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Change in health-related quality of life and social cognitive outcomes in obese, older adults in a randomized controlled weight loss trial: Does physical activity behavior matter?

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Abstract This article compared the effect of dietary weight loss administered alone (WL) or in combination with aerobic training (WL + AT) or resistance training (WL + RT) on health related quality of life, walking self-efficacy, stair climb self-efficacy, and satisfaction with physical function in older adults with cardiovascular disease or the metabolic syndrome. Participants ($N = 249$; $M_{\text{age}} = 66.9$) engaged in baseline assessments and were randomly assigned to one of three interventions, each including a 6-month intensive phase and a 12-month follow-up. Those in WL + AT and WL + RT engaged in 4 days of exercise training weekly. All participants engaged in weekly group behavioral weight loss sessions with a goal of 7–10% reduction in body weight. Participants in WL + AT and WL + RT reported better quality of life and satisfaction with physical function at 6- and 18-months relative to WL. At month 6, WL + AT reported greater walking self-efficacy relative to WL + RT and WL, and maintained higher scores compared to WL at month 18. WL + AT and WL + RT reported greater stair climbing efficacy at month 6, and WL + RT remained significantly greater than WL at month 18. The addition of either AT or RT to WL differentially improved HRQOL and key psychosocial outcomes associated with maintenance of physical activity and weight loss. This underscores the important role of exercise in WL for older adults, and suggests health care providers should give careful consideration to exercise mode when designing interventions.

Keywords Aging · Weight loss · Exercise · Maintenance · Theory · Quality of life

Introduction

Health-related quality of life (HRQOL) is a clinically important outcome in aging, as many healthcare providers understand that patients often value quality over quantity of years lived (Rejeski & Mihalko, 2001). Because physical functioning is a major dimension of HRQOL (Ware et al., 1996), it has become a core consideration for interventions targeting older adults (Pahor et al., 2006). Additionally, obesity is recognized as a major risk factor for the loss of physical function among older adults (Rejeski et al., 2010), and both intentional weight loss and participation in regular physical activity are associated with improvements in physical aspects of HRQOL (Fontaine & Barofsky, 2001;

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McAuley et al., 2008). The current study examines the impact of a community-delivered diet and activity-induced weight loss intervention [i.e., the Community Lifestyle Intervention Program-II (CLIP-II); Rejeski et al., 2017] on social cognitions related to physical functioning and the physical domain of HRQOL among obese older adults. In CLIP-II, older adults were randomized to receive dietary weight loss alone (WL), WL plus aerobic training (WL + AT), or WL plus resistance training (WL + RT). As we reported previously (Rejeski et al., 2017), the WL + AT and WL + RT conditions each led to greater weight loss during the intervention period, and better weight maintenance during the 1-year follow-up as compared to the WL-only condition.

The design of CLIP-II offers the unique opportunity to directly compare the effects of WL via caloric restriction only, WL + AT, and WL + RT on key social cognitive outcomes and the physical dimension of HRQOL; outcomes that play an important role in the adoption and longer-term maintenance of health behavior change (Bandura, 2004; Herens et al., 2016). Evidence-based weight loss programs for older adults now include exercise to enhance their effectiveness (Messier et al., 2004, 2013; Rejeski et al., 2017; Villareal et al., 2011, 2017) and to mitigate the loss of lean mass (Villareal et al., 2011). These are particularly important goals in older adults in light of concerns that loss of lean mas may increase one's risk for fracture and disability (Daly et al., 2005; Frimel et al., 2008). Furthermore, just as the mode of exercise can be expected to have differential effects on metabolic and functional outcomes with weight loss, so too can exercise mode differentially affect psychosocial outcomes and HRQOL (McAuley et al., 1999). For instance, self-efficacy is the central construct in the agentic aspect of social cognitive theory (Bandura, 1986, 1997). This construct reflects individuals' beliefs in their ability to execute a specific course of action successfully. It is consistently identified as a key determinant of behavioral initiation and maintenance, and efficacy beliefs exert a powerful influence on HRQOL (Bandura, 1997; McAuley et al., 2006; McAuley & Blissmer, 2000). Bandura notes that these beliefs are situation- and behavior-specific. As such, a program designed to improve muscular strength is likely to have stronger effects on activities of daily living (Martin Ginis et al., 2006) that rely heavily on strength (e.g., lifting the garage door) than those that focus on aerobic conditioning (McAuley et al., 1999). Conversely, walking exercise is highly specific to functional tasks that involve ambulation, particularly over longer distances. It is also reasonable to expect that either aerobic or resistance training would improve confidence in tasks that depend upon both strength and mobility (e.g., stair climbing).

