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Obesity

Effect of Exercise Type During Intentional Weight Loss on Body Composition in Older Adults with Obesity

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Objective: To examine the long-term effects of exercise modality during weight loss on body composition and associations between body composition and physical function changes.

Methods: Two hundred forty-nine older adults (66.9 ± 4.7 years, 71% women, 32% African American, BMI: 34.4 ± 3.7 kg/m^2) were randomized to weight loss (WL; $n = 82$), WL plus aerobic training (WL + AT; $n = 86$), or WL plus resistance training (WL + RT; $n = 81$) for 18 months. Dual-energy x-ray absorptiometry–acquired body composition, 400-m walk time, and knee extensor strength were measured at baseline and at 6 and 18 months.

Results: Total body mass loss was enhanced when WL was combined with exercise (WL: −5.7 ± 0.7 kg, WL + AT: −8.5 ± 0.7 kg, WL + RT: −8.7 ± 0.7 kg; $P < 0.01$). Total body fat mass loss was significantly greater in WL + AT (−6.8 ± 0.6 kg, −16.4%) and WL + RT (−7.8 ± 0.5 kg, −19.0%) than WL (−4.8 ± 0.6 kg, −10.9%); both $P < 0.01$. Lean mass loss was greatest in WL + AT (−1.6 ± 0.3 kg, −3.1%) compared with WL + RT (−0.8 ± 0.3 kg, −1.5%) or WL (−1.0 ± 0.3 kg; −2.0%); both $P \leq 0.02$. Change in 400-m walk time was associated with change in fat mass (β/SD = +6.1 s; $P < 0.01$), while change in knee extensor strength was associated with change in lean mass (β/SD = +1.6 Nm; $P < 0.01$).

Conclusions: WL + RT results in less lean mass lost than WL + AT; WL plus exercise yields greater fat mass loss than WL alone.

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Introduction

In addition to the well-known cardiometabolic consequences of obesity, excessive adiposity is also a significant contributor to functional limitation in old age (1). Indeed, if left unabated, current trends suggest that the functionally disabled older adult with obesity will soon become the most commonly encountered phenotype of frailty (2). Lifestyle-based interventions in older adults with obesity demonstrate immediate improvement in muscle strength and function, with 5% to 10% weight loss (3-10); yet widespread enthusiasm to recommend intentional weight loss in advanced age is diminished due to significant loss in lean mass (i.e., 10%-50% of total tissue) (11,12) and uncertainty surrounding implications for long-term functional status as well as other health outcomes (13). Weight loss strategies that maximize fat mass loss while minimizing lean mass loss should provide the greatest health benefit for this demographic, although evidence from well-designed trials is needed to guide recommendations (14).

Change in body composition with caloric restriction-induced weight loss is modifiable with exercise. Randomized controlled trial (RCT) evidence in older adults with obesity suggests that the addition of moderate-intensity aerobic (15,16), progressive resistance (9,17), or combined (3,6) exercise programs to caloric restriction results in a more favorable shift in body composition compared to either intervention alone. A direct comparison of the effects of aerobic or resistance exercise during caloric restriction was recently assessed in a short-term (i.e., 6-month) study, with results suggestive of a superior ability of resistance training to attenuate weight loss-associated lean mas loss compared to aerobic training (18); however, confirmatory long-term data are lacking. In addition, while exercise itself does not significantly lower body weight, consideration of the

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synergistic effects of exercise added to caloric restriction to augment loss of total body mass and alter composition in older (i.e., 60+ years at baseline) adults has only been evaluated in a handful of RCTs (3,9,15,17). Overall, these studies suggest similar weight and fat mass loss between treatment groups, with exercise modestly attenuating lean mass loss. Studies, however, are generally small ($n = 11$-28 per treatment group), of relatively short duration (4-12 months), and done under tightly supervised conditions, limiting their external validity. The paucity of data on this topic, coupled with the fact that many commercial weight loss programs focus exclusively on caloric restriction to induce weight loss, creates a rationale for further investigation into the long-term effects of caloric restriction with differing exercise modalities compared to caloric restriction alone on change in body mass and composition in older adults.

