J Frailty Aging 2022;11(2)151-155
Published online February 24, 2022, http://dx.doi.org/10.14283/jfa.2022.15

Brief Report



# Changes in Body Composition in Older Adults after a Technology-Based Weight Loss Intervention

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## Abstract

We conducted a post-hoc analysis of a pre/post, single-arm, non-randomized, multicomponent weight loss intervention in older adults. Fifty-three older adults aged ≥65 with a body mass index ≥ 30 kg/m2 were recruited to participate in a six-month, remote monitoring and video-conferencing delivered, prescriptive intervention consisting of individual and group-led registered dietitian nutrition and physical therapy sessions. We assessed weight, height, and body composition using a SECA 514 bioelectrical impedance analyzer. Mean age was 72.9±3.9 years (70% female) and all had ≥2 chronic conditions. Of those with complete data (n=30), we observed a 4.6±3.5kg loss in weight, 6.1±14.3kg (1.9%) loss in fat mass, and 0.78±1.69L loss in visceral fat (all p<0.05). Fat-free mass (-3.4kg±6.8, p=0.19), appendicular lean mass (-0.25±1.83, p=0.22), and grip strength (+3.46±7.89, p=0.56) did not significantly change. These variables were preserved after stratifying by 5% weight loss. Our intervention led to significant body and visceral fat loss while maintaining fat-free and appendicular lean muscle mass.

*Key words: Weight, telehealth, body composition, muscle mass.*

## Introduction

Obesity affects over 40% of older adults aged over 65 (1) and over 30% have obesity and multiple chronic health conditions that are associated with a three-fold higher risk of disability (2, 3), lower quality of life, and an increased risk of nursing home placement and death (4-6). The public health implications are not trivial, leading to increased healthcare costs and a higher risk of developing frailty (7).

Weight loss interventions, consisting of dietary changes combined with aerobic and resistance exercises, can improve comorbidity and physical function (8, 9). While excess fat has harmful effects, its loss without lean muscle mass or strength retention may worsen physical function (10). Caloric restriction without concomitant resistance exercises is beneficial metabolically (11, 12). However, they have been shown to have a detrimental impact on muscle physiology which paradoxically promotes worsening physical function in older adults (10). Weight-loss induced sarcopenia is of importance when designing and implementing evidence-based interventions to improve the health and well-being of this population.

We previously demonstrated the efficacy of a technology-based, multicomponent, weight-loss intervention in older adults with obesity (13). In this population with multiple chronic conditions, a prescriptive intervention consisting of registered-dietitian and physical therapist delivered intervention led to a 4.7% weight loss with improvements in physical function. The intervention was delivered using telemedicine and participants were provided a remote monitoring device. Such favorable results are important only if weight loss does not negatively affect muscle function or body composition. The purpose of this secondary analysis was to evaluate the changes in body composition resulting from this multicomponent intervention. We additionally explored the differential impact of significant weight loss and whether we could identify baseline characteristics leading to differential responses in body composition.

## Methods

### Design & Setting

The details of the study have been previously published (13). Briefly, this was a six-month, single-arm, pre/post, non-randomized clinical trial in 53 older adults aged 65 years and older whose body mass index was over 30 kg/m$^2$. The intervention was conducted at a community-based aging resource center affiliated with Dartmouth-Hitchcock, a rural academic medical center in Western New Hampshire, United States. All study-related activities, including assessments and intervention delivery, took place between October 2018 and May 2020. The study was approved by the Institutional Review Boards of Dartmouth-Hitchcock and the University of North Carolina at Chapel Hill. The trial is registered at clinicaltrials.gov (NCT 03104205).

### Participants

As part of the inclusion criteria, all adults had access to home high-speed internet access. Exclusion criteria consisted of any electronic health record diagnosis of end-stage congestive heart failure, renal failure, hepatic failure, a terminal illness, severe or uncontrolled psychiatric disease, nursing home or

*Received September 28, 2020*
*Accepted for publication December 26, 2021*

hospital admission within the past six months, bariatric surgery, a life-expectancy <6 months, on obesity-related medications, or if they intentionally lost >5% weight in the past six months. Other details have been previously described. Medical clearance was obtained from the participant's primary care clinician.

### Intervention

A 26-week remote, technology-based program consisted of weekly registered dietitian visits and twice-weekly physical therapy sessions were implemented. An individual in-person session overseen by each of the interventionists took place at baseline, followed by group-led, in-person, monthly sessions. Remote delivery using video-conferencing (Zoom™) allowed dietitians to deliver content and meal-planning with participants on an individual, weekly basis; physical therapists conducted group-based delivery of exercise sessions. All participants were physically located at home during these remote sessions.

