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Human Kinetics
ORIGINAL RESEARCH

Feasibility and Impact of High-Intensity Walking Training in Frail Older Adults

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To investigate the impact of high-intensity walking training (HIWT) on prefrail and frail older adults, five assisted living residents underwent a supervised 12-session intervention. The intervention consisted of 30 min of HIWT at 70–80% of heart rate reserve or ratings of 15 to 17 (hard to very hard) on the Borg Rating of Perceived Exertion scale. Training included walking at fast speeds, multi-directions, stairs, and outdoor surfaces with and without an assistive device. Training significantly reduced frailty using the SHARE-FI ($p = .008$), increased fast gait speed ($p = .01$), improved 6-min walk test distance ($p = .03$), and enhanced Berg Balance Scale scores ($p = .03$). There were no adverse events and all participants reached target training intensity in all 12 sessions. Participants viewed the walking intervention as highly satisfactory (9.6/10 on a Likert scale) and 100% recommended that the assisted living facility should offer HIWT as part of routine programming.

Keywords: frailty, high-intensity training, assisted living residents

Frailty, a syndrome of increased vulnerability resulting in a decline in physiological reserve and function, is a key health issue affecting older adults (Fried et al., 2001). Using the phenotypic frailty criteria, individuals are classified as frail upon meeting three of five criteria, including weakness (grip strength <20th percentile by sex and body mass index), self-reported fatigue, slow walking speed (<20th percentile by sex and height), low physical activity (<383 kcals/week expenditure for males and <270 kcals/week for females), and unintentional weight loss of more than 10 pounds in the last year (Fried et al., 2001). The frailty syndrome contributes to frequent hospitalizations (Chamberlain et al., 2016; Kojima, 2016a), high health care costs (Bock et al., 2016), poor health outcomes (Chamberlain et al., 2016), and disability (Boyd, Xue, Simpson, Guralnik, & Fried, 2005) that increases the risk for nursing home placement (Kojima, 2016b). Many interventions designed to ameliorate the effects of frailty have been tested, and can vary from dietary interventions and nutritional supplementation to resistance exercise (Cadore et al., 2014; De Labra, Gulmaraes-Pinheiro, Maseda, Lorenzo, & Millan-Calenti, 2015), although the results of these strategies are equivocal. Multifactorial interventions have not consistently demonstrated improvements on frailty (Frost et al., 2017) and the optimal exercise prescription for frailty remains undetermined (De Labra et al., 2015).

Interestingly, mobility interventions for this population appear to be underappreciated, despite the fact that four of five frailty phenotypic criteria are directly or indirectly related to mobility deficits. Unfortunately, research on the impact of walking training interventions in this population is limited. For example, older adults enrolled in the LIFE-P study randomized into the physical activity intervention walked for 150 min per week at a Borg Rating of Perceived Exertion (RPE) Scale intensity of 13 (somewhat hard) to 15 (hard to maximal exertion) (Cesari et al., 2015). Compared with a health education intervention, there was a significant decrease in the number of frailty criteria present at both 6 and 12 months, with the greatest impact on sedentary behavior time. However, when omitting sedentary behavior from the frailty diagnosis, the intervention showed no impact on frailty. Other work investigating the outcomes of 32 sessions of self-selected intensity walking or balance intervention in long-term care residents has found no differences in physical performance and disability (Faber, Bosscher, Chin, & van Wieringen, 2006). Such data are consistent with other studies that indicated little improvement in mobility dysfunction following exercise intervention (Cadore et al., 2014; Faber et al., 2006; Latham et al., 2003).

