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Cross-Sectional Analysis of Whole Body and Regional Body Composition Changes After a Short-Term Weight-Loss Program Combining Exercise and Nutritional Counseling

Rafael Antunes Nicoletti[1], Thiago Pereira de Souza[1], Dalton Müller Pessôa Filho[1], Rodrigo Villar[2], Anderson Saranz Zago[1]

[1]Department of Physical Education, School of Sciences, Sao Paulo State University (UNESP) - Bauru, Brazil
[2]Cardiorespiratory & Physiology of Exercise Laboratory, Faculty of Kinesiology and Recreation Management, University of Manitoba, Winnipeg, Canada.

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Abstract

Objectives: This study aimed to determine whether different types of short-term (4 weeks) weight-loss training programs would promote changes in whole body and regional body composition in middle-aged individuals, whether there is a more effective program, and whether there are sex differences between baseline and postinterventions.

Methods: Twenty-six middle-aged (44 ± 7 years), obese, and nonactive females and males were randomly assigned into four groups: nonspecific training program with nutritional counseling (G1), combined resistance and endurance program with nutritional counseling (G2), combined resistance and endurance program without nutritional counseling (G3), and resistance exercise program without nutritional counseling (G4). Body mass, body mass index and fat mass, free fat mass, and percentage of body fat of the whole body and segments (trunk, arms, and legs) were measured at baseline and postinterventions by a dual-energy x-ray absorptiometry.

Results: In G1, body mass and body mass index decreased between baseline and postintervention (82.7 ± 15.6 kg vs. 80.4 ± 14.2 kg, Δ = −2.3 kg; p = .024 and 30.47 ± 5.5 kg/m^2 vs. 29.6 ± 5.1 kg/m^2; Δ = −0.84 kg/m^2; p = .017, respectively). Similar results occurred in G2 (82.0 ± 16.1 kg vs. 79.8 ± 15.8 kg, Δ = −2.2 kg; p = .040 and 28.8 ± 2.4 kg/m^2 vs. 28.0 ± 2.1 kg/m^2; Δ = −0.78 kg/m^2; p = .036, respectively). Free fat mass showed a decrease between baseline and postinterventions for G1 (51.8 ± 14.8 kg vs. 48.7 ± 13.3 kg, Δ = −3.0 kg; p = .032), G2 (53.6 ± 14.5 kg vs. 50.3 ± 12.3 kg, Δ = −3.26 kg; p = .040), and G4 (51.3 ± 12.4 kg vs. 47.7 ± 12.3 kg, Δ = −3.52 kg; p = .002). Only G4 showed an increase in fat mass (22.1 ± 3.6 kg vs. 23.9 ± 4.4 kg, Δ = 1.8 kg; p = .004) and % of body fat (29.7 ± 5.4 kg vs. 32.7 ± 6.3 kg, Δ = ~3%; p = .005) between baseline and postinterventions.

Conclusion: In conclusion, short-term training programs were ineffective in changing body composition positively.

Keywords: Dual-energy x-ray, middle-aged, obesity, overweight, physical training, short-term

Tüm Vücut ve Bölgesel Gövdenin Kesit Analizi Kısa Süreli Kilo Verme Programından Sonra Kompozisyon Değişiklikleri - Egzersiz ve Beslenme Danışmanlığını Birleştirmek

Öz

Amaç: Bu çalışma, orta yaşlı bireylerde kısa süreli (4 hafta) farklı tipte kilo verme eğitim programlarının uygulamalar sonrasında tüm vücut ve bölgesel vücut kompozisyonunda değişiklik yapıp yapmadığını, daha etkili bir program olup olmadığını ve cinsler arasında fark olup olmadığını belirlemeyi amaçladı.

Yöntem: Yirmi altı orta yaşlı (44 ± 7 yaş), obez ve aktif olmayan kadın ve erkek rastgele dört gruba ayrıldı: Beslenme danışmanlığı içeren nonspesifik antrenman programı (G1), beslenme danışmanlığı içeren kombine direnç ve dayanıklılık programı (G2), beslenme danışmanlığı içermeyen kombine direnç ve dayanıklılık programı (G3) ve beslenme danışmanlığı içermeyen direnç egzersiz programı (G4). Tüm vücut ve segmentlerin (gövde, kollar ve bacaklar) vücut kütlesi, vücut kitle indeksi ve yağ kütlesi, serbest yağ kütlesi ve vücut yağ yüzdesi, bir dualenerji x-ışını absorpsiyometrisi ile başlangıçta ve uygulamalar sonrasında ölçüldü.

Bulgular: G1'de başlangıç ve uygulama sonrası arasında vücut kitlesi ve vücut kitle indeksi azaldı (sırasıyla; 82,7 ± 15,6 kg - 80,4 ± 14,2 kg, Δ=-2,3 kg; p = ,024 ve 30,47 ± 5,5 kg/m^2 - 29,6 ± 5,1 kg/m^2; Δ = –0,84 kg/m^2; p = .017). G2'de benzer sonuçlar meydana geldi (sırasıyla; 82,0 ± 16,1 kg - 79,8 ± 15,8 kg, Δ = -2,2 kg; p = ,040 ve 28,8 ± 2,4 kg/m^2 - 28,0 ± 2,1 kg/m^2; Δ = -0,78 kg/m^2); p = .036). Serbest yağ kütlesi, G1 (51,8 ± 14,8 kg - 48,7 ± 13,3 kg, Δ = -3,0 kg; p = ,032), G2 (53,6 ± 14,5 kg - 50,3 ± 12,3 kg, Δ =–3,26 kg; p = ,040) ve G4 (51,3 ± 12,4 kg - 47,7 ± 12,3 kg, Δ = –3,52 kg; p = ,002) gruplarında başlangıç ve uygulama sonrası arasında

