

# Effectiveness of a Group Exercise Program in a Long-Term Care Facility: A Randomized Pilot Trial

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**Objective:** The purpose of this pilot was to determine whether a strength and flexibility program in frail long-term care facility (LTC) residents would result in improved function.

**Design:** A prospective, randomized, controlled, semi-crossover trial was designed with participants assigned either to group exercise (EX) or recreational therapy (C). In the EX group, the intervention continued for 1 year. In the C group, recreation continued for 6 months; these controls were then crossed over to the same exercise intervention as the EX group and followed for an additional 6 months. Functional outcomes were measured at baseline and 3, 6, 9, and 12 months for both groups.

**Setting:** A LTC facility, which included both assisted living (AL) and nursing home (NH) residents.

**Participants:** Twenty frail residents (5 from NH, 15 from AL) aged 75 to 99 years at one LTC facility.

**Intervention:** After random group assignment, the EX group met 1 hour three times per week. An exercise physiologist and LTC staff conducted sessions which included seated range of motion (ROM) exercises and strength training using simple equipment such as elastic resistance bands (therabands) and soft weights. The C group met three times per week and participated in activities such as painting during the first 6 months, before crossing over to exercise.

**Measurements and Methods:** Objective measures of physical and cognitive function were obtained at baseline and 3, 6, 9, and 12 months using the timed get-up-and-go test (TUG), Berg balance scale, physical performance test (PPT), and mini-mental status exam (MMSE). Because we were interested in the impact of exercise on multiple endpoints and to protect the type I error rate, a global hypothesis test was used.

**Results:** There was a significant overall impact across the four measures of the exercise intervention ( $P = 0.013$ ). Exercise benefit as indicated by the difference between exercise and control conditions showed exercise decreased TUG by 18 seconds, which represents an effect size (in standard deviation units) of 0.50, increased PPT scores by 1.3, with effect size = 0.40, increased Berg scores by 4.8, with effect size of 0.32, and increased MMSE by 3.1, with effect size = 0.54. Except for the Berg, 90% confidence intervals on these exercise effects excluded 0.

**Conclusion:** Frail elderly in a LTC facility were able to participate and benefit from a strength training program. The program was delivered with low-cost equipment by an exercise physiologist and LTC staff. The advantage of such a program is that it provides recreational and therapeutic benefits. (*J Am Med Dir Assoc* 2003; 4: 74–80)

**Keywords:** frail elderly; strength training; long-term care

A common goal for frail elderly patients in the community and in long-term care (LTC) facilities is to maintain or improve function. Several studies have demonstrated that

functional measures were stronger predictors of hospital outcomes than admitting diagnoses or diagnosis-related groups.<sup>1–3</sup> Low levels of physical activity and lower extremity weakness have been identified as risk factors for functional status decline and falls.<sup>4–6</sup> Many dependent frail elderly entering a LTC facility have developed disability and dependency despite maximum medical therapy for chronic diseases. Elderly people with chronic diseases often decrease their physical activity. Less activity contributes to strength loss, which begins a downward spiral. Immobility has a number of physiologic and psychological consequences, including muscle atrophy, osteoporosis, impaired balance, orthostatic hypotension, and decreased cardiovascular and pulmonary reserve as well as

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an increase in depression, insomnia, falls, and pressure ulcers.<sup>7-9</sup>

