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Research Report

A Weight Loss Intervention Augmented by a Wearable Device in Rural Older Adults With Obesity: A Feasibility Study

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Abstract

Background: Older persons with obesity aged 65+ residing in rural areas have reduced access to weight management programs due to geographic isolation. The ability to integrate technology into health promotion interventions shows a potential to reach this underserved population.

Methods: A 12-week pilot in 28 older rural adults with obesity (body mass index [BMI] ≥ 30 kg/m^2) was conducted at a community aging center. The intervention consisted of individualized, weekly dietitian visits focusing on behavior therapy and caloric restriction with twice weekly physical therapist-led group strengthening training classes in a community-based aging center. All participants were provided a Fitbit Flex 2. An aerobic activity prescription outside the strength training classes was provided.

Results: Mean age was 72.9 ± 5.3 years (82% female). Baseline BMI was 37.1 kg/m^2, and waist circumference was 120.0 ± 33.0 cm. Mean weight loss (pre/post) was 4.6 ± 3.2 kg (4.9 ± 3.4%; $p < .001$). Of the 40 eligible participants, 33 (75%) enrolled, and the completion rate was high (84.8%). Objective measures of physical function improved at follow-up: 6-minute walk test improved: 35.7 ± 41.2 m ($p < .001$); gait speed improved: 0.10 ± 0.24 m/s ($p = .04$); and five-times sit-to-stand improved by 2.1 seconds ($p < .001$). Subjective measures of late-life function improved (5.2 ± 7.1 points, $p = .003$), as did Patient-Reported Outcome Measurement Information Systems mental and physical health scores (5.0 ± 5.7 and 4.4 ± 5.0, both $p < .001$). Participants wore their Fitbit 93.9% of all intervention days, and were overall satisfied with the trial (4.5/5.0, 1–5 low–high) and with Fitbit (4.0/5.0).

Conclusions: A multicomponent obesity intervention incorporating a wearable device is feasible and acceptable to older adults with obesity, and potentially holds promise in enhancing health.

Keywords: mHealth, Physical function, Trials

Over 40% of older adults are classified as having obesity (1), placing them at increased risk of mobility impairment, nursing home placement, and mortality (2,3). Efficacy of weight loss interventions in adults aged 65+ is well established (4), consisting of regimented caloric intake and programs of aerobic and resistance exercises. Weight loss in conjunction with exercise leads to significant improvements in cardiometabolic status, reduces intramuscular fat deposition, and leads to increased muscle mass, strength, and physical function (3), all which can reduce long-term mortality (5).

Despite the efficacy of weight loss trials in older adults, translation into community or primary care settings is difficult. Interventions require in-person and human interactions or touches that may be challenging for older adults with mobility impairments, particularly in rural, remote areas (6). The emergence of mobile information and communication technologies are modalities that could enhance the reach of behavioral change strategies, even in older adults (7). Available commercial wearable devices provide an opportunity for affordable activity monitoring in real-world settings. Previous work suggests that older adults are willing to consider using wearables in health promotion interventions and that even using prototypes may be more feasible and acceptable than in younger, more technologically savvy populations (8).

While older adults are the fastest growing user group of technology (9), a first step is to determine whether mobile health strategies can feasibly and acceptably be integrated into existing, evidence-based weight loss interventions, in advance of large-scale implementation. The purpose of this pilot study was to evaluate the feasibility, acceptability, and effectiveness of integrating a wearable Fitbit device into a high-touch, multicomponent weight loss intervention at a local community aging center. If feasible, acceptable, and effective, these data could lay the foundation for using other types of broad technology-driven interventions for this high-risk population.

Methods

Design and Setting

This study consisted of a 12-week, single-arm, pilot feasibility study of a multicomponent weight loss intervention in older rural adults with obesity. The study was conducted between January 2018 and June 2019. Because of staffing and resource limitations, only one group of 8–10 participants were enrolled at any given time, thus interventions groups were launched in four consecutive waves (see Supplementary Figure and Appendices). The intervention consisted of dietitian-led weight loss counseling sessions and physical therapist-led group strength training exercise sessions. Physical activity was continuously monitored using a Fitbit Flex 2, a commercial, wearable fitness device. The study was conducted at a community-based aging center affiliated with Dartmouth-Hitchcock in Lebanon, NH, a small community of 13,522 persons located in rural Northern New England. The study was approved by the Committee for the Protection of Human Subjects at Dartmouth and registered on clinicaltrials.gov (NCT#03104192).

