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Effects of a Home-Based DVD-Delivered Physical Activity Program on Self-Esteem in Older Adults: Results from A Randomized Controlled Trial

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Abstract

Objective—Although center-based supervised physical activity interventions have proven to be successful in attenuating health declines in older adults, such methods can be costly and have limited reach. In the present study, we examined the effects of a DVD-delivered exercise intervention on self-esteem and its subdomains and the extent to which these effects were maintained. In addition, we examined whether psychological, demographic, and biological factors acted as determinants of self-esteem.

Methods—Low active, older adults (N=307 ; Mean age =71.0 [SD=5.1] years) were randomly assigned to a six-month, home-based exercise program consisting of a DVD-delivered exercise intervention focused on increasing flexibility, toning, and balance (FlexToBa) or an attentional control DVD condition focused on healthy aging. Physical self-worth, three subdomains of self-esteem, global self-esteem, and self-efficacy were assessed at baseline, six months, and 12 months.

Results—There was a differential effect of time for the two groups for physical self-worth [F interaction (2, 530.10) = 4.17, p = 0.016] and perception of physical condition [F (2, 630.77) = 8.31, p = 0.004]. Self-efficacy, sex, body mass index (BMI), and age were significant predictors of changes in physical self-worth and perception of physical condition.

Conclusion—Our findings suggest a DVD-delivered exercise intervention is efficacious for improving and maintaining subdomain and domain levels of self-esteem in older adults. Additionally, self-efficacy was the strongest predictor of changes in physical self-worth and perceptions of physical condition. This innovative method of delivering an exercise training program via DVD is practical, effective, and has the potential for broad reach and dissemination.

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Keywords

Older adults; self-esteem; Home-based exercise; DVD; randomized controlled trial

Introduction

The number of adults over the age of 65 is rapidly increasing and is projected to double by the year 2050 (1). However, these extended years are often fraught with disease and a multitude of comorbidities. Not only is it becoming more imperative to identify and implement low cost, broadly available methods of maintaining activities of daily living and improving physical function, but it is also important to protect against declines in mental and emotional health.

Self-esteem is defined as the overall affective evaluation of one's worth or value and is an integral component of a positive attitude toward living (2–3). Self-esteem is considered a multidimensional and hierarchical construct with global esteem at the apex, undergirded, in part, by domain levels of esteem (e.g., social esteem, performance esteem, physical self-worth, etc.) which are informed by sub-domain perceptions these esteem domains (4–6). Past research has shown that self-esteem can act as a buffer against the adversity of deteriorating health throughout the aging process (7) and that maintaining self-esteem has many health benefits such as decreased levels of cortisol and reduced anxiety and depression (8). Motl and colleagues (9) have also suggested that there is an inverse relationship between physical self-esteem and depressive symptoms, further highlighting the relationship between self-esteem and health outcomes. Self-esteem is also one of the most consistent determinants of quality of life, especially in the older adult population (10–12), making the maintenance of this construct an important public health goal.

In the context of aging, self-esteem declines dramatically after individuals reach older adulthood (13–14). This is thought to be a result of failing health, changing social roles and dynamics, loss of physical function, onset of cognitive impairment, and other transitions associated with the aging process (13). Orth and colleagues (14) have further shown that self-esteem becomes less stable and more variable from midlife to old age. It is therefore critical to improve, if not simply maintain, levels of self-esteem to protect against intermittent changes in esteem.

Physical activity is a low cost, lifestyle behavior that has consistently been associated with physical and mental health improvements in an older adult population. Given that the effects of physical activity on self-esteem are more likely to be stronger at the proximal, physical domain (e.g., physical self-worth) and sub-domain (e.g., perceptions of physical condition, attractive body, and physical strength) levels, it is important to apply this multidimensional approach, within the physical domain, to the assessment of esteem in physical activity trials.

Several previous, center-based activity interventions have taken this approach. Gothe and colleagues (15) found that changes in all subdomains of self-esteem were significantly associated with changes in physical self-worth following increased physical activity levels

among older adults. Similarly, a six-month exercise trial in older adults reported that higher levels of physical activity were significantly associated with increases in self-esteem at the domain and global levels following the intervention (16). While successful and informative, these studies reflect the more typical center-based approach to exercise trial design and necessitate participants having to attend activity sessions at university, fitness, or medical centers. This may be a challenging endeavor for older adults and likely acts as a barrier to participation for those with poor physical function, limited access to such facilities, or living in more rural communities.

One approach to enhancing reach for those participants with limited access is to design home-based exercise training programs that allow for widespread dissemination while still providing similar health benefits as center-based programs. Although a number of home-based studies report significant effects on function, strength, and balance in older adults (17–18), little is known about the effects of such programs on self-esteem and what underlying factors may be driving the relationship. A number of psychological (e.g., self-efficacy), demographic (e.g., age, sex), and biological (e.g., body mass index [BMI]) factors have been identified as potential determinants of self-esteem and might mediate or moderate changes with physical activity.