Therefore, the primary purpose of this study was to compare the long-term effects of caloric restriction-induced weight loss alone (WL) and with aerobic training (WL + AT) or resistance training (WL + RT) on change in body composition in older adults with obesity undergoing an 18-month community-based weight loss intervention. This analytic plan represents a secondary analysis of a previously reported primary outcome paper (19), and we hypothesized that WL + RT would better preserve lean mass than WL + AT or WL alone. Second, we examined the contributions of change in total body fat and lean masses on change in 400-m walk time and knee extensor strength, as these objectively measured outcomes are clinically relevant and highly predictive of subsequent disability and death (20,21). We hypothesized that change in total body fat mass would be associated with change in 400-m walk time and that change in total body lean mass would be associated with change in knee extensor strength. Data from this aim contribute a growing body of knowledge (6,16,22,23) delineating the relative contributions of fat and lean mass lost during intentional weight loss on physical function.

Methods

Study design

Details of the study design and methods are published (24). Briefly, the Cooperative Lifestyle Intervention Program (CLIP II; ClinicalTrials.gov identifier NCT01547182) was a multisite single-blinded RCT involving three YMCAs in Forsyth County, North Carolina. Participants were randomized to one of three treatment groups: caloric restriction-induced weight loss alone (WL), weight loss plus aerobic training (WL + AT), or weight loss plus resistance training (WL + RT) for 18 months. The study was approved by the Wake Forest University Institutional Review Board. The primary outcome paper, including protocol compliance and the intervention effect on dual primary outcome measures, time to complete a 400-m walk, and knee extensor strength, is published (19).

Study participants

A total of 249 participants were enrolled in the CLIP II study. Eligibility criteria consisted of men and women aged 60 to 79 years who engaged in <60 min/wk of moderately intense physical activity, had $\text{BMI} \geq 28$ kg/m^2 and < 42 kg/m^2, had self-reported limitations with mobility, and had documented evidence of cardiovascular disease (CVD) or a National Cholesterol Education Program Adult Treatment Panel III (ATP III) diagnosis of metabolic syndrome (MetS). Individuals were excluded if they had a myocardial infarction or cardiovascular procedure in the past 3 months, fasting blood glucose ≥ 140 mg/dL, or a diagnosis of type 1 diabetes or insulin-dependent type 2 diabetes or if their primary care physician had concerns regarding their ability to safely participate. All participants provided written informed consent prior to study enrollment.

Intervention descriptions

Full intervention descriptions can be found in the published design paper (24).

Weight loss. The three study arms received the same behavior-based WL intervention in three 6-month phases: intensive (months 1-6), transition (months 7-12), and maintenance (months 13-18), with the goal of eliciting a 0.3 kg/wk weight loss in the intensive phase (~330 kcal/d reduction) and a total weight loss of 7% to 10%. During the intensive phase, participants met at the YMCA for three group sessions and one individual sessions per month (all 60 minutes in duration). Group sessions tapered off to three and then one per month for the subsequent phases, with individual sessions scheduled as needed. In accordance with the 2010 dietary guidelines (25), the macronutrient breakdown of the diet was 20% to 25% protein, 25% to 30% fat, and 45% to 55% carbohydrate. For the WL-only group, participants were instructed not to begin a formal exercise program while actively enrolled in the study.

Aerobic training. The primary mode of AT was an individually tailored, supervised, over-ground walking program. The program frequency was 4 d/wk, progressing to a duration goal of 45 min/d and walking intensity of 12 to 14 on the Borg Rating of Perceived Exertion (RPE) Scale (26).

Resistance training. The RT intervention was also individually tailored and involved a training frequency of 4 d/wk, progressing to 45 min/d, with an RPE of 15 to 18 as a target intensity for each RT exercise. Participants completed three sets of 10 to 12 repetitions on eight machines, with initial resistance determined from one repetition maximum (1RM) testing (goal of 75% of 1RM). When a participant completed 12 repetitions in the third set for two consecutive days, the resistance was increased to ensure progressive overload. To assist with recovery time, participants rotated exercises on a 2-day schedule: day one included leg press, hip adduction, hip abduction, calf extension, seated row, pectoral fly, shoulder press, and rotary torso; day two included leg extension, leg curl, lateral pull down, seated chest press, lateral raise, arm curl, triceps extension, and abdominal crunch.