Frailty is no longer considered an inevitable consequence of aging. Research studies have found that strength loss, which is especially common in the oldest old, can be improved with exercise.<sup>10-12</sup> Aerobic exercise is excellent for cardiovascular and overall conditioning in the healthy elderly, but for the extremely frail elderly with inadequate strength or balance, even walking is difficult. However, strength loss in the elderly can be improved with strength training exercise programs. Improvements in gait speed, balance, performance-based tests of functional independence, self-reported disability, joint stiffness, depressive symptoms, and spontaneous physical activity have been demonstrated.<sup>13,14</sup> These studies have been conducted in frail elderly in the community. Few trials have evaluated the effectiveness of strength training in LTC facilities. The studies that have been conducted in LTC facilities either had no control group<sup>15-17</sup> or used individual physical therapy or special exercise machines.<sup>8,18,19</sup> These studies' results agreed with what was found in the community frail elderly. Strength training resulted in improvement in muscle strength and mobility. Individual physical therapy can also be effective, but a relatively quick detraining effect may be seen as soon as 10 weeks after therapy.<sup>20,21</sup> The detraining phenomenon suggests that some form of maintenance exercise is needed. If the frail elderly in LTC facilities can benefit as much from strength training programs as those in the community, then randomized controlled trials of cost-effective group strength training programs using simple portable equipment (therabands and soft ankle and wrist weights) need to be designed and evaluated. The obvious benefit of conducting exercise in groups with simple portable equipment is that the therapy can be more cost effective than individual physical therapy and could be offered routinely. No such studies have been reported in LTC facilities in the United States. The purpose of this pilot study was to determine whether a group strength and flexibility program for frail residents in a LTC facility results in improved function as compared with control conditions.

## METHODS

### Participants

All eligible residents residing in a 50-bed LTC facility were invited to participate. The facility included both nursing home (NH,  $n = 32$ ) and assisted living (AL,  $n = 18$ ) residents. An education session about the importance of exercise in the frail elderly and the study design was presented to LTC facility administrators, caregivers, residents, and families. The criteria for inclusion were age greater than 65, residence at the facility for greater than 3 months, and the ability to ambulate alone, with assistive devices or one caregiver. Residents were excluded if they had any of the following: (1) an unstable acute illness (eg, pneumonia) or chronic illness (eg, uncompensated congestive heart failure), (2) an inability to follow a two-step command, (3) an assaultive behavior pattern or (4) unwillingness to discontinue any current physical therapy. Of the 21 residents that met the above criteria, 20

agreed to participate in the study. Five residents were from the NH and 15 from AL.

### Study Design

The study was designed as a randomized, controlled, semi-crossover trial in which residents in a LTC facility were assigned to participate in strength and flexibility training or a recreational therapy group during the first 6 months.<sup>22</sup> At the end of the 6 months, the recreational therapy group crossed over to the exercise intervention, and the exercise group continued with the exercise intervention. Both groups were followed for the remaining 6 months of the year. After baseline assessments, randomization was determined by a computer generated algorithm (permuted blocks) stratified by place of residence within the LTC facility (AL vs NH). Assignment to the study group was done by opening sealed envelopes with the random numbers supplied in sequence by the study coordinator.

## INTERVENTION

### Exercise Group

The exercise group of 11 residents was conducted by an exercise physiologist who was assisted by trained LTC staff. The sessions were conducted at the LTC facility in a large lounge area. Because of the frailty of most members of the group, all exercises were done in a seated position. The sessions lasted 1 hour and were conducted three times per week. Each session consisted of warm up, upper body strengthening, lower body strengthening, and cool down. Simple, portable, inexpensive equipment was used and consisted of soft ankle and wrist weights (2 to 4 pounds), therabands (color-coded resistance ranging from 2.5 pounds to 9 pounds) and weighted hand-sized balls and beach balls for kicking and throwing. Residents exercised at the beginning without resistance, concentrating mainly on range of motion, using all the major muscle groups with good form and breathing. Each exercise was begun with one set of 5 repetitions and gradually progressed to two sets of 10 as tolerated. Participants were evaluated weekly for the quality of their movement and number of repetitions with good technique to determine progression of soft weights, balls, or resistance of the therabands.

### Control Group

For the first 6 months, the recreational group met for 1 hour three times per week with an art therapist or social worker. The activities included drawing, painting, doing puzzles, or playing cards. Control subjects were encouraged to continue their usual activities but were asked not to begin an organized exercise program or an individualized training program during the intervention period. At the end of the 6 months, the control group began the same exercise intervention as the exercise group began 6 months earlier.

### Attendance

Attendance records were kept for both the exercise and recreational therapy groups. Compliance was defined as the proportion of scheduled sessions that were attended. LTC staff encouraged and assisted residents from both the control and

exercise group to attend their sessions. Attendance in the exercise group was 80%. Attendance in the recreational therapy group was 56%.