In addition to the effects of exercise training on individuals' confidence, the progress individuals observe as a function of gradual improvements in AT or RT reflect their achievement of attainable shorter-term goals. This generally results in feelings of self-satisfaction that in turn promote positive outcome expectations for future behavior. Such outcome expectations are another important predictor of lasting behavior change (Bandura, 2004). For instance, when training-related improvements are associated with one's ability to engage in valued activities (e.g., remaining in one's home, playing with grandchildren), individuals are likely to feel satisfied with their physical functioning (SAT-F; Katula et al., 2004), and expect this sense of satisfaction to accompany continued participation in physical activity. SAT-F is a social cognition for which deficits are consistently associated with physical disability and limitations in daily activities (Blalock et al., 1988; Katz & Neugebauer, 2001). For valued activities, perceptions of disability may lead to withdrawal from an activity to avoid feelings of dissatisfaction (Katula et al., 2004). Previous research has shown that SAT-F mediates the influence of increased physical activity on quality of life (Rejeski et al., 2001), and improvements in SAT-F have been observed with both physical activity and weight loss interventions (Brawley et al., 2012; Rejeski et al., 2014). The presence of such specificity effects has implications for the design of weight loss intervention content that is more likely to meet the needs of older adults and to enhance longer-term maintenance of lost weight. Yet, existing evidence comparing the effect of WL via caloric restriction only versus WL + AT and WL + RT on HRQOL and social cognitions is limited (Focht et al., 2005). This gap in knowledge provided the scientific premise for these secondary analyses of data from the CLIP-II study.

The physical component of the SF-12 (SF-12P), self-efficacy, and SAT-F were collected at baseline, following the 6-month intensive phase of the interventions, and again after a 1-year follow-up period (i.e., month 18). We hypothesized that participants in either WL + AT or WL + RT would experience greater improvements in HRQOL, SAT-F, and self-efficacy at 6 months as compared to those in WL, and that this effect would persist at the 18-month assessment. Additionally, because self-efficacy is behavior-specific, we expected those in WL + AT to report greater efficacy for walking as compared to those in either WL or WL + RT. By contrast, we anticipated that participants in WL + AT and WL + RT would not differ from one another on stair climbing self-efficacy, but that both would outperform those in WL.

Methods

Participants

CLIP-II recruited overweight and obese older adults with cardiovascular disease (CVD) and/or the metabolic syndrome (MetS) into an 18-month randomized controlled trial (RCT) with three treatment groups: WL via caloric restriction only, WL + AT, or WL + RT. The primary outcome was change in mobility. The methods have been described in detail elsewhere (Marsh et al., 2013). In brief, delivery of this single-blinded RCT occurred in three community YMCAs in Forsyth County, NC, with the interventions being delivered by YMCA staff members. Eligible participants were community dwelling men and women aged 60–79 who were low active (i.e., engaging in < 60 min/week of moderate to vigorous physical activity) with a body mass index ≥ 28 and < 42, self-reported mobility limitations, and documented evidence of CVD or an ATP II diagnosis of MetS (Huang, 2009). We recruited individuals with CVD or MetS as these obesity-related conditions are highly prevalent in older adults (Aguilar et al., 2015; Mozaffarian et al., 2016) and are known risk factors for declining physical function (Kuo et al., 2012; Liaw et al., 2016). Exclusion criteria included severe heart disease, severe systematic disease, having had a myocardial infarction or cardiovascular procedure in the previous 3 months, a blood glucose reading of ≥ 140 mg/dL, diagnoses of Type I or Type II diabetes, or a severe psychiatric condition. The institutional review board at Wake Forest School of Medicine approved the study protocol and we registered CLIP-II with ClinicalTrials.gov (NCT01547182).

Randomization

Recruitment occurred in eight waves with randomization of participants within each wave to one of the three interventions. Randomization occurred following baseline testing using a block randomization scheme that was stratified by wave.