Measurements

Participant age, gender, race/ethnicity, and medical history/comorbid status were captured via self-report at the baseline assessment visit. Also at baseline, height was assessed without shoes to the nearest 0.25 cm using a stadiometer (Portrod, Health-O-Meter) and body mass measured to the nearest 0.05 kg using a calibrated and certified digital scale (Professional 349KLX, Health-O-Meter). All body composition variables were collected at baseline ($n = 247$), 6 months ($n = 223$), and 18 months ($n = 189$). Total body, fat, and lean mass, as well as appendicular lean/fat masses and trunk fat, were assessed using dual-energy x-ray absorptiometry (DXA; iDXA, GE Medical Systems, Waukesha, Wisconsin), following manufacturer recommendations for patient positioning and scanning. Physical function was also assessed at baseline, 6 months, and 18 months via a validated 400-m walk test (that requires walking 10 laps as quickly as possible

TABLE 1 Baseline demographic and body composition measures, according to treatment group and overall

	WL (*n* = 82)	WL + AT (*n* = 86)	WL + RT (*n* = 81)	Overall (*n* = 249)
Age (y)	66.3 ± 4.5	67.5 ± 5.1	66.9 ± 4.4	66.9 ± 4.7
Female, *n* (%)	59 (72.0)	62 (72.1)	56 (69.1)	177 (71.1)
African American, *n* (%)	30 (36.6)	30 (34.9)	20 (24.7)	80 (32.1)
BMI (kg/m^2)	34.7 ± 4.0	33.9 ± 3.5	34.8 ± 3.6	34.4 ± 3.7
Body mass and composition				
Body mass (kg)	95.1 ± 16.7	92.4 ± 13.5	95.6 ± 14.2	94.4 ± 14.9
Fat mass (kg)	42.6 ± 8.8	41.4 ± 7.6	43.2 ± 8.2	42.4 ± 8.2
Fat mass (%)	44.9 ± 5.6	45.0 ± 5.7	45.3 ± 6.0	45.0 ± 5.7
Lean mass (kg)	49.9 ± 10.9	48.3 ± 9.4	49.7 ± 10.1	49.4 ± 10.1
Lean mass (%)	52.4 ± 5.3	52.2 ± 5.4	51.9 ± 5.8	52.1 ± 5.5
Appendicular lean mass (kg)	23.4 ± 5.8	22.4 ± 4.9	23.3 ± 5.5	23.0 ± 5.4
Appendicular fat mass (kg)	17.3 ± 4.5	16.9 ± 4.1	17.6 ± 4.5	17.3 ± 4.4
Trunk fat mass (kg)	24.3 ± 5.6	23.5 ± 4.9	24.4 ± 5.1	24.1 ± 5.2

Data presented as mean ± SD or *n* (%).
AT, aerobic training; RT, resistance training; WL, weight loss.

on a 20-m course between two cones with the time for completion recorded in seconds) (20) and knee extensor strength assessed as peak torque in Newton-meters (Nm) using an isokinetic dynamometer (System 4, Biodex, Shirley, New York) (24).

Statistical analyses

Descriptive statistics were calculated overall and by treatment group at baseline. Overall treatment group comparisons were made using contrasts in a mixed-model analysis of covariance (ANCOVA), with baseline value of the outcome, gender, treatment group, time (6 or 18 months), and a treatment group-by-time interaction included as fixed effects and wave included as a random effect. Data are presented as the average follow-up mean (95% CI) and changes from baseline at 6 and 18 months (95% CI).

To determine the association between change in total body mass, lean mass, and fat mass and previously published intervention effects on 400-m walk time and knee extensor strength (19), we adjusted the above ANCOVA models for two additional pairs of variables: baseline and follow-up total body mass or baseline and follow-up total body composition (lean mass or fat mass, respectively) in treatment groups combined. Analyses were performed using SAS v9.4 (SAS Institute, Cary, North Carolina) and using a Bonferroni-adjusted type I error rate of 0.025.

Results

Participant characteristics

Table 1 presents baseline demographic and body composition measures, according to treatment group and overall. Briefly, 249 older (66.9 ± 4.7 years) adults (71% women, 32% African American) with BMI of 34.4 ± 3.7 kg/m^2 and CVD and/or MetS participated in this 18-month RCT, of whom 247 had complete DXA data at baseline (90% retention at 6 months, 77% retention at 18 months; see CONSORT diagram in Supporting Information Figure S1). At baseline, overall total body, fat, and lean masses were 94.4 ± 14.9 kg, 42.4 ± 8.2 kg (45.0 ± 5.7%), and 49.4 ± 10.1 kg (52.1 ± 5.5%), respectively, with no differences between treatment groups.

