

A Randomized Controlled Trial of Weight-Bearing Versus Non-Weight-Bearing Exercise for Improving Physical Ability After Usual Care for Hip Fracture

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ABSTRACT. Sherrington C, Lord SR, Herbert RD. A randomized controlled trial of weight-bearing versus non-weight-bearing exercise for improving physical ability after usual care for hip fracture. *Arch Phys Med Rehabil* 2004;85:710-6.

Objective: To compare the effects of weight-bearing and non-weight-bearing home exercise programs and a control program on physical ability (strength, balance, gait, functional performance) in older people who have had a hip fracture.

Design: Randomized controlled trial with 4-month follow-up.

Setting: Australian community-dwellers (82%) and residents of aged care facilities who had completed usual care after a fall-related hip fracture.

Participants: One hundred twenty older people entered the trial, 40 per group (average age \pm standard deviation, 79 ± 9 y) and 90% completed the 4-month retest.

Intervention: Home exercise prescribed by a physical therapist.

Main Outcome Measures: Strength, balance, gait, and functional performance.

Results: At the 4-month retest, there were differences between the groups in the extent of improvement since the initial assessment for balance ($F_{10,196}=2.82$, $P<.001$) and functional performance ($F_{6,200}=3.57$, $P<.001$), but not for strength ($F_{12,190}=1.09$, $P=.37$) or gait ($F_{8,200}=.39$, $P=.92$). The weight-bearing exercise group showed the greatest improvements in measures of balance and functional performance (between-group differences of 30%–40% of initial values).

Conclusions: A weight-bearing home exercise program can improve balance and functional ability to a greater extent than a non-weight-bearing program or no intervention among older people who have completed usual care after a fall-related hip fracture.

Key Words: Exercise therapy; Hip fractures; Physical therapy; Rehabilitation.

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FALLS AND FRACTURES in older people are of major public health significance. One in 3 older people experience 1 or more falls each year¹ and about 1 in six 50-year-old Western women will have at least 1 hip fracture before they die.² It is estimated that by 2050 the total global cost of hip fractures will be \$131.5 billion annually.³ Unfortunately, outcomes after hip fracture are often poor.⁴

Despite such poor outcomes, few clinical trials have investigated medium to long-term rehabilitation strategies after hip fracture. In a study of home exercise among 42 people 7 months after hip fracture,⁵ we found greater improvements in quadriceps strength, weight-bearing ability, and walking speed in those who completed a daily weight-bearing home exercise program than in a no-intervention control group. However, another study, by Tinetti et al,⁶ found a program of systematic home-based physical and functional therapy⁷ to be no more effective than the usual home-based rehabilitation intervention after hip fracture.

In addition to the paucity of research into the subject, there is also a lack of consensus among researchers and clinicians about which exercise regimen is best for older people after hip fracture. Traditionally, non-weight-bearing bed exercises have been prescribed.⁸ However, it has been argued that rehabilitation exercise is most effective when it is closely related to the particular task that it is intended to improve (eg, standing up, walking, stair climbing).⁹ This argument is based on evidence that the training response is specific to the method of training employed.¹⁰ Exercise conducted in a weight-bearing posture (ie, standing) would be more relevant to daily tasks.

To address these issues, we conducted a randomized controlled trial that compared the effects of weight-bearing and non-weight-bearing home exercise programs and those of a no-intervention control program among older people who had completed usual care after a fall-related hip fracture.

METHODS

Participants

One hundred twenty older people participated in the study. The average age \pm standard deviation (SD) of subjects was 79 ± 9 years (range, 57–95y). Eighty-two percent of the sample lived in the community and the remainder lived in low- or high-care residential aged care facilities. Ninety-six subjects (80%) were women.

Subjects were recruited through 6 hospitals in Sydney, Australia. Depending on the hospital, subjects were identified during visits to orthopedic and rehabilitation wards, from lists provided by medical records departments, and through information provided by ward staff. Subjects were excluded if they were unable to complete the assessments or the home-exercise program because of (1) severe cognitive impairment, (2) medical conditions, or (3) complications from the fracture resulting in delayed healing and associated weight-bearing restrictions. Subjects who did not meet the inclusion criteria were identified through face-to-face or telephone interviews with them and/or

their caregivers and by information provided by hospital and/or aged care facility staff.