### Outcome Measures

The primary outcome variables were measurements of cognitive and physical function. These were assessed at baseline and at 3, 6, 9, and 12 months using the Folstein mini-mental status exam (MMSE),<sup>23</sup> timed get-up-and-go test (TUG),<sup>24</sup> Berg balance scale,<sup>25</sup> and physical performance test (PPT).<sup>26</sup> All the performance tests were administered by physical and occupational therapists who were blinded to the group assignments. The MMSE was administered by two trained medical students and research nurses also blinded to group membership. All of the performance tests have been validated in older populations and have good interrater reliability.<sup>27-29</sup> These tests were used, rather than measurements of muscle strength or circumference, because our focus was on superior functional performance. A number of studies have already documented significant correlations between muscle strength and various functional parameters such as walking speed.<sup>10</sup> TUG measures the time it takes a person to rise to standing from a standard armchair, walk a distance of 3 meters, turn, walk back to the chair, and sit down. The Berg Balance Scale measures "functional balance" common to many daily tasks such as reaching, bending, and rising. The participant performs 14 activities, each measured on a 5-point ordinal scale ranging from 0 to 4 (0 = unable to perform, 4 = independent) so that the aggregate score ranges from 0 to 56. The 7-point PPT has the participants do a number of usual tasks such as lifting a book to a shelf or simulated eating. These tasks are then timed and scored based into which time category they fall, with the maximum score of 24. The PPT was found to be very responsive as a functional measure to detect change in performance in the frail elderly.<sup>29</sup>

One additional test administered only at baseline was the functional independence measure (FIM). This is a validated instrument used in rehabilitation medicine.<sup>30</sup> The FIM has six subscales that evaluate both motor and cognitive function, which are used to document the severity of disability as well as outcomes of rehabilitation treatment. The results of the cognitive and motor subscales are combined into a summary score with the maximal obtainable score of 126 for a totally independent subject. This test was administered before randomization to fully characterize the study population but not used in follow-up assessment because assistance was needed from LTC staff to administer this test, and therefore it could not be blinded. Also, this test is scored based on what people usually do for themselves. This test could be subject to bias in a LTC facility because nurses' aides, either for time efficiency or to be helpful, may perform tasks that the residents are able to perform themselves.

### Statistical Methods and Design Features

With measurements at baseline and 3, 6, 9, and 12 months, we modeled the change due to the intervention as well as the variance and covariances across the repeated measures with linear mixed models using SAS's Proc Mixed program.<sup>31</sup>

Baseline measures served as random variable covariates to increase precision. The design is somewhat unusual because the control patients were crossed over to exercise after the 6-month measurement rather than continuing with control conditions. This semicrossover design has certain efficiency advantages over the traditional design in which controls remain under control conditions throughout the trial.<sup>22</sup> The crossover data on the controls do not directly impact the estimate of the effect of exercise. Instead, they add precision to the analysis. The direct information about the exercise effect is obtained from the 3- and 6-month measures when controls were not receiving the exercise intervention. The efficiency advantage is most clear for estimating average change due to an intervention (the average impact was the focus of our trial), subgroup x treatment interaction effects, covariances of baseline characteristics, treatment effectiveness, and change in the exercise effectiveness past the 6-month crossover point.<sup>22</sup> SAS Proc Mixed provided maximum likelihood estimates of the effect of the exercise sessions for each of the four variables<sup>31</sup> after adjusting for baseline, period effects, and patient status (NH vs AL).

An important practical advantage of crossing the controls after 6 months instead of continuing with control conditions is that the NH administration and the patients found randomization more acceptable. The reasons were that all patients under study were promised that they would receive the exercise intervention. Only one potentially eligible resident at the LTC facility refused to volunteer. We believe that this high proportion of volunteers is at least in part due to the promise that all would participate in the exercise session. This approach also simplified institutional review board approval because no one was denied the intervention.