Corresponding author: Rafael Antunes Nicoletti
E-mail: rafael-nicoletti@hotmail.com

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bir düşüş gösterdi. Yalnızca G4, yağ kütlesinde (22,1 ± 3,6 kg - 23,9 ± 4,4 kg, Δ = 1,8 kg; p = ,004) ve vücut yağı yüzdesinde (29,7 ± 5,4 kg - 32,7 ± 6,3 kg, Δ = ~%3; p = .005) başlangıç ve uygulama sonrası arasında artış gösterdi.

Sonuç: Sonuç olarak, kısa süreli antrenman programları vücut kompozisyonunu olumlu yönde değiştirmede etkili olmamıştır.

Anahtar Kelimeler: Çift enerjili röntgen, orta yaşlı, obezite, kilolu, beden eğitimi, kısa süreli

Introduction

Overweight and obesity are associated with several chronic diseases, including cardiovascular diseases, type 2 diabetes, and musculoskeletal disorders (Lang et al., 2008; WHO, 2018), which are responsible for 3.4 million deaths/year worldwide, costing ~$190.2 billion to the health care system/year (Blüher, 2019; Oussaada et al., 2019); however, it is largely preventable (WHO, 2018).

Currently, lifestyle interventions (i.e., diet, physical activity, and behavior) are considered the first line of treatment (Blüher, 2019; Webb & Wadden, 2017). An unhealthy diet, characterized by a low intake of fruit and vegetables and a high intake of salt, fats, and sugar, contributes to the high incidence of the aforementioned disease (WHO, 2018). Besides, the current guidelines and studies about physical activity recommend 150–250 min/week and up to 60 min/day of moderate-intensity exercise for weight gain prevention or modest weight reduction (2–3 kg) (Ryan & Kahan, 2018). However, epidemiological data have shown that a significant number of adults do not reach the recommended physical activity guidelines (Lang et al., 2008; Ryan & Kahan, 2018).

One of the main reasons for failure in engaging in regular exercise programs is a perceived lack of time affecting practitioners' adherence and, consequently, the exercise program results (Burgess et al., 2017; Petridou et al., 2019). Therefore, programs that promise fast weight loss in a shorter time became very attractive. These programs have been increasingly growing due to the publicized and advertised benefits propagated by the fitness industry and media (i.e., TV shows). However, it is still unclear how these programs impact participants' whole body and regional body composition. To date, no studies are comparing short-term weight-loss exercise programs (i.e., endurance, resistance, combining resistance, and endurance) with and without nutritional counseling (NC) in overweight middle-aged individuals.

Therefore, this study aimed to determine whether different short-term (4 weeks) weight-loss training programs would promote positive changes in whole body and regional body composition of middle-aged individuals and whether there is a more effective program for weight loss. Additionally, a comparison between females and males was included in the analysis to identify the influence of sex on the whole body and regional body composition between pre- and postinterventions.

It was hypothesized that 4 weeks of weight-loss training would promote whole body and regional body composition changes. It is also hypothesized that combined training (resistance and endurance) with NC would be the most effective program for promoting whole body and regional body composition modifications in both sexes.

Method

Participants

Participants were recruited through poster advertisements. Individuals were eligible to participate if they were 30–60 years of age; overweight or obese, sedentary or not regularly active; nonsmokers; drink less than three alcoholic beverages/day; had no cardiovascular, cardiopulmonary, cerebrovascular, musculoskeletal, neurologic, or psychiatric disorders; or other medical or orthopedical conditions that could affect their ability to participate in the proposed weight-loss program (WLP). Prior to starting, participants received all details about the experimental procedures and signed an informed consent form approved by the Institutional Review Board at the Sao Paulo State University, Brazil (protocol #: CEP-254424).

Table 1.
Mean ± Standard Deviation for Age, Height, Body Mass, Body Mass Index, Fat Mass, Fat-Free Mass, Percentage of Body Fat, and Deltas for Each Group Between Pre- and Postintervention

