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Physical Activity in Prefrail Older Adults: Confidence and Satisfaction Related to Physical Function

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Abstract

We examined the hypothesis that physical activity will have favorable effects on measures of self-efficacy for a 400-m walk and satisfaction with physical functioning in older adults 70+ years of age who have deficits in mobility. We randomized a total of 412 adults aged 70–89 years at elevated risk for mobility disability to either a physical activity or a successful aging educational control intervention for 12 months. Participants in the physical activity intervention had more favorable changes in both outcomes as a result of treatment than those in the successful aging intervention. Gender, age, and scores on a short physical performance battery did not moderate these effects. Physical activity is an effective means of intervening on self-efficacy and satisfaction with physical function in older adults with impaired lower extremity functioning. This is an important finding in light of the importance of these process variables in behavior change and quality of life.

Keywords

Self-efficacy; Aging; Disability; Mobility; Quality of life

Individuals over the age of 69 years represent one of the fastest growing segments of the U.S. population (Manton & Vaupel, 1995). Although an important public health goal continues to be an increase in life expectancy, of even greater importance is that extended life should include the capacity to live independently and to function well (Katz et al., 1983). In this regard, the loss of activities of daily living that depend upon mobility represent a serious decline in functional health, increasing the risk of institutionalization and death (Branch & Jette, 1982). The Lifestyle Interventions and Independence for Elders Pilot

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Study (LIFE-P) was designed to examine whether a physical activity (PA) program, as compared with a successful aging (SA) education control condition, could prevent mobility disability in at-risk functionally compromised older adults aged 70 to 89 years. As reported in the main outcomes article (Pahor et al., 2006), participants in the PA group experienced greater improvement than those in the SA group on a short physical performance battery (SPPB) and in 400-m walking speed. Those in the PA group also had a lower incidence of major mobility disability, which we defined as the incapacity to complete a 400-m walk. In this study we examine differences between the SA and PA groups with respect to changes in self-efficacy for the 400-m walk and satisfaction with physical function, which are two important secondary outcomes of interest in the LIFE-P.

Evidence suggests that cognitions related to self-efficacy for performance of specific behaviors and satisfaction for physical function are important in understanding why social cognitive theory (Bandura, 1986) is relevant to more general health outcomes in PA trials such as self-reported physical impairments (Blalock, DeVellis, DeVellis, & Sauter, 1988), performance-based measures of physical function (Rejeski, Ettinger, Martin, & Morgan, 1998), greater disability in valued activities (Katz & Neugebauer, 2001), and quality of life (McAuley et al., 2006; Rejeski & Mihalko, 2001). By their very nature, PA interventions provide mastery experiences that are central to the development of self-efficacy beliefs and to enhanced feelings of satisfaction with older adults' level of physical functioning. Consistent with work by Sonstroem and Morgan (1989) with self-esteem, one might argue that changes in behavior specific self-efficacy beliefs determine changes in higher order constructs such as satisfaction with physical functioning. However, research by McAuley and his group (McAuley, Blissmer, Katula, Duncan, & Mihalko, 2000) using model-fitting procedures suggests that the effects of self-efficacy on physical self-worth are mediated by perceptions related to body attraction and level of physical conditioning. The main point of this discussion is to underscore the interrelationship and conceptual importance of both self-efficacy and satisfaction with physical function in research on PA programming with older adults. In addition, in the current trial, there is a very good rationale for assessing self-efficacy related to a 400-m walk, because this test has strong associations with functional limitations, disability, and mortality (Newman et al., 2006; Pahor et al.).

Research on elderly community-dwelling adults does suggest that participation in PA has a robust effect on improving functionally based self-efficacy beliefs (McAuley & Katula, 1998). We have observed similar effects in randomized clinical trials with older adults whose function is compromised by chronic health conditions such as arthritis (Rejeski et al., 1998) and cardiovascular disease (Rejeski et al., 2003). In addition, in PA studies of middle- and older-aged adult populations, positive changes have been observed in satisfaction with physical function (Rejeski, Shelton, Miller, Dunn, & Sallis, 2001; Rejeski et al., 2002).