Because interest was focused on the impact of exercise on four variables (PPT, TUG, Berg, MMSE), a multiple endpoint global hypothesis testing strategy to avoid multiple hypothesis tests was used.<sup>32</sup> This strategy avoids the mistake of inflating the type I error rate with multiple univariate tests. The single global test maintains the proper type I error probability. At the same time, it has greater power than univariate testing when the intervention effects on the multiple outcomes are consistently in favor of the intervention. Geriatric management trials often fail to show significance on their chosen primary endpoint, even though secondary endpoints show significance and meta-analysis indicates superiority of the test interventions.<sup>33</sup> The only disadvantage is that inference at the individual variable level can be cumbersome. We used a simple average of standardized (to variance = 1) effects across the four endpoints.<sup>34</sup> With 20 patients, this trial with its semicrossover design had 80% power to obtain a significant global test at  $\alpha = .05$ , assuming an overall effect size of 0.5 standard deviations (SD).

### RESULTS

Table 1 compares the exercise and control groups at baseline. Almost all differences are within their respective standard errors, indicating very similar groups at baseline. Because the study population included both NH and AL residents, we compared these two group scores. The average FIM score of

**Table 1.** Baseline Means and Percentages of Exercise and Control Groups

Baseline Variable	Exercise (n = 11)	Control (n = 9)	Difference (SE)* (Exercise – Control)
Percent nursing home	27%	22%	5% (20%)
Percent women	82%	67%	15% (20%)
Age: mean (range)	88 (75–96)	88 (78–99)	–.3 (3.1)
FIM (functional independence measure)	91 (49–119)	104 (71–123)	–13.5 (10)
Outcomes at baseline			
TUG (timed get-up-and-go) (sec)	45 (17–52)	49 (12–141)	–4 (15)
PPT (physical performance test)	8.0 (3–14)	9.7 (5–15)	–1.7 (1.5)
Berg (Berg balance scale)	33 (11–52)	32 (5–52)	–.1 (6.7)
MMSE (mini-mental status exam)	21 (10–29)	22 (13–29)	–1.6 (2.6)

Note range of possible values: FIM 6–126, MMSE 0–30, PPT 0–15, Berg 0–56, TUG <20 predicts good ADLs.

\* SE refers to the standard error of the difference;  $\pm$  2 SE gives a 95% confidence interval.

residents in the NH was 66.4 (49–77) with an SD of 10.5. The average FIM of the AL population was 107 (59–123) with a SD of 17. Clearly, the AL population had higher overall function, but there was overlap between the two groups. Because the study criteria selected out those higher functioning residents of the NH, these residents were more similar to the AL residents. However, as evidenced by their baseline FIM and TUG scores, this was a very frail population.

Table 2 provides estimates of the effect of the exercise intervention as compared with control conditions. These are reported in SD units (effect sizes) to allow comparisons across the four variables. Column one of Table 2 also reports the effects in the original scale units. For each outcome, the intervention effect was positive in favor of exercise. The effect sizes are all substantial, and the lower limits of the confidence intervals are at or above 0 except for the Berg balance scale. The global test of superiority of exercise across all four variables was significant at a  $P = 0.013$ .  $P$  value = 0.013 has a standard interpretation, except that it gives a probability of all four consistent effects (or larger ones) arising by chance alone.

### Sensitivity Analysis

Two patients were noncompliant with their assignment, one switched to exercise immediately, and the other who was assigned to exercise refused to attend. The results in Table 2

**Table 2.** Overall Effects of the Exercise Intervention on TUG, PPT, Berg Balance, and MMSE

	Intervention Effect (Original Scale)	Effect Size*	90% Confidence Interval
TUG	18 sec faster	.54	(.12, .95)
PPT	1.3 better	.40	(.002, .80)
Berg	4.8 better	.32	(–.09, .74)
MMSE	3.1 better	.54	(.15, .92)

\* Effect sizes are the difference between exercise and control conditions in standard deviation units (see text). The positive effect sizes mean exercise was superior.

The  $P$  value for the global test was 0.013. The  $P$  value has a standard interpretation except that it gives the probability of the four consistent effects (of this size or larger) arising by chance (under the no difference hypothesis). Global effect size = .87.

included these patients as they were assigned (intention-to-treat analysis). When they were eliminated from analysis, the results were slightly more positive in favor of the exercise intervention and the  $P$  value was slightly reduced.

