Effects of a DVD-Delivered Exercise Intervention on Physical Function in Older Adults


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Background. Given the rapidly increasing demographic of older adults, it is vital to implement effective behavioral strategies to improve physical function to maintain activities of daily living. However, changing physical activity in older adults remains extremely difficult. The current trial tested the efficacy of a novel, 6-month, home-based, DVD-delivered exercise program focusing on flexibility, balance, and toning on the physical function of older adults.

Methods. Older adults (N = 307) were recruited from 83 towns and cities throughout central Illinois. The trial consisted of 4 waves of recruitment and randomization from May 2010 through January 2012. Inclusion criteria included being inactive, at least 65 years of age, English speaking, providing physician’s consent, and willingness to be randomized. Eligible participants were randomly assigned to 1 of 2 treatment conditions: the exercise intervention or a healthy aging, attentional control. Functional assessments were completed at baseline and following the 6-month DVD intervention. Measures included the Short Physical Performance Battery, assessments of flexibility and strength, and self-reported functional limitations.

Results. Participants in the DVD intervention condition demonstrated significant improvements in the Short Physical Performance Battery (p = .005), lower extremity flexibility (p = .04), and upper body strength (p = .005). There were no effects of the intervention on self-reported functional limitations.

Conclusions. The exercise intervention produced a clinically significant improvement in the Short Physical Performance Battery and improvements in flexibility and strength, demonstrating the effectiveness of a low-cost DVD exercise program in improving physical function in older adults.

Key Words: Clinical trial—DVD—Home-based exercise—Functional performance—Public health—Gait—Balance.

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Exercise training has been reliably demonstrated to enhance function in older adults (1–3) and to confer a protective effect for functional limitations and disability (4–6). Typically, functional performance has been assessed by measures of strength, mobility, and balance, all of which have been associated with disability, morbidity, and mortality (7,8). For example, an analysis of nine combined cohort studies reported gait speed over as little as 4 m to be predictive of increased survival odds in older adults (8). Gait speed combined with assessments of balance and chair stands form the basis of the Short Physical Performance Battery (SPPB; 9–11), a measure of physical function. The SPPB has predicted nursing home admission and mortality (9), as well as mobility and disability up to 4 years later in older community-dwelling adults. The Lifestyles Interventions and Independence for Elders Pilot study (2), a comprehensive program consisting of titrated supervised exercise training and 10 weeks of group-based behavioral counseling, provided the first evidence in a randomized controlled setting that SPPB scores could be improved in older adults at risk for disability. Although such evidence is impressive, the majority of older adults in the population are largely inactive with only 25% of men and 20% of women aged 65 years and older meeting public health recommendations (12). Although center-based interventions have been successful in improving functional performance in older adults, such approaches can be costly, have limited reach, can be difficult to implement, and are often not generalizable (13). Therefore, low-cost, broad-reaching, and innovative approaches to delivering physical activity programs are needed. One contemporary delivery approach for exercise training is by DVD. Exercise DVDs witnessed an annual growth of 11.2% over the past 5 years with revenue of $264.4 million (14). Importantly, more than 20% of these DVDs are purchased by older adults (14). In spite of this popularity, there is no empirical evidence to determine whether DVD exercise programs are safe and effective or,
importantly, whether they can improve physical function in community-dwelling older adults.

The current trial was designed to test the effectiveness of a home-based, 6-month, DVD-delivered exercise program focusing on flexibility, toning, and balance on physical function in older adults compared with an attentional control condition using a health aging DVD. It was hypothesized that the participants in the DVD exercise condition would improve functional performance and reduce functional limitations across the trial period.

**METHODS**

**Study Design**

A complete description of the *Flexibility, Toning, and Balance (FlexToBa)* trial, including the design, methods, and measures has been published elsewhere (15). Briefly, the study was a 6-month randomized controlled exercise trial with a FlexToBa DVD exercise condition and a healthy aging DVD control condition. Study protocols were reviewed and approved by a university Institutional Review Board and all participants completed a written informed consent.