As previously reported (19), median (25th, 75th percentiles) attendance to scheduled WL intervention sessions was 71.1% (40.5, 83.3) for WL only, 83.1% (47.6, 92.9) for WL + AT, and 85.7% (70.7, 92.7) for WL + RT. All three treatment groups lost significant weight from baseline (−6.1% [95% CI: −7.5 to −4.7] for WL only, −8.6% [95% CI: −10.0 to −7.2] for WL + AT, and −9.7% [95% CI: −11.1 to −8.4] for WL + RT), and both WL plus exercise treatment groups had greater improvement in 400-m walk time than WL alone (mean difference 16.9 [95% CI: 9.7 to 24.0] seconds, $P < 0.01$) and experienced a similar change in knee extensor strength (combined WL + AT and WL + RT mean difference −3.6 [95% CI: −7.5 to 0.3] Nm, $P = 0.07$).

Intervention effect on body mass and composition

Adjusted overall intervention effects on body composition are presented in Table 2. Total body mass was significantly reduced in all treatment groups (WL: −5.7 ± 0.7 kg, WL + AT: −8.5 ± 0.7 kg, WL + RT: −8.7 ± 0.7 kg; all $P < 0.01$). The two WL plus exercise treatment groups had lower follow-up total body mass compared to WL alone (WL + AT: 85.9 ± 0.9 kg and WL + RT: 85.6 ± 0.7 kg vs. WL: 88.6 ± 0.7 kg; both $P < 0.01$) and were not different from each other ($P = 0.75$). Significant overall treatment effects were also observed for total body fat mass ($P < 0.01$) and total body lean mass ($P < 0.01$). As with total body mass, WL + AT and WL + RT treatment groups had similar and greater reductions in fat mass compared to WL alone (both $P < 0.01$). Interestingly, absolute lean mass was lower in WL + AT (47.8 ± 0.3 kg) compared to WL + RT or WL alone (48.5 ± 0.3 kg and 48.4 ± 0.3 kg, respectively; both $P < 0.01$). However, because of a greater reduction in fat mass in WL + AT compared to WL alone, follow-up lean mass as a percentage of total body mass was significantly higher in WL + AT compared to WL alone (55.8 ± 0.3% vs.

TABLE 2 Overall intervention effects on body composition measures, adjusted for baseline value of the outcome, treatment group, gender, time, and treatment group by time interaction

