ORIGINAL ARTICLE

Feasibility and Outcomes of a Home-Based Exercise Program on Improving Balance and Gait Stability in Women With Lower-Limb Osteoarthritis or Rheumatoid Arthritis: A Pilot Study

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ABSTRACT. Williams SB, Brand CA, Hill KD, Hunt SB, Moran H. Feasibility and outcomes of a home-based exercise program on improving balance and gait stability in women with lower-limb osteoarthritis or rheumatoid arthritis: a pilot study. Arch Phys Med Rehabil 2010;91:106-14.

Objective: To evaluate the feasibility and gait stability and balance outcomes of a 4-month individualized home exercise program for women with arthritis.

Design: Pre-post interventional study.

Setting: General community.

Participants: Women (N=49) (volunteers) with lower-limb osteoarthritis or lower-limb rheumatoid arthritis were enrolled. Only 39 subjects were eligible and completed the study.

Intervention: After completion of the initial assessment, all participants received home balance exercises from an experienced physiotherapist based on assessment findings and exercises available from commercially available kits. All measures were repeated 4 months later.

Main Outcome Measures: Falls risk (Falls Risk of Older People—Community Setting) and balance measures.

Results: Thirty-nine women (mean age, 69.3y; 95% confidence interval, 65.7–72.9) completed the 4-month program. At baseline, 64% of participants reported falling in the preceding 12 months, and the average falls risk (Falls Risk of Older People—Community Setting) score was 14.5, with 42% rated as moderate risk (16–23). Participants achieved improved performance on most balance and related measures after the exercise program, including falls risk (P=.01), activity levels (P=.015), fear of falling (P=.022), functional reach test (P=.001), rising index for sit to stand (P=.001), step width in walking (P=.001), and body mass index (P=.006).

Conclusions: An individualized balance training home exercise program is feasible for older women with osteoarthritis or rheumatoid arthritis and may improve stability during walking and other functional activities.

Key Words: Arthritis; Exercise; Postural balance; Rehabilitation.

ARTHRITIS IS THE MOST common chronic condition causing severe long-term pain and physical disability in the Australian community, affecting 14% of the total population in 2001.[1] The prevalence of arthritis increases with age. In 2001, the condition was reported by 43% of people age 65 to 74 years and over half (52%) of people age 75 years and over.[1]

Arthritis includes a range of conditions. Two of the most common forms are OA and RA. OA is characterized by joint pain and impairment of joint mobility. It is associated with loss of joint cartilage and changes in underlying bone surfaces, often accompanied by trauma or degenerative changes. It is the leading cause of pain and disability in the community, is associated with substantial loss of quality of life, and is the predominant condition leading to joint replacement surgery of the hip and knee.[2] OA is the third largest contributor to life-years lost because of disability, with 4.8% of total life lost because of disability.[3] The incidence of OA is higher among women than men among all age groups.[4] RA is a chronic autoimmune disease associated with chronic joint inflammation that leads to progressive joint damage and often, severe disability. The etiology of RA is unknown, and it occurs in approximately 1% of the population worldwide.[4] Approximately twice as many women as men are affected by RA.[4]

Falls and associated injuries are common and are costly to both the older person and the wider community.[5] Approximately 1 in 3 people age over 65 years living in the community fall each year.[5] Arthritis has been reported as a risk factor for falls.[6-10]

An important risk factor for falls is balance impairment.[5] A number of studies have reported balance impairment in people with arthritis.[11-16] The benefits of exercise in arthritis management have been widely reported;[17-20] however, most of this research has involved exercises to improve strength and flex-

List of Abbreviations

BMI	body mass index
CI	confidence interval
FROP-Com	Falls Risk of Older People—Community Setting
OA	osteoarthritis
RA	rheumatoid arthritis
VAS	visual analog scale
WOMAC	Western Ontario and McMaster Universities Osteoarthritis Index

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ibility and reduce pain. Most interventions reported in the recent Cochrane review by Fransen and McConnell[17] on exercise for knee arthritis are lower-limb muscle strengthening and walking/aerobic exercise programs.

In nonarthritic populations, the benefits of exercise programs targeting balance performance are well established.[21-23] However, in clinical practice, most common management for hip and knee OA is mobilizing and strengthening and does not appear to incorporate balance assessment and balance training exercise routinely as a management option for people with lower-limb arthritis. Few studies have evaluated the effectiveness of balance exercises specifically in people with arthritis.[24,25] These studies found that a short period of balance exercises (8 and 6 weeks, respectively) improved functional capacity of participants. These studies included participants with knee OA. A limited range of balance assessment tools was used. Both studies had a strong focus on proprioceptive function, although Sekir and Gur[25] did measure static standing in various foot positions and visual inputs. In contrast, the present study focused primarily on balance performance, falls risk, and falls-related measures as well as gait measures.