However, despite encouraging results from previous research, there is a lack of research evidence on older adults (70+ years) who are at high risk for losing their functional independence as a result of severe deficits in mobility. This is an obvious gap in the literature, given the well-known psychological, social, and health care consequences that are associated with disability. Can self-efficacy beliefs related to an important clinical outcome such as the 400-m walk or the satisfaction that older adults have for their physical function

be preserved or enhanced through involvement in PA? In the current study, the hypotheses examined are that older adults randomized to PA will have more favorable scores for both self-efficacy beliefs related to the 400-m walk and satisfaction for physical function at 6- and 12-month assessments than those randomized to SA. Because gender, advanced age, and level of compromised function can influence patterns of PA (Crespo, Keteyian, Heath, & Sempos, 1996; Martin & Sinden, 2001), we conducted post hoc analyses to evaluate how changes in the two outcomes might be moderated by these variables.

Methods

Participants

Our goal in this study was to randomize 400 participants across a 9-month interval of time with a minority participation rate of at least 25%. The LIFE-P also had a target of at least 40% of participants with baseline SPPB scores between 4 and 7. All participants completed an informed consent prior to baseline assessments. We randomized each eligible participant by means of a Web-based system to one of the two study arms. We stratified randomization by gender and by field center to ensure nearly equal sample sizes of men and women for the two intervention groups within each center. Human subjects institutional review boards at all sites approved the study protocol.

Details of the randomization procedure and a consort diagram can be found in the articles by Rejeski and colleagues (2005) and Pahor and colleagues (2006), respectively. At the time of randomization, we assigned 213 participants to the PA group and 211 to the SA group, with 68.9% of the sample consisting of women and 31.1% consisting of men. In addition, 30% of the sample participants had a high school education or less, 39.4% were married, and 18.2% were African American; the average body mass index was 30.23. A limited amount of demographic data partitioned by treatment group can be found in Table 1 and a more complete description can be found in the article by Pahor and colleagues.

Eligibility

Major inclusion criteria were as follows: men and women had to be between 70 and 89 years of age, have a SPPB summary score <10 (Guralnik, Ferrucci, Simonsick, Salive, & Wallace, 1994), be able to complete the 400-m walk in 15 minutes at baseline (Simonsick, Montgomery, Newman, Bauer, & Harris, 2001), and be sedentary (<20 minutes of exercise each week for the past month). We excluded individuals if they had a major medical or psychiatric condition that might pose a risk for either safety or intervention compliance or if they had a Mini-Mental State Examination score of <21 (Folstein, Folstein, & McHugh, 1975). Complete details can be found in the design article for the LIFE-P published by Rejeski and his colleagues (2005).

Measures

Self-efficacy for the 400-m walk—The major outcome in the LIFE-P was a self-paced 400-m walk test (Simonsick et al., 2001). Researchers conducted this test in a corridor with two cones spaced 20 m apart. Individuals walked at a comfortable, self-directed pace with the only restriction that they would not be able to participate in the study if they took more

than 15 minutes to complete the course. Researchers recorded the time it took for participants to complete the 400-m walk in minutes and seconds.

The 400-m walk efficacy scale was completed after participants had finished the 400-m walk test. The instructions read as follows: "You have just completed a walk that was about ¼ *mile*. Please answer the following questions that concern your confidence (or certainty) in being able to walk at a similar pace for different distances *1 week from now*." Five questions were rated on a 0 (no confidence) to 10 (complete confidence) scale with responses summed and converted to a 0- to 100-point scoring system. The first item was written as follows: How much confidence do you have in your ability to walk *half as far as you did today*, at the same pace, 1 week from now? The other four items were similar in content except that the italicized content changed. For the second item, it read *the same distance that you did today*; for the third item, it read *half again as far (the same distance plus half of that distance)*; for the fourth item it read *twice as far*, and for the fifth item it read *three times as far*.

We constructed this measure in a manner consistent with methods established by Bandura (1986). At baseline, we found 400-m walk self-efficacy scores to be moderately correlated in an inverse manner with walking speed during the 400-m walk test, $r = -.46$, $p < .0001$. In the current study, older adults who had more severe mobility problems as defined by SPPB scores < 7 had significantly lower mean self-efficacy scores, 63.9, than those with fewer mobility problems, 76.1, $p < .001$. It is also interesting to note that, in the current study, change in self-efficacy from 0 to 6 months was significantly related to change in satisfaction with physical function from 0 to 12 months ($r = .33$, $p < .0001$). The Cronbach alpha for the measure was 0.90.

Satisfaction with physical function—We used a six-item satisfaction measure originally developed by Ray and colleagues (Ray et al., 1996) to assess satisfaction with physical function. Each item was rated on a 7-point scale that was scored from −3 to +3, with numbers on the scale anchored by the following phrases: very dissatisfied (−3), somewhat dissatisfied (−2), a little dissatisfied (−1), neither (0), a little satisfied (+1), somewhat satisfied (+2), and very satisfied (+3). An example item is as follows: "In the past 4 weeks, how satisfied have you been with the muscular strength in your legs?"