Recruitment

Participants were recruited as a convenience sample from local primary care clinic practices and physicians using posters, presentations, and word-of-mouth and not targeted by the electronic medical record (EMR). Screening of referrals and communication to front-line clinicians were conducted 2–4 weeks prior to each wave of the intervention. Any referrals were screened by the research assistant. English-speaking, community-dwelling older adults, aged 65 years and older were eligible if their body mass index (BMI) was greater than 30 after medical record review. Exclusion criteria consisted of an EMR diagnosis of dementia or cognitive impairment; uncontrolled psychiatric illness; weight loss surgery; life-threatening illness or those receiving palliative/hospice services; current participation in another weight loss study/program; obesogenic medications; or advanced congestive heart, renal, or liver insufficiency. Participants were also excluded if there was documented weight loss of ≥5% in the past 6 months. The research assistant subsequently screened participants by phone, requiring a score of ≥3 on the Callahan Cognitive questionnaire (10), and a Functional Status Questionnaire score of ≥71.2 for basic and ≥56.4 for instrumental activities of daily living (11). Demographic, co-morbidity, and smoking status was obtained from the EMR. Self-reported questionnaires provided information on education and income. The study was described by the research assistant who then invited participants for a baseline visit to obtain informed consent and subjective and objective assessments if eligible. Participants were compensated with a $25 gas card.

Weight Loss Intervention

A registered dietitian was responsible for delivering the dietary and behavioral intervention. Caloric needs were based on the Automated Self-Administered 24-hour Dietary Assessment Tool (ASA-24) (12) and indirect calorimetry data (REEVue, Korr, Salt Lake City, UT). Individual meal plans were then created. A calorie restricted diet of 500–750 kCal/d (minimum intake of 1,200 kCal/d) was advised with sufficient dietary vitamin D (1,000 IU/d). Macronutrient distribution consisted of 50% carbohydrates, 30% fat, and 20% protein (1–1.2 g/kg/d), of which protein was prioritized during the creation of meal plans. There were 12, individual, 30-minute 1:1 sessions focusing on intensive behavioral therapy sessions using motivational interviewing techniques. Each session focused on specific, measurable, attainable, relevant, and timely goals. Evidence-based materials (13,14) were provided and individual meal plans were created using balanced, heart-healthy, guidelines, focusing on fiber intake from whole grains and plants. Tracking of food was strongly encouraged with food records or using the Fitbit app, but not formally assessed. Records were evaluated by the dietitian if available.

An initial assessment conducted by a physical therapist of strength, flexibility, balance, and aerobic capacity permitted the creation of personalized exercise plans aimed at gradually increasing physical activity level. This was followed by group-based resistance exercise sessions held twice weekly performed at moderate intensity (13–15 rating of the Borg perceived exertion scale) (15) targeting major muscle groups using resistance bands and adjustable cuff weights. Aerobic exercise was performed independently and progressed with physical therapist guidance though weekly discussion and coaching. Written materials and principles were based on the LIFE study (16). Participants were encouraged to perform resistance exercises 1 day per week outside of the on-site sessions, spaced 24 hours apart and/or focusing on different muscle groups. Daily aerobic exercise was guided and tracked using weekly diaries as participants progressed. Intervention staff encouraged 150 minutes of moderate-vigorous intensity of activity weekly.

Participants were provided a Fitbit Flex 2 and a Samsung Galaxy Tab A tablet with the corresponding Fitbit application. They were instructed on how to use Fitbit, the app, how to charge the wearable, and provided written instructions for each of these components, including instructions on how to connect to their home-WiFi. Data were synchronized remotely at home, or on-site during the intervention. Data (steps, activity) were evaluated on a weekly basis by downloading data from the Fitbit website. Study staff monitored whether participant's synchronized their data or had battery problems. Feedback was provided to participants by the physical therapist during sessions, who reviewed activity data. All participants were provided a digital A+D Bluetooth scale at home for monitoring of weekly weight.