				P value			
	WL (*n* = 81)	WL + AT (*n* = 86)	WL + RT (*n* = 80)	Overall	WL + AT vs. WL	WL + RT vs. WL	WL + AT vs. WL + RT
Body mass (kg)	88.6 (87.2 to 90.0)	85.9 (84.4 to 87.3)	85.6 (84.3 to 87.0)	< 0.0001	0.0002	< 0.0001	0.7473
Δ 6 months	−6.2 (−7.9 to −4.5)	−7.9 (−9.6 to −6.34)	−8.5 (−10.2 to −6.9)				
Δ 18 months	−5.3 (−7.1 to −3.5)	−9.1 (−10.9 to −7.3)	−8.9 (−10.7 to −7.2)				
Fat mass (kg)	37.6 (36.5 to 38.7)	35.5 (34.4 to 36.6)	34.5 (33.4 to 35.6)	< 0.0001	0.0006	< 0.0001	0.0911
Δ 6 months	−5.1 (−6.5 to −3.7)	−6.4 (−7.7 to −5.1)	−7.8 (−9.1 to −6.5)				
Δ 18 months	−4.4 (−5.8 to −3.0)	−7.3 (−8.7 to −5.9)	−7.9 (−9.2 to −6.5)				
Fat mass (%)	42.6 6 (41.9 to 43.3)	41.1 (40.4 to 41.8)	40.0 (39.4 to 40.7)	< 0.0001	0.0003	< 0.0001	0.0092
Δ 6 months	−6.0 (−8.2 to −3.8)	−8.2 (−10.3 to −6.1)	−11.2 (−13.3 to −9.1)				
Δ 18 months	−4.4 (−7.1 to −2.5)	−9.9 (−12.2 to −7.6)	−11.3 (−13.5 to −9.1)				
Lean mass (kg)	48.4 (47.9 to 48.9)	47.8 (47.2 to 48.3)	48.5 (48.0 to 49.0)	< 0.0001	0.0046	0.6011	0.0006
Δ 6 months	−1.1 (−1.7 to −05)	−1.5 (−2.1 to −0.9)	−0.7 (−1.2 to −0.1)				
Δ 18 months	−0.9 (−1.5 to −0.2)	−1.7 (−2.3 to −1.1)	−1.2 (−1.6 to −0.4)				
Lean mass (%)	54.5 (53.8 to 55.1)	55.8 (55.2 to 56.5)	56.9 (56.2 to 57.5)	< 0.0001	0.0004	< 0.0001	0.0066
Δ 6 months	4.7 (3.1 to 6.3)	6.3 (4.7 to 7.7)	8.9 (7.4 to 10.5)				
Δ 18 months	4.2 (2.5 to 5.8)	7.7 (6.1 to 9.4)	9.1 (7.5 to 10.7)				
Appendicular lean mass (kg)	22.3 (21.9 to 22.8)	21.9 (21.5-22.3)	22.3 (21.9 to 22.7)	< 0.0001	0.0182	0.8320	0.0263
Δ 6 months	−0.7 (−1.2 to −0.3)	−1.1 (−1.5 to −0.6)	−0.7 (−1.1 to −0.2)				
Δ 18 months	−0.7 (−1.1 to −0.2)	−1.1 (−1.6 to −0.6)	−0.8 (−1.2 to −0.3)				
Appendicular fat mass (kg)	15.5 (15.1 to 15.9)	14.9 (14.5 to 15.3)	14.3 (13.9 to 14.7)	< 0.0001	0.0062	< 0.0001	0.0166
Δ 6 months	−1.8 (−2.3 to −1.3)	−2.2 (−2.7 to −1.7)	−3.0 (−3.5 to −2.5)				
Δ 18 months	−1.7 (−2.2 to −1.1)	−2.6 (−3.1 to −2.0)	−2.9 (−3.4 to −2.4)				
Trunk fat mass (kg)	21.1 (20.3 to 21.8)	19.6 (18.9 to 20.3)	19.2 (18.5 to 19.9)	< 0.0001	0.0003	< 0.0001	0.3173
Δ 6 months	−3.3 (−4.2 to −2.4)	−4.2 (−5.0 to −3.3)	−4.8 (−5.7 to −3.9)				
Δ 18 months	−2.7 (−3.7 to −1.8)	−4.8 (−5.7 to −3.8)	−4.9 (−5.8 to −4.0)				

Data presented as mean (95% CI).
AT, aerobic training; RT, resistance training; WL, weight loss.

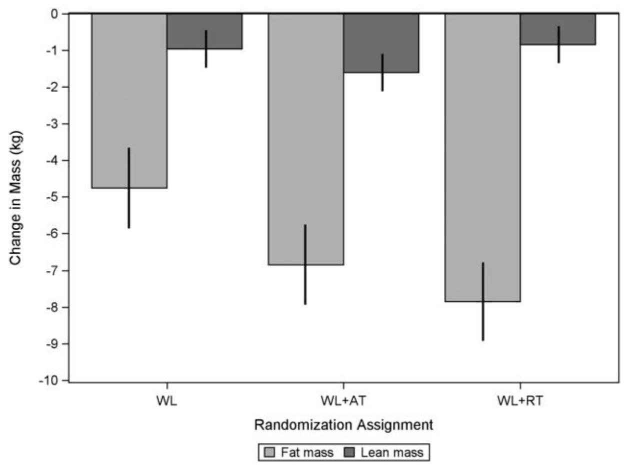

Figure 1 Overall change in total body mass, partitioned into fat and lean compartments, by treatment group and adjusted for baseline value of the outcome, treatment group, gender, time, and treatment group by time interaction.

54.5 ± 0.3%; $P < 0.01$). Treatment effects for appendicular lean mass, appendicular fat mass, and trunk fat were similar to those observed for total body lean and fat masses, respectively (Table 2).

Model-adjusted change estimates for total body mass, partitioned into total body fat and total body lean compartments and presented by treatment group, are shown in Figure 1. As pictured and in accordance with follow-up data, change in absolute lean mass was -0.9 ± 0.3 kg, -1.6 ± 0.3 kg, and -0.8 ± 0.3 kg for the WL, WL + AT, and WL + RT treatment groups, respectively, with significant differences reported between WL and WL + AT and between WL + AT and WL + RT (both $P < 0.01$).