	Groups	PRE	POST	Δ
Age (years)	G1	47 ± 5	–	–
	G2	45 ± 9		
	G3	36 ± 5		
	G4	48 ± 9		
Height (m)	G1	1.65 ± 0.11	–	–
	G2	1.68 ± 0.11		
	G3	1.68 ± 0.10		
	G4	1.68 ± 0.09		
Body mass (kg)	G1	82.66 ± 15.59	80.36 ± 14.21*	−2.3 ± 1.76
	G2	81.96 ± 16.15	79.76 ± 15.79*	−2.2 ± 2.23
	G3	77.14 ± 15.25	75.68 ± 15.96	−1.46 ± 2.18
	G4	76.86 ± 13.92	75.48 ± 13.44	−1.38 ± 2.03
Body mass index (kg/m²)	G1	30.47 ± 5.49	29.63 ± 5.14*	−0.84 ± 0.58
	G2	28.76 ± 2.38	27.98 ± 2.06*	−0.78 ± 0.77
	G3	27.32 ± 3.89	26.85 ± 4.48	−0.47 ± 2.17
	G4	27.15 ± 3.71	26.64 ± 3.21	−0.51 ± 0.75
Fat mass (kg)	G1	26.98 ± 7.60	27.82 ± 6.84	0.84 ± 2.15
	G2	24.53 ± 6.22	25.40 ± 6.29	0.87 ± 2.21
	G3	22.68 ± 7.34	22.17 ± 8.33	−0.51 ± 1.32
	G4	22.11 ± 3.65	23.91 ± 4.38*	1.80 ± 1.23
Fat-free mass (kg)	G1	51.79 ± 14.78	48.75 ± 13.33*	−3.04 ± 2.53
	G2	53.57 ± 14.51	50.31 ± 12.32*	−3.26 ± 3.28
	G3	50.51 ± 13.75	49.66 ± 15.90	−0.85 ± 3.06
	G4	51.26 ± 12.42	47.74 ± 12.34*	−3.52 ± 2.09
Percentage of body fat (%)	G1	33.70 ± 8.65	35.68 ± 7.91	1.98 ± 2.57
	G2	31.04 ± 8.19	32.79 ± 6.92	1.75 ± 2.93
	G3	30.40 ± 8.91	30.54 ± 10.49	0.14 ± 1.91
	G4	29.74 ± 5.41	32.71 ± 6.29*	2.97 ± 2.06

Note: Nonspecific training with nutritional counseling (G1; $n=6$); endurance and resistance training with nutritional counseling (G2; $n=7$); endurance and resistance training without nutritional counseling (G3; $n=5$); resistance training without nutritional counseling (G4; $n=8$). *Statistical differences between preintervention (PRE) and postintervention (POST) within the same group ($p \leq .05$).

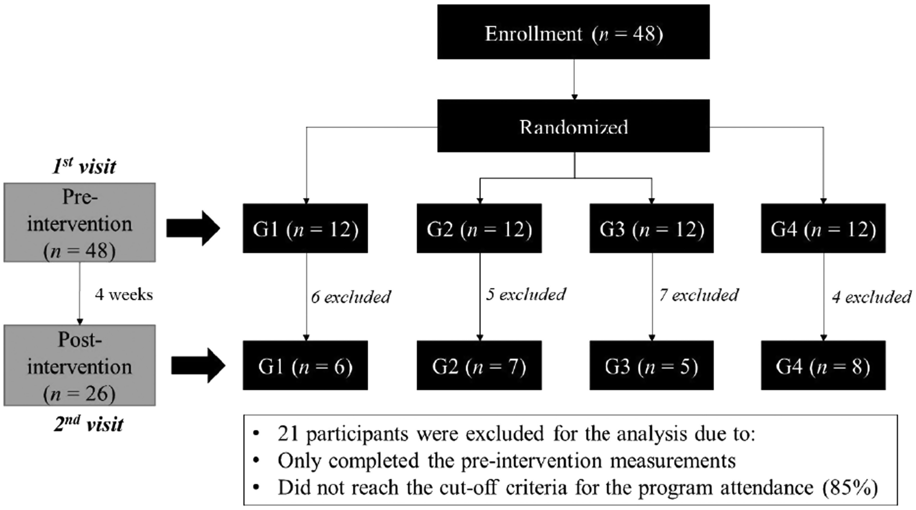

Figure 1.
Diagram Illustrating Participant Flow Through Experimental Study Design.

Forty-eight individuals volunteered for this study. After premeasurements, participants were randomly assigned into four different groups, as described in Table 1. Twenty-one ($n = 21$) participants were excluded from the analysis because they only completed the preassessment phase or did not reach the cut-off attendance criteria of 85% during the program (Figure 1).

Each person visited the laboratory at the beginning (PRE) and after 4 weeks of intervention (POST) for anthropometry and body composition data collection. Participants were asked to refrain from performing any exercise 24 hours before testing, drinking alcohol, caffeinated and sugary/sports beverages on testing days, and consuming a large meal within 2 hours of testing.

Procedures Before and After Interventions

Anthropometry

An electronic scale measured body mass (BM) with a precision of 0.1 kg, and a stadiometer measured the height with a precision of 0.1 cm (W200A-LED, Welmy, Sao Paulo, Brazil). Body mass index (BMI) was calculated by dividing BM by the square of the height (H) (BMI = BM/H kg/m^2).

Body Composition

Fat mass (FM), free fat mass (FFM), and percentage of body fat (%BF) of the whole body and segments (trunk, arms, and legs) were measured by a dual-energy x-ray absorptiometry (DEXA, Discovery, Wi/Hologic Inc., Bedford, USA). Data were determined as described previously (Laskey, 1996). The same experienced technician performed all the DEXA scans to ensure consistency.

Intervention

Weight-Loss Program and Nutritional Counseling

All the groups had the same training volume (3 times/week and 90 minutes/session, and 4 weeks duration). Participants performed a WLP with resistance exercises and/or moderate endurance walking/jogging (MEWJ) in different or in the same sessions and received or did not receive a weekly NC appointment as per the following description:

- G1 ($n = 6$): Resistance and MEWJ training program performed in different sessions with NC;
- G2 ($n = 7$): Resistance and MEWJ training program performed in the same session with NC;
- G3 ($n = 5$): Resistance and MEWJ training program performed in the same session without NC;
- G4 ($n = 8$): Resistance training program without NC.