**Setting and Participants**

Figure 1 shows the flow of participants through the trial. Participants (*N* = 307) were recruited via local media from 83 towns and cities covering an area of more than 5,000 square miles in central Illinois. Four waves participated in the intervention from May, 2010 through January, 2012. The study was designed to be as generalizable as possible and therefore exclusion criteria were limited. Eligibility criteria for entry into the trial included being inactive (ie, physically active for 30 minutes or more, ≤2 days per week over the past 6 months), aged 65 and older, English speaking, capable of participating in a physical activity program without exacerbating any preexisting condition(s), as determined by written physician approval, and willingness to be randomized. Cognitive status was determined during an initial screening telephone call using the 13-item modified Telephone Interview of Cognitive Status measure and participants who scored greater than or equal to 21 were eligible for participation (16). Following successful completion of a screening telephone interview, participants were mailed a questionnaire packet and scheduled for functional testing. All physical function assessments were completed in rented facilities throughout central Illinois (eg, hotel meeting rooms, recreational centers). Participants were paid $75 for completion of all testing and questionnaires and entered into a drawing for one of two $250 awards per wave, as an incentive to complete all testing.

Following testing, participants from each wave were randomized to one of the two treatment arms (DVD intervention or healthy aging control). Given the relatively large sample size, the single-blind nature of the design, and randomization occurring at study onset, significant imbalance between conditions was not expected and therefore blocking was not implemented. We stratified by sex, age (ie, <70 and ≥70), and geographical classification (ie, rural, micropolitan, urban, and micropolitan).

**Outcomes**

The primary outcomes were physical function performance and functional limitations assessed at baseline and following the 6-month DVD intervention. The assessors were blinded to participants’ group placement at both time points.

*Functional performance.*—The SPPB (11) assesses balance, gait speed, and lower extremity strength. Briefly, balance was assessed by asking participants to maintain upright posture for up to 10 seconds per test while standing with their feet in side-by-side, semi-tandem, and tandem positions. Gait speed was assessed by measuring the time taken by a participant to walk a 4-m course at a normal pace. Lower extremity strength was assessed by a chair stand test in which participants were instructed to sit in and fully rise from a chair five times as quickly as possible, without using their arms for support. Performance scores for each SPPB individual test and a summary score aggregating the individual tests were calculated as per standard SPPB protocol. In addition to the SPPB, we measured upper body strength and endurance with an arm curl test, upper body flexibility with the back scratch test, and lower body flexibility with the sit and reach test (17).

*Functional limitations.*—We used the abbreviated function component (18) of the Late-Life Function and Disability Instrument (19,20) to assess the degree of difficulty experienced with basic and advanced lower extremity and upper extremity function. Participants were asked to indicate how much difficulty they have with each task on a 5-point Likert scale ranging from 5 (none) to 1 (cannot do). The three subscales were combined to provide a total functional limitations score for analysis with lower scores indicating fewer difficulties in performing activities of daily living.

**Interventions**

Participants in the FlexToBa intervention condition were provided with three DVDs, two resistance bands (one of light and one of moderate intensity), a yoga mat, and a FlexToBa handbook. The DVD set comprises an introduction to the program, progressions, and safety principles and two disks each consisting of six progressive exercise sessions with two sets of 11–12 different exercises focusing on balance, strength, and flexibility. Participants were encouraged to exercise with the FlexToBa DVDs three times per week on nonconsecutive days and to progress to the next session every 4 weeks. A trained exercise leader modeled the exercise and narrated the
program with detailed explanations and demonstration of each movement prior to leading participants through that exercise. The exercise leader was accompanied by three age-appropriate models who had completed a similar, onsite exercise training program prior to DVD production. Modifications of each exercise were modeled for those who required an easier task and for those preferring a more challenging version of the activity. Participants were provided with daily exercise logs to complete and return by mail on a monthly basis. These logs were used to provide individualized graphical and written feedback of their progress in the trial. Finally, all FlexToBa participants received a short biweekly support telephone call with an exercise “tip of the day” for the first 2 months and a monthly call thereafter.

Participants in the control condition were provided with a copy of the commercially available Dr. Andrew Weil “Healthy Aging” DVD and asked to watch the 85-minute documentary in its entirety and to continue with their normal day-to-day lives. They also received telephone calls on the same schedule as the treatment condition in which healthy aging topics were discussed and a health “tip of the day” was provided.