A potential limitation of these and other studies is the lack of incorporation of specific exercise training principles into the physical interventions utilized (Keetch, Lee, & Schmidt, 2008; Kleim & Jones, 2008). For example, data in patients with or without neurological injury (stroke or SCI) suggest that stepping practice at high aerobic intensities (70–80% of predicted maximum heart rate) or difficult stepping tasks may facilitate gains in locomotor function. Manipulating intensity via increased movement speeds or loads can increase neuromuscular and cardiopulmonary demands and, with repeated training, may increase physiologic reserve. The lack of functional capacity to withstand stressors is a hallmark of the frailty syndrome, and exercise intensity as a stressor could be a critical parameter to improve function. Further, practice of stepping in variable contexts may simulate many of the demands encountered in the home and community and may facilitate the ability to adapt to novel locomotor tasks. High-intensity, variable stepping training has resulted in significant improvements in gait speed and endurance, metabolic capacity, and selected gait kinematics in patients with chronic or subacute stroke (Hornby et al., 2016; Straube et al., 2014) incomplete spinal cord injury (Leech, Kinnaird, Holleran, Kahn, & Hornby, 2016), and octogenarians (Guadalupe-Grau et al., 2016). These findings suggest the potential efficacy of

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high-intensity walking training for prefrail and frail populations. To date, these interventions have not been applied to frail older adults with predefined mobility limitations.

The goal of the present study was to determine the feasibility of a physical-therapist-supervised high-intensity walking training (HIWT) intervention for prefrail and frail older adults residing in an assisted living facility. To assess feasibility, we evaluated the acceptability, demand, and adaptation (Bowen et al., 2009) of HIWT for prefrail and frail older adults residing in an assisted living setting. The secondary objectives of this study were to determine the effectiveness of this intervention on frailty, physical functioning, quality of life, and daily stepping activity.

Methods

Design

We used a mixed-method design to examine the feasibility and outcomes of a HIWT intervention in a single arm, pretest-posttest design.

Participants and Setting

We recruited participants through CJE Senior Life Gidwitz Place, an assisted living facility. Residents live in their own apartment, but have access to assistance with activities of daily living, as well as medication reminders and housekeeping. All meals are provided and nursing assistants are available 24 hr a day. Residents who need additional support can have a specially-assigned resident assistant available 24 hr a day, 7 days a week to provide supervision, personal care assistance, and escorts to meals and activities.

Screening for Eligibility and Enrollment

Recruitment took place during an all-resident quarterly meeting. Interested participants contacted research staff who conducted an in-person assessment and screening of eligibility. Study participants were 65 years or older living at the facility, not currently being treated by a physical therapist, were prefrail or frail as measured by the SHARE-FI, and had no other health problems that contraindicated participation as determined by the Exercise and Screening for You (EASY) (Resnick et al., 2008). Participants were deemed to be cognitively competent if able to read informed consent and successfully describe study procedures back to the research staff member. The study protocol was approved by the Northwestern University Institutional Review Board (STU00202690).

Measures

Feasibility. The primary outcome of this study was feasibility as assessed by participant satisfaction rates and intervention evaluations. Satisfaction rates were calculated using an 11-point Likert scale to measure overall intervention satisfaction. Participants also completed open-ended evaluation questions to provide insight regarding the acceptability, perceived demand, and potential integration within assisted living facilities (Bowen et al., 2009).

Frailty. The main performance outcome in this study was frailty as measured by the SHARE-FI (Romero-Ortuno, 2013). This measure defines frailty as a latent variable indicted by five different but related variables based on the Fried phenotypic criteria. SHARE-FI calculators are freely accessible (Romero-Ortuno & Soraghan, 2014), providing a continuous frailty score and classification into frailty categories of nonfrail, prefrail, and frail.

Physical functioning. Mobility measures included the 6-min walk test (Enright, 2003), and both self-selected and fast gait speed over a 10-ft distance (Middleton, Fritz, & Lusardi, 2015) which were performed twice, with the average score recorded. In addition, balance was assessed with the Berg Balance Scale (Berg, Wood-Dauphinee, Williams, & Maki, 1992) and the five repetition sit-to-stand test (Bohannon, 1995) was used as an assessment of lower extremity strength.

Self-reported health. Participants completed the PROMIS-global health (Hays, Bjorner, Revicki, Spritzer, & Cella, 2009), which measures overall health in the domains of physical function, fatigue, pain, emotional distress, and social health. We calculated an overall score, as well as separate physical and mental health summary scores. We also administered the short forms of the PROMIS-fatigue and PROMIS-physical function.