Resistance exercises consisted of 3 sets with 15 repetitions, each of the upper and lower body, trunk, and core exercises. The intensity was defined by the maximum load sufficient to perform 15 repetitions without movement concentric failure. Moderate endurance walking/jogging exercise was performed on a treadmill, where participants kept the exercise intensity between 13 and 15 rating of perceived exertion scale on the Borg Scale (BORG, 1982). A Certified Exercise Physiologist supervised all exercises based on the WHO recommendations (Amine et al., 2003). Participants under NC were instructed to balance caloric intake and expenditure, avoid excessive carbohydrates, sugars, salts, and fats, and eat fruits and vegetables, avoiding processed foods as described previously in "Healthy-lifestyle counseling" from WHO (2018). A Certified Nutritionist supervised the NC counseling through weekly meetings.

Statistical Analysis

Descriptive statistics are presented as mean ± SD. The Shapiro–Wilk test was used to determine normal data distribution. If the data passed the normality test ($p > .05$), a one-way analysis of variance (ANOVA) was used to identify differences in the whole body composition, regional body composition, and deltas ($\Delta = POST - PRE$) between groups (G1, G2, G3, and G4) at PRE and POST. Otherwise, a Kruskal–Wallis one-way ANOVA on ranks was used to detect such differences. For identifying differences within groups and sex between PRE and POST, a paired t-test was adopted; otherwise, a Wilcoxon Signed Rank Test was used. Additionally, female and male results were compared regardless of intervention type and NC at PRE and POST using a t-test or a Mann–Whitney U test. The significant level was defined as $p \leq .05$. The data were analyzed using the SigmaPlot 12.0 statistical package (Systac Software, Inc., San Jose, Calif, USA).

Results

Participant's mean ± SD values at PRE, POST, delta ($\Delta = POST - PRE$) for age (years), H (m), BM (kg), BMI (kg/m^2), FM (kg), FFM (kg), and %BF for each group are reported in Table 1.

Whole Body Composition

There were no differences for age, BM, BMI, FM, FFM, and %BF between groups at PRE ($p > .05$), confirming the match for all variables before interventions (PRE). For the POST, no differences were found in BM, BMI, FM, FFM, and %BF between groups. Also, no differences were found in delta (Δ = POST − PRE) for the ΔBM, ΔBMI, ΔFM, ΔFFM, and Δ%BF between groups (Table 1). There were differences (within groups) in BM and BMI for G1 and G2 from PRE to POST. On average, BM was reduced by 2.3 kg ($t(5) = -3.200$, $p = .024$) and 2.2 kg ($t(6) = -2.605$, $p = .040$), and BMI decreased to −0.84 kg/m^2 ($t(5) = -3.513$, $p = .017$) and −0.78 kg/m^2 ($t(6) = -2.689$, $p = .036$), respectively (Table 1). From PRE to POST, FFM in the G1 was reduced by −3.04 kg ($t(5) = -2.937$, $p = .032$), and in the G2, it was reduced by −3.26 kg ($t(6) = -2.618$, $p = .040$). There were no differences in FM and %BF for G1 and G2. In the G3, there were no differences for any variables ($p > .05$). In the G4, FM increased by 1.8 kg ($t(7) = 4.119$, $p = .004$), FFM decreased by 3.52 kg ($t(7) = -4.755$, $p = .002$), and %BF increased by ~3% ($t(7) = 4.080$, $p = .005$). There were no differences between PRE and POST just for BM and BMI ($p > .05$) (Table 1).

Regional Body Composition

Regional body composition was divided into trunk, arms, and legs and compared between and within groups (PRE and POST). No differences were shown between groups (G1, G2, G3, and G4), and PRE and POST for FM, FFM, and %BF for these body segments as well as in ΔFM, ΔFFM, and Δ%BF.

Regional body composition distribution within groups is depicted in Figure 2. For the G1, there were significant reductions in trunk FFM from PRE to POST ($t(5) = -3.263$, $p = .022$) (Figure 2A) and arms FFM from PRE to POST ($t(5) = -2.640$, $p = .046$) (Figure 2-A2). Arms %BF increased from PRE to POST ($t(5) = -2.634$, $p = .046$) (Figure 2A). There were no differences from PRE to POST in the trunk FM and %BF, arms FM, and legs FM, FFM, and %BF ($p > .05$). For the G2, trunk FFM was significantly reduced from PRE to POST ($t(6) = -2.694$, $p = .036$) (Figure 2B). However, no differences were found between PRE and POST for trunk FM and %BF, arms and legs FM, FFM, and %BF ($p > .05$). For the G3, there were no differences between PRE and POST for trunk, arms, and legs ($p > .05$) (Figure 2C).

For the G4, trunk FM increased from PRE to POST ($t(7) = 3.171$, $p = .016$) as well as trunk %BF ($t(7) = 3.460$, $p = .011$) (Figure 2D). However, trunk FFM was reduced from PRE to POST ($t(7) = -3.324$, $p = .013$). In the arms, FM did not change ($p > .05$), FFM was reduced ($t(7) = -4.181$, $p = .004$), and %BF increased from PRE to POST ($t(7) = 3.654$, $p = .008$) (Figure 2D). Legs FM increased from PRE to POST ($t(7) = 5.240$, $p = .001$) as well as legs %BF ($t(7) = 4.938$, $p = .002$). However, leg FFM was diminished between PRE and POST ($t(7) = -3.069$, $p = .018$) (Figure 2D).