There is a need for research evaluating whether an exercise program of an appropriate length (4 months, which is considered short-term exercise[26]) targeting balance performance is feasible and able to achieve positive outcomes with a sample of people with arthritis (a highly prevalent condition) to support the wider use of balance retraining in this clinical group.

METHODS

Ethics approval for the pilot study was obtained through the Melbourne Health Human Research Ethics Committee, and all participants provided informed written consent.

Participants

Participants were women with lower-limb OA or lower-limb RA. They had a disease diagnosis of RA or OA based on the criteria set for each disease by the American College of Rheumatology.[27,28]

Participants were excluded if they (1) did not have lower-limb arthritis, (2) were bed-bound, (3) had Parkinson disease, stroke, multiple sclerosis, history of cardiac syncope, or epilepsy, (4) had undergone lower-limb surgery within the previous 12 months, and/or (5) had intra-articular viscosupplementation or a corticosteroid injection within the last 6 months.

Participants with lower-limb arthritis were recruited from public hospitals and private rheumatology clinics. Rheumatologists at participating clinics were provided with details of inclusion and exclusion criteria for the project. Patients attending a participating clinic appointment who met the inclusion criteria were asked by the clinic staff whether they were interested in participating in the project, and if so, whether their contact details could be forwarded to the research team to discuss the project further. Potential participants were then contacted by a member of the research team by phone for further screening, and if suitable and happy to participate, were invited to attend the National Ageing Research Institute Gait and Balance Laboratory for a baseline assessment. Participants were undergoing treatment as prescribed by their rheumatologist or general practitioner. Participation in the study did not limit changes to drug regimens/treatments occurring during the study.

Assessment Tools

The following assessment tools were administered at baseline and after 4 months of the exercise intervention, with the same physiotherapist performing both assessments.

Falls risk. Falls risk was assessed with the FROP-Com assessment tool,[a,29] which consists of 13 falls risk factor domains, with most risk factors scored to reflect graded risk on a 4-point scale (nil, mild, moderate, or severe). A higher score reflected a greater level of falls risk. Three falls risk scores are reported. The first is a full profile with home environment score and falls in the last 12 months included. Although the initial baseline assessment was undertaken at the National Ageing Research Institute Gait and Balance Laboratory, the physiotherapist completed the home environment score when attending the participant's home at the first intervention visit (within 1 week of baseline). For the pre-post comparison of FROP-Com scores, data for the "falls history" item were modified to include only falls in the preceding 4 months at both measurement occasions. Because a home assessment was not conducted at follow-up, this second falls risk score presented includes all FROP-Com items except the "home environment safe" factor. The third falls risk score reported has removed the physical activity component to determine whether falls risk changes were not a result of addition of exercise alone. The maximum possible overall score is 60 without the "home environment safe" item, and 57 for the analysis without the "home environment safe" and physical activity items (63 for full test). In a previous study, a sample of community older people with no falls in the past 12 months scored an average of 8 on the FROP-Com, while a group of persons who presented to a hospital emergency department after a fall scored an average of 26.[30]

Balance measures. Balance is multidimensional, and a comprehensive assessment requires use of a number of different types of balance tasks and conditions.[31,32] For this study, both clinical measures and force platform measures were selected to evaluate domains of balance responsive to change with the exercise intervention.

The following clinical balance measures were used. Participants were given 1 trial for practice of each task, and then subsequent trials were recorded.

In the Clinical Test of Sensory Interaction on Balance (first 4 components),[33] participants were tested with feet shoulder-width apart, and performance was timed up to 30 seconds. Timing was stopped if participants required steadying, moved their feet, or opened their eyes in an eyes-closed task. The 4 conditions tested were eyes open or closed on either a stable (firm) or foam surface. Only results from the fourth (most challenging) condition, eyes closed on a foam surface, were analyzed because there was a ceiling effect for the first 3 conditions.

In the Functional Reach Test,[34] participants stood next to a wall unsupported with their feet a comfortable distance apart and their dominant arm raised to 90° shoulder flexion. They were asked to reach as far forward as possible without overbalancing. Overbalancing was defined as needing to take a step, requiring hands-on assistance to maintain balance, or needing to lean against the wall. The distance of additional reach was recorded (cm).

In the Step Test,[35] the number of times participants could step 1 foot fully on and then off a 7.5-cm-high block step in 15 seconds was recorded. Each leg was tested separately, and performance on the side with a poorer score (worse) is reported.