Ambulatory activity. We used the StepWatch (Modus, Inc., San Francisco, CA) to record the total number of steps completed per day over a 7-day observation period before and after the intervention. Participants also wore the StepWatch during each intervention session and we calculated the average number of steps completed per session. We conducted further analysis of daily stepping activity to examine the frequency of distinct bouts of physical activity completed per day, as well as the average duration and number of steps per bout of physical activity. We defined a distinct bout of physical activity as two or more consecutive minutes of stepping activity and the termination of a physical activity bout as three or more consecutive minutes of no stepping activity.

Intervention

All participants completed 12, 30-min sessions over 5 weeks (2–3 sessions/week). The physical therapist supervising the one-on-one intervention instructed participants to maximize their stepping activity at a high intensity with a goal to maintain their heart rate within 70% to 80% of heart rate (HR) maximum or a Borg RPE between 15 and 17. The targeted training zone of 70–80% of HR maximum was calculated using the age-predicted maximum HR ($HR_{maximum} = 208 - [0.7 \times age]$) (Tanaka, Monahan, & Seals, 2001). Targeted HRs were reduced by 10 beats for participants on beta blockers. To achieve a RPE between 15 (Hard) and 17 (Very Hard), participants were instructed to walk more quickly than their usual pace and wore ankle cuff weights to increase limb loading. Training sessions focused on variable walking tasks including overground training and stair climbing. Overground training consisted of high speeds and variable tasks such as obstacle negotiation, walking on a compliant surface, outdoor ambulation, and directional changes (walking backwards and sideways). Participants performed stair climbing in the assisted living facility stairwell using a reciprocal or step-to gait pattern as able. Stair climbing was progressed to reduce handrail use, incorporate faster speeds, and reduce rest breaks between floors. Across participants, 100% of sessions involved both gait and stair climbing tasks.

Statistical Analysis

To assess feasibility, the primary author analyzed answers to open-ended program evaluation questions through conventional content analysis. Responses were read and codes were applied to each answer. Codes were analyzed for frequency to identify meaningful patterns and themes. To evaluate secondary outcomes, we used paired t-tests to assess group mean differences between baseline and posttest.

Results

Participants were on average 87.2 years of age, three of five participants were male, and 100% were White. At baseline, four participants were categorized as frail and one participant was considered prefrail according to their SHARE-FI score.

Baseline performance characteristics of study participants are shown in Table 1. All participants completed 12 sessions over 5 weeks of training and achieved the targeted intensity of a 15–17 rating on the Borg RPE scale in every session. Despite self-reporting the targeted RPE intensity, actual HR reserve during training was, on average, 16% under our targeted goal (Table 2). Participants took an average of 850.4 steps per 30-min intervention session, which represented approximately 50% of the total daily steps at baseline. There were no adverse events reported during the course of the study.

Intervention Evaluation

Participants reported very high satisfaction with the HIWT intervention (9.6 on a 10-point Likert Scale, where higher scores indicated greater levels of satisfaction). All participants stated that the assisted living facility should continue to offer a HIWT intervention for residents. Participants noted benefits of the intervention on their physical health, endurance, and self-efficacy for movement. Of note, two participants stated that over the course of the 12-session intervention they were able to transition from walking with a walker to no device or walking with a walker to a straight cane.

One male participant stated:-

“Lately, I have been getting lunch and my appetite is increasing. I feel my body is getting stronger overall. I have more vigor; more endurance.”

Another female participant commented:

“I feel more confident in bending down to pick up stuff and walking better with my cane. I never thought that I could do it really–the stairs. I couldn’t believe myself that I walked six flights of stairs.”

Table 2 Training Intervention Parameters

Training Parameters	Mean ± (SD)
Sessions, n	12 ± 0.0
Steps/session	850.4 ± 201.26
Average peak RPE	16.6 ± 0.55
Average peak HR reserve (%)	54 ± 5.2

Abbreviations: RPE = rating of perceived exertion; HR = heart rate.