Intervention

The WL portion of the intervention comprised three phases: an *intensive* phase (months 1–6), a *transition* phase (months 7–12), and a *maintenance* phase (months 13–18). During the initial *intensive* phase, participants met with trained staff members at a local YMCA for three group sessions and one individual session each month. The group sessions, which lasted 60 min, were tapered to two monthly sessions and one monthly session during the *transition* and *maintenance* phases, respectively. Session content was informed by the agency aspect of social cognitive theory (Bandura, 1997), and the use of the group as an agent of change in the group dynamics literature (Brawley et al., 2012, 2014; Focht et al., 2004; Rejeski et al., 2003; Rejeski & Focht, 2002). Specifically, CLIP-II employed a well-studied group-mediated cognitive behavioral (GMCB) intervention with content focused on changing the determinants of self-efficacy (e.g., mastery experiences, social modeling) and setting highly specific proximal goals. The *intensive* phase of the study eased participants into diet and exercise goals to provide early mastery experiences and build self-efficacy. To facilitate week-to-week group discussions, the intervention included activities designed to foster small group formation. Self-regulatory skills were developed through weekly homework assignments, and support among members was encouraged through weekly discussions of successes, failures, and methods for overcoming barriers to individual and group progress. The *maintenance* phase transitioned participants away from staff- and group-supported self-regulation toward personal responsibility for self-regulation. Intermittent group discussions continued to provide opportunities for group member support. Initially, participants aimed to achieve a weight loss of 0.3 kg per week, with a distal goal of 7–10% reduction in body mass.

Although a detailed description of these intervention procedures is outside of the scope of this secondary analysis of HRQOL, SAT-F, and self-efficacy, readers can refer to our previous publications for additional information. A detailed description of the rationale and content behind the GMCB approach can be found in Focht et al. (2004), and Brawley et al. (2014) provided a thorough presentation of the model's theoretical basis, the content of each intervention phase, and a meta-analytic description of social-cognitive, physical function, and adherence effects of interventions conducted using the GMCB approach.

With regard to the exercise component of CLIP-II, individuals assigned to the WL + AT or WL + RT conditions engaged in four sessions of aerobic or resistance training exercise each week. The aerobic exercise prescription consisted primarily of walking on an indoor track 4 days each week, and participants were guided toward achieving 45 min of uninterrupted exercise at a rating of perceived exertion (RPE) of 12–14 on the Borg RPE scale (Borg, 1973) during each session. Those who received RT also worked toward exercising for 45 min at an RPE of 15–18 on 4 days each week, completing exercises on eight Cybex resistance machines. During the first week, participants engaged in one set of 10–12 repetitions at 40% of their one-repetition max; a value determined during an orientation appointment. By weeks 3–12, the goal for participants was to complete three sets of 10–12 repetitions at 70% of their one-repetition max; a goal that was increased to 75% from week 13 onward. Additionally, during this final phase, participants completed the third set to volitional fatigue. If they were able to achieve at least 12 repetitions, the resistance was increased in an effort to maintain a consistent RPE.

Measures

Participants completed assessments at baseline, following the intensive phase (month 6), and following the maintenance period (month 18). The physical component of the SF-12 provided a measure of general HRQOL for physical functioning (e.g., "Does your health now limit you in moderate activities such as moving a table, pushing a vacuum cleaner, bowling, or playing golf"). This six-item measure has extensive data supporting its validity and reliability (Ware et al., 1996). On the SF-12P, higher scores indicate better physical health status, and an improvement of 3–5 units is generally considered clinically meaningful (Stewart et al., 1989; Wyrwich et al., 2005).

We collected two measures of task self-efficacy. The first, which assessed self-efficacy for walking, included eight-items and asked participants about their ability to walk at a moderate pace without stopping for 5, 10, 15, 20, 25, 30, 35, and 40 min. Ratings were provided on an 11-point Likert scale with options ranging from 0 ("No Confidence") to 10 ("Complete Confidence"). Stair-climbing self-efficacy was collected immediately following the completion of a stair-climbing task. Here, participants were asked to assess their confidence in their ability to complete the task 2, 4, 6, 8, and 10 times without stopping. Again, ratings were provided on an 11-point Likert scale with options ranging from 0 ("No Confidence") to 10 ("Complete Confidence"; Focht et al., 2005; Rejeski et al., 1995). For each self-efficacy measure, items were averaged and then multiplied by 10 to produce a score ranging from 0 to 100, with a higher score representing better confidence. These measures of self-efficacy were developed based on methodology outlined by Bandura (1986, 2006) and have been shown to be responsive to change in previous work (Focht et al., 2005; Rejeski et al., 2008). A study involving older adults reported that stair climbing self-efficacy correlated significantly in expected directions with both knee strength and VO2peak. Moreover, the 2-week test–retest reliability was 0.93 (Rejeski et al., 1995). Additionally, as evidence of construct validity, we observed that self-efficacy for walking was significantly related to 400-m walk performance ($r_s = -.49, p < .001$), and stair-climbing self-efficacy was significantly related to performance on the stair-climb task ($r_s = -.41$, $p < .001$). To illustrate reliability of these measures, we examined correlations for each efficacy measure within the WL condition, as these individuals received no exercise intervention. Here, correlations between self-efficacy for walking at baseline and month 6 was $r_s = .69$, $p < .001$. Likewise, correlations between stair-climbing self-efficacy at baseline and month 6 was $r_s = .69$, $p < .001$.