The following force platform measures were used:

The NeuroCom Balance Master (long plate)[b,36] was used to assess balance during several functional tasks. Performance was assessed in the appropriate stance position based on manufacturer recommendations for the participant's height. All

tasks were assessed with shoes removed. Retest reliability of the tests has been established.[37,38]

The limits of stability test using the NeuroCom Balance master is a dynamic standing balance test that measures participants' ability to voluntarily control weight shift in 8 directions. Feet were positioned apart at a distance determined by the manufacturer's guidelines based on the height of the participant. Instructions to the participant were to move as far toward a target set at 100% of their limit of stability (based on height) and to hold for 8 seconds. An average (composite) score was derived from the 8 trials. A safety harness was worn during testing but did not restrict trunk movement. The measures reported include reaction time, the time between the signal to move and the initiation of movement (seconds); and maximum excursion, the furthest distance traveled by the center of gravity away from upright stance (% limits of stability). Faster reaction times (lower scores) and larger maximum excursion (higher scores) indicated better performance.

To measure response to perturbations, participants stood on the Chattecx Balance System[c39] without shoes, with feet 12cm apart. A safety harness was worn during testing. Based on previous results, a test condition with the platform tilting rhythmically (8° amplitude, 8.3s/cycle) in an anteroposterior direction with a distracter task (counting backward by 3's from a randomly selected 3-digit number) was selected as the task that discriminated best between groups with mild falls risk.[40] The mediolateral amplitude of center of pressure adjusted for height (cm) is reported. Lower scores indicated better performance.

Leg muscle power measures. The sit to stand task on the NeuroCom Balance Master (long plate)[36] was used as an indicator (but not an absolute measure) of leg muscle power. Participants were instructed to stand as quickly as they could from being seated on a wooden box (41cm high) positioned on the forceplate to a standing position, without arm/hand assistance, and then to maintain a steady stance for 5 seconds. Three trials were conducted, and scores averaged. The reported parameters were (1) mean weight transfer time, time between the onset of the cue to move and the arrival of the center of gravity over the feet (seconds, lower scores indicated better performance); and (2) mean rising index, the amount of force exerted by the legs during the rising phase expressed as a percent of body weight. Higher scores indicated better performance.

Gait measures. The NeuroCom Balance Master (long plate)[36] was used to assess several gait measures. Retest reliability of the tests has been established.[37,38]

To measure stability during gait (step width, cm), participants were positioned approximately 1m before the start of the long plate (shoes removed), and when the test commenced, they walked at their comfortable pace across the long plate. Three trials were conducted, and scores were averaged.

To measure stability during turning, participants were positioned at the start of the long plate. They were asked to take 2 steps forward starting with the left foot, quickly turn 180° to the left, and walk back to the start location. The test was performed 3 times, then repeated starting with the right foot and turning to the right. Participants used their own method of turning (eg, pivot or stepping around). Mean turn-sway velocity is reported—the average distance travelled by the center of gravity during the turn expressed in degrees a second. Lower scores indicated better performance.

Clinical measures of gait were also used. Gait velocity[41] was assessed by timing participants walking at their "comfortable walking pace" along the central 6m of a 10-m walkway (m/min) using their usual indoor gait aid.

In the Timed Up and Go test,[42] participants were timed standing up from a chair (45cm), walking 3m with their usual gait aid at comfortable speed, turning, and then returning to sit in the chair (seconds).

Related measures. Related measures were also performed to further assess falls risk and the impact of arthritis on each participant's function.

- BMI was calculated (weight/height^2).
- Sites of lower-limb pain were documented, and the most severely affected joint was recorded.
- Number of falls in the past 12 (baseline) and past 4 months (baseline and postexercise) were assessed by retrospective recall.
- Lower-limb pain (average pain on movement over the previous week) was assessed using a 100-mm horizontal VAS.[43]
- Activity level was assessed using the Human Activity Profile.[44] This questionnaire evaluated 94 activities listed in hierarchical order of increasing energy expenditure. Items were self rated as "still doing," "have stopped doing," or "never did." The Adjusted Activity Score, calculated by subtracting the number of lower-numbered activities listed as "have stopped doing" from the highest numbered activity still being done, was reported.
- Falls self-efficacy was assessed using the Modified Falls Efficacy Scale.[45] This tool measured confidence in performing 14 activities without falling. Items were self-rated on a 0 to 10 scale where 10 was completely confident in performing the task without falling and 0 was not confident at all. Average Modified Falls Efficacy Scale score is reported.
- The WOMAC[46,47] was used for participants with OA only. It was used to assess the 3 dimensions of pain, joint stiffness, and disability. Lower scores indicated less pain, less stiffness, or less disability.