Participants suggested several strategies for assisted living facilities to offer HIWT programming. Overall, a group intervention was suggested as an acceptable alternative to a one-on-one intervention. Suggested group size varied from one additional person to a small group of five or less, while two participants voiced that the size of group was of no concern. To facilitate participation in such a walking program, participants recommended that assisted living facilities make a walking program a social event to provide motivation to participate. Specifically, participants noted that music, providing a snack following the intervention, making the length no more than 30 min, and having a staff person on hand to provide supervision and motivation would be essential aspects.

Statistically significant improvements were found between baseline and posttest for frailty, fast gait speed, 6-min walk test, and Berg balance scores (Table 1). Importantly, the intervention elicited marked improvements in frailty in all participants. Three participants improved from frail to prefrail classifications on the SHARE-FI, one participant progressed from prefrail to nonfrail, and another changed from frail to nonfrail. No significant effects with training were observed for self-selected gait speed, all PROMIS measures, and the five-repetition sit-to-stand. The average daily step count at posttest improved 17% from baseline. Detailed stepping activity patterns across participants are found in Table 3.

Discussion

This goal of this pilot study was to determine the feasibility and potential efficacy of HIWT among assisted living residents. Results

Table 1 Demographics and Clinical Characteristics at Baseline, Pretest, and 5-Week Posttest

Variable	Baseline Mean ± (SD)	Posttest Mean ± (SD)	*p* Value
SHARE-FI	3.6 ± 0.94	1.2 ± 1.03	**.001**
Self-selected gait speed (m/s)	0.5 ± 0.11	0.6 ± 0.13	.08
Fast gait speed (m/s)	0.7 ± 0.31	0.9 ± 0.30	**.003**
6-min walk test (m)	217 ± 150	401 ± 202	**.06**
5 repetition sit-to-stand (s)	28.4 ± 14.66	20.1 ± 7.72	.10
Berg Balance Score	32.2 ± 9.23	37.8 ± 9.04	**.01**
PROMIS Physical Function	29.7 ± 13.20	32.9 ± 7.20	.57
PROMIS Global Health–Physical	38.9 ± 4.50	40.0 ± 6.00	.70
PROMIS Global Health–Mental	48.9 ± 6.0	44.5 ± 5.6	.14
PROMIS Fatigue	57.0 ± 2.90	55.0 ± 5.5	.37
Average daily step count	1680 ± 1060	1970 ± 860	.14

Bold values denote statistically significant at $p < .05$.

Table 3 7-Day Physical Activity (PA) Observation at Baseline and 5-Week Posttest

Variable	Baseline Mean ± (SD)	Post-Test Mean ± (SD)	*p* Value
Number of PA bouts completed per day	22.2 ± 8.82	19.4 ± 8.07	.19
Duration of PA bout	24.62 ± 5.83	26.0 ± 3.89	.30
Steps completed per PA bout	148.10 ± 21.67	145.0 ± 26.88	.61

support that prefrail and frail older adults can safely engage in HIWT at a self-reported hard to very hard intensity on the Borg RPE scale and that participation has significant effects on reducing the degree of frailty and improving endurance, gait speed, and balance. Our findings are notable for several reasons. First, our intervention engaged assisted living residents safely in a high-intensity walking intervention. Second, participant had significant changes in both the degree and classification of frailty as assessed through a clinically validated measure of frailty status. Third, although not targeting balance, we found significant balance improvements in all subjects. Comparing balance changes in this study to the minimal detectable change values for older adults (Donoghue & Stokes, 2009), four of five participants exceeded the minimal detectable change. These results suggest a potential new approach to the treatment of balance impairments often found in frail older adults that warrants further investigation.