Self-efficacy has been consistently associated with improvements in self-esteem in aging adults. McAuley and colleagues (19) conducted a 12-month randomized controlled trial in older adults and found that individuals with positive changes in self-efficacy demonstrated improvements in self-esteem in those sub-domain levels of physical condition, attractive body, and strength. Similarly, Opdenacker and colleagues (20) found self-efficacy mediated the relationship between physical activity and self-esteem in older adults. In a randomized controlled trial in aging individuals, physical activity was related to self-efficacy, physical self-esteem, and quality of life (11).

In terms of demographic determinants, it has also been suggested that self-esteem varies in its trajectory across the lifespan such that old age is a critical period for self-esteem development or restoration (13). Sex has also been shown to play a moderating role in the trajectory of self-esteem across the lifespan, such that females display lower levels of esteem than males, but the two trajectories converge at old age (14). Tiggemann (21) has demonstrated that BMI, a potential biological determinant, has an inverse relationship with self-esteem in that higher levels of BMI are associated with lower levels of self-esteem. Greater physical function has also been associated with higher levels of self-esteem. Among stroke survivors, maintenance of activities of daily living in conjunction with physical function improvements were the strongest predictors of self-esteem (22).

The purpose of the present study was to examine the immediate (post intervention) and maintenance (six-month follow-up) effects of a DVD-delivered, home-based, physical activity intervention on self-esteem and its physical subdomains. Furthermore, we investigated the potential effects of psychological, demographic, and biological factors on self-esteem across the trial and follow-up.

Methods

Participants, Design, and Procedures

Study design details, methods, and participant flow through the program have been reported elsewhere (23–24). Briefly, participants (N=307) were low active, older adults residing in central Illinois who volunteered to participate in a six month, home-based, DVD-delivered exercise intervention. Sample characteristics are shown in Table 1. Eligibility criteria included being 65 years of age or older; low active (i.e., physically active for 30 minutes or more 2 days/week on average over the past 6 months); capable of participation in a program comprised of flexibility, strength, and balance exercises without exacerbating pre-existing conditions, as decided by their personal physician; and willingness to be randomized. Participants were randomly assigned to either a DVD-delivered exercise condition (n=158) focused on increasing flexibility, toning, and balance (FlexToBa) or an attentional control DVD condition (n=149) focused on healthy aging. The FlexToBaTM intervention is comprised of three DVDs designed to progressively move participants through six exercise sessions, one for each month of the program. Each session includes two sets of 10–12 exercises focused on strength, balance, and flexibility. An exercise specialist modeled all exercises on screen and additional age-matched models demonstrated modifications of each exercise (i.e., simpler and more challenging versions). The attentional control group received a *Healthy Aging*TM DVD, a commercially delivered health documentary produced by Dr. Andrew Weil. Both conditions received support from laboratory staff via telephone, starting with biweekly calls for the first two months, and then titrating down to once a month for the remainder of the intervention. Assessments were completed at baseline, post intervention (i.e., after completion of the six month program), and follow-up (i.e., six months after completion of the program). In addition, participants completed self-efficacy assessments at three weeks.

Measures

Demographics—Participants self-reported age, sex, race, ethnicity, and highest level of education. BMI was calculated using measured height and weight collected at the baseline testing appointment.

Global Self-Esteem—Global self-esteem was assessed with the Rosenberg Self-Esteem Scale (RSE; 25). Participants were asked to respond to statements similar to the following: “I am able to do things as well as most people,” and “I feel that I’m a person of worth, at least on an equal basis with others.” Each item is scored on a 5-point Likert scale from *strongly agree* (1) to *strongly disagree* (5), with lower scores indicating higher levels of self-esteem. Possible range of scores is 10–50 and internal consistency in the present study was excellent, $\alpha = .90$.

Physical Self-Perception Profile—The Physical Self-Perception Profile (26) was used to assess physical self-worth and its three subdomains: perception of physical condition, perception of physical strength, and perception of attractive body. Participants were asked to respond to statements such as: “I am physically stronger than most people of my sex,” and “I feel confident in the physical side of myself.” Each item is scored on a 4-point Likert scale

from *not at all true* (1) to *completely true* (4). Internal consistency for physical self-worth, perception of physical condition, perception of physical strength, and perception of attractive body were all excellent, α s .89.

Self-Efficacy—The Exercise Self-Efficacy (EXSE; 27) scale is a task self-efficacy measure used to assess participants' change in their beliefs in their abilities to continue exercising at varying timepoints in the future at a moderate intensity three times a week for <40 minutes per session (e.g., "I am able to exercise three times per week at moderate intensity, for 40+ minutes without quitting for the next two months"). Each item was scored on an 11-point scale ranging from *not at all confident* (0%) to *highly confident* (100%) increasing in 10-point increments, with higher scores indicating higher levels of self-efficacy. All items are summed and divided by the number of items resulting in a total efficacy score. Internal consistency at three weeks and six months were excellent, α s .99. Changes in exercise self-efficacy from week three of the program to 6 months were represented by residualized change scores. Previous research indicates that participants often recalibrate their efficacy perceptions after starting a physical activity program; therefore, self-efficacy scores as measured at week three of the intervention were used in all analyses instead of baseline values (28–29).