In a maximum likelihood factor analysis, we found all six items to have high loading on a single factor (>.70) with a Cronbach alpha of 0.94. The scale correlates in the expected direction with negative feeling states ($r = -.46$, $p < .01$), positive feeling states ($r = .51$, $p < .01$), and an index of quality of life ($r = .28$, $p < .01$; Reboussin et al., 2000). We have used this measure in several randomized controlled trials involving PA and have found that it is sensitive to change in older adults populations (Rejeski, Shelton, et al., 2001; Rejeski et al., 2002). One scores the measure by summing across the six items and then dividing by 6 to create an average score that can range from −3 to +3.

SPPB—The SPPB involves three areas of performance: balance, chair stands, and 4-m self-paced walking speed (Guralnik, Ferrucci, Simonsick, Salive, & Wallace, 1995). Performance in each of these three areas is assigned a categorical score ranging from 0 to 4,

with 4 indicating the highest level of performance and 0 an inability to complete the test. One calculates a summary score ranging from 0 (worst performers) to 12 (best performers) by adding walking speed, chair stands, and balance scores.

CHAMPS PA questionnaire—We used an interview version of the CHAMPS questionnaire (Stewart et al., 2000) to assess changes in PA over time as a manipulation check for the interventions. The CHAMPS measure was developed specifically for older adults; investigators can derive average minutes and frequency of both moderate and overall PA performed across an average week in the past month. The measure has good psychometric properties and is sensitive to change (see Stewart et al.).

PA Arm

The PA intervention employed a combination of aerobic, strength, balance, and flexibility exercises. We divided the intervention into three phases: adoption (Weeks 1–8), transition (Weeks 9–24), and maintenance (Weeks 25 to end of trial). Exercise training was primarily center based during the adoption phase with a systematic transition to home-based exercise. Furthermore, walking was the primary mode of PA, given its widespread popularity and ease of administration in older persons (U.S. Department of Health and Human Services, 1996; also see King, Rejeski, & Buchner, 1998). Other forms of endurance activity (e.g., stationary cycling) were, however, utilized on a limited basis when regular walking was contraindicated. In line with the Surgeon General's recommendations, the walking component had a general weekly goal of 150 minutes performed 5 or more days of the week, which was approached in a progressive and individualized manner across the first 3 months of the trial (Ettinger et al., 1997; Rejeski, Ettinger, et al., 1998). However, we do want to emphasize that these goals were only used as a general guide to prescription because a considerable number of participants' physical abilities were compromised to the point that it did not permit this level of activity at any point during the trial.

Each session was preceded by a brief warm-up period and followed by a brief cool-down period. Moreover, participants performed 10 minutes of lower extremity strengthening exercises by using variable-weight ankle weights followed by a brief lower extremity stretching protocol. Supplemental materials were supplied to reinforce the strength training so that it could be generalized to the home environment. Balance training was also introduced during the initial (adoption) phase of the program. Interested readers are referred to a method paper for the LIFE-P published by Rejeski and his colleagues (2005) for more details on the PA intervention.

Restarting a suspended PA program—At times PA was suspended as a result of a hospitalization, injury, or other health event. Evaluation for restarting PA depended on the functional impact of the illness and any activity limitation prescriptions that were provided by the participant's health care team, including the primary care physician, surgeon, consultants, or therapists. Irrespective of the phase of the intervention that a suspension occurred, we conducted all restarts in a supervised setting until such time that participants could engage safely in home-based PA.

SA Arm

An active control intervention was used in the LIFE as a comparison group to the PA intervention and was framed in the context of health education for SA. This program was based on workshops on a variety of health topics relevant to older adults (e.g., healthful nutrition, how to effectively negotiate the health care system, how to travel safely, recommended preventive services and screenings at different ages, where to go for reliable health information, etc.) and also involved a short instructor-led program (5–10 minutes) of upper extremity stretching exercises. This brief stretching program was performed during each class to provide direct behavioral attention to participants and to help foster adherence to the intervention arm without directly affecting the study outcomes. The education sessions and stretching component of the SA program provided instructor support and promoted group interaction. Participants also learned how to actively "take charge" of their health in seeking out appropriate medical information and services.