Relationship between change in total body mass and composition and physical function

Modeling results for the association between change in total body mass and composition and the physical function outcome measures of 400-m walk time and knee extensor strength are presented in Table 3. No interaction between treatment group and change in total, fat, or lean mass for either functional outcome was observed. In treatment groups combined and after adjustment for baseline value of the outcome, treatment group, gender, time, and treatment group by time interaction, the magnitude of change in total body mass was associated with change in 400-m walk time ($P < 0.01$), with every 1 kg lost associated with a 0.97-second reduction in 400-m walk time. This association was driven primarily by change in fat mass ($\beta \pm$ SE: 1.35 ± 0.34 seconds; $P < 0.01$). The magnitude of change in total body mass was not associated with change in knee extensor strength ($P = 0.06$); however, change in knee extensor strength was directly associated with change in lean mass ($\beta \pm$ SE: 1.28 ± 0.43 Nm; $P < 0.01$).

Discussion

Results from this study confirm and extend previous research in older adults, demonstrating the ability of structured exercise to attenuate the proportion of weight lost as lean mass (18), while reporting the novel result of the superior ability of WL + RT to preserve absolute lean mass as compared to WL + AT in the long-term and when executed in a community setting. To date, four RCTs have been published in which the additive effect of exercise to WL has been compared to WL alone in older (i.e., 60+ years at baseline) adults, with two studies employing RT (9,17), one study employing AT (15), and one using a combined approach (3). In general agreement with trials employing some form of RT in combination with WL, we observed a significant reduction in the percentage of total body mass lost as lean mass when RT is added to WL (10%) compared to WL alone (16%) (3,9,17). Original findings presented here show half as much lean mass is lost with WL + RT compared to WL + AT (−0.8 kg vs. −1.6 kg, respectively), despite a similar overall reduction in total body mass, when interventions are directly compared. Although novel, given that RT is a well-established stimulus for muscle growth and maintenance in weight-stable older adults (27), results are not overly surprising. What is surprising, however, is that we did not find a lean mass sparing effect of WL + AT compared to WL alone. This is in contrast to several tightly controlled studies conducted in middle-aged and older adults (28), including results from the similarly aged (i.e., 60+ years at baseline, mean: 67.2 years) and designed (i.e., WL + moderate-intensity walking, 3-5 d/wk for 35-45 min/d vs. WL alone) study by Chomentowski et al. (15). Differences in study duration (4 months vs. 18 months in the present study), setting (clinical vs. community-based), or total WL achieved in the WL-only arms (9.2% vs. 6.1% in the present study) may contribute to this discrepancy and warrant further exploration.

Provocative results from this community-based trial also suggest augmented total body mass loss in WL + AT and WL + RT compared to WL alone; our data show an unprecedented near doubling of absolute fat mass (and, therefore, total body mass) loss when exercise is added to caloric restriction induced WL. In contrast, previous trials in older adults report significant, yet similar, weight and fat mass loss between WL only and WL plus exercise arms, with a 5% to 20% reduction in fat mass, depending on the magnitude of total WL achieved (3,9,15,17). Although the behavior-based WL

TABLE 3 Change in 400-m walk time and knee extensor strength per unit change in body mass, lean mass, and fat mass

	Δ Body mass (kg)			Δ Lean mass (kg)			Δ Fat mass (kg)		
	β	SE	*P*	*β*	SE	*P*	*β*	SE	*P*
Δ 400-m walk time (s)	0.97	0.29	0.0008	0.60	0.93	0.5210	1.35	0.34	0.0001
Δ Knee extensor strength (Nm)	0.26	0.14	0.0635	1.28	0.43	0.0033	0.19	0.17	0.2766

Nm, Newton-meter.

intervention was common to all CLIP II treatment groups, session attendance was lower in the WL only treatment group (71.1%) as compared to the WL plus exercise arms (83.1% and 85.7% for WL + AT and WL + RT, respectively) and may signal reduced dietary compliance. Indeed, the amount of total WL achieved by the WL plus exercise arms (~9%) aligns more closely to what is observed in other trials than the WL-only arm (~6%). Nevertheless, this finding is important, as it contributes to a growing body of literature examining the effectiveness of single versus multiple health behavior change interventions among older adults (29) and underscores the translational value of combined caloric restriction and exercise interventions to maximize weight and fat mass loss while preserving physical function.