Satisfaction (SAT-F) with various components of physical function (e.g., "In the past 4 weeks, how satisfied have you been with the muscular strength in your legs?") was assessed using a 6-item scale originally developed by Ray et al., (1996). Participants rated satisfaction on a 7-point scale scored from − 3 (very dissatisfied) to + 3 (very satisfied). In a maximum likelihood factor analysis, all six items for the SAT-F scale loaded on a single dimension and had a Cronbach alpha of 0.94 (Reboussin et al., 2000). In that same study, the measure was found to be inversely related to negative affect and direct related to positive affect (*p*s < .001). In a study with patients who had peripheral artery disease, SAT-F had a 1–3-week test–retest reliability of 0.73. Moreover, several studies have found the measure to be sensitive to change in randomized controlled trials of physical activity (Rejeski et al., 2001, 2002, 2008).

Analyses

The comparisons of interest in this study were between WL versus WL + AT, WL versus WL + RT, and WL + RT versus WL + AT on SF-12P, walking self-efficacy, stair-climbing self-efficacy, and SAT-F scores at 6 and 18 months. We used two-sided tests at $\alpha = .05$ following the intention to treat principle. To test the treatment effects, we employed mixed model analyses of covariance (ANCOVAs) with an unstructured covariance matrix. Covariates included time (month 6; month 18), the baseline value of the outcome tested, and sex, which were entered as fixed effects, as well as YMCA site and wave within site, which were entered as random effects. Overall significance tests for each of the four models were conducted using likelihood ratio tests that compared the model presented to a model with only the intercept. Adjusted means and estimated treatment differences were calculated; we used the Tukey adjustment for multiplicity for the three pairwise comparisons.

Results

Participant characteristics

A CONSORT diagram and detailed recruitment and retention information have been published previously

Table 1 Participant characteristics: mean ± SD or *N* (%)

	WL ($N = 82$)	WL + AT ($N = 86$)	WL + RT ($N = 81$)	Overall ($N = 249$)
Age (years)	66.3 ± 4.5	67.5 ± 5.1	66.9 ± 4.4	66.9 ± 4.7
Sex				
Female	59/82 (72.0%)	62/86 (72.1%)	56/81 (69.1%)	177/249 (71.1%)
Male	23/82 (28.0%)	24/86 (27.9%)	25/81 (30.9%)	72/249 (28.9%)
Race				
African American	30/82 (36.6%)	30/86 (34.9%)	20/81 (24.7%)	80/249 (32.1%)
Hispanic	1/82 (1.2%)	1/86 (1.2%)	1/81 (1.2%)	3/249 (1.2%)
White	49/82 (59.8%)	55/86 (64.0%)	58/81 (71.6%)	162/249 (65.1%)
Other/mixed/missing	2/82 (2.4%)	0/86 (0.0%)	2/81 (2.5%)	4/249 (1.6%)
Highest level of education				
< High school diploma	1/82 (1.2%)	3/86 (3.5%)	1/81 (1.2%)	5/249 (2.0%)
High school/some college	33/82 (40.2%)	32/86 (37.2%)	40/81 (49.4%)	105/249 (42.2%)
Associate's degree or higher	48/82 (58.5%)	51/86 (59.3%)	40/81 (49.4%)	139/249 (55.8%)
SF-12 P	43.6 ± 10.0 ($N = 79$)	41.8 ± 10.0 ($N = 81$)	40.1 ± 10.6 ($N = 73$)	41.9 ± 10.2 ($N = 233$)
SE for walk	54.2 ± 30.2 ($N = 82$)	55.6 ± 28.7 ($N = 86$)	51.7 ± 28.2 ($N = 81$)	53.9 ± 29.0 ($N = 249$)
SE for stairs	58.6 ± 24.2 ($N = 82$)	58.8 ± 24.5 ($N = 86$)	59.0 ± 23.9 ($N = 81$)	58.8 ± 24.1 ($N = 249$)
SAT-F	− 1.4 ± 1.4 ($N = 82$)	− 1.3 ± 1.4 ($N = 86$)	− 1.4 ± 1.6 ($N = 81$)	− 1.4 ± 1.5 ($N = 249$)
Body mass index (kg/m^2)	34.7 ± 4.0 ($N = 82$)	33.9 ± 3.5 ($N = 86$)	34.8 ± 3.6 ($N = 81$)	34.4 ± 3.7 ($N = 249$)