Intervention

After the baseline assessment, all participants were visited at home by an experienced physiotherapist for provision of an individualized home exercise program. Participants were asked to complete the exercises 5 days a week for 4 months. The balance, strengthening, and walking exercises were selected from the Otago exercise program[48] and the Visual Health Information Exercise Prescription Kits—Balance & Vestibular Rehabilitation set.[d] These exercise packages were chosen because they are readily available, they have the diversity of exercises required across a broad range of functional abilities, and the Otago program has evidence to support its effectiveness in improving balance and reducing falls.[48] Exercises were selected based on clinical judgment drawing on the results from the baseline assessment (table 1). Each participant was provided with an exercise folder that included a description, graphics and dosage of each exercise prescribed, and an exercise calendar for each month of the program. If an exercise weight was required, these were provided by the physiotherapist.

Depending on assessment findings, level of comorbidity, safety, and endurance, participants were provided with between 4 and 8 exercises (~20–30mins including rests) as well as a recommendation to walk in the community at least 3 times each week.

The physiotherapist reviewed the exercises at the home of the participant on 2 subsequent occasions—at approximately 4 and 8 weeks from the initial visit. Exercises were ceased,

Table 1: Exercise Prescription—List of Possible Impairments, Some Exercise Options and Strategies to Modulate the Difficulty of Exercises, Example

Possible Areas of Impairments in Baseline Balance and Mobility Performance	Exercise Options	The Following Options Were Used for Baseline, Modification, or Progression of Each Exercise
Reduced stability in standing Reduced control and coordination of movement Slow gait speed, reduced step length, and increased step width Slow or unsteady when turning when walking Difficulty standing from sitting Reduced forward reach Reduced stability with stepping forward Difficulty with standing stability with dual tasks Reduced lower limb strength	Warm-up exercises, eg, joint (cervical, thoracic, lumbar, ankle) mobility Strengthening exercises, eg, quadriceps, hip abductors with/without weights/functional Stretching exercises, eg, calf stretch Balance exercises Stability exercises, eg, calf raises, toe raises, tandem stance, single leg stance Control and coordination exercises Weight shift exercises, eg, backward walk, anterior posterior weight shift, tandem walk (forward and back), reaching, alternate stepping, marching Turning exercises Sit to stand exercises Walking exercise	With or without vision (eyes open, eyes closed) With or without visual fixation With or without head movements With or without arm movements With or without trunk movements Footwear changes Stance surface—stable or mobile, compliant or not Speed variations Dual tasks—cognitive, upper limb Dosage changes Frequency changes Resistance—use of weights Foot placement Use of upper limb support Chair height Time to hold steady or attempt to maintain balance Strategy use—ankle, hip, stepping, protective
Example: Reduced forward reach Exercise 1: Balance exercises—calf raises in standing without hand support, hold for 3s Made easier—use hands lightly on bench for support Made harder—turn head while rising Exercise 2: Weight shift exercises—move weight forward and back in rocking motion Made easier—do quickly with bench in front for confidence Made harder—do as slowly as possible holding at the extremes of movement with no support in front (have support for safety to the side)		

modified, or progressed as required. The exercise program was modified if participants found any exercises too easy (ie, their balance reactions were not being challenged) or too hard (ie, requiring excessive protective reactions [eg, hands on bench] to maintain balance) or complained of pain or difficulty when performing the exercises (see table 1). If a participant was using weights for an exercise, progression was made when the target repetition (10 repetition maximum) was met. Any change in the participants' medical or physical status was also considered in modification of the exercise program. Participants were educated in progression and modification of exercises to ensure appropriate exercise for the entire exercise period.

If participants were undertaking any type of exercises or physical activity prior to beginning the project, they were encouraged to continue that activity in addition to the home exercise program. Walking was an added exercise only if participants were not already undertaking a walking program. Participants were contacted by phone by a research assistant at approximately 11 and 13 weeks to support ongoing participation in the program. If required, further contact by the physiotherapist was provided between these phone contacts.

The duration of the intervention was 4 months. Although this is considered short-term exercise,[26] it is similar to other studies looking at the benefit of exercise as an intervention in an arthritis population.[17] Most interventions reported in the Cochrane review by Fransen and McConnell[17] on exercise for knee arthritis were 8 to 24 weeks. The timeframe of 4 months is a reasonable time to achieve sustainable changes through exercise and ensure adequate exercise participation rates.