Dietitian-led sessions focused on caloric restriction (500-750 kCal/day deficit; minimum 1,200 kCal/day), Vitamin D (1,000 units/day), protein intake (1-1.2 g/kg/day or 20% intake). They created individualized meal plans guided by the Harris-Benedict equation (14). Physical therapists guided a program that paralleled the America College of Sports Medicine recommendations for exercise in older adults and modeled after the LIFE study (15), details of which are fully described elsewhere (13). Sessions (~75 minutes) were conducted twice weekly via video-conferencing, and once a week at home, with participants asked to report out and document each of the exercises at home (16). These sessions consisted of personalized resistance, flexibility, and balance planning. Resistance exercises were performed to a level of 8-12 repetitions. Additionally, each participant received an aerobic prescription of 150 minutes per week, individually broken up to meet the participant's daily schedule. All exercises were performed to a Borg exertional scale of 13. Participants were provided a detailed, standardized instruction manual in setting up the video-conferencing in their homes. A Fitbit Alta HR was given to promote physical activity engagement throughout the study. The research assistant was available for troubleshooting throughout the study.

### Measurements

Weight was assessed using a standardized A+D digital scale without shoes, jackets, or heavy clothing. Height was measured using a stadiometer. A 5% change in weight was considered clinically significant (17). Percent body and visceral fat were assessed using the Seca 514 mBCA bioelectrical impedance analyzer (Hamburg, Germany). This eight-point method uses a flow of low alternating current. Participants were asked their physical activity level (on 5 levels), which was inputted into the system. Waist circumference was measured and entered as a variable in the Seca system. The research assistant had participants standing barefoot for 20 seconds while holding the hand electrodes. Appendicular lean mass (ALM) was defined as the sum of the upper and lower extremities and then normalized for both BMI and height ($m^2$) as outlined in the recent Sarcopenia Definitions Outcome Consortium definitions recommendations (18). This analyzer has proprietary algorithms that evaluate visceral adipose tissue, which is reported in liters.

We also determined changes in grip strength using a JAMAR handheld dynamometer as part of this analysis as this measure is used to categorize persons at risk for weakness (18). Strength was measured in both hands three times, alternating every 30 seconds, with the arm extended at 90°, and laid on a flat surface. Grip strength has been shown to relate to upper and lower extremity strength, and can predict mobility disability (test-retest reliability, r=0.954 in healthy older adults) (19). Maximum values were used in the analysis.

### Statistical Analysis

Our primary analysis was to determine the changes in body composition, specifically whether fat and muscle mass changed with weight loss. We represent continuous variables as means ± standard deviation, and categorical values as counts (percent). To assess differences between completers vs. dropouts (participants that did not complete the intervention) and completers with full data to those without (unable to complete follow-up body composition measures due to COVID-19 restrictions; data on weight were available), we performed an unpaired t-test or chi-square. Intra-group comparisons of baseline and 6-month values were assessed using a paired t-test (or their non-parametric equivalent). We evaluated the differences in measures in participants losing ≥ 5% weight loss over time. In addition, we calculated the effect size as a comparison measure between those losing significant weight and those that did not. Several exploratory analyses were conducted to understand participants who may have lost fat-free mass or appendicular lean mass through weight loss or changes in visceral adipose tissue compared to those who gained or preserved mass. We additionally evaluated participants losing strength but who lost weight. Last, we assessed participants losing weight but not losing visceral fat mass. Descriptive statistics evaluating these groups baseline characteristics were conducted. All analyses were performed using STATA v.15. A p-value <0.05 was considered statistically significant.

## Results

Baseline characteristics of the 53 participants that consented and enrolled are presented in Table 1. All participants were aged ≥ 65 years, and all fulfilled the criteria for multiple chronic conditions (≥ 2 medical conditions). The mean age was 72.9 ± 3.9 years, the majority were female (69.8%), and few participants reported a low income or were receiving Medicaid benefits. The majority had a diagnosis of hypertension (71.7%) and were married (66%). Attendance rates were 84% and 77% for the video-based nutrition and physical activity sessions. Table 1 highlights the baseline differences in characteristics between dropouts (n=9) and those completing the intervention (n=44). Additionally, we did not observe any statistical