Short Physical Performance Battery—The Short Physical Performance Battery (SPPB) was used to assess functional performance and comprised three parts: a balance test, a mobility test, and a lower extremity strength test (30). A total summary score as well as scores from each individual test are calculated with a possible range of 0–12, with higher scores indicating better physical function. Changes in function from baseline to 6 months were represented by residualized change scores.

Data Analysis

Initially, independent sample t-tests were conducted to determine baseline differences between the two groups. Linear mixed models were then used to examine (a) the effect of the FlexToBa intervention on self-esteem outcomes post intervention and at follow-up and (b) the extent to which improvements in self-efficacy as a result of the intervention predicted improvements in self-esteem outcomes (i.e., global self-esteem, physical self-worth, physical condition, body attractiveness, and physical strength). Estimated marginal means (EMM) models were used to test the primary effects of the FlexToBa intervention on self-esteem and its subdomains at the end of the intervention and follow-up. Post-hoc, pairwise comparisons between groups and across time points were tested using the Least Significant Difference Test.

Hierarchical linear regression models in which repeated measures (baseline, 6 months, 12 months) were nested within persons were used to test the effects of changes in self-efficacy, independent of age, sex, and BMI, on changes in self-esteem outcomes over time (N=921 person*time observations). A hierarchical approach was used in which we tested the unconditional means model (UMM) and unconditional growth model (UGM), followed by the fixed effects of group assignment (FlexToBa vs. control), the primary predictor variables (change in exercise self-efficacy), hypothesized covariates (age, sex, BMI), and interactions.

The maximum likelihood method (ML) and the variance components covariance structure were used for all tests. Model fit was estimated using -2 Restricted Log Likelihood, Akaike's Information Criterion (AIC), and Schwarz's Bayesian Criterion (BIC). Effect size was expressed as Cohen's d in the EMM models and as residual (within person) and intercept-related (between persons) Pseudo- R^2 in the hierarchical models. Predictor variables were considered significant at $p < 0.05$, but were retained in the model at $p < 0.10$. Data were analyzed in SPSS 22 (Chicago, IL).

Results

Participant Characteristics

Those retained in follow-up analyses did not significantly differ from dropouts in key demographic characteristics (i.e., sex, race, ethnicity, education, BMI) other than age, such that older individuals were less likely to complete follow-up assessments, $p = 0.05$. More information relative to these differences has been reported elsewhere (31). In relation to the present analyses, no baseline differences were observed between FTB and control participants for all self-esteem variables (i.e., global self-esteem, physical self-worth, physical condition, physical strength, and body attractiveness), self-efficacy, and physical function, all $ps > 0.188$.

Global Self-Esteem

Estimated Marginal Means—There was a significant time effect, $F(2, 498.86) = 5.15$, $p = .006$, for global self-esteem; however, there were no group effects or group by time interactions, $p = .73$ and $p = .96$, respectively. Both the FlexToBa and control groups showed improvements in global self-esteem from baseline to end of intervention with maintained levels for both groups from end of intervention to follow-up. As there was no significant group by time interaction in the estimated marginal means, we did not explore a linear regression model for global self-esteem.

Physical Self-Worth

Estimated Marginal Means—There was a significant time effect, $F(2, 523.11) = 25.10$, $p < 0.001$, for physical self-worth that was driven by a group by time interaction, $F(2, 530.10) = 4.17$, $p = 0.016$. Pairwise comparisons indicated that those in the FlexToBa group significantly increased in physical self-worth from baseline to end of intervention, $p < 0.001$, $d = .56$, and decreased from end of intervention to follow up, $p = .043$; however levels of physical self-worth at follow up were significantly greater than baseline levels, $p = .003$. While increases were observed in both groups from baseline to follow-up, these effects were greater in the FTB group compared to the control group, $d = 0.52$, $d = 0.22$, respectively.

Linear Regression Models—Results of the unconditional means model (UMM) suggested 45% of the total variance in perception of physical self-worth was within persons ($ICC = 0.55$). Independent of sex, age, and BMI, improvements in self-efficacy significantly predicted improvements in physical self-worth, $\beta = .46$ (0.13), $t = 3.58$, $p < 0.001$. While older adults demonstrated higher levels of physical self-worth overall, $p = .039$, participants with higher BMI displayed greater increases in physical self-worth across time, $p < .001$.

Similarly, while females had lower levels of physical self-worth overall compared to their male counterparts, females showed greater improvements in physical self-worth over time, $p < .001$. Furthermore, females in the FTB group demonstrated higher levels of physical self-worth overall compared to females in the control group, $p = .015$. The UMM, UGM, and final model are presented in Table 3.