Outcome Measures

The primary outcome measures were feasibility, acceptability, and preliminary effectiveness of the intervention. Feasibility was defined

as achieving a target enrollment of 32 participants; additional markers included the proportion of those enrolled (relative to those screened), and the proportion of those eligible electing to participate (relative to those screening positively). Successful retention was predefined as a dropout rate of <20%. Attendance of >75% of sessions and completion of >80% of study measures were considered acceptable. Likert scales (ranging 1–5) were used to evaluate acceptability of each of the individual components (dietitian, physical therapist, technology).

Objective data were assessed at baseline and at study conclusion, and were entered by the research assistant into RedCAP, a secure, research data collection platform, with data double-verified. Weight was measured using an A+D scale, and height was measured using a Seca 216 stadiometer at the aging center. BMI was calculated as weight (kilograms) divided by height (meters) squared. Waist circumference was measured at the level of the iliac crest using a standard tape measure.

Physical function was assessed using gait speed, grip strength, five-times sit-to-stand test, and 6-minute walk test. Gait speed was measured over a 5-m course at usual pace, with an acceleration and deceleration before and after measurements were taken. A 6-minute walk test assessed aerobic capacity according to standard protocols. Three trials of grip strength of each hand were conducted using a JAMAR Plus dynamometer, alternating every 30 seconds between trials, with the maximum value reported. Participants grasped the device comfortably to permit squeezing, as long and as tightly as possible. Five-times sit-to-stand was performed with participants seated at the edge of a chair, with their arms folded, and their buttocks hitting the chair on each repetition.

Subjective measures were collected at baseline and at 12-week follow-up using a tablet-based version of RedCAP. The Patient-Reported Outcome Measurement Information System (PROMIS) General Health Questionnaire (physical and mental health) (17) is a self-reported, 10-item scale (five participants each) that gauges physical, mental, and social aspects of health. A mean standardized score is 50; 10 points indicate 1 *SD*, with higher scores indicating better health. The Late-life Function and Disability Instrument correlates with gait speed and lower-limb function (18), and was assessed using the 32-item function component only.

Statistical Analysis

Demographic characteristics and baseline metrics were evaluated using descriptive statistics. The analysis of outcomes was limited to those who completed the program. Primary effectiveness outcomes were change in weight, percent weight loss, and change in physical function. Paired *t*-tests evaluated pre-post changes in all continuous variables and chi-squared tests for categorical data. Unpaired *t*-tests or chi squares, or their non-parametric equivalents, compared differences in baseline characteristics between study completers and non-completers. Study data were analyzed using R (www.R-project.org). A *p*-value of <.05 was considered statistically significant.

Results

Baseline characteristics are presented in Table 1. Mean age was 72.9 ± 5.3 years; the majority were female (82.1%). Mean score for basic and instrumental activities of daily living were 97.4 ± 6.0, and 82.5 ± 12.4, respectively. Mean distance to the center was 19.8 ± 13.8 miles. Other than insurance status, there were no significant baseline differences among the completers versus non-completers (Supplementary Appendix 1).