Ethics approval was obtained from the South Western Sydney Area Health Service Research Ethics Committee, the Hope Healthcare Ethics Committee, and the Central Sydney Area Health Service Ethics Review Committee. Informed consent was obtained from all subjects before their participation.

Assessment Procedure

Structured interviews and physical assessments were done in subjects' homes before the intervention, and 1 month and 4 months after the initial assessment. The first author and 2 other physical therapists conducted assessments. Assessors were not blinded to group allocation. With few exceptions, the same assessor conducted all 3 assessments for a particular subject. To maximize standardization between testers, several training sessions were held and a measurement protocol was followed. Footwear was standardized across the 3 assessments. Each assessment took approximately 45 minutes.

Measurement Tools

Strength. The maximal voluntary strength of the knee extensor muscles was tested using a strap with a spring gauge.¹¹ Subjects sat on a tall chair with a strap around the leg 10cm above the ankle joint. The hip and knee joints were at 90° angles. In 2 trials, the subject attempted to pull against the strap assembly with maximal force for 2 to 3 seconds, and the greater force was recorded.

A hand-held dynamometer¹² (positioned 5cm proximal to the malleoli) was used to measure isometric force generation of the hip abductor and hip flexor muscles. Subjects lay supine on a plinth with the hips in the anatomic position. Again, 2 attempts were made for each test and the higher value recorded.

Lateral step-up ability was measured with the subject standing. With both feet adjacent, the subject placed 1 foot onto a 10-cm block and attempted to lift the other leg off the ground. The subject's need for support was documented on a 5-point scale (unable, required assistance from another person, required 2 hand supports, required 1 hand support, required no hand support). Although this procedure has previously been described as part of an exercise program⁵ and is used clinically to evaluate patient performance, its use as a measurement tool has yet to be investigated.

Balance. Postural sway was measured with the subject standing on the floor and on a 7-cm medium-density foam rubber mat, using a portable sway meter as described elsewhere.¹¹ Total sway path over 30 seconds was measured in millimeters.

Functional reach,¹³ the distance a subject can reach forward without moving the feet, was measured in centimeters using a retractable tape measure. Two attempts were completed and the better effort was recorded.

The step test,¹⁴ which measures the number of times that a subject can step up onto a 5-cm block without hand support in 15 seconds, was assessed for each leg. For this test, the subject stood in front of the block and placed the whole of 1 foot up onto and then down off the block repeatedly.

Gait. Measures were first taken while the subjects walked 6m at their usual comfortable pace with the least supportive aid that the examiner judged to be safe. Time taken was recorded with a stopwatch. Walking aid used and the number of steps taken were also recorded. Subjects then walked 6m as quickly as they could, and the same measures were repeated.

Functional performance. The Physical Performance and Mobility Examination¹⁵ (PPME) involves measures of bed

mobility, transfer skills, multiple stands from a chair, standing balance, step-up ability, and ambulation. Assistance and time taken for each category are quantified, and each is scored on a 3-point scale (high pass, 2; low pass, 1; fail, 0). The maximum possible score is 12. The time taken to stand up from and sit down on a 45-cm chair 5 times and to move from lying to sitting over the side of a bed were also recorded.

Self-report. The structured interview obtained information on the following measures: self-rated fall risk, balance, health, quality of night-time sleep, pain, mobility and activity levels, and impairments relating to activities of daily living (ADLs).

Intervention

The study design involved 3 groups, a weight-bearing home exercise (WBE) group, a non-weight-bearing home exercise (NWBE) group, and a control group. At their first appointments, subjects were allocated to groups using assignments sealed in opaque envelopes. The randomization schedule was produced with a random number table, with subjects being randomized to groups in blocks of 6.