Statistical Analysis

The SPSS statistical software package (version 14)[e] was used for analyses. Descriptive statistics were used to describe performance at baseline and 4-month reassessment. For normally distributed variables (skew <3), paired sample t tests were used to compare baseline and follow-up assessment scores. For nonnormally distributed variables, the Wilcoxon signed-rank test was used to compare score differences. A Bonferroni adjustment was made where several tests were assessing the same subdomain. Subanalyses were performed using an independent group t test to determine the influence of higher exercise adherence ($>67\%$, which was the median compliance), pain (VAS ≥ 20mm), and type of arthritis (OA or RA) on the average change in each outcome measure.

If a measurement was unable to be performed by a participant on 1 or both measurement occasions (because of equipment malfunction or unavailability, or inability of the participant to perform the test), the participant was excluded from that analysis.

Adherence with exercise was defined as the proportion of available weeks that the participant completed all the exercises prescribed 5 or more days a week. The walking exercise was not included in this analysis because it was not consistently a formal component of the exercise program—for example, in cases in which participants were already undertaking regular walking.

A priori power analysis using data from a previous study with subjects with OA[11] indicated that a sample of 37 participants would have a power of 0.8 to detect an effect size of 0.5 at the .05 level on 2 of the outcome measures (Step Test and Timed Up & Go). A 0.5 SD difference between groups was selected because it represents a moderate effect size.[49]

RESULTS

All variables were normally distributed except for the Clinical Test of Sensory Interaction on Balance.

Forty-nine women with arthritis completed the initial assessment. One participant was excluded because she did not meet the inclusion criteria. Seven participants (14.6%) withdrew from the study between the initial and 4-month reassessment (5 for inconvenience [4 unable to commit to exercises, 1 unable to attend follow-up assessment], 2 for planned surgery [unrelated to program]), leaving 41 participants who completed the exercise program and returned for a follow-up assessment. Two participants were not included in analysis because they had cortisone injections into lower-limb joints during the exercise period, resulting in 39 eligible participants completing the program (27 with OA and 12 with RA) (table 2). Those completing the program had a mean age of 69.3 (95% CI, 65.7–72.9) years, most reported their knees or feet as the most severely affected joints, and 64% reported 1 or more falls in the preceding 12 months. There were no significant differences in baseline characteristics and measures between those who did and those who did not return for the follow-up assessment, except that those who did not return were significantly younger (mean, 60.1y; 95% CI, 52.0–68.1) compared with those returning (mean, 69.3y; 95% CI, 65.7–72.9; $P=.034$).

Pearson r correlations between all baseline outcome measures identified mild to moderate correlations between a number of the measures, although the highest correlation identified was r equal to .75, between the Step Test and gait velocity.

At baseline (as measured by the FROP-Com for the previous 12-month period including the home assessment category), 22 (57.9%) participants were rated as having a low falls risk (FROP-Com score <16) with 16 (42.1%) rated as having a moderate falls risk (FROP-Com score 16–23). No participants were rated as having a high falls risk (FROP-Com >23). One participant (younger and working full time) did not fully complete the FROP-Com because of limited available time for the assessment procedures.

The most common falls risk factors rated as moderate or severe were foot problems (eg, corns/bunions/pain; 32 [82%] participants), greater than 4 prescription medications (24 [62%] participants), and 3 or more chronic medical conditions affecting their balance and mobility (21 [54%] participants).

Table 3 reports initial and follow-up scores on all outcome measures for the full sample completing the reassessment (the relevant adjusted P values are reported). Also reported are the normative score range for samples of healthy older people. There was significant improvement on a number of variables after the exercise intervention: falls risk ($P=.01$), activity profile ($P=.015$), fear of falling ($P=.022$), functional reach test ($P=.001$), rising index for sit to stand ($P=.001$), step width in walking ($P=.001$), and body mass index ($P=.006$). There was a trend for improvement in all other variables except gait velocity. The change in falls risk score without the physical activity component included was also significant ($P=.026$).

Normative data, where available, are included in table 3. The study sample includes only women and was slightly younger than those from the normative scores.

After the exercise period, there were improvements (although not statistically significant) on several WOMAC subcategories for the OA group, as reported in table 4.

Participants completed all the prescribed exercises 5 or more days a week a median of 66.7% of available weeks. No participant ceased the exercises because of an exacerbation of symptoms caused by the exercises, and there were no falls associated with performing the exercise program.