WL weight loss, *AT* aerobic training, *RT* resistance training, *SE* self-efficacy, *SAT-F* satisfaction with physical function

(Rejeski et al., 2017). Of the 249 older adults randomized to treatment, 90.3% provided follow-up data at month 6, and 77.1% provided data at month 18. Loss to follow-up did not differ by condition at either time point ($p \geq .06$). Table 1 provides the baseline descriptive statistics for the sample. The mean (SD) age of participants was 66.9 (4.7) years, and the baseline BMI was 34.4 (3.7) kg/m^2 (3.7). The sample was largely female (71.1%), 65.1% were white, and the educational background was diverse. Specifically, 42.2% had a high school diploma, and 55.8% had an associate's degree or higher.

Treatment effects

Overall tests of significance indicated each of the four models was highly significant ($\chi^2 > 135$, $df = 7$, $p < .001$; Table 2). After controlling for site, wave, sex, and baseline values of each relevant outcome, both WL + AT and WL + RT exhibited statistically higher scores on the SF-12P at both the 6-month (WL vs. WL + AT $p = .025$; WL vs. WL + RT $p = .004$) and 18-month (WL vs. WL + AT $p = .004$; WL vs. WL + RT $p = .013$) follow-up assessments when compared to WL; however, there were no differences between WL + AT and WL + RT ($ps \geq .989$) at either time point [see Tables 3, 4 for adjusted means (95% CIs) and mean differences (95% CIs) for all comparisons]. Participants in WL + AT reported statistically greater walking self-efficacy at month 6 when compared with WL + RT ($p = .016$) and WL ($p < .001$), and WL + AT maintained higher walking self-efficacy relative to WL at month 18 ($p < .001$). For stair-climbing self-efficacy, participants in both exercise conditions reported higher levels at month 6 (WL vs. WL + AT $p = .032$; WL vs. WL + RT $p = .027$) relative to WL, and for WL + RT this effect was sustained at month 18 ($p = .040$). Regarding SAT-F, participants in both WL + AT and WL + RT reported significantly higher scores at month 6 and month 18 (all $ps < .001$). Stair-climbing self-efficacy and SAT-F did not differ by exercise condition at either time point.

Table 2 Results of likelihood ratio tests

Outcome	χ^2	*df*	*p* value
SF-12 P	311.921	7	< .001
SE for walk	135.475	7	< .001
SE for stairs	154.045	7	< .001
SAT-F	80.138	7	< .001

Discussion

As hypothesized, the addition of either AT or RT to caloric restriction resulted in statistically significant improvements in HRQOL scores, walking self-efficacy, stair-climbing

Table 3 Baseline adjusted means and pairwise mean differences at 6 months for the 3 intervention groups

Variables	Adjusted means (95% CI): treatment groups			Mean differences (95% CI) for pairwise comparisons		
	WL Only	WL + AT	WL + RT	WL versus WL + AT	WL versus WL + RT	WL + AT versus WL + RT
SF-12 P	44.51	48.62	49.45	− 4.11*	− 4.94*	− 0.82
	(42.60, 46.42)	(46.83, 50.41)	(47.60, 51.29)	(− 7.91, − 0.31)	(− 8.82, − 1.06)	(− 4.57, 2.92)
SE for walk	57.43	79.99	67.13	− 22.6*	− 9.70	12.86*
	(51.40, 63.47)	(74.27, 85.71)	(61.34, 72.91)	(− 34.2, − 11.0)	(− 21.4, 2.00)	(1.51, 24.21)
SE for stairs	59.38	69.90	70.21	− 10.5*	− 10.8*	− 0.31
	(54.23, 64.53)	(65.08, 74.73)	(65.31, 75.11)	(− 20.5, − 0.54)	(− 20.9, − 0.77)	(− 10.0, 9.40)
SAT-F	0.08	1.31	1.77	− 1.23*	− 1.69*	− 0.46
	(− 0.27, 0.43)	(0.98, 1.65)	(1.43, 2.11)	(− 1.85, − 0.62)	(− 2.31, − 1.07)	(− 1.06, 0.14)