**Statistical Analysis**

$t$ tests were conducted to determine whether treatment conditions differed on baseline values of the primary outcome measures. Next, mixed model analysis of variance examined treatment effects on outcomes at the end of the
intervention. Treatment condition, sex, and sample location (ie, rural, micropolitan, and micro-urban) were between-group factors and time was the within-group factor. Finally, we conducted mixed model analysis of covariance on the primary outcomes, using baseline values as the covariates. Effect sizes were expressed as partial $\eta^2$ (0.01 = small effect, 0.06 = medium effect, and 0.14 = large effect). $F$ tests and effect sizes are reported for analyses of covariance.

**RESULTS**

**Demographic Characteristics**

Participant characteristics for demographic factors and basic health status (ie, mean number of participant-reported cardiovascular, pulmonary, and musculoskeletal conditions) did not significantly differ between the two conditions at baseline ($p > .05$; Table 1).

**Adherence, Retention, and Program Satisfaction**

Of the 307 participants randomized to the trial (FlexToBa: $n = 158$; control: $n = 149$), 260 (85%) were retained at 6 months (Figure 1). For the FlexToBa condition, adherence to the prescribed protocol (3 times per week), as reported by activity logs, was 75.7% across the trial (range: 93.2% at month 1 to 60% at month 6). Program evaluations were received from 114 (72.2%) of the intervention participants. Respondents reported being “satisfied” or “completely satisfied” with the overall FlexToBa program (88.5%), the professionalism of staff (94.7%), the quality of DVD (85.1%), the quality of supplemental written materials (89.9%), the exercise progressions (85.1%), and the appropriateness of modified exercises (89.3%).

**Intervention Effects on Functional Performance and Functional Limitations**

Table 2 shows the intervention effects on functional fitness outcomes for the FlexToBa and control groups at both, baseline and month 6, time points along with the adjusted month 6 means from the analysis of covariance. There were no significant differences between the two groups on any of the outcome variables at baseline, although participants in the intervention group completed more repetitions than the control group. The analysis of covariance for the SPPB revealed a significant group effect, $F(1,240) = 8.10$, $p = .005$, $\eta^2 = 0.03$. As can be seen in Table 2, the FlexToBa condition significantly improved its SPPB score by .52 and the control condition declined slightly. This difference was both statistically significant and clinically important (21). There was a significant group effect for upper body strength, $F(1,236) = 8.79$, $p = .003$, $\eta^2 = 0.04$, with the FlexToBa participants increasing the number of arm curls performed, whereas the control condition did not change. Additionally, there was a main effect for sex, $F(1,236) = 4.33$, $p < .04$, $\eta^2 = 0.02$, with men completing more arm curls than women. Relative to flexibility, there was a significant intervention effect for lower body flexibility (ie, chair sit and reach), $F(1,238) = 4.06$, $p = .04$, $\eta^2 = 0.02$, but not for upper body flexibility (ie, the back scratch test), $F(1,235) = 1.66$, $p = .20$. Participants in the intervention condition maintained lower extremity flexibility over the trial, whereas participants in the control condition became less flexible. There were significant main effects for sex in both flexibility measures with women being more flexible than men ($p < .05$). Analysis of the self-reported functional limitations data revealed no significant group effect, $F(1,245) = 0.07$, $p = .79$. There was, however, a main effect for sex with men reporting more functional limitations than women, $F(1,245) = 0.743$, $p = .007$, $\eta^2 = 0.03$. Finally, there were no effects for geographical location.

**Adverse Events**

During the 6-month intervention period, there were nine adverse events reported in the FlexToBa condition, of which four were classified as related to the research. These were all associated with exacerbation of preexisting knee pain. There were four serious adverse events reported in the FlexToBa condition and three in the control condition, none of which were related to the research (eg, abdominal surgery, pacemaker battery replacement, thyroid removal).
**Table 2. Intervention Effects on Functional Performance and Functional Limitations**