Contact mode and frequency—The SA program met in small groups weekly for the first 24 weeks and monthly thereafter. We made telephone calls after each missed session to problem-solve barriers to attendance and to encourage regular participation.

Statistical Methods

We compared baseline characteristics between randomized groups, and all tests of group differences were based on the principle of intent-to-treat. We used *t* tests to compare means of continuous characteristics, and we used chi-square tests to compare proportions. We computed percentage adherence to center-based PA as the proportion of total expected sessions that participants attended. We defined the number of expected sessions of the intervention by the contact frequency of sessions in the PA intervention group for each interval of interest. The intervention effect on change in moderate intensity PA from the CHAMPS was a prespecified aim of the LIFE-P. We assessed intervention differences at 6 and 12 months by using the Wilcoxon rank-sum test to account for the skewness of the distribution of this measure.

We used a mixed-effects analysis of covariance model to obtain adjusted mean changes for each outcome at 6 and 12 months. Terms entered into these models included the baseline level of the outcome; gender; clinical site; an indicator of visit for the repeated outcome measures; intervention; and the Intervention × Visit interaction. We carried out this mixed-effects likelihood analysis of repeated outcomes in Proc Mixed of SAS, Version 8, using an alpha level of $p < .05$, and an unstructured covariance matrix to account for correlation between repeated outcomes. Molenberghs and Kenward (2007, p. 53) provide justification of how this type of analysis is completely consistent with the intent-to-treat principle.

To investigate whether the intervention effect on satisfaction with function and self-efficacy was moderated by baseline levels of gender, age (<76 years vs ≥76 years), and SPPB score (<7 vs ≥7), we fit separate mixed-effects analysis of covariance (ANCOVA) models that included two-way interaction terms between each of these baseline variables and the intervention effects. We used *t* tests to test for mean differences at baseline for satisfaction with function and self-efficacy between these prespecified levels of gender, age, and SPPB

score. Because the outcomes in this study were secondary in the LIFE-P, we did not calculate statistical power for any of the analyses.

Results

Table 1 provides descriptive statistics on the LIFE study participants. With the exception of the fact that participants in the PA group had a slightly higher prevalence of diabetes than those in the SA group, 27.23% versus 16.11%, at baseline the two groups were equivalent on demographic, medical, and biometric characteristics. The mean (± *SD*) age of participants was 76.77 (± 4.24) years and 67.0% had more than a high school education. The most common comorbidities were hypertension (69.10%), arthritis (21.98%), and diabetes (21.70%). At baseline, participants were obese ($M \pm SD = 30.33 \pm 6.53$) and had compromised physical function as is evident from a mean total SPPB score of 7.57 (± 1.45).

Intervention Checks: Adherence To Center-Based Exercise and Level of PA

Adherence rates to center-based sessions for active participants in the PA group were 77.4% from baseline to 6 months and 60.9% from 6 months to 12 months. The slightly lower adherence rates in the PA group during the second 6-month interval was due to the fact that center-based visits were optional during the maintenance phase. For the SA group, adherence to schedule sessions was 70.1% and 73.3% during the same time periods, respectively. From the CHAMPS questionnaire administered at each visit, we determined that participants in the SA group reported a weekly mean increase of 18.94 minutes of PA that was of moderate intensity or greater from baseline to 6 months and an increase of 5.76 minutes from baseline to 12 months. In contrast, in the PA group, the mean weekly increases from baseline to 6 and 12 months were 112.66 minutes and 63.23 minutes, respectively. The treatment group differences at both time points were statistically different from one another; at 6 months the *p* value was <.001 and at 12 month it was .005.

Change in 400-m Walk Efficacy and Satisfaction With Physical Function

Table 2 provides the raw means (± *SD*) by treatment group for each assessment visit, whereas Table 3 provides the baseline scores and the adjusted means for the change scores (± 95% confidence interval, or CI) that were associated with each statistical model. Inspection of the raw means suggest that both treatment groups experienced an increase in satisfaction with physical function from baseline to follow-up assessments, but that the change was greater for participants in the PA group. What is interesting about the change in 400-m walk self-efficacy for participants in the SA group is that scores deteriorated over time, whereas those in the PA group experienced a slight increase at 6 months followed by a return to baseline at 12 months. It appears that PA may serve to preserve self efficacy for mobility in this older group of prefrail individuals.