Confidence intervals for pairwise differences use a Tukey adjustment for multiple comparisons

*Mean differences signifies statistical significance at $p < .05$

self-efficacy, and SAT-F. When taken alongside the consistent evidence that weight-bearing exercise during WL helps to retain bone (Beavers et al., 2017) and muscle (Villareal et al., 2011) while reducing risk of falls (Rose & Hernandez, 2010), our results build on the already strong body of evidence showing that exercise is an important component of weight loss interventions for older adults (Messier et al., 2004, 2013; Rejeski et al., 2017; Villareal et al., 2011, 2017). Unfortunately, geriatricians are often hesitant to prescribe weight loss to their overweight/obese older patients out of fear of muscle and bone loss, which could place these individuals at heightened risk for frailty (Felix & West, 2013). At the same time, recent discussions of weight loss in the popular media have downplayed the importance of exercise during weight loss when compared with food choice [e.g., “To Lose Weight, Eating Less is Far More Important than Exercising More,” The New York Times (Caroll, 2015)]. This narrative further promotes the existing emphasis on caloric restriction alone and ignores the needs of special populations such as older adults. As demonstrated in CLIP-II, the addition of AT or RT to a WL intervention not only produced better weight loss (Rejeski et al., 2017) and improvements in HRQOL, but also left participants more confident and more satisfied with their physical functioning. As noted by Bandura (1997, 2004), individuals display continued interest in activities for which they are efficacious and from which they derive continued satisfaction. By extension, weight loss interventions that bolster older adults’ confidence in their ability to move through the world and increase satisfaction with function are likely to increase the probability of sustained behavior change and concomitant benefits to health and HRQOL.

Key contributions of this study include the fact that it was translational in nature; that is, we conducted CLIP-II in community-based YMCAs, and YMCA staff delivered the interventions rather than professionally-trained interventionists. Additionally, the study design enabled direct comparison of WL, WL + AT, and WL + RT on HRQOL, self-efficacy, and SAT-F. As hypothesized, the addition of any form of exercise to dietary weight loss produced improvement in HRQOL and SAT-F beyond those observed in the WL-only condition, and the mode of exercise differentially affected self-efficacy. Specifically, both conditions improved walking and stair-climbing self-efficacy in the short term, but only WL + AT produced lasting improvements in walking self-efficacy across the 18-month study period, while WL + RT produced lasting improvements in stair climbing self-efficacy. These findings support the notion that either AT or RT benefit HRQOL and the longer-term maintenance of weight loss and behavior change, but they also suggest the mode of exercise should be carefully considered alongside the needs and preferences of the individual. For instance, for many older adults, factors related to independence (e.g., being able to continue to engage in valued activities) are important motivators for weight loss (Pellegrini et al., 2017), and we posit such individuals are likely best served by a training program that directly builds confidence in these areas. The self-efficacy and satisfaction data presented herein capture perceptions related to walking and stair-climbing performance. As such, additional research examining the influence of AT and RT on self-efficacy and satisfaction specifically related to independence and activities of daily living is warranted.

These mode-specific effects point to a rich area of future research that considers the needs of the individual. For more than a decade, health behavior researchers have discussed the challenge of maintaining moderate-to-vigorous aerobic exercise, which can be aversive for older adults (Brawley et al., 2003; Buman et al., 2010). A promising alternative lies in programs that integrate physical activity

Table 4 Baseline adjusted means and pairwise mean differences at 18 months for the 3 intervention groups