Females Versus Males

Participants were further separated into female and male groups to determine the influence of sex on whole body and regional body composition, comparing PRE and POST independently of intervention type and NC. Table 2 presents participants' mean ± SD at PRE, POST, and Δ for age (years), *H* (m), BM (kg), BMI (kg/m^2), FM (kg), FFM (kg), and %BF for each group. Statistical analysis indicated that females and males were age-matched, as shown by no differences in age ($p < .05$). However, females were shorter compared to males ($t(24) = -4.743$, $p < .001$) (Table 2).

Whole Body Composition

Prior to the intervention, female and male groups were BMI-matched, as shown by no differences in BMI between females and males at PRE and POST ($p > .05$). Females were lighter than males as shown by their BM values at PRE ($t(24) = -3.380$, $p = .002$) and POST ($t(24) = -3.632$, $p = .001$). Significant differences were found in FM between females and males, in which females had higher values of FM compared to males at PRE. However, there were no differences between females and males in the POST ($p > .05$). Females had lower values of FFM than males at PRE ($t(24) = -6.279$, $p < .001$) and POST ($t(24) = -6.492$, $p < .001$). Females also showed higher %BF compared to males at PRE ($t(24) = 6.823$, $p < .001$) and POST ($t(24) = 6.176$, $p < .001$) (Table 2). No differences were found in ΔBM, ΔBMI, ΔFM, ΔFFM, and Δ%BF between all variables ($p > .05$) (Table 2).

Furthermore, there was a 1.92 kg reduction in BM between PRE and POST for females ($t(16) = -4.538$, $p = .001$), but not for males ($p > .05$). Body mass index was similar between PRE and POST for females and males ($p > .05$). There were no differences in FM between PRE and POST for females ($p > .05$). However, there was a 1.38 kg increase in FM between PRE and POST for males ($t(8) = 2.441$, $p = .041$). Female and male groups showed a 2.60 kg and 3.19 kg reduction in FFM between PRE and POST, respectively (F: ($t(16) = -4.444$, $p = .001$); M: ($t(8) = -2.803$, $p = .023$). Furthermore, female and male groups showed a 1.77% and 2.05% increase in %BF between PRE and POST, respectively (F: ($t(16) = 2.700$, $p = .016$); M: ($t(8) = -1.956$, p(exact) = .05) (Table 2).

Regional Body Composition

Females showed higher arms FM values compared to males at PRE ($t(24) = 2.887$, $p = .008$) and POST ($t(24) = 2.595$, $p = .016$). For arms FFM, females presented lower values compared to males at PRE ($t(24) = -7.962$, $p = .001$) and POST ($U = 2.000$, $p < .001$). The %BF in the arms in the female group was higher than males at PRE ($U = 0.000$, $p < .001$) and POST ($t(24) = 7.180$, $p < .001$). Statistical differences were also shown in legs FM between females and males at PRE ($U = 11.00$, $p < .001$) and POST ($U = 16.000$, $p = .001$), where females had higher levels of FM in their legs. Free fat mass in the legs were lower in females than males at PRE ($U = 12.000$, $p < .001$) and POST ($t(24) = -5.826$, $p < .001$). In the legs, females showed higher %BF compared to males at PRE ($t(24) = 8.214$, $p < .001$) and POST ($t(24) = 8.224$, $p < .001$), as indicated in Table 2.

Trunk FM was not different between females and males at PRE and POST ($p > .05$). Free fat mass in the trunk was lower in females than males at PRE ($t(24) = -6.090$, $p < .001$) and POST ($U = 5.000$, $p < .001$). Females showed higher %BF in the trunk compared to males at PRE ($t(24) = 4.027$, $p < .001$) and POST ($t(24) = 3.253$, $p < .003$). ΔFM, ΔFFM, and Δ%BF in the trunk, arms, and legs were not different between females and males ($p > .05$).

No differences were shown in the trunk FM of female group between PRE and POST (Figure 3A). However, in the male group, trunk FM increased from PRE to POST ($t(8) = 2.313$, $p = .049$) (Figure 3B). Trunk FFM was reduced from PRE to POST in females ($t(16) = -3.910$, $p = .001$, Figure 3A) and males ($t(8) = -3.003$, $p = .017$, Figure 3B). Females trunk %BF showed trends to increase from PRE to POST ($t(16) = 2.046$, $p = .058$, Figure 3A); while males showed increase in trunk %BF between PRE to POST ($t(8) = 2.749$, $p = .025$, Figure 3B).