**Table 1.** Baseline Characteristics

| | Overall N=53 | Completers N=44 | Dropouts N=9 | P-value |
|---|---|---|---|---|
| Age, years | 72.9 ± 3.9 | 73.2 ± 3.9 | 71.4 ± 3.8 | 0.20 |
| Female Sex | 37 (69.8) | 32 (72.7) | 5 (55.6) | 0.30 |
| Education | | | | 0.17 |
| High school | 7 (13.2) | 7 (15.9) | 0 | |
| Some College | 15 (28.3) | 14 (31.8) | 1 (11.1) | |
| College Degree | 15 (28.3) | 12 (27.3) | 3 (33.3) | |
| Post-College Degree | 16 (30.2) | 11 (25.0) | 5 (55.6) | |
| Income | | | | 0.45 |
| Less than $25,000 | 10 (18.9) | 9 (20.5) | 1 (11.1) | |
| $25,000 to $49,999 | 10 (18.9) | 7 (15.9) | 3 (33.3) | |
| $50,000 to $74,999 | 11 (20.8) | 11 (25.0) | 0 | |
| $75,000 to $99,999 | 13 (24.5) | 10 (22.7) | 3 (33.3) | |
| $100,000 or more | 9 (17.0) | 7 (15.9) | 2 (22.2) | |
| Insurance | | | | |
| Medicaid | 1 (1.9) | 0 | 1 (11.1) | 0.15 |
| Medicare | 48 (90.6) | 41 (93.2) | 7 (77.8) | 0.03 |
| Private | 32 (60.4) | 25 (56.8) | 7 (77.8) | 0.24 |
| Smoking Status | | | | |
| Current | 1 (1.92) | 1 (2.3) | 0 | 0.78 |
| Former | 21 (40.4) | 17 (38.6) | 4 (50.0) | |
| Never | 30 (57.7) | 26 (59.1) | 4 (50.0) | |
| Marital Status | | | | |
| Married | 35 (66.0) | 28 (63.6) | 7 (77.8) | 0.53 |
| Widow | 5 (9.4) | 5 (11.4) | 0 | |
| Single | 13 (24.5) | 11 (25.0) | 2 (22.2) | |
| Co-Morbidities | | | | |
| Anxiety | 5 (9.4) | 4 (9.0) | 1 (11.1) | 0.85 |
| COPD | 4 (7.5) | 3 (6.8) | 1 (11.1) | 0.66 |
| Depression | 12 (22.6) | 12 (27.3) | 0 | 0.08 |
| Diabetes | 14 (26.4) | 14 (31.8) | 0 | 0.05 |
| Fibromyalgia | 2 (3.8) | 2 (4.6) | 0 | 0.51 |
| High Cholesterol | 19 (39.9) | 15 (34.1) | 4 (44.4) | 0.56 |
| Hypertension | 38 (71.7) | 31 (70.5) | 7 (77.8) | 0.66 |
| Osteoarthritis | 19 (35.9) | 16 (36.4) | 3 (33.3) | 0.86 |
| Sleep Apnea | 21 (39.6) | 18 (40.9) | 3 (33.3) | 0.67 |
| Stroke | 2 (3.8) | 1 (2.3) | 1 (11.1) | 0.21 |

All values represented are means ± standard deviation or counts (%); Table adapted from Batsis JA BMC Geriatrics 2021.

differences in baseline body composition measures in those completing the intervention who lacked follow-up data as a result of COVID-19 or in those who dropped out (Supplemental Table 1).

Table 2 outlines our primary findings. We present the key anthropometric and body composition data changes amongst the participants with complete data (n=30). There were significant reductions in weight (4.6±3.5kg), body mass index (1.8±1.4kg/m$^2$), and waist circumference (2.6±5.4cm). We also observed significant changes in total fat mass (-6.09±14.3kg), percent body fat (-1.88±2.54%) and visceral adipose tissue (-0.78±1.69L). Concomitantly, there were no statistical differences observed at follow-up of fat-free mass (-3.4kg±6.8, p=0.19) and grip strength (+3.46±7.89, p=0.56). There was a non-significant increase in appendicular lean muscle mass (-+0.39±2.65kg;p=0.43) in those completing the intervention