Within the FTB group alone, independent of BMI and sex, adherence to the intervention and improvements in self-efficacy were marginally significant predictors of improvements in physical self-worth, $\beta = .49$ (0.26), $t = 1.88$, $p = 0.063$; $\beta = .31$ (0.17), $t = 1.81$, $p = 0.071$, respectively. Overall, individuals who reported greater weekly use of the DVD demonstrated greater physical self-worth, $p = .063$. Self-efficacy improvements continued to marginally predict greater overall levels of physical self-worth within the intervention group, $p = 0.071$.

Physical Condition

Estimated Marginal Means—There was an overall time effect, $F(2, 535.27) = 26.98$, $p < .001$, for physical condition that was driven by a group by time interaction, $F(2, 630.77) = 8.31$, $p = .004$. Pairwise comparisons indicated that those in the FTB group significantly increased in physical condition esteem from baseline to end of intervention, $p < 0.001$, $d = .61$, and decreased from end of intervention to follow-up, $p < .001$. However, physical condition esteem in the FTB group increased significantly from baseline to follow-up, $p = .005$, $d = .37$, while levels did not change from baseline to follow-up in the control condition, $p = .67$, $d = .19$.

Linear Regression Models—Results of the UMM suggested 44% of the total variance in perception of physical condition esteem was within persons ($ICC = 0.56$). Increases in exercise self-efficacy was the strongest predictor of changes in physical condition esteem, $\beta = .66$ (0.13), $t = 5.12$, $p < .001$, explaining 9% of the between persons variance. While females and high BMI participants displayed lower levels of physical condition esteem overall, p s both $< .001$, females and higher BMI individuals demonstrated greater improvements in physical condition across time, $p = .003$ and $p < .001$, respectively. Age was not associated with perception of physical condition, $p = .20$. The UMM, UGM, and final model are presented in Table 4.

In the FTB group, adherence to the intervention and improvements in self-efficacy were significant predictors of improvements in physical condition, independent of BMI, $\beta = .48$ (0.18), $t = 2.73$, $p = 0.007$; $\beta = .74$ (0.20), $t = 3.71$, $p < 0.001$, respectively. Additionally, improvements in physical function significantly predicted improvements in perceptions of physical condition, $p = .019$.

Perception of Attractive Body

Estimated Marginal Means—There was a significant time effect, $F(2, 536.69) = 28.33$, $p < .001$, for perception of attractive body; however, there was no group effect or group by time interaction, $p = .78$ and $p = .75$, respectively. Both the FlexToBa and control groups showed improvements in perception of attractive body from baseline to end of intervention, end of intervention to follow-up, and baseline to follow-up. As there were no significant

group by time interactions in the estimated marginal means model, we did not explore a linear regression model for perception of body attractiveness.

Perception of Physical Strength

Estimated Marginal Means—There was a significant time effect $F(2, 525.25) = 15.24, p < .001$, for perception of physical strength; however, there was no group effect or group by time interaction, $p = .36$ and $p = .33$, respectively. Neither the FlexToBa nor the control groups differed in their perceptions of physical strength from baseline to follow-up. As there was no significant group by time interaction in the estimated marginal means, we did not explore a linear regression model for perception of physical strength.

Discussion

The purpose of this study was to examine the potential of a DVD-delivered exercise intervention to improve multidimensional self-esteem in older adults. Major findings suggest the FlexToBa intervention was effective for improving older adults' physical self-worth and physical condition from pre- to post-intervention and at six-month follow-up. These effects may have been especially salient for females, younger adults, and obese individuals. Additionally, consistent with previous literature, improvements in self-efficacy emerged as a significant predictor of improved self-esteem over time. Importantly, these findings are within the context of a DVD-delivered exercise program, unlike past research which has been primarily conducted in structured, supervised settings. This highlights the fact that self-efficacy may successfully be targeted through a home-based exercise program and, in turn, positively affect important psychosocial outcomes such as self-esteem.

Our analyses of the determinants of changes in self-esteem levels suggest that changes in self-efficacy resulting from the intervention play an important role in these effects. Specifically, improvements in self-efficacy over the course of the intervention were associated with improvements in physical self-worth and perceptions of personal condition. This finding is consistent with past research emphasizing the relationship between self-efficacy and self-esteem within an exercise intervention framework (16; 20; 32) and has implications for future research in older adults. As previous literature has suggested (32), providing efficacy enhancing exercise experiences, such as highlighting past successes (mastery experiences) or providing a role model (social modeling), is likely to enhance self-esteem. The FlexToBa group was exposed to age-appropriate models demonstrating each exercise and its modifications and received monthly feedback of their progress, both serving as important sources of efficacy enhancement. It is also plausible that the presence of the group instructor within the FlexToBa DVD provided specific support for improving both perceptions of physical self-worth and physical condition. This is supported by previous research in which improvements in esteem were observed in the context of an individualized, instructor-led exercise condition compared to a group setting (33). Importantly, our program was able to successfully target sources of self-efficacy information via DVD to mirror previous findings from center-based programs (15; 34) and extend them into the home, easing the burden on both participants and research staff and increasing the potential for scalability (see Exercise Log, Exercise Prescription, and Feedback Form,

Supplemental Digital Content 1, which illustrate elements of self-efficacy targeted in the current study).