In the arms, FFM decreased from PRE to POST ($t(16) = -3.818$, $p = .002$) for females (Figure 3A), but not for males (Figure 3B). Females' arms

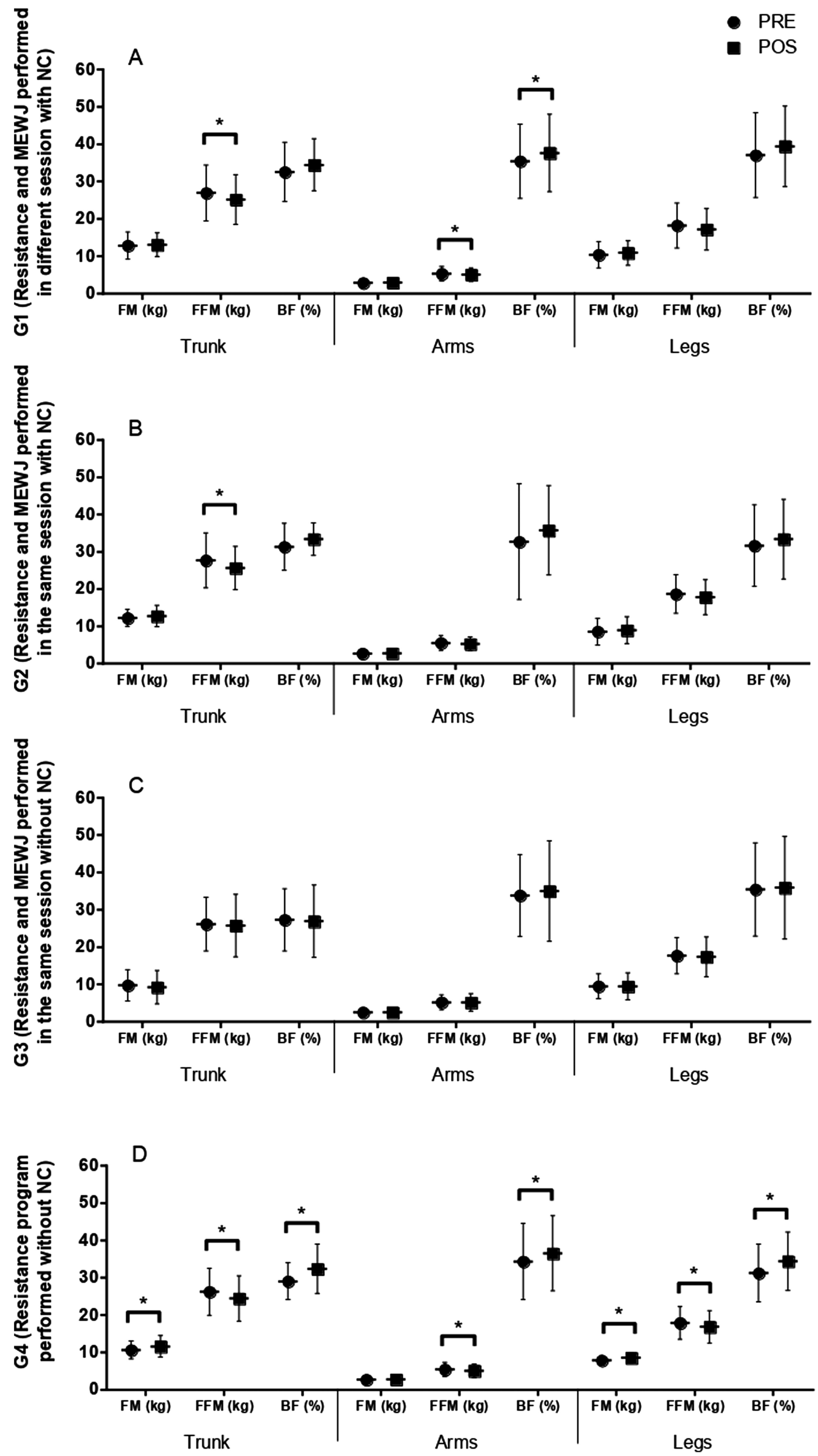

Figure 2.

*Regional Body Composition (Fat Mass, Free Fat Mass, and % Body Fat) of the Trunk, Arms, and Legs in G1 (Resistance and MEWJ Performed in Different Sessions With NC; Panel A), G2 (Resistance and MEWJ Performed in the Same Session With NC; Panel B), G3 (Resistance and MEWJ Performed in the Same Session Without NC; Panel C), and G4 (Resistance Program Performed Without NC; Panel D). MEWJ = moderate endurance walking/jogging; NC = nutritional counseling. *Statistical Differences Between Preintervention (●) and Postintervention (■) (p < .05).*

Table 2.
Mean ± Standard Deviation for Age, Height, Body Mass, Body Mass Index, Fat Mass, Fat-Free Mass, Percentage of Body Fat, and Deltas Between Females and Males at Pre- (PRE) and Postintervention (POST).

	Groups	PRE	POST	Δ
Age (years)	Female	43.65 ± 8.18	–	–
	Male	48.56 ± 8.75		
Height (m)	Female	1.629 ± 0.07#	–	–
	Male	1.768 ± 0.07		
Body mass (kg)	Female	73.75 ± 11.81#	71.83 ± 10.88#*	−1.92 ± 1.74
	Male	90.72 ± 12.87	89.05 ± 12.64	−1.67 ± 2.48
Body mass index (kg/m²)	Female	27.89 ± 4.81	27.70 ± 4.97	−0.19 ± 1.83
	Male	28.92 ± 2.66	27.97 ± 2.41	−0.94 ± 1.46
Fat mass (kg)	Female	25.81 ± 6.07#	26.43 ± 5.9	0.61 ± 1.94
	Male	20.56 ± 4.60	21.94 ± 6.04*	1.38 ± 1.69
Fat-free mass (kg)	Female	44.54 ± 7.38#	41.92 ± 6.25#*	−2.62 ± 2.43
	Male	65.66 ± 9.52	62.47 ± 9.94*	−3.19 ± 3.41
Percentage of body fat (%)	Female	35.40 ± 4.68#	37.17 ± 4.27#*	1.77 ± 2.70
	Male	23.06 ± 3.72	25.12 ± 5.53*	2.05 ± 2.13

Note: #Statistical differences between females and males at preintervention (PRE) or postintervention (POST). *Statistical differences within groups at PRE. Female ($n = 17$) and male ($n = 9$).