The WBE group did its exercises in weight-bearing positions. This program has been implemented in several Sydney hospitals, where it has been modified from programs used for rehabilitation after stroke.^{9,16} The exercises were: sit-to-stand (repeated stands from a chair or adjustable-height exercise plinth), lateral step-up (as described in the testing procedure), forward step-up-and-over (stepping onto a block with both legs and down off it again), forward foot taps (tapping 1 foot up onto a block while supporting the weight on the other leg), and a stepping grid (stepping in different directions as guided by marks on the floor). These exercises were initially conducted with tables, chairs, or walking aids used for support. The exercises were progressed by increasing the number of repetitions, lessening the hand support, increasing the height of the blocks, or decreasing the chair height.

The NWBE group carried out all exercises in a non-weight-bearing (supine) position as commonly prescribed after hip fracture.^{8,17} These exercises were: hip abduction (sliding the straight leg out to the side), hip flexion (lifting the straight leg), hip and knee flexion and extension (sliding the heel toward the buttock by bending the hip and knee), end of range knee extension (straightening the bent knee over a wedge), and ankle dorsiflexion and plantarflexion. The exercises were progressed by increasing the number of repetitions.

For the exercise groups, a physical therapist prescribed the exercise program based on predetermined guidelines, after conducting the initial assessment. One to 5 of the 5 exercises were chosen and the number of repetitions suggested was based on the subjects' performance of the exercises. Subjects were provided with line drawings of the exercises and asked to complete the program daily and to record the number of repetitions completed. Participants in the WBE group were provided with 1 or 2 blocks (5-10cm thick) to use for the step-up exercises. A follow-up visit was made 1 week later to assess performance of the exercises, to provide feedback on performance, and to revise the suggested repetitions. At 1- and 4-month follow-up assessment visits, exercise performance was also assessed, more exercises were prescribed, and the number of repetitions was increased if the subjects felt that they could do more.

The control group did not receive any interventions.

Statistical Analysis

Data were analyzed with multivariate general linear models. Each model assessed the effects of intervention on the differ-

Table 1: Demographic, Health, Disability, and Mobility Characteristics of Intervention and Control Groups at Preintervention Assessment

Characteristics	Weight-Bearing Exercise (n=40)	Non-Weight-Bearing Exercise (n=40)	Control (n=40)
Mean age (y)	80.1±7.5	79.1±8.9	77.2±8.9
Female	30 (75)	31 (78)	34 (85)
Community-dweller	31 (78)	34 (85)	33 (83)
Mean days since fracture	153.9±50.2	158.5±55.7	145.7±45.5
Left-sided fracture	19 (48)	24 (60)	23 (58)
Pain from fracture: mild or less	32 (80)	30 (75)	34 (85)
Mean medications taken	4.1±2.6	4.9±3.5	3.7±2.3
Mean illnesses reported	2.8±1.6	3.0±2.0	3.3±2.2
Health: excellent or very good	14 (35)	15 (38)	11 (28)
Balance: always steady	9 (23)	11 (28)	15 (38)
Fall risk: low	16 (40)	16 (40)	16 (40)
Falls in past 12mo: >1	17 (43)	8 (20)	14 (35)
Mental status: intact	28 (70)	31 (78)	31 (78)
Sleep quality: good or very good	21 (53)	21 (53)	15 (38)
Mean Katz ADLS score ²³	3.2±2.0	3.1±2.4	3.2±2.5
Undertakes sport	1 (3)	4 (10)	3 (8)
Walks for exercise	17 (43)	18 (45)	20 (50)
Able to do heavy housework	10 (25)	11 (28)	13 (33)
Able to climb flight of stairs	23 (58)	28 (70)	24 (60)
Able to walk 800m	16 (40)	20 (50)	21 (53)
Hours on feet per day: >4	17 (43)	22 (55)	23 (58)
Indoor walking: unaided	14 (35)	20 (50)	19 (48)
Outdoor walking: unaided	4 (10)	9 (23)	5 (13)
Mean FAC score ²⁴	4.4±0.9	4.6±0.6	4.3±0.7

NOTE. Values are mean ± SD or n (%).