Table 1. Participant Characteristics

	Total (*N* = 28)
Age, years	72.9 (5.3)
Female sex, %	23 (82.1%)
White race, %	28 (100.0%)
Socioeconomic factors	
Marital status, %	
Single	0 (0.0%)
Married	14 (50.0%)
Divorced	12 (42.9%)
Widowed	2 (7.1%)
Insurance, %	
Medicare	28 (100.0%)
Medicaid	0 (0.0%)
Private insurance	18 (64.3%)
Smoking status, %	
Non-smoker	19 (67.9%)
Former smoker	9 (32.1%)
Education, %	
High school	2 (7.1%)
Some college	8 (28.6%)
College degree	8 (28.6%)
Post-college degree	10 (35.7%)
Income, %	
<$25,000	2 (7.1%)
$25,000–$49,999	18 (64.3%)
$50,000–$74,999	4 (14.3%)
$75,000–$99,999	2 (7.1%)
$100,000–$199,999	1 (3.6%)
≥$200,000	1 (3.6%)
Anthropometric measures	
Weight, kg	98.4 (19.0)
BMI, kg/m^2	37.1 (6.1)
Waist circumference, cm	120.0 (33.0)
Comorbidities	
Anxiety, %	3 (10.7%)
Coronary artery disease, %	3 (10.7%)
COPD, %	1 (3.6%)
Depression, %	6 (21.4%)
Diabetes, %	5 (17.9%)
Fibromyalgia, %	1 (3.6%)
High cholesterol, %	9 (32.1%)
Hypertension, %	14 (50.0%)
Non-skin cancer, %	1 (3.6%)
Osteoarthritis, %	12 (42.9%)
Rheumatologic disease, %	2 (7.1%)
Sleep apnea, %	6 (21.4%)

Note: BMI = body mass index; COPD = chronic obstructive pulmonary disease. All variables indicated are mean ± *SD*, or counts (%).

We screened 90 participants of which 40 (44.4%) were eligible, and 33 (75%) enrolled and provided written informed consent. Seven participants declined due to competing time commitments. Our completion rate was high (84.8%). Of those that dropped out, two had chest pain, one was diagnosed with lung cancer, one had too much generalized pain, and the other was fatigued. Attendance was high. Of the 12 nutrition/behavioral sessions, the mean number of sessions attended was 11.2 ± 1.0, and of the 24 physical therapy sessions, participants attended an average of 21.1 ± 2.4 sessions. Attendance rates were 91.9% and 93.8% of the total number of physical therapy and nutrition/behavioral sessions, respectively, with 25 (89.3%) and 26 (92.9%) participants attending >75% of sessions.

Participants demonstrated significant weight loss of 4.62 ± 3.15 kg (−4.88%; $p < .001$) with changes in hip and waist circumference of −12.53 ± 35.0, $p = .07$, and −10.62 ± 32.2 cm, $p = .09$, respectively (Table 2). Changes in objective physical measures of 6-minute walk, gait speed, and five times sit-to-stand were observed (all $p < .05$). We noted improvements in late-life function scales (5.2 ± 7.11) and PROMIS mental (5.0 ± 5.7) and physical (4.4 ± 5.0) scores (all $p < .001$).

Generally, all participants had favorable impressions of the intervention including the length and number of the sessions (Table 3). All respondents (100%) would recommend the intervention to family members. Older adults had favorable views of Fitbit, with satisfaction in its use, usability, and feedback potential. Self-reported adherence of wearing Fitbit for the entire day was high (93.9%).

There were a total of 43 adverse events (Supplementary Appendix 2); the majority were classified as minor and related to exercise. Only two were classified as serious, both of which involved chest pain: one participant was diagnosed with gastroesophageal reflux and the other was diagnosed by new-onset coronary artery disease. These were adjudicated by the safety monitor.

Discussion

Results of this pilot are the first to demonstrate the integration of a commercial wearable into a community-based weight loss program in older adults with obesity residing in rural areas. Despite misconceptions that this demographic is unable to use technology, these results not only showed effectiveness in the primary study outcomes but also showed ease of use, satisfaction, and engagement with the intervention and the technology itself. These findings suggest that wearable fitness devices have the potential to be acceptable and subsequently used in health promotion interventions in older adults.

Rural areas lag in offering health promotion programs. Few studies have primarily focused on weight loss efforts (19–21). In a population that often has lower health literacy and limited access to technology, this project found that offering such devices within the context of a health promotion program was highly promising as reflected by the high recruitment and retention rates despite convenience and passive sampling. Although we used an electronic health record to document eligibility, future studies could incorporate its use as a potential recruitment tool to expand reach. Retention rates in other rural obesity studies vary widely between 78% and 90% (19,20). None of the current study's participants dropped out due to technology problems, which may be expected after short-term usage or due to rural accessibility barriers. While the mean distance to the center was acceptable (<30 minutes), such a program may not necessarily be acceptable to others traveling further distances due to its intensive frequency (6). Telemedicine may be more acceptable to certain rural populations (6,22) and could be explored in future studies.