<table>
<thead>
<tr>
<th></th>
<th>FlexToBa (mean ± SE, 95% CI)</th>
<th>Control (mean ± SE, 95% CI)</th>
<th><em>p</em> Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPPB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>10.38±0.118 (10.15, 10.61)</td>
<td>10.46±0.14 (10.19, 10.74)</td>
<td>.76</td>
</tr>
<tr>
<td>Post</td>
<td>10.91±0.15 (10.62, 11.21)</td>
<td>10.37±0.15 (10.07, 10.67)</td>
<td>.011</td>
</tr>
<tr>
<td>Postadjusted</td>
<td>10.91±0.13 (10.66, 11.17)</td>
<td>10.38±0.13 (10.11, 10.65)</td>
<td>.005</td>
</tr>
<tr>
<td>Arm curls</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>14.32±0.321 (13.69, 14.95)</td>
<td>13.91±0.382 (13.16, 14.66)</td>
<td>.052</td>
</tr>
<tr>
<td>Post</td>
<td>15.90±0.44 (15.05, 16.76)</td>
<td>13.98±0.45 (13.08, 14.87)</td>
<td>.002</td>
</tr>
<tr>
<td>Postadjusted</td>
<td>15.33±0.36 (14.62, 16.04)</td>
<td>13.80±0.37 (13.07, 14.54)</td>
<td>.003</td>
</tr>
<tr>
<td>Back scratch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>−4.79±0.454 (−5.69, −3.89)</td>
<td>−4.23±0.54 (−5.29, −3.16)</td>
<td>.079</td>
</tr>
<tr>
<td>Post</td>
<td>−3.59±0.51 (−4.60, −2.57)</td>
<td>−4.26±0.51 (−5.27, −3.26)</td>
<td>.352</td>
</tr>
<tr>
<td>Postadjusted</td>
<td>−2.81±0.30 (−3.40, −2.21)</td>
<td>−3.35±0.30 (−3.94, −2.76)</td>
<td>.199</td>
</tr>
<tr>
<td>Sit and reach</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>−0.63±0.329 (−1.28, 0.016)</td>
<td>−0.70±0.392 (−1.47, 0.07)</td>
<td>.939</td>
</tr>
<tr>
<td>Post</td>
<td>−0.88±0.43 (−1.72, −0.04)</td>
<td>−1.97±0.44 (−2.84, −1.11)</td>
<td>.076</td>
</tr>
<tr>
<td>Postadjusted</td>
<td>−0.57±0.30 (−1.16, 0.03)</td>
<td>−1.43±0.31 (−2.04, −0.82)</td>
<td>.045</td>
</tr>
<tr>
<td>Functional limitations*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>65.10±0.423 (64.26, 65.93)</td>
<td>65.06±0.476 (64.12, 66.00)</td>
<td>.465</td>
</tr>
<tr>
<td>Post</td>
<td>65.92±0.74 (64.47, 67.38)</td>
<td>65.61±0.77 (64.09, 67.12)</td>
<td>.764</td>
</tr>
<tr>
<td>Postadjusted</td>
<td>64.88±0.47 (63.96, 65.81)</td>
<td>65.06±0.49 (64.09, 66.02)</td>
<td>.796</td>
</tr>
</tbody>
</table>

Notes: CI = confidence interval; FlexToBa = Flexibility, Toning, and Balance; Postadjusted = adjusted for baseline value; SPPB = Short Physical Performance Battery.

Postintervention FlexToBa: n = 127 and control: n = 133.

*LL-FDI total score.

**DISCUSSION**

Larson (22) has recently noted that in spite of the myriad benefits of exercise training for physical and mental health, the most urgent need is for the development and testing of programs that promote exercise and health in late life. We would further propose that such programs should consider the importance of being accessible for as many older adults as possible and target factors that have the potential to reduce disability and subsequent morbidity and institutionalization (23). This study demonstrates the feasibility, acceptability, and efficacy of delivering regularly scheduled exercise focusing on older adults via the medium of DVD. As such, this novel intervention is capable of reaching participants from outlying geographical areas who typically would not be able to attend center-based activity trials conducted at university or medical centers. In addition, the FlexToBa program provides systematic, programmatic activities with alternative versions of each exercise that allow individuals of all capabilities to complete the program successfully.