Abbreviations: FAC, Functional Ambulation Categories; Katz ADLS, Katz Activities of Daily Living Scale.

ences between the preintervention assessment and 1- and 4-month assessment performance on each of the 4 multivariate physical domains (strength, balance, gait, functional performance). Multivariate analysis of variance (ANOVA) discriminant function coefficients were then computed to assess the relative contribution of the domain variables to the significant results. Univariate analyses from the general linear model are also reported here. If they revealed significant between-group differences ($P < .05$), the Hochberg post hoc test¹⁸ was used to identify differences between pairs of groups.

Between-group comparisons were conducted for preintervention means and postintervention measures not covered by the multivariate analyses (ie, lateral step-up, walking aid use, self-report measures, time between assessments) using factorial (group × time) ANOVA for continuous measures, the Mann-Whitney *U* or Kruskal-Wallis tests for ordinal measures, and chi-square tests for dichotomous variables.

If continuous data were found to be skewed, logs of the scores were computed and statistical testing was carried out on the more normally distributed variables. For several variables, data for some subjects were unobtainable because of impaired performance. Where this occurred, the mean ± 3 SDs (in the direction of impaired performance) was used as the test value.

All available data were analyzed by initial group assignment (ie, an intention-to-treat approach). The analyses were performed using SPSS^a for Windows.

RESULTS

Preintervention: Subject Characteristics

Subject characteristics are summarized in table 1. There were no clinically important or statistically significant differences between the 3 study groups at the initial assessment.

Subject Adherence to Protocols and Experience of Exercise

All 120 subjects completed the initial assessment and 108 (90%) underwent at least part of the 1- and 4-month assessments. Figure 1 shows the proportion of subjects lost to follow-up at 4 months by group. In addition, 2 subjects at 1 month and 4 subjects at 4 months were unable to complete the entire physical assessment because of ill health. Subject numbers completing each test are shown in tables 2 through 5.

Statistical testing did not reveal any significant differences in the time between assessments for the 3 groups. The mean number of days between preintervention and 1-month assessments was 33.8±17.0 for the WBE group, 31.9±7.0 for the NWBE group, and 30.5±4.5 for the controls; and between the preintervention and 4-month assessments it was 120.5±12.9 for the WBE group, 119.4±7.7 for the NWBE group, and 118.9±9.4 for the controls.

There were no statistically significant differences in compliance with the exercise program between the subjects in the 2 exercise groups who had follow-up assessments, as determined by completion of exercise records and reports by the subjects. At 1 month, 85% of the WBE group and 89% of the NWBE group were doing the exercises at least 3 times weekly; at 4 months these figures were 69% and 73%. Data on actual number of repetitions completed (from subject exercise logs) were not analyzed because they were incomplete. There were also no statistically significant differences in subject reports of pain from the exercises (at 1mo, 15% of the WBE group and 16% of the NWBE group reported moderate or marked pain; at 4mo, these figures were 29% and 14%, respectively) or their perception of the usefulness of the exercises (at 1mo, 70% of the WBE group and 66% of the NWBE group reported mod-