Various covariance structures were modeled, and they demonstrated little difference regarding the effect sizes in Table 2. No evidence of change in the effectiveness of exercise after 3 and 6 months was found. Because of the complexity of crossing controls after the 6-month measurement, we decided to check the results by ignoring measurements at 9 and 12 months. This analysis simplified the design to the common parallel groups design, ie, to a simple exercise versus control group comparison at 3 and 6 months. This yielded very similar effect sizes to the analysis of the full data set: TUG = 0.38, PPT = 0.42, Berg = 0.27, and MMSE = 0.58 (compare with Table 2). The global test  $P$  value for this reduced data set increased to  $P = 0.057$  because of the lower precision of the reduced data. Because of the strong results for MMSE and its distinction from the other variables, we performed another global test for TUG, PPT, and Berg without the MMSE. The  $P$  value increased to 0.068.

Thirteen percent of repeated measurements after baseline were missing because of death or patient inability to perform the test because of acute illness. Note that only one resident (a member of the exercise group at 10 months) died during follow up. This low mortality is likely a function of the screening process at baseline.

Table 3 provides results for raw change from baseline to 6 months by group. Note that for all four measures, the exercise

**Table 3.** Raw Change from Baseline to 6 Months for Exercise and Control Groups

	Exercise	Control	Exercise – Control	Standard Error
TUG* (sec)	–18	+5.5	–24	18
PPT	1.2	–1.6	2.7	1.4
Berg	–.6	–5.9	5.3	5.1
MMSE	2.0	–2.2	4.2	1.8

Global test,  $P = 0.02$ .

\* Negative value better for this test.

change was superior to controls. Again for sensitivity analysis, we performed a global test on this simple change data, and it proved to be significant also ( $P = 0.02$ ). This raw change analysis is equivalent to a repeated measures time x group interaction test but is less efficient than using baseline measures as covariates (the approach used above).<sup>35</sup>

## DISCUSSION

Exercise for the elderly is increasingly recognized as an important tool to postpone disability or improve function.<sup>36,37</sup> Some strength training studies have found that the most frail seem to derive the greatest benefit from exercise.<sup>19,38,39</sup> This pilot study has demonstrated that frail elderly residents in a LTC facility were able to participate routinely in a group strength and flexibility program. There were no injuries sustained in the program. The exercise group had significant improvements in overall function as compared with those residents participating in a recreational therapy group. The improvement in function was consistent across each test used.

This study adds to the body of literature that suggests frail, institutionalized elderly can participate and benefit from a strength and flexibility training program. Only three prospective randomized controlled trials have evaluated the effectiveness of strength training exercise groups in LTC facilities. All three studies found improvement in muscle strength or mobility and function in the groups that received the strength training, which is consistent with our study. The first two controlled studies conducted with the frail elderly in “rest homes” did use strength training groups and found functional improvement after 7<sup>40</sup> or 12 months<sup>41</sup> of exercise, but details of the exercise program were not provided. A more recent randomized controlled trial was conducted with 68 residents recruited from five LTC facilities in Canada.<sup>42</sup> The control group was a seated range of motion exercise group. Both groups exercised for 45 minutes three times per week for 4 months. Significant improvements in mobility, balance, and hip strength were seen in the exercise group at the end of 4 months. The exercise equipment (therabands and soft weights) and functional assessment tools used (TUG and Berg Balance) were similar to our study. However, their exercise groups included standing strength and balance exercises and walking. The average TUG score at baseline for the exercise group in the Canadian study was fairly good at 22 seconds, whereas our average TUG score at baseline was 45 seconds. It has been well validated<sup>24</sup> that individuals with a TUG score greater than 30 usually have some impairment in their activities of daily living. Baseline FIM for our exercise group was 91 out of 126, whereas the exercise group in the Canadian study had a baseline FIM of 114. It is notable that dealing with the more frail population at baseline, functional benefits were still derived from exercise in our study. It is difficult to directly compare the magnitude of the results of our study with the Canadian study because there are many different variables, both in the study design and follow-up. There are several studies that have found that individuals with the poorest performance at baseline had the greatest improvement with resistance exercise.<sup>19,29</sup>