Subanalyses were performed to determine the influence of higher adherence with exercise (>67%), higher levels of joint pain (VAS ≥20mm) at baseline, and the type of arthritis (OA or RA) on outcomes. There were no statistically significant

Table 2: Sample Characteristics for Participants Completing Follow-Up Assessment

	OA (n=27)	RA (n=12)	Total Sample (N=39)
Mean age (y), (95% CI)	70.5 (66.4–74.7)	66.3 (58.4–74.3)	69.3 (65.7–72.9)
Mean BMI (kg/m^2), (95% CI)	28.6 (26.4–30.9)	26.6 (23.9–29.4)	28.0 (26.3–29.8)
Arthritis details			
Most severely affected lower limb, n (%)			
Hip	3 (11.1)	1 (8.3)	4 (10.3)
Knee	20 (74.1)	5 (41.7)	25 (64.1)
Feet	4 (14.8)	6 (50.0)	10 (25.6)
Total number of painful joints, mean (95% CI)	7.4 (4.3–10.5)	15.9 (9.3–22.5)	10.0 (7.0–13.1)
Number of painful lower limb joints, mean (95% CI)	3.0 (0.8–4.0)	6.3 (3.0–9.7)	4.0 (2.7–5.3)
Spread of number of lower limb painful joints, n (%)			
0–1	8 (29.6)	3 (25.0)	11 (28.2)
2–4	16 (59.3)	2 (16.7)	18 (46.2)
5–10	2 (7.4)	3 (25.0)	5 (12.8)
>10	1 (3.7)	4 (33.3)	5 (12.8)
Falls			
Number of falls (in previous 12mo), n (%)			
0	9 (33.3)	5 (41.7)	14 (35.9)
1	6 (22.2)	2 (16.7)	8 (20.5)
2	8 (29.7)	4 (33.3)	12 (30.8)
≥3	4 (14.8)	1 (8.3)	5 (12.8)
Days to reassessment, mean (95% CI)	141.8 (132.5–151.1)	147.9 (136.5–159.3)	143.7 (136.6–150.8)

Table 3: Gait and Balance Variables

	Pre Mean (95% CI)	Post Mean (95% CI)	*P*	Normative Data (Where Available)[Reference]
Pain (VAS) (mm) (N=39)	39.90 (32.6–47.2)	36.08 (28.2–43.9)	.312	—
BMI (kg/m^2) (N=39)	28.03 (26.3–29.7)	27.63 (26.0–29.3)	.006*	In 1999–2000, 46% Australian women age >25y rated as healthy weight, ie, BMI 18.5–25[55]
Falls risk (*significance <.05)				
Full FROP-Com† (n=38)	14.45 (13.0–15.9)	—	—	8[29]
FROP-Com without HA‡ (N=39)	11.87 (10.6–13.1)	9.79 (8.1–11.5)	.01*	—
FROP-Com without HA and without physical activity score (N=39)	11.18 (9.8–12.6)	9.46 (7.9–11.1)	.026*	—
Activity and Falls Efficacy Scales (*significance <.05)				
Human Activity Profile-AAS (N=39)	56.51 (52.1–60.9)	59.1 (54.7–63.5)	.015*	>54[56]
Modified Falls Efficacy Scale (N=39)	8.77 (8.4–9.2)	9.06 (8.7–9.4)	.022*	9.8 (9.2–10.0)[57] (mean age, 74.1y)
Balance (*significance <.008)				
Clinical Test of Sensory Interaction on Balance; EC Foam (s)	30.00 (median)	30.00 (median)	.255 Wilcoxon	29.5 (28.4–30.0)[58] (Age 65–84y, men and women)
Functional Reach Test (cm) (N=39)	26.67 (24.2–29.1)	29.56 (27.8–31.4)	.001*	36.9 (35.8–37.9)[59]
Step test—worse leg (no. in 15s) (N=38)	14.55 (13.1–16.1)	15.61 (14.2–17.1)	.044	15.6 (15.0–16.2)[59]
Limits of Stability—composite MXE (%)—NeuroCom (n=35)	80.80 (76.1–85.5)	84.29 (79.9–88.7)	.025	87.6 (83.9–91.3)[36]
Limits of Stability—composite reaction time (s)—NeuroCom (n=35)	0.99 (0.9–1.1)	0.97 (0.9–1.0)	.704	0.9 (0.8–1.0)[36]
Response to perturbation with AP distraction (cm)—Chattecx (n=33)	1.55 (1.3–1.8)	1.34 (1.1–1.6)	.103	1.42 (1.2–1.6)[40]
Leg Muscle Power (*significance <.025)				
Sit to stand—weight transfer time (s) (n=37)	0.44 (0.4–0.5)	0.34 (0.3–0.4)	.056	0.5 (0.4–0.6)[36]
Sit to stand—rising index (% body weight) (n=37)	13.95 (12.3–15.6)	16.73 (15.0–18.5)	.001*	21.2 (19.0–23.4)[36]
Gait (*significance <.0125)				
Step width (cm) (n=32)	16.22 (15.1–17.4)	13.92 (12.6–15.2)	.001*	Preferred step width, 0.13[60]
Clinical Gait Velocity (m/min) (n=34)	69.68 (63.1–76.3)	68.63 (61.2–75.3)	.646	86.4 (79.8–93.0)[61]
Step and Quick Turn—sway (for worse direction) (°/s) (n=38)	41.98 (36.7–47.2)	35.53 (30.1–40.1)	.043	24.5 (19.8–29.2)[36]
Timed Up and Go (s) (N=39)	12.59 (9.8–15.4)	10.98 (9.6–12.4)	.066	7.24 (6.9–7.6)[61]