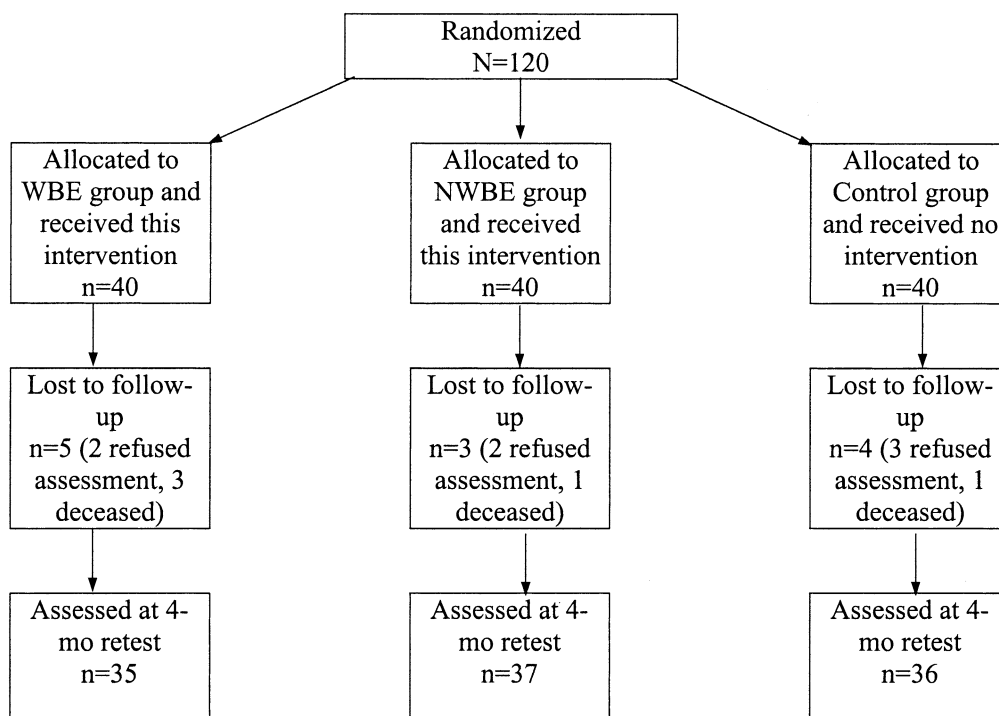


Fig 1. Flow of subjects through the study.

erate or marked usefulness; at 4mo, these figures were 71% and 76%, respectively). There was a trend indicating a difference between the groups for the perceived difficulty of the exercises at the 1-month assessment (15% of the WBE group and 8% of the NWBE group found the exercises difficult or very difficult; Mann-Whitney $U=429.5$, $z=-1.73$, $P=.08$), and a significant difference at the 4-month assessment (17% of the WBE group and 0% of the NWBE group found the exercises difficult or very difficult; Mann-Whitney $U=363.0$, $z=-2.50$, $P=.01$).

Effect of the Intervention on Physical Performance

Tables 2 through 5 show preintervention and 1- and 4-month assessment values for the continuous variables. Mean between-group differences and their 95% confidence intervals are reported in the table footnotes.

At the 1-month assessment, no differences were found between groups in the extent of improvement since the initial assessment for strength ($F_{12,198}=0.92$, $P=.53$), balance ($F_{10,200}=1.47$, $P=.15$), gait ($F_{8,204}=0.47$, $P=.88$), or functional performance ($F_{6,204}=2.03$, $P=.06$).

At the 4-month assessment, there were differences between the groups in the extent of improvement since the initial assessment for balance ($F_{10,196}=2.82$, $P<.001$) and functional performance ($F_{6,200}=3.57$, $P<.001$), but not for strength ($F_{12,190}=1.09$, $P=.37$) or gait ($F_{8,200}=0.39$, $P=.92$). The standardized discriminant function coefficients for the variables within the balance domain were $-.306$ for the step test on the affected leg, $-.449$ for the step test on the nonaffected leg, $-.662$ for functional reach, $-.397$ for sway distance on the floor, and $.092$ for sway distance on foam. For the functional performance domain, these values were $.852$ for timed sit-to-stand, $.273$ for timed supine-to-sit, and $-.210$ for PPME total score.

There were also statistically and clinically significant between-group differences for several ordinal variables. A

larger proportion of people from the WBE group became able to undertake the lateral step-up on the affected leg without hand support at 1 month (WBE, 30%; NWBE, 11%; control, 8%; $\chi^2=7.32$, $P=.03$) and on the nonaffected leg at 4 months (WBE, 30%; NWBE, 11%; control, 8%; $\chi^2=10.15$, $P=.006$). At 4 months, more people in the WBE group became able to walk unaided (WBE, 36%; NWBE, 6%; control, 14%, $\chi^2=20.02$, $P<.001$).

Effect of Interventions on the Self-Reported Measures

No differences between the groups were found for self-rated fall risk, balance, health, quality of night-time sleep, pain, activity levels, Katz Activities of Daily Living Scale, or Functional Ambulation Categories performance at either 1- or 4-month assessments.