The Folstein MMSE was administered at baseline and

follow-up to assure that the exercise and control group were similar and to evaluate whether exercise had any effect on cognitive function. The Folstein was developed as a screening tool rather than an outcome measure, and its sensitivity to change is variable.<sup>43</sup> However, it is very interesting that the exercise group had a significant increase in MMSE scores. Most of the exercise studies in institutional studies did not look at cognition as an outcome. One similar study that did evaluate a change in MMSE after strength training found no significant change.<sup>18</sup> Only three large-scale prospective studies have been done to evaluate this question. One of these studies found no association between cognitive function and physical activity,<sup>44</sup> but two of these studies did report less cognitive decline in the most active elderly people.<sup>45,46</sup> The most recent of these studies used the MMSE as its outcome measure and found, even with only moderate physical activity, there was less cognitive decline than with sedentary individuals.<sup>46</sup> Some of the improvements seen in our study could have been related to the mental stimulation provided during exercise sessions or improvement in affect rather than the exercise *per se*. Because 50% of the study group had an MMSE  $\leq 21$ , it was difficult to screen for depression with a questionnaire. The recreational control group also had mental stimulation, but this group had poorer attendance. Clearly, the effect of exercise on cognition requires further study.

There are several limitations to this current study. The biggest limitation is the small numbers studied. However, the overall intervention effect was significant and consistent across all measures. The measure with the smallest effect size was the Berg balance scale. This is not surprising because the exercise program did not train directly for balance. The strength training provided in the study may have had an indirect impact on balance. The improvement of the TUG may have been affected by improved chair rise times, and any future studies should measure this separately. Given the characteristics of the study group, we believe the results can be generalized to frail, cognitively impaired LTC residents with deconditioning who are ambulatory with caregiver assistance. Because we selected out the higher functioning residents of the NH, this study may be more representative of the AL population. Attendance was the only measure used to reflect the intensity of strength training, and it was high at 80%. Some of the participants did progress with training as evidenced by the fact that 60% of the residents progressed to a heavier grade theraband. The more mobile patients may have benefited more if their self-paced chair exercises were complemented with an ambulatory balance and strengthening regimen.

Strength training exercise therapy is a tool underused by physicians directing the multidisciplinary care of the frail elderly. A survey conducted in nursing homes in Canada<sup>42</sup> found that most nursing homes provided range of motion exercise but not strength training. Participation in these programs by the residents was only 10 to 15%. If a proactive approach is not taken toward promoting physical activity in LTC facilities, most residents who were able to ambulate independently will spend most of their time either lying down or sitting.<sup>47</sup> Inevitably this will lead to deconditioning, func-

tional status decline, falls, and poorer hospital outcomes. A slight increase in resident function may seem insignificant, but any therapeutic intervention that assists and maintains minimal mobility could decrease the risk of pressure ulcers and contractures and allow residents to assist more with transfers and walking short distances. Residents with better function can participate in more activities with a better quality of life.

Implementing a strength training program at a LTC facility is not cost prohibitive. The average cost of an exercise physiologist ranges between \$40 to \$60 per hour. When a strength training program is first implemented, their services would be needed 3 hours per week. Once staff at the LTC facility are adequately trained (after 1–2 months), the exercise physiologist could function as a periodic consultant to provide different exercise routines and evaluate residents for progress.

## CONCLUSION

Frail elderly in a LTC facility benefited from a strength training program that can be designed by an exercise physiologist using low-cost equipment. The advantage of such a program is that it provides not only a recreational activity for the resident but also therapeutic benefits. With a burgeoning elderly population, any program that can slow functional decline and potentially improve independence and quality of life could have a significant public health impact. Additional larger scale studies of strength training in LTC facilities (including AL) are needed to determine the ideal frequency, duration, and maintenance for subgroups of residents at different stages of decline or dysfunction.

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