Physical function also played an important role in the relationship between physical activity and self-esteem within the intervention group. Individuals in the FTB group who demonstrated improvements in physical function across the program evidenced greater improvements in perceived physical condition. More research is needed in the context of home-based interventions to further explore the predictive role of physical function. Of further interest were the differential effects of sex, age, and BMI on levels of self-esteem. Overall, women had lower levels of physical self-worth than men, which is consistent with the literature (35). However, women in the FlexToBa group showed greater improvements in physical self-worth compared to women in the control group. This finding suggests that the FlexToBa intervention provided key components for improving physical self-worth for women, more so than the healthy aging control group, which aligns with past research indicating a positive association between exercise in adult women and high self-perceptions of esteem (34; 36–37). Additionally, while those with higher BMIs had lower levels of esteem overall, these individuals demonstrated greater improvements in subdomains of self-esteem over time. This may be due in part to the exercise modifications and progressions inherent in the FlexToBa program, allowing individuals of all body compositions and capabilities to be successful in completing the exercises. Given that past research has suggested obese individuals feel embarrassed or ashamed of their bodies when exercising in public (38), this program allowed participants to be active in the comfort of their own homes which potentially contributed to improvements in esteem. Age was also associated with self-esteem, such that older individuals demonstrated higher levels of physical self-worth compared to their younger counterparts. It is possible that the older adults in the present study were more comfortable with their bodies and therefore demonstrated higher levels of self-esteem (39).

While significant improvements at the end of the intervention were seen on the domain and subdomain levels of self-esteem, neither perceived physical strength or global self-esteem differed by group. One possible explanation for the lack of improvement in the strength subdomain might lie in the item content of the scale assessing this construct. Whereas the intervention targeted elements of strength necessary for improving aspects of function necessary for activities of daily living, items on the strength subscale of the Physical Self-Perceptions Profile (PSPP) are more comparative in content. For example, the PSPP includes items such as, “I have muscles that are much stronger than most others of my sex,” and “In situations requiring strength, I am one of the first to step forward.” It is therefore quite possible that while the FTB intervention indeed resulted in objectively measured strength outcomes (24), the strength components addressed in the PSPP were not relevant to these improvements.

That global self-esteem did not change across time is perhaps more understandable and is likely due to the shorter follow-up period or that individuals started with higher levels of global self-esteem and therefore did not have much room for improvements. However, there is considerable support in the literature concluding that physical activity influences global self-esteem indirectly through the proximal levels of self-esteem’s multidimensional schema

following an exercise intervention (11; 26; 36). It is therefore reasonable to consider that while the FTB program may have provided improvements in sub-domain and domain levels of self-esteem, these effects were not substantial enough to influence global self-esteem.

This study has several strengths. Although there is considerable support in the literature for the positive relationship between exercise training and self-esteem, this research has typically used university or medical center-based exercise interventions (11; 32), which may limit accessibility for large numbers of older adults in need of such programs. The novel nature of this DVD-delivered, theory-based intervention has the potential for widespread dissemination and adaptability to other media, setting it apart from other commercially available exercise programs for aging individuals. Further, this method is low cost and can be provided for those who may have limited access to exercise facilities (e.g., those living in rural areas, without adequate transportation, or who are unwilling to negotiate the daunting nature of busy university campuses). Further strengths include the targeting of activities that are fundamental to maintaining an independent lifestyle (i.e., strength, flexibility, and balance), as well as providing modified versions of all exercises which allow individuals of all abilities to complete the program successfully. These physical activity determinants are traditionally targeted in face-to-face settings; however, we were able to successfully target them in a mediated setting ultimately leading to improvements in various aspects of health.

This study had several limitations that should be considered when interpreting the data. The sample was primarily white and female, despite our attempts to recruit from minority groups, which may limit generalizability of the results. However, the distribution of males and females who participated is proportionately equivalent to other research endeavors in older adults (1). Future researchers might target minority groups to determine if the effects reported herein are maintained in racially diverse populations, a task made easier through the DVD-delivery mode of this program. Furthermore, as this sample consists of relatively healthy adults, it is possible that significant improvements were not present for components of self-esteem due to a ceiling effect. Subsequent studies might target diseased populations to determine whether the effects reported herein can be magnified.

In conclusion, we report the intervention effects and maintenance at six-month follow-up of a DVD delivered exercise training program on multidimensional self-esteem in older adults. Individuals in the FTB group experienced improved perceptions of physical self-worth and physical condition, suggesting the DVD-delivered exercise program was beneficial for improving self-esteem over time on both the sub-domain and domain level. Importantly, change in self-efficacy, a key component of social cognitive theory (40), was found to be a significant determinant of improvements in self-esteem. Given that self-efficacy is a malleable construct, exercise interventions should provide activity experiences designed to enhance efficacy and thereby improve self-esteem, an important component of quality of life. The results of this study lead us to be optimistic that this innovative method of delivering an exercise program can be disseminated on a broad scale to improve self-esteem in older adults.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

These data were presented in part at the Society of Behavioral Medicine meetings in Philadelphia, PA, in April 2014, and San Antonio, TX, in April 2015.