In the statistical models, there was not a significant Treatment × Time interaction term for either outcome; recall that baseline scores were covariates in these models. Therefore, results from the mixed model ANCOVAs on these study outcomes support the statistical significance of the observed treatment effects for both outcomes: $F(1, 401) = 15.70$, $p < .0001$ for satisfaction with function and $F(1, 401) = 21.22$, $p < .0001$ for self-efficacy.

Collapsing across the 6- and 12-month visits, we found that participants in the PA arm had significantly more favorable mean delta scores (95% CI) for both satisfaction with function, 0.74 (CI = 0.58–0.89), and self-efficacy, 2.49 (CI = −0.19–5.18), than did those in the SA arm, 0.30 (CI = 0.15–0.46) and −6.03 (CI = −8.73 to −3.33), respectively. More important, as the *p* values illustrate in Table 3, group comparisons at both the 6- and 12-month visits were statistically different from one another. It is worth noting that there is little or no overlap in the CIs between group means for each outcome.

Moderator Variables: Gender, Age, and SPPB Scores

Mixed-model ANCOVAs yielded no significant two-way interactions between gender, age, SPPB level and the intervention effect for either self-efficacy or satisfaction with physical function. Thus, there was no evidence for moderation of treatment effects by any of these three variables. Worthy of mention is the fact that, at baseline, older participants (≥76 years) had lower mean ± standard deviation scores for self-efficacy, 71.2 ± 19.1, than did those who were younger (<76 years), 76.3 ± 18.9; $F(1, 400) = 6.77$, $p = .0097$. There were also dramatic baseline differences for both satisfaction with function and self-efficacy between those with higher (≥7) as opposed to lower (<7) SPPB scores: The mean ± standard deviation was 0.4 ± 1.6 versus −0.4 ± 1.4 for satisfaction with physical function, $F(1, 401) = 8.17$, $p = .0045$, and 76.1 ± 17.7 versus 63.9 ± 21.0 for 400-m walk self-efficacy, $F(1, 400) = 11.45$, $p = .0008$, respectively. Finally, it is instructive to note that those in the SA arm with low SPPB scores at baseline (<7) experienced statistically greater decline in self-efficacy from baseline at both the 6-month visit,−9.2, and the 12-month visit, −12.1, as compared with those in the SA arm in the higher SPPB category (≥7), −4.8 and −4.5, respectively; $p = .023$ at 6 months and $p = .004$ at 12 months.

Relationship Between Outcomes and Performance Measures of Function

As secondary analyses, we also examined relationships between self efficacy for the 400-m walk and satisfaction for physical function with the performance measures published in the main outcomes article (Pahor et al., 2006). At baseline, self-efficacy for the 400-m walk correlated in the expected direction with 400-m walk time, $r = −.46$, $p < .0001$, and with SPPB scores, $r = .32$, $p < .0001$. The correlations for satisfaction with function at baseline were $r = −.26$, $p < .001$ for 400-m walk time and $r = .24$, $p < .001$ for the SPPB. Interestingly, 12-month change in the 400-m self-efficacy scale was not related to change in 400-m walk time; however, it was related to change in SPPB scores, $r = .30$ ($p < .0001$); similarly, 12-month change in satisfaction with function was weakly related to change in 400-m walk time yet had $r = .21$ ($p < .0001$) with change in the SPPB.

Discussion

In this study we examined the influence of a PA intervention on satisfaction with physical function and self-efficacy for a 400- m walk in prefrail older adults. The results indicated that participants in PA, as compared with participants in SA, had significantly better profiles for satisfaction with physical function and self-efficacy for the 400-m walk at both follow-up visits. Although the magnitude of these differences was modest in some cases, the average effect of treatment was expected to be smaller in this population as a result of acute

illnesses and symptoms associated with chronic conditions such as knee and hip osteoarthritis. Furthermore, although older participants and those with lower SPPB scores at baseline reported lower values for both satisfaction with physical function and self-efficacy for the 400-m walk, we found that age, gender, and SPPB scores did not moderate the effects of the intervention on study outcomes.

These data are significant in light of the importance of satisfaction with physical function and self-efficacy in the process of behavior change and quality of life. Compromised satisfaction with physical function has been linked to greater physical impairment (Blalock et al., 1988), greater disability in valued activities (Katz & Neugebauer, 2001; Neugebauer, Katz, & Pasch, 2003), and depressive symptoms (Neugebauer, Katz, & Pasch, 2003). Moreover, improvements in satisfaction with physical function have been found to mediate the influence of a PA intervention on subjective well-being (Rejeski, Shelton, et al., 2001). Thus, satisfaction with physical function is a highly relevant construct for older adults, and interventions that serve to improve satisfaction with physical function may ultimately lead to enhanced well-being.