Results of the 6-min walk test are considerably higher than the 50-m minimally clinically important difference for older adults (Perera, Mody, Woodman, & Studenski, 2006) and are markedly larger than other published reports (Brach et al., 2016; Deley et al., 2007). We believe that the much more intense training stimulus provided in our intervention facilitates greater physiological adaption which enabled greater performance improvements. While sex differences may contribute to participants having varying levels of previous exposure with vigorous intensity physical activity, we do not believe past exposure influenced study findings. All participants, regardless of sex, achieved the targeted Borg RPE intensity during the intervention sessions. The actual HR training intensity range, in terms of sex (men: 48–58% and women: 49–58%), showed that both men and women walked at similar intensities.

Older adults engage in high levels of sedentary behavior (i.e., sitting) and these levels are highest among frail adults who sit for more than 85% of their waking hours per day (Blodgett, Theou, Kirkland, Andreou, & Rockwood, 2015; Jansen et al., 2015). We found no significant change in daily stepping activity, despite pronounced endurance, mobility, and balance improvements, as well as greater physical capability self-reported on the intervention evaluation. The lack of increased lifestyle walking despite greater proficiencies after training supports the role of and need for additional opportunity and motivation to promote lifestyle behavior change. The strategies identified by participants to implement a walking intervention in an assisted living facility provide new knowledge on person-centered methods for practitioners to offer such opportunities for sedentary behavior reduction and increased physical activity. Furthermore, older adults report that the fear of falling is a barrier to physical activity participation (Lees, Clarkr, Nigg, & Newman, 2005). To promote utilization of this walking intervention in assisted living facilities, implementation barriers, such as fear of falling, should be addressed. While supervised exercise is equivocal to unsupervised exercise in reducing the fear of falling, (Donat & Ozcan, 2007), we hypothesize that the social support embedded within this supervised intervention incentivize participation, making this intervention possible for widespread adoption by frail older adults. The high levels of participant satisfaction and recommendations for ongoing supervised exercise suggest the potential expansion of this intervention among larger populations of frail older adults.

The lack of statistical significance in daily stepping activity may be attributed to this pilot study being underpowered. However, the average mean change of 290 more steps or a 17% improvement in daily stepping activity at posttest compared with baseline represents an important increase in physical activity levels. As increased daily step activity over time is associated with lower mortality rates (Dwyer et al., 2015), our findings of a 17% improvement in daily stepping activity after a short duration intervention are notable and indicate that further research on this approach is warranted.

We found no significant change in self-reported health, functioning, and fatigue levels. This finding contrasts with work by Landi et al. (2010), which endorsed the role of regular physical activity in improving mood and increasing positive well-being. Likewise, Serra et al. (2015) reported that superior 6-min walk test performance is associated with better health-related quality of life in older women. It may be that despite physical improvements with the HIWT intervention, there was no translation into increased levels of lifestyle walking and overall regular physical activity, limiting the potential benefits for nonphysical function outcomes. Furthermore, this may reflect the lack of change in lifestyle activity as changes in functional ability alone may not be enough to improve these patient-reported outcomes.

Several limitations of this study deserve attention. First, this study is a small, single-group pilot study based out of a single assisted living facility. The generalizability of these findings is limited. The short duration of the intervention and lack of long-term follow up also limits our ability to understand the lasting effects of this intervention. Finally, all participants in this study ambulated on level ground with their assisted device independently or with supervision. Without an assistive device, participants required supervision to minimal assistance at times. We do not know how frail older adults who require greater amounts of physical assistance to ambulate would tolerate this intervention and this warrants further investigation.

In sum, a short intervention of HIWT is safe and potentially efficacious in reducing frailty, improving mobility, and increasing balance among older adult assisted living residents. Despite limitations of a small sample size and lack of long-term follow-up, this study has important implications for both long-term care practitioners and future research. For those in long-term care, our findings point to mechanisms of offering HIWT to a population of frail and pre-frail older adults. For researchers, this study supports a potential new treatment approach for frailty that deserves further investigation on a larger scale to understand the long-term impact on a more diverse sample of frail older adults. Future studies should continue to determine the optimal walking training parameters to improve functional ability, lifestyle activity, and quality of life in frail populations.

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