Secondary analyses from this study demonstrate that loss of total body mass is associated with improvement in mobility (as measured by the 400-m walk), driven by reductions in fat mass, and that change in knee extensor strength is directly associated with change in lean mass. Findings contribute to a growing body of data implicating fat, rather than lean, mass as a primary target tissue affecting mobility related tasks (6,22,23) and confirm the importance of preserving lean mass for strength during WL in older adults (30). Careful interpretation of these findings, however, necessitates consideration of the magnitude of functional change considered clinically meaningful. Data from the Lifestyle Interventions and Independence for Elders Pilot (LIFE-P) study, for instance, suggest that a 20-second change in 400-m walk time represents the lower end of the range for clinical significance (31). Using this threshold and results from our modeling approach, a loss of at least 20.6 kg of total body mass or 14.8 kg of fat mass would be needed to elicit a modest improvement in mobility, which are slightly higher than other reported estimates (22). While the baseline walking speed of our sample was much greater than that of the LIFE population (32), calling into question the exact cut-point necessary to achieve clinical significance, it is important to recognize that the degree of weight and fat mass loss necessary to induce a meaningful change in mobility is likely substantial and may be difficult to achieve.

Although clinical cut-points for absolute knee strength have yet to be established, this association should be considered in light of the relatively small percentage of lean mass lost, as well as other known predictors of muscle strength. As presented in the primary outcome paper (19), using normalized values, both WL + RT and WL + AT experienced gains (15% and 14%, respectively) in relative knee extensor strength. Increases in relative strength signal an improvement in muscle quality, which is arguably more important than muscle quantity, and may be driven by reduced fat infiltration (33,34) and inflammatory burden (35), as both predict muscle strength independent of mass and are improved with weight loss. Collectively, this framework tempers the concern regarding weight loss-associated lean mass loss, although data presented here suggest weight loss interventions that can preferentially reduce fat mass might yield the greatest functional benefit.

Practically, our findings may be used to inform optimal geriatric weight management strategies, as there is a dearth of RCT evidence in this area (14,36), and improve clinical efficacy of diet and exercise recommendations. With regard to the latter, current federal physical activity guidelines are the same for older and younger adults and include 150 min/wk of moderate to vigorous physical activity plus moderate-intensity muscle strengthening activities on two or more days (37). National surveillance data, however, suggest that these ambitious guidelines are less likely to be met by older adults, with just 15% of adults aged 65 to 75 years meeting goals for both aerobic and strength training activities (38). Moreover, recent findings from a short-term clinical trial in older adults with obesity suggest that a combined AT and RT intervention is no better at attenuating weight loss-associated lean mass loss and promoting fat mass loss than WL + RT (18). Thus, a geriatrician managing the older adult with sarcopenic obesity may stress the importance of WL + RT therapy—perhaps even more so than a combined exercise approach, should incorporating both modalities hinder compliance—although, certainly, final recommendations must be carefully and individually considered.

Strengths of this study design include the direct comparison of exercise type during weight loss on body composition, inclusion of a large, heterogeneous sample, and long study duration. Moreover, because the intervention was accomplished in a community setting, results are highly translatable and align with the recent National Institutes of Health vision of effectively disseminated clinical intervention research (39). That said, this study does have weaknesses worth noting. First, study findings should only be generalized to older adults with obesity and documented CVD and/or MetS. Second, although DXA-acquired total body lean and fat mass represents the gold standard in total body composition assessment, and can provide some regional estimates, it does not assess change in fat infiltration. Intriguing recent data suggest decreases in visceral and intermuscular adipose tissue are important mechanisms underlying improved function with WL and exercise interventions (23) and should be explored further. Third, while we present associations between change in body composition and two clinically meaningful functional endpoints, these analyses are by no means comprehensive. Future work formally exploring the mediating effect of change in total body composition and change in physical function would significantly add to this area of inquiry.

Conclusion

The primary findings from this 18-month community-based RCT demonstrate the following: (1) WL + RT results in less lean mass lost than WL + AT, and (2) WL plus RT or AT results in greater overall reductions in total body mass than WL alone, driven by augmented fat mass loss. Second, fat mass loss is primarily responsible for weight loss-associated improvements in mobility, whereas lean mass loss is primarily responsible for weight loss-associated declines in strength. Collectively, these results indicate that the combination of WL + RT may yield the greatest weight loss and the most favorable shift in body composition compared to WL + AT or WL alone, thereby maximizing potential functional benefit. O

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