Additionally, self-efficacy is the central construct in social cognitive theory (Bandura, 1997) and research has consistently demonstrated its importance as both a determinant and consequence of PA behavior (McAuley & Blissmer, 2000). More specifically, self-efficacy has been found to predict long-term PA behavior (McAuley, Jerome, Marquez, Elavsky, & Blissmer, 2003) and mediate the influence of PA on improvements in quality of life (McAuley et al., 2006). Furthermore, our own work has found self-efficacy to be an important variable in the disability process. In a 30-month prospective study of older adults with knee pain (Rejeski, Miller, et al., 2001), we found that together with knee strength, self-efficacy predicted self-reported disability and stair climb performance. Moreover, improvements in self-efficacy have been found to mediate the influence of a PA intervention on improvements in physical performance in older adults with knee osteoarthritis (Rejeski, Ettinger, et al., 1998).

Both outcome measures were significantly correlated with SPPB scores and 400-m walk time at baseline; however, changes in both measures over the course of study were only related to change in SPPB scores. Readers should keep in mind that the SPPB is a composite measure of leg strength, balance, and mobility suggesting that balance and strength contribute to perceptions of confidence and satisfaction with physical function in older prefrail populations. Furthermore, because of safety concerns with this population, the 400-m walk was self-paced, a feature of the test that does compromise its usefulness in examining how change in this variable might relate to change in either self-efficacy or satisfaction with physical function.

To our knowledge this is the first PA study to demonstrate improvements in satisfaction with physical function and self-efficacy in older adults particularly vulnerable for mobility disability. These changes in psychological functioning parallel improvements in lower extremity function that we have published previously (Pahor et al., 2006). Equally important, the results of the present study suggest that participants in the SA condition

actually experienced decreases in self-efficacy for the 400-m walk, suggesting that perceptions of capabilities decrease over time without participation in PA.

What may seem incongruent is that participants in the SA group actually rated their satisfaction with physical function higher at the follow-up visits, even though the increases were statistically lower than those observed in the PA group. One potential explanation for this finding is that the health information and light stretching provided in the SA treatment was adequate enough to make these older adults feel somewhat better about their physical function but insufficient to counter the loss of task-specific self-efficacy related to the 400-m walk. Interestingly, McAuley and his colleagues (2000) found a light stretching and toning condition to have a positive influence on self-esteem and self-efficacy that was comparable to a regimen of aerobic activity. However, their measures of self-efficacy were more global than those employed in the current study; participants did not perform the tasks in question, and their older adult sample was healthier than ours. Nonetheless, it does appear that more general measures related to perceptions of physical functioning can be influenced by treatments that do not change objective measures of function.

Additionally, our examination of moderator variables (gender, age, SPPB score) suggests that there are subgroups that may be particularly vulnerable to age-related declines in self-perceptions. Older participants and those with lower SPPB scores reported significantly lower satisfaction for physical functioning and self-efficacy for the 400-m walk at baseline. These data suggest that certain participants may be at risk for lower functioning and future PA interventions may be well served to identify and target these subgroups to provide additional attention and assistance.

We recognize that there are limitations to the current study design. For example, one cannot rule out nonequivalence in contact time between SA and PA as a potential threat to group differences in study outcomes. Although it is not an ideal solution to this potential threat, we did examine the relationship between contact time and change in study outcomes within the SA group across the 12 months of the study. There was no dose-response effect in that adherence to scheduled sessions in the SA group was unrelated to either change in self-efficacy ($p = .84$) or to change in satisfaction with physical function ($p = .50$), suggesting that increasing contact time for those in the SA group would not have altered our findings. It is also worth noting that requiring participants to attend an extraordinary number of sessions in attention control treatment conditions in long-term trials does have a down side; that is, it can make participants irritable, leading either to “angry responders” or retention problems. Some readers also may be concerned about the wide range of treatment that was received by different participants.

Specifically, there were a number of acute illnesses during the study and participants had a wide range of physical abilities despite the fact that all were prefrail. This latter difference created variability in PA goals. There is no easy solution to this problem of heterogeneity in treatment; it is the reality of conducting research and running clinical programs for this population. Recently prepared guidelines for PA and older adults acknowledge this fact and encourage more scientific study on these populations, recognizing that impaired older adults have much to gain from even minimal changes in PA behavior (Nelson et al., 2007).