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Acronyms

BMI	body mass index
FlexToBa	Flexibility, toning, and balance intervention
RSE	Rosenberg Self-Esteem Scale
EXSE	Exercise Self-Efficacy Scale
SPPB	Short Physical Performance Battery

References

1. Ortman, J.; Velkoff, VA.; Hogan, H. An aging nation: The older population in the United States. United States Census Bureau; 2014. p. P25-1140.
2. Rosenberg, M. Society and the adolescent self-image. Princeton, NJ: Princeton University Press; 1965.
3. Blascovich, J.; Tomaka, J. Measures of personality and social psychological attitudes. San Diego, CA: Academic Press; 1991. Measures of self-esteem; p. 115-160.
4. Shavelson RJ, Hubner JJ, Stanton GC. Self-concept: Validation of construct interpretations. *Rev Educ Res.* 1976;407–441.
5. Marsh HW, Shavelson R. Self-concept: Its multifaceted, hierarchical structure. *Educ Psychol.* 1985; 20(3):107–123.
6. Fox KR. Self-esteem, self-perceptions and exercise. *Int J Sports Med.* 2010
7. Robins RW, Trzesniewski KH. Self-esteem development across the lifespan. *Curr Dir Psychol Sci.* 2005; 14(3):158–162.
8. Liu SY, Wrosch C, Miller GE, Pruessner JC. Self-esteem change and diurnal cortisol secretion in older adulthood. *Psychoneuroendocrino.* 2014; 41:111–120.
9. Motl RW, Konopack JF, McAuley E, Elavsky S, Jerome GJ, Marquez DX. Depressive symptoms among older adults: long-term reduction after a physical activity intervention. *J Behav Med.* 2005; 28(4):385–394. [PubMed: 16049630]
10. Diener E. Subjective well-being. *Psychol Bull.* 1984; 95:542–575. [PubMed: 6399758]
11. Elavsky S, McAuley E, Motl RW, Konopack JF, Marquez DX, Hu L, Jerome GJ, Diener E. Physical activity enhances long-term quality of life in older adults: efficacy, esteem, and affective influences. *Ann Behav Med.* 2005; 30(2):138–145. [PubMed: 16173910]
12. Rejeski WJ, Mihalko SL. Physical activity and quality of life in older adults. *J Gerontol A Biol Sci Med Sci.* 2001; 56(suppl 2):23–35. [PubMed: 11730235]
13. Trzesniewski KH, Donnellan MB, Robins RW. Stability of self-esteem across the life span. *J Pers Soc Psychol.* 2003; 84(1):205–220. [PubMed: 12518980]
14. Orth U, Trzesniewski KH, Robins RW. Self-esteem development from young adulthood to old age: a cohort-sequential longitudinal study. *J Pers Soc Psychol.* 2010; 98(4):645. [PubMed: 20307135]