The approach of nutritional counseling, behavior therapy, strength training, tailored physical activity guidance, and augmented use of technology demonstrated weight loss and improved physical function. To assess improved health beyond weight loss, we examined multiple functional outcomes that could easily be performed at a community aging center with minimal equipment and training. Our 3-month weight loss goals approached 5% weight loss and objective physical measures also improved, suggesting that a larger powered study could evaluate these proximal outcome measures.

Table 2. Preliminary Objective Effectiveness Measures

	Baseline ($N = 28$)	Week 12 ($N = 28$)	Difference ($N = 28$)	Percent Change	p-Value
Anthropometric					
Weight, kg	98.4 (19.0)	93.7 (19.4)	−4.62 (3.2)	−4.88 (3.4)	<.001
BMI, kg/m^2	37.1 (6.14)	35.4 (6.4)	−1.76 (1.19)	−4.88 (3.39)	<.001
Waist circumference, cm	120.0 (32.95)	109.4 (12.3)	−10.62 (32.2)	−6.02 (12.01)	.09
Hip circumference, cm	133.7 (34.43)	121.1 (13.0)	−12.5 (35.0)	−6.87 (11.90)	.07
Waist-to-hip ratio	0.90 (0.08)	0.90 (0.07)	0.01 (0.06)	1.09 (6.42)	.54
Objective measures					
6-min walk test, m	405.9 (89.2)	448.7 (88.2)	35.7 (41.2)	9.4 (11.0)	<.001
50 m improvement, n (%)			9 (33.33)		
Maximum gait speed, s	1.19 (0.26)	1.29 (0.35)	0.10 (0.24)	8.92 (19.18)	.04
Improved 0.1 m/s (%)			12 (42.9)		
Mean grip strength, kg	21.4 (8.2)	22.27 (7.1)	0.83 (5.6)	9.82 (29.6)	.44
Sit-to-stand, s	9.77 (2.8)	7.71 (2.2)	−2.06 (2.00)	−18.81 (18.09)	<.001
Subjective measures					
Late-life functionality					
Total	61.1 (8.1)	67.2 (10.1)	5.2 (7.1)	8.6 (11.2)	.003
Upper extremity	79.6 (10.8)	83.0 (10.7)	3.0 (10.3)	4.7 (13.0)	.19
Basic lower extremity	74.7 (13.6)	83.2 (13.5)	6.9 (11.2)	10.4 (14.0)	.01
Advanced lower extremity	50.4 (13.0)	59.4 (15.4)	7.2 (9.4)	14.2 (17.6)	.002
PROMIS, total					
Mental health T score	49.5 (8.5)	54.8 (8.7)	5.0 (5.7)	10.9 (12.5)	<.001
Physical health T score	48.7 (6.4)	53.4 (7.7)	4.4 (5.0)	9.3 (10.3)	<.001
Fitbit activity measures	Mean	Range	Median	IQR	
% days worn[a]	93.9 (9.7)	57.1–100.0	96.4	7.6	
Steps per day	6,133 (2,922)	1,877–14,815	5,467	3,476	

Notes: BMI = body mass index; IQR = interquartile range; PROMIS = Patient-Reported Outcome Measurement Information System. All values listed are mean (*SD*), or count (%).

[a]Days worn are represented Percent Change in Difference: the difference in the means as a percent of mean baseline measurement. Percent Change: the mean of an individuals change relative to their baseline.