Abbreviations: AAS, adjusted activity score; AP, anteroposterior; HA, home assessment; L, leg length; MXE, maximum excursion; Wilcoxon, Wilcoxon signed-rank test.
*Denotes a significant *P* value. A Bonferroni adjustment was made where several tests were assessing the same subdomain; significance values are denoted in parentheses.
†Includes home assessment item at baseline (maximum score=63) and falls in last 12mo.
‡Excludes home assessment item (maximum score=60) and falls in last 4mo.

differences in change scores from baseline to follow-up between (1) OA and RA participants, (2) those with higher adherence and lower adherence, or (3) those with higher pain (≥20mm score on VAS, 85% of participants) and those with lower pain (<20mm score on VAS, 15% of participants) at baseline.

Table 4: WOMAC Scores for OA Group

WOMAC Category	Pre Mean (95% CI)	Post Mean (95% CI)	*P*
Pain	31.3 (23.3–39.3)	26.4 (16.6–36.3)	.25
Stiffness	39.2 (28.9–49.5)	31.9 (22.4–41.5)	.10
Function	32.0 (22.4–41.5)	25.0 (16.3–33.8)	.12
Total WOMAC	32.1 (23.4–40.9)	26.7 (18.2–35.2)	.09

DISCUSSION

The results of this study demonstrate that a home-based balance training exercise program is feasible for women with lower limb OA and RA and provide preliminary support that improved outcomes can be achieved on a number of balance, muscle strength, and gait stability measures. These improvements are consistent with studies of other clinical groups that have shown benefit from training incorporating balance exercises.[5,21]

Most participants completed the program. When asked whether they were satisfied with the program, none of these reported difficulty in completing the exercises. No participants discontinued because of pain exacerbation or injury. The 4 participants who were unable to commit to the exercises reported finding time to do the exercises difficult. One of these

participants declined to commit prior to being prescribed the exercises. It is unlikely the feasibility of the program is compromised by the response from these participants, but issues of motivation to undertake exercises may require more focus. Although not included in the data analysis, 2 participants had corticosteroid injections during the intervention. The specific details contributing to why these participants required the injections is not known, but the injections were most likely needed because of an exacerbation of symptoms. These participants reported that they did not feel the intervention contributed to the need for the injections, but this possibility could not be ruled out. These participants were able to complete the period of exercise intervention; however, it may have been possible only because of the injections.

Improving balance, muscle strength, and gait stability may have implications for function and activity for people with arthritis. While a number of the significant changes such as step width, and step, and quick turn were of a magnitude of 10% to 20% change and considered clinically meaningful, others such as the Modified Falls Efficacy Scale may be too small to be clinically meaningful despite being statistically significant. These physical and psychological changes may also be associated with increased activity levels, which was also evident in this study. Despite the Human Activity Profile baseline scores suggesting a relatively active group of participants (which may be explained by the younger age of this sample), the baseline scores for our sample on measures of dynamic balance (Step Test and Functional Reach Test) indicate a decline in balance status. Selection of reasonably active participants may have been a result of the study requirement to attend a laboratory for testing and the commitment to exercise. The improvements with exercise in falls risk score where the physical activity component had been removed suggests that despite the existing level of physical activity, the home-based balance and strength training program had an additional effect. Participation in the exercise program was also associated with reduced BMI that could have contributed to lower levels of pain and improved activity. Avoidance of tasks by people with arthritis because of fear of falling[7,10,50] may lead to an increase in arthritis symptoms (weakness, joint inflexibility, fatigue, pain, stiffness) and an increased falls risk.

