3%), TNF-α (-19.8%) and monocyte chernotactic protein-1 (MCP -1) (-15.3%) decreased, while IGF-1, an anabolic hormone, increased (+16.4%). On the other hand, there was no significant change in ADP or CRP.[36] In the present study, ADP levels (+152.73%) increased, and leptin (-37.5%), IL-6 (-21.21%), TNF- α (-23.2%) and CRP (-67.03%) decreased.

Interestingly, Colato et al.,[37] found increased levels of TNF-α and CRP after 12 weeks of concurrent training in 41 overweight / obese patients. Although there was an improvement in body composition and an increase in T-cell proliferation, the authors emphasize that exercise progression may be physiologically stressful for these patients, as demonstrated by inflammatory markers.

Another study carried out in DM2 patients also compared the effects of three different exercise modalities on metabolic control, insulin resistance, inflammatory markers, adipocytokines, hemodynamic parameters and tissue expression of the insulin receptor substrate 1 (IRS-1) after 12 weeks of training. Forty-eight patients were randomized into 4 training groups (3 times per week/60 minutes per session): aerobic group (AG; n=12), resistance group (RG; n=12), experimental group (EG; n=12) and control group (CG; n=12). (HbA1c), lipid profile, insulin resistance index (HOMA), adipocytokines (adiponectin, visfatin and resistin), TNF-α, interleukin, high-sensitivity CRP (hs-CRP) and glycated hemoglobin (HbA1c) were measured at baseline and at the end of the study. All 4 groups exhibited a decrease in blood pressure, fasting plasma glucose, postprandial plasma glucose, lipid profile and hs-CRP; however, only resistance training (RT) and aerobic + resistance training (ART) produced increased IRS-1 expression after training. Improvements in aerobic capacity were demonstrated by the significant increase (16.3%) in VO$_2$max[38] These findings corroborate those of the present research in biochemical parameters, and it should be noted that the

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positive variation of VO_2max in both studies was very similar (16.3% x 16.8%).

With respect to hemodynamic parameters, the present study found a 5% decrease in SBP; however, DBP remained unchanged. A study conducted by Niño et al.,[39] aimed to evaluate the effects of aerobic (AT), resistance (RT) and concurrent (ART) training programs on systolic and diastolic blood pressure, both at rest and during submaximal exercise in healthy young people. Thirty-nine healthy active individuals were randomized to all three types of training and one control group. Exercise groups were trained for 60 minutes, three times a week for six weeks and a submaximal cycle ergometer test was performed before, at the end and three weeks after training. Blood pressure was measured before and during the test. In the submaximal test, SBP and DBP decreased significantly (p <0.05) after "detraining" (three weeks after) in the three exercise groups. However, significant reductions were observed at rest between pre-training and detraining only in the ART group (p <0.05). The difference in these findings from those of the present study is that only SBP decreased, while DBP remained unchanged.

Conclusion

An eight-week concurrent training program reduced cardiometabolic risk and positively altered biophysical and biochemical variables in this individual case report. So, further studies are indicated to confirm the positive aspects of concurrent training on active lifestyle.

Acknowledgments

None.

Conflicts of interest

The author declares there are no conflicts of interest.

Funding details

None.

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