15. Gothe NP, Mullen SP, Wójcicki TR, Mailey EL, White SM, Olson EA, Szabo AN, Kramer AF, McAuley E. Trajectories of change in self-esteem in older adults: exercise intervention effects. *J Behav Med.* 2011; 34(4):298–306. [PubMed: 21222223]
16. McAuley E, Elavsky S, Motl RW, Konopack JF, Hu L, Marquez DX. Physical activity, self-efficacy, and self-esteem: Longitudinal relationships in older adults. *J Gerontol B Psychol Sci Soc Sci.* 2005; 60(5):268–275.
17. Bates A, Eccleston P, Kershaw M. BEST at home: a pilot evaluation of a home-based strength and balance exercise program. *Health Promot J Austr.* 2011; 22(3):234–237. [PubMed: 22497070]
18. Cyarto E, Brown W, Marshall A, Trost S. Home and Group-Based Exercise for Balance Confidence and Balance Ability. *J Gerontol.* 2008; 54:272–280.
19. McAuley E, Mailey EL, Mullen SP, Szabo AN, Wójcicki TR, White SM, Gothe N, Olson EA, Kramer AF. Growth trajectories of exercise self-efficacy in older adults: influence of measures and initial status. *Health Psychol.* 2010; 30(1):75.
20. Opdenacker J, Delecluse C, Boen F. The longitudinal effects of a lifestyle physical activity intervention and a structured exercise intervention on physical self-perceptions and self-esteem in older adults. *J Sport Exerc Psychol.* 2009; 31(6):743. [PubMed: 20384010]
21. Tiggemann M. Gender differences in the interrelationships between weight dissatisfaction, restraint, and self-esteem. *Sex roles.* 1994; 30(5–6):319–330.
22. Shida J, Sugawara K, Goto J, Sekito Y. Relationship between self-esteem and living conditions among stroke survivors at home. *Jpn J Nurs Sci.* 2014; 11(4):229–240. [PubMed: 25306927]
23. McAuley E, Wójcicki TR, White SM, Mailey EL, Szabo AN, Gothe N, Olson EA, Mullen SP, Fanning J, Motl RW, Rosengren K, Estabrooks P. Physical activity, function, and quality of life: Design and methods of the FlexToBa™ trial. *Contemp Clin Trials.* 2012; 33(1):228–236. [PubMed: 22024470]
24. McAuley E, Wójcicki TR, Gothe NP, Mailey EL, Szabo AN, Fanning J, Olson EA, Phillips SM, Motl RW, Mullen SP. Effects of a DVD-delivered exercise intervention on physical function in older adults. *J Gerontol A Biol Sci Med Sci.* 2013; 68(9):1076–1082. [PubMed: 23401566]
25. Rosenberg M. Rosenberg self-esteem scale (RSE). Acceptance and commitment therapy. Measures package. 1965:61.
26. Fox KR, Corbin CB. The physical self-perception profile: Development and preliminary validation. *J Sport Exerc Psychol.* 1989
27. McAuley E, Lox C, Duncan TE. Long-term maintenance of exercise, self-efficacy, and physiological change in older adults. *J Gerontol.* 1993; 48(4):218–224.
28. McAuley, E.; Mihalko, SL. Advances in sport and exercise psychology measurement. Morgantown, WV: Fitness Information Technology, Inc; 1998. Measuring exercise-related self-efficacy; p. 371–390.
29. McAuley E, Mullen SP, Szabo AN, White SM, Wójcicki TR, Mailey EL, Gothe NP, Olson EA, Voss M, Erickson K, Prakash R, Kramer AF. Self-regulatory processes and exercise adherence in older adults: executive function and self-efficacy effects. *Am J Prev Med.* 2011; 41(3):284–290. [PubMed: 21855742]
30. Guralnik JM, Simonsick EM, Ferrucci L, Glynn RJ, Berkman LF, Blazer DG, Scherr PA, Wallace RB. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. *J Gerontol.* 1994; 49(2):M85–M94. [PubMed: 8126356]
31. Wójcicki TR, Fanning J, Awick EA, Olson EA, Motl RW, McAuley E. Maintenance effects of a DVD-delivered exercise intervention on physical function in older adults. *J Gerontol A Biol Sci Med Sci.* 2014:glu188.
32. McAuley E, Blissmer B, Katula J, Duncan TE, Mihalko SL. Physical activity, self-esteem, and self-efficacy relationships in older adults: a randomized controlled trial. *Ann Behav Med.* 2000; 22(2):131–139. [PubMed: 10962706]
33. Kleinert J, Pels F, Podlog L. The Presence of an Exercise Instructor or Group Members Affects Physical Self-Concept and Physical Self-Esteem: An Experimental Study in the Elderly. *Health.* 2014

34. Elavsky S. Physical activity, menopause, and quality of life: the role of affect and self-worth across time. *Menopause* (New York, NY). 2009; 16(2):265.
35. Kling KC, Hyde JS, Showers CJ, Buswell BN. Gender differences in self-esteem: a meta-analysis. *Psychol Bull.* 1999; 125(4):470. [PubMed: 10414226]
36. Sonstroem RJ, Harlow LL, Josephs L. Exercise and self-esteem: Validity of model expansion and exercise associations. 1994
37. Elavsky S. Longitudinal examination of the exercise and self-esteem model in middle-aged women. *J Sport Exerc Psychol.* 2010; 32(6):862. [PubMed: 21282842]
38. Thomas SL, Hyde J, Karunaratne A, Kausman R, Komesaroff PA. They all work... when you stick to them": A qualitative investigation of dieting, weight loss, and physical exercise, in obese individuals. *Nutr J.* 2008; 7(1):34. [PubMed: 19025661]
39. Gove WR, Ortega ST, Style CB. The maturational and role perspectives on aging and self through the adult years: An empirical evaluation. *Am J Sociology.* 1989:1117–1145.
40. Bandura, A. Self-efficacy: The exercise of control. Macmillan; 1997.

Table 1

Sample Characteristics

Variable	Mean (SD)
Age (years)	71.01 (5.14)
Sex	
Male	23.1%
Female	76.9%
BMI (baseline)	30.01 (5.69)
Race/Ethnicity %	
Nonwhite	3.3%
Hispanic	2.6%
College Education %	43.9%

Table 2

Mean values (SD) for all self-esteem variables at baseline, 6 months, and follow-up