Future research is needed to examine the predicted influence of improvements in these constructs and other outcomes. For example, we would expect improved self-efficacy to be related to long-term adherence to PA and to mediate the influence of the intervention on improvements in physical functioning. We would also expect improved satisfaction with physical function to mediate the influence of the intervention on subjective well-being. Future studies with larger samples and longer follow-up are needed to examine the structural pathways linking the effects of increased PA, self-efficacy, and satisfaction with function to both physical functioning and the progression of disability. For example, in the current study, change in self-efficacy from 0 to 6 months was correlated with change in satisfaction with physical function from 0 to12 months, $r = .33$, $p < .0001$.

In conclusion, the present study demonstrates that even in older adults with impaired lower extremity functioning, a multimodal PA intervention can improve self-efficacy and satisfaction related to physical functioning, potentially buffering individuals against further decline over time. Furthermore, these effects are independent of age, gender, and baseline SPPB score. Additionally, it appears that, without intervention, some older adults at risk for mobility disability continue to experience declines in these perceptions, which could contribute to a downward spiral of psychological well-being and physical functioning and, ultimately, disability.

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Appendix

Research Investigators for the Pilot Phase of Life

The following individuals are from the Cooper Institute, Dallas, TX: Steven N. Blair, PED—Field Center Principal Investigator; Timothy Church, MD, PhD, MPH—Field Center Coprincipal Investigator; Jamile A. Ashmore, PhD; Judy Dubreuil, MS; Georita Frierson, PhD; Alexander N. Jordan, MS; Gina Morss, MA; Ruben Q. Rodarte, MS; Jason M. Wallace, MPH. The following individuals are from the National Institute on Aging: Jack M. Guralnik, MD, PhD—Coprincipal Investigator of the Study; Evan C. Hadley, MD; Sergei Romashkan, MD, PhD.

The following individuals are from Stanford University, Palo Alto, CA: Abby C. King, PhD—Field Center Principal Investigator; William L. Haskell, PhD—Field Center Co-principal Investigator; Leslie A. Pruitt, PhD; Kari Abbott-Pilolla, MS; Karen Bolen, MS; Stephen Fortmann, MD; Ami Laws, MD; Carolyn Prosak, RD; Kristin Wallace, MPH. The following individuals are from Tufts University: Roger Fielding, PhD; Miriam Nelson, PhD. (Dr. Fielding’s contribution is partially supported by the U.S. Department of Agriculture, under agreement No. 58-1950-4-401. Any opinions, findings, conclusion, or recommendations expressed in this publication are those of the author and do not necessarily reflect the view of the U.S. Dept of Agriculture.)

The following individuals are from the University of California—Los Angeles: Robert M. Kaplan, PhD, MA. The following individuals are from the VA San Diego Healthcare System and University of California—San Diego: Erik J. Groessl, PhD. The following individuals are from the University of Florida, Gainesville: Marco Pahor, MD—Principal Investigator of the Study; Michael Perri, PhD; Connie Caudle; Lauren Crump, MPH; Sarah Hayden; Latonia Holmes; Cinzia Maraldi, MD; Crystal Quirin. (Dr. Pahor is partially supported by the Geriatric Research, Education and Clinical Center, or GRECC, of the Malcom Randall Veteran's Affairs Medical Center, North Florida/South Georgia Veterans Health System, Gainesville, FL.)

The following individuals are from the University of Pittsburgh, Pittsburgh, PA: Anne B. Newman, MD, MPH—Field Center Principal Investigator; Stephanie Studenski, MD, MPH—Field Center Coprincipal Investigator; Bret H. Good-paster, PhD, MS; Nancy W. Glynn, PhD; Erin K. Aiken, BS; Steve Anthony, MS; Sarah Beck (for recruitment papers only); Judith Kadosh, BSN, RN; Piera Kost, BA; Mark Newman, MS; Jennifer Rush, MPH (for recruitment papers only); Roberta Spanos (for recruitment papers only); Christopher A. Taylor, BS; Pam Vincent, CMA. (The Pittsburgh Field Center was partially supported by the Pittsburgh Claude D. Pepper Center under Grant P30 AG024827.) The following individuals are from Wake Forest University, Winston-Salem, NC: Stephen B. Kritchevsky, PhD—Field Center Principal Investigator; Peter Brubaker, PhD; Jamehl Demons, MD; Curt Furberg, MD, PhD; Jeffrey A. Katula, PhD, MA; Anthony Marsh, PhD; Barbara J. Nicklas, PhD; Jeff D. Williamson, MD, MPH; Rose Fries, LPM; Kimberly Kennedy; Karin M. Murphy, BS, MT (ASCP); Shruti Nagaria, MS; Katie Wickley-Krupel, MS.