DISCUSSION

This study found between-group differences for the domains of balance and functional ability but not for strength and gait, with the weight-bearing exercise group showing the greatest improvement. For the balance domain, the most important contributors to this effect were improved functional reach and step test abilities. This indicates that these subjects gained better control of their center of mass while reaching and while stepping, presumably because the exercises they undertook provided a greater challenge to the postural control system. No between-group differences were evident for improvements in postural sway, which has been shown to be an important risk factor for falling.¹⁹ However, performance on this test is variable, so improvements may be more difficult to demonstrate than on other balance measures used. Previous exercise programs that have led to improved postural sway have been supervised and of longer duration.²⁰ This program involved few visits to subjects and was also conservative in its challenges to the postural control system. Because the exercises

Table 2: Strength Between-Group Comparisons

Outcome by Group	Preintervention	1 Month	4 Months
Hip abduction affected leg			
WBE	47.8±29.8	55.7±28.1	57.9±27.9
NWBE	49.9±25.7	54.1±26.0	56.3±24.3
Control	46.1±26.0	52.4±25.4	53.0±28.0
Hip abduction nonaffected leg			
WBE	63.1±28.5	66.6±25.0	72.2±31.3
NWBE	61.4±29.1	65.9±27.0	68.8±27.2
Control	60.8±31.3	62.9±30.9	64.8±30.1
Hip flexion affected leg			
WBE	39.8±23.6	47.6±25.3	50.4±28.3
NWBE	38.8±21.2	45.8±24.8	49.3±23.1
Control	38.2±22.1	41.5±22.4	43.3±26.4
Hip flexion nonaffected leg			
WBE	52.9±23.9	57.9±24.9	60.8±29.4
NWBE	56.4±24.1	60.4±25.5	62.9±25.3
Control	53.4±26.2	59.1±26.5	55.3±26.7
Knee extension affected leg			
WBE	124.5±62.7	141.0±56.3	152.9±75.9*
NWBE	108.8±48.1	119.6±47.3	125.6±47.2
Control	106.4±53.8	113.4±61.0	112.9±73.0
Knee extension nonaffected leg			
WBE	146.6±71.2	162.9±70.0	172.0±79.6*
NWBE	146.9±61.4	153.3±68.5	152.2±60.3
Control	139.8±64.5	145.5±80.2	139.2±78.9

NOTE. Values are mean ± SD (N). Subject numbers at 1 month: WBE, n=33; NWBE, n=37; control, n=36; 4 months: WBE, n=32; NWBE, n=34; control, n=36. At 4 months, post hoc tests revealed differences between the control and WBE groups for knee extension strength for both the affected leg (mean difference, 31.8N; 95% confidence interval [CI], 9.5–54.0; $P=.02$) and the nonaffected leg (mean difference, 27.2N; 95% CI, 5.6–48.7; $P=.04$).

were carried out at home, often while the person was alone, safety was a prime consideration in exercise prescription.

The greatest contribution to the between-group difference in functional abilities resulted from improved sit-to-stand performance. The weight-bearing group improved the most on timed sit-to-stand. This indicates the potential of this exercise program to improve functional abilities that may have implications for an older person's ability to continue to live independently in the community. Each subcomponent of the PPME is measured on a 3-point scale, therefore, the lack of marked changes in the PPME score may indicate the poor sensitivity of the scale to smaller changes.

Multivariate analysis of the strength domain did not reveal significant between-group differences. However, the WBE group did show a greater improvement in knee extension strength and lateral step-up ability. Greater improvements in muscle strength may have resulted from programs that specifically targeted strength by overloading muscles in a more intense and structured manner. There was also a correlation between improvements in sit-to-stand ability and in knee extension strength for both the affected ($r=.28$, $P=.005$) and nonaffected ($r=.23$, $P=.02$) leg.

Although the multivariate analysis of the gait domain found no significant between-group differences, when compared with the other groups, more people in the WBE group were able to walk unaided at the 4-month retest. This suggests better walking ability and greater confidence while walking, despite no change in gait speed or stepping rate. It is possible that greater between-group differences in these gait parameters could have resulted if the WBE program had specifically targeted these factors. A more extensive WBE program could also include activities to prepare participants to deal with real-life environmental challenges, such as practice on ramps, stairs, and various surfaces.