	Baseline	6 months	Follow-Up
Variable	M (SD)	M (SD)	M (SD)
Global Self-Esteem			
FlexToBa	42.09 (5.73) (n=158)	43.27 (5.10) (n=124)	42.93 (5.77) (n=111)
Control	41.97 (6.59) (n=148)	43.00 (6.05) (n=133)	42.67 (6.16) (n=127)
Physical Self-Worth			
FlexToBa	13.35 (3.89) (n=158)	15.60 (4.10) (n=124)	14.96 (1.91) (n=111)
Control	13.99 (4.56) (n=148)	14.98 (4.52) (n=132)	14.76 (2.18) (n=127)
Physical Condition			
FlexToBa	12.98 (3.59) (n=158)	15.35 (4.29) (n=124)	14.11 (2.44) (n=111)
Control	13.07 (4.09) (n=148)	13.97 (4.46) (n=132)	13.71 (2.40) (n=127)
Body Attractiveness			
FlexToBa	12.30 (3.91) (n=158)	13.85 (4.37) (n=124)	14.40 (1.69) (n=110)
Control	12.61 (4.48) (n=148)	13.84 (4.42) (n=133)	14.35 (1.30) (n=127)
Physical Strength			
FlexToBa	12.74 (4.03) (n=158)	14.34 (4.20) (n=124)	13.81 (2.23) (n=111)
Control	12.59 (4.08) (n=148)	13.44 (4.42) (n=133)	13.47 (2.12) (n=127)

Table 3

Mixed models associated with Physical Self-Worth (PSW)

Predictor Variable											
UMM				Random Intercept				UGM: Linear Time Fixed			
Fixed Effects											
	<i>B</i> (SE)	<i>t</i>	<i>p</i>	<i>B</i> (SE)	<i>t</i>	<i>p</i>		<i>B</i> (SE)	<i>t</i>	<i>p</i>	
Intercept	14.53 (0.13)	107.8	<0.001	14.39 (0.19)	76.01	<0.001		13.91 (0.21)	66.01	<0.001	
Time								0.56 (0.11)	4.96	<0.001	
Group											
Group*Time											
BMI											
BMI*Time											
Sex											
Sex*Time											
Sex*Group											
Age											
EXSE											
Random Effects	<i>var</i> (SE)	<i>Z</i>	<i>p</i>	<i>var</i> (SE)	<i>Z</i>	<i>p</i>		<i>var</i> (SE)	<i>Z</i>	<i>p</i>	
Residual	14.554 (0.728)	20.00	<0.001	6.651 (0.426)	15.62	<0.001		6.400 (0.409)	15.66	<0.001	
Intercept				8.161 (0.916)	8.91	<0.001		8.083 (0.896)	9.02	<0.001	
Model Fit											
-2 Log Likelihood	4412.587			4216.084				4191.917			
AIC	4416.587			4222.084				4199.917			
BIC	4425.956			4236.138				4218.655			
Pseudo-R ² Within				0.54				0.04			
Pseudo-R ² Between								0.01			

All tests were conducted using hierarchical linear regression using maximum likelihood estimation for all models. UMM=unconditional means model; UGM=unconditional growth model; *B* = parameter estimate; SE=standard error; AIC=akaike information criterion; BIC=bayesian information criterion

Table 4

Mixed models associated with Physical Condition (COND)

Predictor Variable												
Fixed Effects	UMM			Random Intercept			UGM: Linear Time Fixed			Final Model		
	B (SE)	t	p	B (SE)	t	p	B (SE)	t	p	B (SE)	t	p
Intercept	13.80 (0.13)	104.08	<0.001	13.66 (0.19)	73.58	<0.001	13.31 (0.21)	64.27	<0.001	15.18 (0.62)	24.77	0.001
Time							0.42 (0.11)	3.77	<0.001	-0.15 (0.23)	-0.66	0.507
Group										-1.00 (0.73)	-1.37	0.173
Sex										-2.72 (0.68)	-4.01	<0.001
Sex*Time										0.78 (0.26)	2.99	0.003
Sex*Group										2.01 (0.82)	2.45	0.015
BMI										-0.24 (0.03)	-7.04	<0.001
BMI*Time										0.08 (0.02)	3.96	<0.001
EXSE										0.66 (0.13)	5.12	<0.001
Random Effects												
	var(SE)	Z	p	var(SE)	Z	p	var(SE)	Z	p	var(SE)	Z	p
Residual	14.053 (0.703)	20.00	<0.001	6.285 (0.400)	15.71	<0.001	6.155 (0.391)	15.73	<0.001	5.872 (0.382)	15.36	<0.001
Intercept				7.894 (0.870)	9.07	<0.001	7.820 (0.857)	9.12	<0.001	6.030 (0.727)	8.3	<0.001
Model Fit												
-2 Log Likelihood	4384.569			4176.03			4161.924			4015.455		
AIC	4388.569			4182.03			4169.924			4019.455		
BIC	4397.938			4196.084			4188.663			4028.766		
Pseudo-R ² Within				0.55			0.02			0.05		
Pseudo-R ² Between							0.01			0.23		

All tests were conducted using hierarchical linear regression using maximum likelihood estimation for all models. UMM=unconditional means model; UGM=unconditional growth model; *B* = parameter estimate; SE=standard error; AIC=akaike information criterion; BIC=bayesian information criterion