The observed improvement in falls risk as measured using the FROP-Com is clinically important for people with arthritis. Other studies have recognized arthritis as a falls risk factor.[6-10] The percentage of people with arthritis falling in a 12-month period varies between studies, but each is greater than 40%.[9,12] In the present study, 64% of the women with arthritis had fallen in the past year. In comparison, one third of people over 65 years of age have at least 1 fall a year.[5,51] A possible explanation for this high proportion of fallers may be a selection bias as a result of recruiting participants with arthritis from hospitals and clinics rather than from the general community. However, the high rate of falling and the evidence that falls risk assessment and targeted interventions in older populations can be effective[5,52] may indicate the need for wider application by health professionals of the FROP-Com or other falls risk assessment tools with this clinical group, at least for those presenting to hospital/rheumatology clinics. To reduce the potential for measurement bias, the use of a falls diary rather than retrospective recall of falls data may have been more appropriate in this study and is encouraged in subsequent research.

The exercises prescribed in this study were individualized for each participant. To obtain the most appropriate program, a combination of exercises from 2 available exercise packages was used. Although the Otago program[48,52] has been shown to be effective in decreasing falls in older people living at home, clinical experience of our team has been that often there is a need to include additional, more challenging balance exercises. Where this was necessary, additional exercises were prescribed from the Visual Health Information Exercise Prescription Kit. The principles of prescription and modification of balance exercises ensured that the participants were challenged sufficiently within safety limits. This combination of exercises requires further evaluation in a randomized trial design study and in different clinical samples.

The implementation of balance exercises in center-based community programs is varied. Balance training is often misunderstood to be exercises in standing, where participants may be completing simple strengthening exercises, or with upper-limb support from a rail or chair. Studies investigating the benefits of balance exercises have concluded that exercises should (1) challenge balance reactions, (2) be dynamic in nature, (3) involve weight shift, (4) be performed without upper limb support, (5) be of moderate intensity, and (6) be progressive.[5,21,53] An individualized home program as undertaken in this study can ensure these criteria are met and can include all components for arthritis management: strengthening, mobilizing, and balance retraining.

The physical and psychologic improvements were gained with relatively low resource use: 5 physiotherapy sessions (2 assessments in the laboratory and 3 home visits) over 4 months. The program was feasible to implement. Home visits enabled individualized, safe, and effective exercise to be prescribed and an appropriate environment to be identified for doing the exercises. A high standard of adherence was set, asking participants to complete all the prescribed exercises at least 5 days a week for the exercise period. A median of 67% indicates that most women (>50%) met this high standard on at least 13 of the 20 weeks available. Factors that may have contributed to the acceptance of the program included the home visit support, the clearly documented exercise program, the adherence calendar, phone calls for motivation and monitoring, and a scheduled reassessment date. Adherence to exercise can be difficult to measure, particularly where the prescription of exercise varies among persons. The number of exercises varied between participants because of differences in medical and physical status, interruptions caused by medical issues during the exercise period, and the motivation and enthusiasm for exercise as determined by the physiotherapist on prescription or at review of exercises.

Study Limitations

There were several limitations to this study. The sample size is small because of difficulty recruiting participants within the allocated study period. This problem was magnified on several of the measures because of missing data. There is potential bias in deleting participants with missing data from a specific analysis, but when the mean substitution approach to manage missing data was performed, results remained unchanged. The proportion of dropouts as a percentage of the total sample was also moderately high relative to other exercise programs (9 of 41). Women only were recruited, so results cannot be directly generalized to men with arthritis. This study targeted only women because there is a higher proportion of women with arthritis in the community,[4] and sex effects have been previously demonstrated on some balance and mobility-related tasks.[54] A similar study involving men with arthritis is warranted. This study investigated women with either OA or RA as a group. There were no statistical differences in changes in outcome measures in this study between the OA and RA groups. There is value in future studies evaluating this exercise approach for each type of arthritis separately because the

impact of the different forms of arthritis on balance, responsiveness to the intervention, and issues around adherence may differ between the groups.

Pain medication doses were not collected for this study. The impact of balance retraining on pain and the use of centrally acting pain medications would be interesting and a consideration for future research.

A comprehensive balance assessment undertaken for participants in this study took up to 2 hours to complete, which may limit application to clinical practice. An abbreviated selection of the assessment tools from this study could address this but would require further research.

Given that specific balance retraining has not previously been implemented in this clinical group (in isolation) and given the limited funding available, this study was implemented as a pilot study pre-post design. A randomized controlled trial in which participants are randomly allocated to a control group or exercise group would more clearly determine the effectiveness of this home exercise program. However, the study does establish the feasibility of this type of program in this particular clinical group. This study may also provide information for a larger study.

CONCLUSIONS

An individualized balance home exercise program is feasible and acceptable to women with lower-limb arthritis. The program may improve their stability during walking and other functional activities and improve activity level; however, these outcomes need to be evaluated within a randomized controlled trial that incorporates a cost-effectiveness analysis.

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Suppliers

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