%BF increased from PRE to POST ($t(16) = 2.717$, $p = .015$, Figure 3A), but not in males ($p > .05$) (Figure 3B). There were no differences in arms FM between PRE and POST for females and males ($p > 0.05$) (Figure 3A and B, respectively). Fat mass in the legs increased from PRE to POST for both females ($t(16) = 2.408$, $p = .028$) and males ($t(8) = 2.602$, $p = .032$) (Figure 3A and B, respectively). Free fat mass in the legs decreased in females ($t(16) = -3.651$, $p = .002$; Figure 3A) and males ($t(8) = -2.252$, $p = .05$; Figure 3B). Legs %BF increased from PRE to POST in females ($t(16) = 3.363$, $p = .004$; Figure 3A) and males ($t(8) = 2.921$, $p = .019$; Figure 3B).

Discussion

To date, this is the first study to determine whether (1) short-term (4 weeks) weight-loss training programs would promote changes in whole body and regional body composition, (2) which program is more effective, and (3) whether sex influences modifications in body composition. In fact, all the groups significantly changed their body composition in 4 weeks, except G3. However, these results differed from expected. Contrary to our hypothesis, there were no or unfavorable changes in body composition after training. Neither of the four short-term weight-loss programs effectively produced positive results, as shown by the FFM, FM, and %BF in females or males.

The G1 and G2 showed a reduction in BM, BMI, and FFM and no significant changes in FM and %BF. If only BM and BMI results were analyzed, the programs would be considered effective. However, the

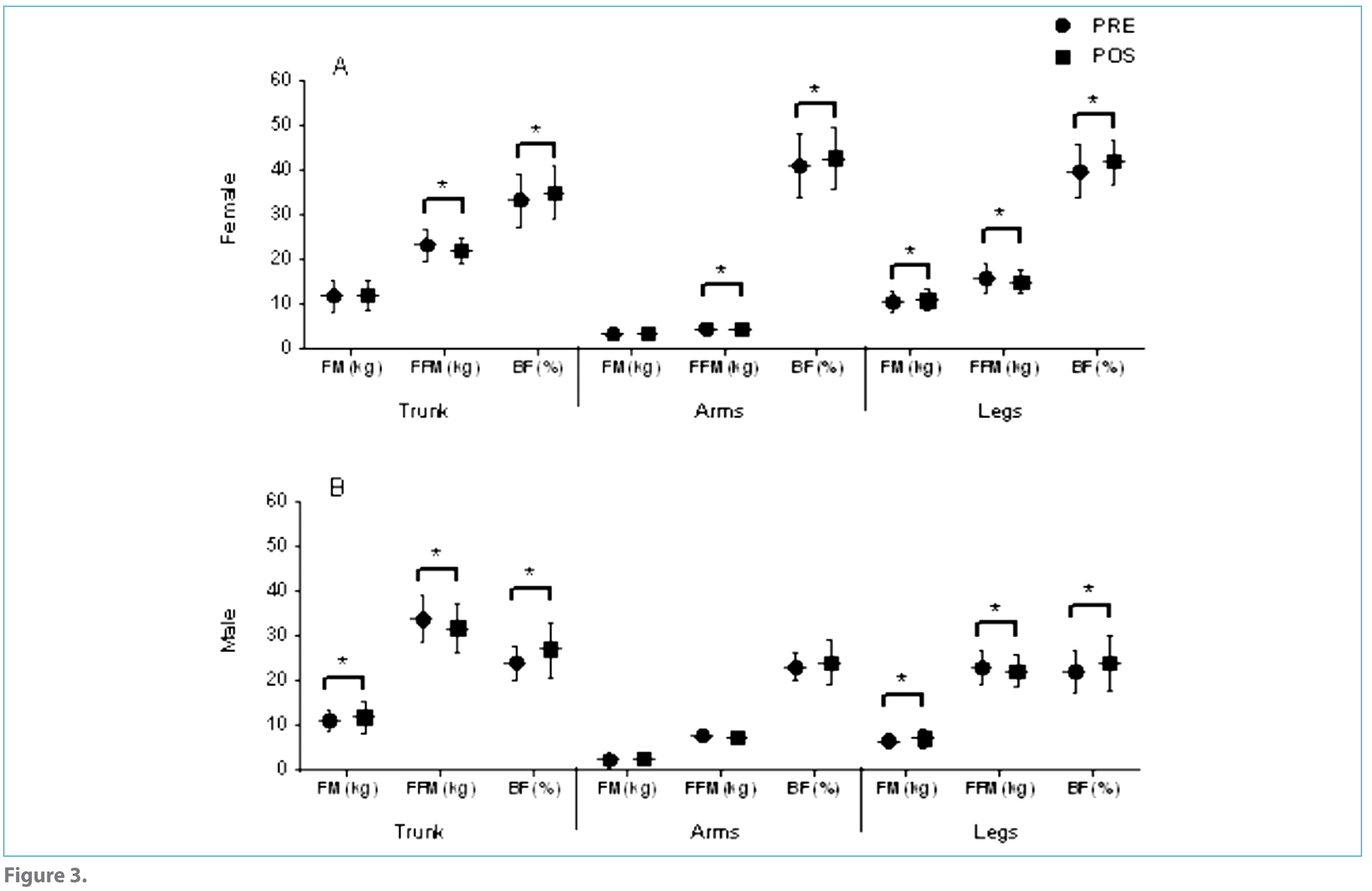

Figure 3.
*Regional Body Composition (Fat Mass, Free Fat Mass, and % Body Fat) of the Trunk, Arms, and Legs in Females (Panel A) and Males (Panel B). *Statistical Differences Between Preintervention (●) and Postintervention (■) ($p < .05$).*