The lack of between-group differences in the extent of improvement in self-reported measures of functional ability, general health, or activity levels indicates that the between-group differences discussed above were not perceived to have resulted in measurable effects on ability to perform everyday activities. This may reflect that self-reported functional outcomes may be difficult to change with exercise alone, because they are likely to be affected by psychosocial and environmental factors as well as by physical ability.²¹

Although weight-bearing exercise is less commonly used in current clinical practice than non-weight-bearing exercise, it was not associated with adverse effects in this study. No falls were reported while doing the exercises, and subjects did not report more pain while doing the weight-bearing exercise program than what was reported by subjects doing the non-weight-bearing program. Subjects in the exercise groups also had a comparable level of compliance with the prescribed exercise program, suggesting a similar acceptance of the exercises. Subjects in the weight-bearing group found the exercises moderately more difficult, which probably reflects the use of greater muscle forces and more muscle groups to gain and maintain the upright position required for the weight-bearing exercises. It is possible that the weight-bearing exercises had a greater effect on the physical outcome measures purely as a result of this greater level of difficulty.

This exercise program was conducted in the home, with little supervision from the physical therapists, so it was not possible to gather reliable information about the actual intensity of training, that is, the number of repetitions completed or the duration of exercise sessions. As a result, we cannot provide information about the amount of practice required to produce the improvements in motor function that were found.

Table 3: Balance Between-Group Comparisons

Outcome by Group	Preintervention	1 Month	4 Months
Step test affected leg (steps)			
WBE	7.0±5.4	10.0±6.4*	11.0±6.3*
NWBE	7.7±7.1	8.3±7.3	9.4±6.7
Control	8.3±6.5	9.4±7.0	9.0±7.3
Step test nonaffected leg (steps)			
WBE	7.8±5.2	11.4±6.0*	11.7±5.9*
NWBE	7.6±5.8	8.7±6.5	9.1±5.8
Control	8.9±6.3	10.3±6.4	9.9±7.2
Functional reach (cm)			
WBE	17.5±6.8	21.0±9.0	24.8±8.8*
NWBE	18.4±9.1	18.7±7.4	19.9±8.1
Control	17.8±8.7	19.9±9.0	19.4±10.0
Sway distance floor (mm)			
WBE	76.4±45.8	78.8±47.7	79.0±46.0
NWBE	75.9±53.6	81.3±53.1	70.0±52.8
Control	90.3±50.3	89.2±54.4	89.8±59.9
Sway distance foam (mm)			
WBE	136.6±81.2	128.5±80.5	115.7±73.3
NWBE	146.3±108.1	142.5±111.2	122.0±84.1
Control	143.5±95.6	128.8±85.2	129.0±79.4

NOTE. Values are mean ± SD. Subject numbers at 1 month: WBE, n=33; NWBE, n=37; control, n=36; 4 months: WBE, n=33; NWBE, n=35; control, n=36.

* $P < .05$. Univariate tests of between-group differences on change scores. At 4 months, post hoc tests revealed differences between the WBE and control groups for the step test on both the affected leg (mean difference, 2.8 steps; 95% CI, 0.9–4.8; $P = .01$) and the nonaffected leg (mean difference, 2.6 steps; 95% CI, 0.9–4.7; $P = .008$) and for the functional reach (mean difference, 5.9cm; 95% CI, 2.1–9.6; $P = .004$) and between the WBE and NWBE groups for the step test on both the affected (mean difference, 2.9 steps; 95% CI, 0.9–4.8; $P = .01$) and nonaffected legs (mean difference, 3.1 steps; 95% CI, 1.3–4.8; $P = .003$) and for the functional reach (mean difference, 7.1cm; 95% CI, 3.4–10.9; $P = .001$).

Nineteen percent of subjects in the exercise groups who underwent the final assessment were not doing the prescribed exercises at that time. This compliance rate is consistent with other exercise intervention studies²² and is not surprising, because no contact was made with the subjects between the 1- and 4-month assessments. A program that incorporated more visits or follow-up phone calls might have produced a higher compliance rate. A more intense program might also have led to greater between-group differences in the outcome measures.