Overall, the intervention produced significant, albeit, modest improvements in physical performance, particularly for the SPPB, strength, and upper and lower extremity flexibility. Given that the SPPB (9,10) and its individual components (24) have been associated with lower extremity and mortality events, it is encouraging that this novel, home-based, media-delivered intervention resulted in a clinically meaningful improvement in physical performance. Kwon and colleagues (24) reported that 0.3–0.8 reflects the range for a small meaningful change in the SPPB with substantial change being indicated by a range of 0.4–1.5. In this study, the overall difference between the two conditions as a function of the intervention was 0.60. We note, however, that the study sample had reasonably high levels of function to begin with (M at baseline, 10.47±0.7) but that the intervention was still able to elicit a clinically meaningful improvement during the 6-month period. This improvement is only slightly lower than the adjusted between-group effect (0.7 at 6 months) reported by the Lifestyles Interventions and Independence for Elders Pilot study group (2,25). However, the Lifestyles Interventions and Independence for Elders Pilot trial was designed to improve function in sedentary older adults at risk for disability with a SPPB score of less than or equal to 9. As indicated by Rejeski and colleagues (26), baseline values inherently influence changes in functional performance with greater improvements often elicited in those with the worst baseline performance. If programs such as the FlexToBa intervention can maintain levels of performance in relatively well-functioning healthy older adults in the community and improve the function of those who are more compromised, this could have considerable public health impact.

We might also note that we conducted supplementary analyses of treatment effects on the individual components of the SPPB. Although there were significant improvements for balance and lower extremity strength (ie, chair stand test) for the FlexToBa condition compared with the control condition, neither group differed in their gait times. Given the nature of the program content, this finding is probably unsurprising. However, Cesari and colleagues (24) have demonstrated that the lower extremity strength and balance...
components of the SPPB have equal prognostic value to the gait aspect of this measure. Subsequent applications of the FlexToBa intervention may also wish to encourage participants to supplement the DVD content with periodic bouts of walking or other aerobically based activities.

Strengths of the study include a reasonable sample size, multiple measures of physical function, an innovative delivery method, and a highly successful attempt at reaching a geographically diverse population. Although there were no significant effects of geographical location on our primary outcomes, we were able to include participants from rural (~35%), micropolitan (~23%), and micro-urban (~42%) areas. As there were few exclusionary criteria associated with study participation, our intervention can also be characterized as being conducted in a translational context with potential for implementation with other populations including those with disease status. Additionally, the program reflects a successful, low-cost intervention that can be tailored to individual capabilities. The FlexToBa intervention appears to be safe with few adverse events being reported and no serious adverse events that were classified as a result of the intervention. Finally, the intervention was well-tolerated with participants reporting high levels of satisfaction with all aspects of the program. We further note that adherence to the protocol, as evidenced by exercise logs, was quite good (~75% across 6 months) suggesting that participants are as likely to use a DVD activity program on a regular basis as much as individuals who might attend a center-based program.

We also acknowledge a number of limitations. First, our sample was predominantly female (~77%), although there are proportionately more women aged 65 years and older than are men and women are more likely to participate in health-related endeavors than are men (27). Additionally, the minority composition of the sample was poor, in spite of best efforts at recruiting in minority areas and focusing on some sites with significantly higher numbers of minority adults. We recognize that our measures of strength were directed at assessing upper body strength (ie, arm curls and grip strength) and, given the range of activities within the FlexToBa program, inclusion of other lower extremity strength measures would have been ideal. However, lower extremity strength is also targeted in the SPPB via the chair stand test. Finally, it is important to recognize that the FlexToBa intervention was of relatively short duration (ie, 6 months). Long-term adherence to exercise training and the maintenance of accrued benefits have been a considerable challenge in behavioral interventions. It will be important to determine whether improvements in function brought about by the FlexToBa intervention are sustained beyond program end and whether differential doses of the program have differential effects on both maintenance of an active lifestyle and functional performance.

In summary, this randomized trial revealed that a low cost, targeted delivery of a physical activity program that packages flexibility, strengthening, and balance activities can significantly improve functional performance in older adults. The FlexToBa intervention’s effect on the SPPB was modest but statistically significant and clinically meaningful, which may have the potential to enhance clinical practice. Additionally, the intervention is easily distributable to practitioners, includes built-in modifications for all exercises, and promotes safe and effective execution of these exercise activities. It is recognized that the trial participants are largely healthy older adults and the effectiveness of the intervention in more diverse samples and settings remains to be established. However, at this point, we are cautiously optimistic that the use of DVD-delivered exercise programs designed for older adults can be both effective and utilized on a broad scale.

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