The following individuals are from the Data Management, Analysis and Quality Control Center (DMAQC): Michael E. Miller, PhD—DMAQC Field Principal Investigator; Mark Espeland, PhD—DMAQC Coprincipal Investigator; Fang-Chi Hsu, PhD; Walter J. Rejeski, PhD; Don P. Babcock, Jr., PE; Lorraine Costanza; Lea N. Harvin; Lisa Kaltenbach, MS; Wei Lang, PhD; Wesley A. Roberson; Julia Rushing, MS; Scott Rushing; Michael P. Walkup, M.S. (The Wake Forest University Field Center is, in part, supported by the Claude D. Older American Independence Pepper Center under Grant 1 P30 AG21332.) The following individuals are from Yale University: Thomas M. Gill, MD. (Dr. Gill is the recipient of a Midcareer Investigator Award in Patient-Oriented Research, Award K24AG021507, from the National Institute on Aging.)

Table 1

Descriptive Characteristics on Total Sample and by Treatment Arms

Variables	Total Randomized Sample	Physical Activity	Successful Aging	*p*
Age	76.77 ± 4.24	76.53 ± 4.17	77.01 ± 4.31	.24
Gender				.88
Female	292 (68.9)	146 (68.5)	146 (69.2)	
Male	132 (31.1)	67 (31.5)	65 (30.8)	
Education				.86
<High school	11 (2.6)	5 (2.3)	6 (2.8)	
High school	116 (27.4)	58 (27.2)	58 (27.5)	
>High school	284 (67.0)	142 (66.7)	142 (67.3)	
Other	13 (3.1)	8 (3.8)	5 (2.4)	
Body mass index	30.23 ± 6.04	30.71 ± 6.24	29.74 ± 5.80	.10
Arthritis	93 (21.98)	50 (23.47)	43 (20.48)	.77
Heart attack	39 (9.20)	24 (11.27)	15 (7.11)	.14
CHF	24 (5.66)	11 (5.16)	13 (6.16)	.66
Hypertension	293 (69.10)	148 (69.48)	145 (68.72)	.87
Cancer	74 (17.45)	38 (17.84)	36 (17.06)	.83
Diabetes	92 (21.70)	58 (27.23)	34 (16.11)	.01
SPPB score	7.5 ± 1.4	7.6 ± 1.5	7.5 ± 1.4	.43
400-m time	8.17 ± 1.89	8.16 ± 1.90	8.18 ± 0.90	.90

Notes: CHF = congestive heart failure; SPPB = short physical performance battery.
For the total randomized sample, $N = 424$; for the physical activity and successful aging arms, $n = 213$ and 211, respectively.
Percentages are shown in parentheses.

Table 2

Raw Means for Outcome Variables by Treatment Group at Each Assessment Visit

Variable	Group	Baseline	6 Months	12 Months
Satisfaction with function	SA	0.3 (1.6)	0.7 (1.5)	0.6 (1.7)
	PA	0.2 (1.5)	1.1 (1.5)	0.9 (1.6)
400-m walk efficacy	SA	72.4 (19.6)	67.2 (25.3)	66.7 (26.1)
	PA	74.2 (18.7)	78.4 (23.4)	74.2 (27.0)

Note: SA = successful aging; PA = physical activity. Standard deviations are shown in parentheses.

Table 3

Baseline and Adjusted Mean Delta Scores for Outcomes From the Statistical Models

		Adjusted Mean Delta (95% CI): Baseline to 6 Months			Adjusted Mean Delta (95% CI): Baseline to 12 Months		
Variable	**Baseline *M* (*SD*)**	**SA**	**PA**	***p***	**SA**	**PA**	***p***
Satisfaction with function	0.3 (1.6)	0.3 (0.2, 0.5)	0.8 (0.7, 1.0)	.001	0.3 (0.1, 0.5)	0.6 (0.5, 0.8)	.006
400-m walk efficacy	73.3 (19.2)	−5.7 (−8.6, −2.7)	4.5 (1.5, 7.5)	<.001	−6.1 (−9.3, −2.8)	0.2 (−2.9, 3.4)	.005

Note: CI = confidence interval; SA = successful aging; PA = physical activity.