The WBE program was designed to reflect the way muscles work during daily weight-bearing tasks, such as standing up,

walking, reaching, and stair-climbing. Larger improvements for the WBE group were found for the measures that reflected daily task requirements (functional reach, step test, sit-to-stand ability, walking aid use, and step-up ability); there were no measures in which the NWBE group improved more than the weight-bearing group. It therefore appears that exercises that more closely approximate daily functional tasks are a better choice for this population.

The external validity of this study is likely to be high. Subjects were representative of those with fractured hips, people with a wide range of ages (57–95y) were included, and

Table 4: Gait Between-Group Comparisons

Outcome by Group	Preintervention	1 Month	4 Months
Time to walk 6m at comfortable pace (s)			
WBE	14.3±10.0	12.3±9.0	11.8±9.2
NWBE	15.9±13.2	14.2±11.4	13.2±12.9
Control	14.2±10.9	13.3±12.1	13.2±11.7
No. of steps taken in 6m at comfortable pace			
WBE	19.3±10.1	18.7±10.8	18.3±11.0
NWBE	17.6±6.4	17.0±5.2	17.3±7.1
Control	17.1±8.8	17.7±11.1	17.2±9.4
Time to walk 6m at fast pace (s)			
WBE	10.4±8.6	9.2±8.4	9.2±9.1
NWBE	12.3±10.8	11.0±10.0	9.9±10.8
Control	11.2±10.2	11.9±15.7	11.0±11.6
No. of steps taken in 6m fast pace			
WBE	17.1±9.8	16.2±10.3	16.3±10.7
NWBE	16.1±5.8	15.6±5.3	15.7±6.0
Control	15.9±8.3	16.7±12.8	16.3±9.9

NOTE. Values are mean ± SD. Subject numbers at 1 month: WBE, n=33; NWBE, n=37; control, n=37; 4 months: WBE, n=33; NWBE, n=36; control, n=36.

Table 5: Functional Performance Between-Group Comparisons

Outcome by Group	Preintervention	1 Month	4 Months
Timed sit-to-stand ×5 (s)			
WBE	25.4±18.5	20.0±14.1	18.0±12.4*
NWBE	28.1±20.4	24.9±20.3	20.3±12.7
Control	21.7±12.8	22.5±21.8	23.2±15.4
Timed supine-to-sit (s)			
WBE	4.6±3.9	3.8±3.6	3.4±3.5
NWBE	6.8±8.7	5.4±5.5	5.5±9.2
Control	4.5±3.6	3.7±3.4	4.1±3.5
PPME total score			
WBE	9.4±2.1	10.2±2.3	10.3±2.3
NWBE	9.5±2.0	9.9±1.8	10.5±1.5
Control	9.8±1.8	10.2±1.7	10.1±1.8

NOTE. Values are mean ± SD. Subject numbers at 1 month: WBE, n=33; NWBE, n=37; control, n=34; 4 months: WBE, n=33; NWBE, n=36; control, n=36.

* $P<.05$. Univariate tests of between-group differences on change scores. At 4 months, post hoc tests revealed differences for timed sit-to-stand between the WBE and control groups (mean difference, 8.1s; 95% CI, 3.4–12.8; $P<.001$) and between the NWBE and control groups (mean difference, 5.8s; 95% CI, 1.2–10.5; $P=.02$).

there were few exclusion criteria. In addition, subjects were recruited from several hospitals, both public and private care, and from several different settings (orthopedic wards, rehabilitation wards, physical therapy departments). The subjects had received several different treatment approaches before entering the study and represented a range of socioeconomic and ethnic backgrounds.

CONCLUSIONS

This study indicates that a home-exercise program with limited supervision can be of benefit after hip fracture. Weight-bearing exercise produced greater improvements than non-weight-bearing exercise or no exercise, particularly in balance and functional performance. All participants had completed the usual postfracture care, so it is evident that they had the potential for further improvements in physical functioning, particularly with a weight-bearing exercise program.

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