interpretation of the results changes drastically when FFM, FM, and %BF results are considered (Table 2). Since FM and %BF did not change in both groups, the decrease in BM and BMI was driven by the loss in fat-free mass, which is related to a muscle mass loss instead of body fat. The loss of muscle mass can be explained by a catabolic effect caused by training and reduced calorie and protein intake. Muscular catabolism might be related to insufficient protein ingestion leading to a negative nitrogen balance (Kerksick et al., 2018). Over time, the protein breakdown exceeds the protein synthesis resulting in muscle mass loss (Kerksick et al., 2018). Training induces protein breakdown (catabolism), requiring higher consumption of proteins and calories for muscular reconstruction (anabolism) (Vargas et al., 2018). Our participants followed the Amine et al. (2003) recommended guidelines for the NC intervention; however, protein supplementation was not included. Therefore, the combined results of training and nutrition may generate a nitrogen balance toward protein degradation, not synthesis, resulting in fat-free mass reduction.

In the current study, FM and %BF were unaltered after the training interventions, which aligns with the results of Devin et al. (2016) and Kong et al. (2016). These researchers reported that moderate-intensity short-term training programs (<5 weeks) do not promote significant body composition changes in older and young adults. However, Keating et al. (2014), Sanal et al. (2013) and Schejrve et al. (2008) reported that 12 weeks of different types of training programs (e.g., aerobic and combined (aerobic + resistance)) was sufficient to promote a reduction in whole body and regional BF in middle-aged overweight and obese individuals. Short-term programs (<8 weeks) have shown significant effects on reducing BM and BMI, as we found in our study. However, these results can be misleading, giving people the impression of healthy weight loss. Our data clearly show that BM and BMI cannot be used alone to measure body composition changes. Also, results from such studies need to be analyzed with extreme caution before jumping too quickly to conclusions about weight loss. As previously mentioned, the BM and BMI reduction observed in this study resulted from a decrease in FFM, which is not desirable due to its consequences on health.

For the G4, FM and %BF increased, and FFM decreased with any alterations in BM and BMI. These results showed that this intervention had a negative impact on body composition. The FM increases and FFM reduction explain the lack of change in BM and BMI. The problem is that higher FM and lower FFM will have a detrimental health effect over time. Our results oppose studies that showed that resistance training promoted increased muscle mass and whole body and regional BF and remodeling body composition in middle-aged adults (Skrypnik et al., 2015). The divergences in the results are related to the duration of the intervention (4 weeks vs. 12 weeks). Previous studies (Ho et al., 2012; Sanal et al., 2013) showed that combined resistance and endurance training over 12 weeks promoted positive benefits in whole body and regional body composition. Our study showed that 4 weeks of a WLP was maybe too short to affect body composition positively. It is also possible that the NC strategies were not the most effective and adequate for 4 weeks of training. This group's loss of muscle mass (FFM reduction) may also be explained by a catabolic effect caused by training and low protein consumption (Vargas et al., 2018).

The comparison between females and males was included in the analysis to identify the influence of sex on the whole body and regional body composition between pre and postintervention regardless of intervention type and NC. In the current study, females showed similar age and BMI, lower values of height, BM, and FFM, and higher FM and %BF values compared with males' whole body and regional body composition. These results are compatible with scientific evidence showing genetic differences in body composition between sexes (Donges & Duffield, 2012; He et al., 2018). Females had reductions in BM and FFM, while males showed increases in FM and %BF with a concomitant decrease in FFM, which was not expected as a result of an exercise program, as reported previously (Skrypnik et al., 2015). For example, Skrypnik et al. (2015) reported that aerobic and/or resistance exercises effectively increased FFM and decreased FM and %BF.

In conclusion, none of the 4 weeks, short-term WLPs were efficient to positively modify whole body and regional body composition in females and males, regardless of combining exercise and NC. Conversely, our results show that these short-term programs did not affect or, even worse, had an adverse effect on body composition. Additionally, any weight-loss program reporting only BM and BMI needs to be analyzed with extreme caution because it can mislead the interpretation and understanding of the results. More sensitive measurements such as FFM, FM, and %BF are essential for more accurate program results. Moreover, additional studies taking into consideration the participants' daily energy requirements should be performed to complement the data from the current study. Based on our results, it is recommended that weight-loss programs be planned with more than 4 weeks of physical exercises, thus avoiding short-term programs, with the adoption of healthy diets, avoiding excessive carbohydrates, sugars, salts, fats, and processed foods, and with more evaluations accurate to identify real changes in body composition.

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Informed Consent: Written informed consent was obtained from all participants for the study.

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