Table 3. Participant Satisfaction With the Intervention and Fitbit

Questions	Mean	Range	Median (IQR)
Satisfaction questions on overall intervention			
Overall satisfaction	4.5 (1.1)	1.0–5.0	5.0 (0.2)
Helpful in assisting in achieving your goals	4.4 (1.1)	1.0–5.0	5.0 (1.0)
Beneficial and worth your time	5.0 (0.2)	4.0–5.0	5.0 (0)
Satisfaction with the length of sessions			
Physical therapy	4.6 (1.1)	1.0–5.0	5.0 (0.0)
Dietitian	4.5 (1.2)	1.0–5.0	5.0 (0)
Satisfaction with the number of sessions			
Physical therapy	4.4 (1.2)	1.0–5.0	5.0 (0.2)
Dietitian sessions	4.5 (1.3)	1.0–5.0	5.0 (0.0)
Satisfaction questions on Fitbit			
Overall satisfaction with Fitbit[a] (n = 2)	4.0 (1.2)	1.0–5.0	4.0 (1.0)
Easy to use without much difficulty	4.1 (1.2)	1.0–5.0	5.0 (1.2)
Real-time feedback helpful in promoting physical activity	4.2 (1.0)	1.0–5.0	5.0 (1.0)
Helpful in achieving your goal	3.6 (1.4)	1.0–5.0	4.0 (2.0)

Notes: IQR = interquartile range. All questions were rated 1–5 (1 being low/strongly disagree, 5 being high/strongly agree). All values represented are mean (*SD*), range and median (IQR).

[a]Two values missing.

Importantly, our objective changes in function also paralleled subjective measures, thus suggesting true improvement in health and wellness.

Acceptability of the intervention and the use of Fitbit were very high in all participants in part due to the technical support and monitoring that was provided to participants. Older adults believe that technology could enhance behavioral change (23) and hence future studies should evaluate whether the technology can mediate the relationship in improving weight loss and physical function in older rural adults. Evidence-based interventions are based in grounded behavioral theory; further research could help understand mechanisms by which technology can improve distal outcomes of weight loss and physical function. Additionally, elements of perceived usefulness and ease of use could be integrated into established behavioral change models to enhance weight loss interventions. Further, there were no differences in baseline characteristics between completers and non-completers with the exception of income status, suggesting the importance of socioeconomic status in the engagement of this population.

This study was not without its limitations. As a pilot study, it evaluated a small number of participants, the preponderance of which were females. We intentionally used a pre-post design to evaluate feasibility, rather than invest in a larger two-arm, randomized design. The preliminary effectiveness suggests that it would be reasonable to conduct a larger study; however, we acknowledge that our findings were neither powered for weight loss nor enhancing physical function. While the integration of commercial technology as an adjunctive strategy in weight loss interventions permits widespread generalizability downstream, a major limitation is the difficulty in keeping up with technological advances in a larger (and longer) randomized control trial. We relied on step counts aggregated on a daily basis in this system a priori; other measures exist including sleep, wear time, and other features that older devices may not be measured reliably. Using a wearable's ability to track food intake should be considered in the future. Emerging software analytics will permit more granular evaluation of activity. Our results may also not be representative of the general population as it is limited to a geographical area with a relatively homogenous population.

Finally, our purpose was to evaluate the ability to integrate Fitbit among a multicomponent intervention in older adults and not to ascertain whether Fitbit led to weight loss or improved physical function. While our retention is likely attributed to the hands-on contact with the interventionist, it is unclear whether the use of technology enhanced the retention or effectiveness outcomes. A longer study is needed both in terms of short-term weight loss but also in terms of weight maintenance strategies, comparing interventions with and without technology augmentation. The acceptability off remote monitoring strategies hold promise, particularly in rural areas. Further research is needed.

Conclusions

Older rural adults demonstrated the feasibility of integrating a wearable fitness device to track physical activity level, in a high-touch, individualized, multicomponent obesity intervention. Future randomized controlled trials are needed to expand the findings of this project.

Supplementary Material

Supplementary data are available at *The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences* online.

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Authors' contributions

J.A.B.: conceived, designed, analyzed, drafted, and approved final version. C.L.P.: analysis and approval of final version. M.M.C.: conceived, designed, and approved final version. S.B.C.: conceived, designed, and approved final version. F.L.-J.: conceived, designed, and approved final version. R.I.A.: designed and approved final version. D.P.: conceived, designed, and approved final version. D.K.: conceived, designed, and approved final version. T.A.M.: conceived, designed, analyzed, and approved final version. S.J.B.: conceived, designed, and approved final version.

Conflict of Interest

None reported.

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