**Table 2.** Anthropometric, Body Composition, and Handgrip Changes with Weight Loss

| | Overall Intervention | | | | Weight Loss Change | | | |
|---|---|---|---|---|---|---|---|---|
| | **Baseline** | **Follow-up** | **Δ** | **p-value** | **< 5%**** | **≥ 5%** | **p-value** | **ES** |
| Anthropometrics | N=30 | N=30 | | | N=22 | N=22 | | |
| Weight, kg | 97.8±16.3 | 93.2±15.8 | –4.6±3.5 | <0.001 | -4.5±3.0 | -4.7±3.6 | 0.88 | --- |
| BMI, kg/m² | 36.5±5.2 | 34.7±5.4 | -1.8±1.4 | <0.001 | -1.01±1.39 | -2.62±0.83 | <0.001 | 1.40 |
| Waist Circumference, cm | 115.5±13.0 | 112.8±11.9* | -2.6±5.4 | 0.01 | 0.14±4.87* | -5.31±4.51* | 0.004 | 1.16 |
| Fat | Baseline | Follow-up | Δ* | p-value | Difference | Difference | p-value | ES |
| Total Mass, kg | 48.8±20.9 | 42.8±10.9* | -6.09±14.3 | 0.03 | -6.6±19.7 | -5.5±3.2† | 0.83 | |
| Body Fat% | 47.7±7.9 | 45.8±7.9* | -1.88±2.54 | <0.001 | -1.39±2.62 | -2.43±2.41† | 0.27 | 0.42 |
| VAT, L | 4.39±2.25 | 3.61±1.69* | -0.78±1.69 | 0.006 | -0.16±1.23 | -1.44±1.20† | 0.01 | 1.06 |
| Muscle Mass & Function | Baseline | Follow-up | Δ | p-value | Difference | Difference | p-value | ES |
| Fat Free Mass, kg | 50.4±11.1 | 48.5±10.8* | -1.81±6.1 | 0.12 | -0.44±5.29 | -3.4±6.81 | 0.19 | 0.49 |
| ALM, kg | 12.8±3.5 | 13.1±5.1* | +0.39±2.65 | 0.43 | 0.95±3.16 | -0.25±1.83 | 0.22 | 0.46 |
| ALM/height², kg/m² | 4.74±0.93 | 4.89±1.55* | 0.14±0.92 | 0.41 | 0.32±1.05 | -0.06±+0.74 | 0.27 | 0.41 |
| Grip Strength, kg | 24.8±9.9 | 25.9±10.6* | 1.2±7.0 | 0.33 | -1.05±5.57 | 3.46±7.89 | 0.56 | 0.67 |

All values represented as mean ± standard deviation; Abbreviations: ALM – appendicular lean mass; BMI – body mass index; ES – effect size; VAT – visceral adipose tissue; *counts are reduced at follow-up (n=30) as a result of COVID-19. Differences are based on those with complete data. Baseline data outlines those with full follow-up data; **follow-up weights were captured on all 44 completers virtually; †p<0.05 between baseline and follow-up values

with full body composition data.

As a secondary analysis, we evaluated the response heterogeneity by stratifying the cohort to those who lost ≥ 5% weight and those who did not. Across all measures, we found non-significant changes in all our key body composition measures other than visceral adipose tissue. The effect sizes suggest considerable differences between those losing weight compared to those not losing significant weight. Lastly, we did not find any evidence that participant's baseline characteristics differed by weight loss status (Supplemental Table 2).

## Discussion

Our post-hoc analysis suggests that a successful technology-based weight loss intervention safely maintains muscle mass, reduces fat, and preserves muscle strength. These preliminary findings provide additional insights to suggest that multicomponent interventions are critically important to preserving muscle function through technology-based means.

There are no technology-based weight loss studies in older adults evaluating body composition and its effects on muscle mass and function. Muscle strength, and to a lesser degree, muscle mass are both important determinants of physical function in older adults, particularly as they engage in such health promotion interventions (18). These findings have significant implications in the context of COVID-19 __ multi-component interventions can be delivered from a central locale to under-resourced areas without a concern that muscle mass or strength will be lost (20). While a larger clinical trial needs to verify these results, these promising findings suggest that body composition measurement, which is costly and may not be fully accessible, may not necessarily be required.

Interestingly, while non-significant, several participants lost a small degree of fat-free mass yet demonstrated small gains in appendicular lean mass and grip strength. Even if such increases are minimal and may not be clinically significant, they suggest preservation despite the marked reductions in body fat and visceral adipose tissue. These implications are important as they are often a harbinger of key geriatric syndromes, including falls (21). Yet, it is unclear whether the reduction in fat, the preservation of strength, or the marginal increase in ALM resulted in this increase in function. The interrelation between muscle and fat is complex, particularly if changes are observed in intramuscular fat which is known to increase in the aging process. Future studies warrant evaluating changes in intramuscular fat as this promotes a negative cycle of increased inflammation, hormonal dysregulation, and sarcopenia, all of which are observed within sarcopenic obesity (22). Furthermore, as we evaluated body composition using bioelectrical impedance, we could not assess bone mass, a component of fat-free mass.