Variables	Adjusted means (95% CI): treatment groups			Mean differences (95% CI) for pairwise comparisons		
	WL only	WL + AT	WL + RT	WL versus WL + AT	WL versus WL + RT	WL + AT versus WL + RT
SF-12 P	43.08	48.50	47.92	− 5.42*	− 4.83*	0.58
	(41.04, 45.12)	(46.43, 50.57)	(45.92, 49.92)	(− 9.64, − 1.20)	(− 9.01, − 0.66)	(− 3.60, 4.77)
SE for walk	56.09	79.81	68.06	− 23.7*	− 12.0	11.75
	(49.86, 62.32)	(73.56, 86.05)	(62.01, 74.10)	(− 36.1, − 11.3)	(− 24.2, 0.23)	(− 0.44, 23.94)
SE for stairs	60.56	68.05	70.87	− 7.50	− 10.3*	− 2.81
	(55.43, 65.68)	(63.01, 73.09)	(65.97, 75.76)	(− 17.7, 2.68)	(− 20.3, − 0.28)	(− 12.8, 7.12)
Sat-F	0.21	1.32	1.76	− 1.11*	− 1.55*	− 0.45
	(− 0.15, 0.58)	(0.95, 1.69)	(1.41, 2.12)	(− 1.78, − 0.43)	(− 2.21, − 0.89)	(− 1.11, 0.22)

Confidence intervals for pairwise differences use a Tukey adjustment for multiple comparisons

*Mean differences signifies statistical significance at $p < .05$

into daily life and train valued activities that promote independence. A number of research teams have provided promising early evidence on the benefits of this approach. For example, Martin Ginis et al., (2006) randomly assigned older adults to receive resistance training alone, or in combination with an educational component that tied the resistance training movements to key activities of daily living. Those who received the education component in combination with resistance training reported greater self-efficacy for activities of daily living and had stronger beliefs that resistance training would have a positive effect on these activities. Clemson et al. (2012) provided another interesting example of an exercise intervention that was integrated into older adults' daily lives. These investigators randomized participants to one of three groups: (a) an attention control group that engaged in gentle exercise, (b) a structured exercise intervention to increase balance and strength, or (c) a LIFE intervention in which participants learned to integrate balance and strengthening activities into their everyday routines. Both structured exercise and the LIFE intervention yielded improvements in dynamic balance and balance confidence compared to control participants, and when asked to rate their own global health status, participants in the LIFE arm alone perceived a modest but significant improvement relative to controls. Collectively, these novel interventions suggest that there is value in integrating physical activity programs into the lives of older adults, and in linking intervention-related changes with valued outcomes (e.g., one's ability to engage with family or live independently), as these strategies may better promote older individuals' self-efficacy and satisfaction with their physical function, and ultimately help to sustain lifestyle behavior change.

Limitations

Despite the integrity of the study design and the aforementioned benefits that exercise in combination with caloric restriction had on HRQOL and social cognitive outcomes, there are limitations that warrant consideration. First, the study design lacked a no-treatment, attention control group. Although the lack of this comparison arm prevented us from evaluating the potential benefits of caloric restriction alone on the outcomes of interest, participants dislike assignment to such treatment groups and we felt that the most important comparisons were between WL, WL + AT and WL + RT. Second, the study design did not include a combined exercise condition of AT with RT. Recent findings by Villareal et al., (2017) suggest that combined training may be preferable for weight loss and improvement in functional health; however, their study only lasted 6-months. Moreover, the complexity and burden of sustaining a combined program over the long term is a question that merits attention. And third, we did not have sufficient power to examine whether sex may have moderated the treatment effects on our outcome measures. We would argue that this is yet another topic worthy of investigation in future large-scale intervention trials studying the individual and combined effects of different modes of exercise plus caloric restriction on HRQOL, self-efficacy, and satisfaction with functioning.

Conclusions

Results of this study indicate that the combined effect of physical activity and caloric restriction for weight loss among overweight and obese older adults with CVD and/or MetS was superior to caloric restriction alone in enhancing key social cognitive outcomes and HRQOL. Importantly, we observed these effects following the intensive 6-month phase of the intervention and at an 18-month follow-up assessment. Given the importance of self-efficacy and satisfaction with regard to longer-term lifestyle behavior change, we believe the results of this study underscore the important and unique role of both AT and RT in the design of weight loss interventions for older adults. Further research is warranted on how to best integrate both modes of exercise into the daily lives of older adults to optimize long term maintenance of behavior change.

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Compliance with ethical standards

Conflict of interest Jason Fanning, Michael P. Walkup, Walter T. Ambrosius, Lawrence R. Brawley, Edward H. Ip, Anthony P. Marsh, and W. Jack Rejeski declares no conflicts of interest.

Human and animal rights and Informed consent All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

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