While we acknowledge that our sample size was small, we attempted to differentiate body composition changes among persons with and without clinically significant weight loss. Our findings were not surprising as weight (and BMI) are highly correlated with overall and visceral fat mass; hence, weight loss was associated with larger changes in these parameters (23). While we did not observe differences among muscle parameters by weight loss, we did evaluate the effect size. Our results suggest that there may be a signal to suggest differences between these two groups that need to be examined in a future study. Our findings likely parallel Heymsfield's who noted that 75% of weight loss is fat while the remainder is fat-free mass (24). Importantly, participants' baseline characteristics were no different in those with and without clinically significant weight loss.

Our study had limitations. Our pre/post design limited our ability to draw conclusions on the effects of our intervention.

Due to COVID-19, we were unable to gather data from participants. Our small sample size may have prevented some of our findings from reaching statistical significance. The duration of our study was only six months; future studies are necessary to ascertain the intervention's long-term effects. Last, we used bioelectrical impedance rather than dual energy x-ray absorptiometry, computer tomography, or magnetic resonance imaging. However, guidelines note that this measure can successfully be used, even in older adults (25, 26).

## Conclusions

A telemedicine-based health promotion intervention consisting of a dietitian and physical therapist-based delivered nutrition and physical activity intervention led to decreases in body and visceral fat but preservation of muscle mass and strength. These findings demonstrate that novel ways of delivering weight loss interventions can have favorable changes in body composition.

*Funding:* Dr. Batsis' research reported in this publication was supported in part by the National Institute on Aging and Office of Dietary Supplements of the National Institutes of Health under Award Number K23AG051681. Support was also provided by the Dartmouth Health Promotion and Disease Prevention Research Center supported by Cooperative Agreement Number U48DP005018 from the Centers for Disease Control and Prevention, and the The Dartmouth Clinical and Translational Science Institute, under award number UL1TR001086 from the National Center for Advancing Translational Sciences (NCATS) of the National Institutes of Health (NIH). Dr. Batsis has been a consultant for Dinse, Knapp, McAndrew, LLC, Legal Firm and for Turner Farms, LLC. He also has received funding from the Patient Centered Oriented Research Institute. Dr. Batsis also holds equity in SynchroHealth LLC, a remote monitoring startup. Mr. Petersen was supported by the Burroughs-Wellcome Fund: Big Data in the Life Sciences at Dartmouth. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health or other sponsors, or represent the official position of the Centers for Disease Control and Prevention. The funders had no role in the design, conduct or analysis of the study. Dr. Jimenez is funded by R01MD012610 and U54MD002266-14S1 from the National Institutes of Health.

*Acknowledgements:* We thank the following persons who assisted in the execution of study activities: Rima Al-Nimr, Christina Aquila, Emma Brooks, Vanessa Brown, Molly Caisse, Matthew M. Clark, Peter DiMilia, Lori Fortini, Fredric Glazer, Tyler Gooding, Aimee Burnett Greeley, Ann Haedrich, Gregory Hagley, Chizuko Horiuchi, Shelley Hunevan, Diane Kelecy, David Kotz, Mary Lowry, Xingyi Li, Todd Mackenzie, Rebecca Masutani, Kristina Moses, Janice Montgomery, Dawna Pidgeon, KC Wright. A special thanks to Dr. Ellen Flaherty for her support, Stephen Bartels, Martha Bruce, Francisco Lopez-Jimenez, Michael Jensen for their mentorship.

*Clinical Trial Registration:* Registered on Clinicaltrials.gov #NCT03104205. Registered on April 7, 2017. First participant enrolled on October 1st, 2018.

*Conflict of interest:* None.

*Ethical standard:* This study was approved by the Dartmouth-Hitchcock Institutional review board (28905) and the University of North Carolina at Chapel Hill Institutional Review Board #20-2541.

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How to cite this article: J.A. Batsis, D. Shirazi, C.L. Petersen, et al. Changes in Body Composition in Older Adults after a Technology-Based Weight Loss Intervention. J Frailty Aging 2022;11(2)151-155; http://dx.doi.org/10.14283/jfa.2022.15