ARTICLES

The Relationship between Falls Efficacy and Improvement in Fall Risk Factors Following an Exercise Plus Educational Intervention for Older Adults with Hip Osteoarthritis

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ABSTRACT

Purpose: Older adults with decreased confidence in their ability to prevent a fall may benefit from an exercise programme that includes self-efficacy-enhancing education. The objectives of this study were to explore differences in fall-risk outcomes in older adults with higher vs. lower levels of falls efficacy and to evaluate the relationship between baseline falls-efficacy status and changes in fall risk factors following two interventions.

Method: Fifty-four older adults with hip osteoarthritis and at least one risk factor for falls received aquatic exercise twice weekly plus education once weekly (EE) or aquatic exercise only, twice weekly (EO), for 11 weeks.

Results: EE participants with low baseline falls efficacy demonstrated significantly ($p < 0.05$) greater improvement in balance and falls efficacy compared to EE participants with high baseline falls efficacy. In the EE group only, baseline falls-efficacy status (low vs. high median split on the Activities-specific Balance Confidence Scale) was significantly ($p < 0.05$) correlated with positive balance and falls-efficacy change scores (Spearman rank $r = 0.45$ and 0.63 respectively).

Conclusions: Individuals with one or more fall-risk factors and low falls efficacy may benefit from receiving an intervention that combines exercise with self-efficacy-enhancing education. Falls-efficacy screening may be important for decisions regarding referral to fall-prevention programmes.

Key Words: falls, accidental; balance, postural; hydrotherapy; pain; rehabilitation; osteoarthritis, hip.

RÉSUMÉ

Objectifs : Les personnes âgées en perte de confiance face à la prévention des risques de chute pourraient bénéficier d'un programme d'exercices qui comprend une éducation visant à accroître l'auto-efficacité. Les objectifs de cette étude étaient d'explorer les différences dans les résultats face aux risques de chute chez les personnes âgées ayant un degré plus élevé d'auto-efficacité par rapport aux personnes dont l'auto-efficacité est moindre, et d'évaluer la relation entre l'efficacité de base et les changements dans les facteurs de risques de chute à la suite de deux interventions.

Méthode : On a prescrit à 54 personnes âgées ayant au moins un facteur de risque de chute et de l'arthrose de la hanche un programme d'exercices aquatiques deux fois par semaine, ajouté à de l'éducation une fois par semaine (EE), ou des exercices aquatiques seulement, deux fois par semaine (EO), pour 11 semaines.

Résultats : Les participants avec EE ayant une faible auto-efficacité de base face aux chutes ont affiché une amélioration plus importante et plus significative ($p < 0,05$) de leur équilibre et de leur degré d'efficacité face aux chutes. Chez les sujets avec EE seulement, l'efficacité de base face aux chutes (médiane faible vs médiane élevée, séparée sur l'échelle d'équilibre et de confiance lors d'activités) était considérablement corrélée ($p < 0,05$) avec les changements positifs au chapitre de l'équilibre et de l'efficacité lors de chutes (classement de Spearman $r = 0,45$ et 0,63, respectivement).

Conclusions : Les personnes ayant au moins un facteur de risque de chute et une faible efficacité lors de chutes pourraient bénéficier d'une intervention qui allie de l'exercice et l'éducation visant à accroître leur auto-efficacité. Le dépistage de l'efficacité en cas de chute pourrait constituer un outil de décision important au moment de recommander un patient pour un programme de prévention des chutes.

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Approximately one-half of deaths due to injury occur in the elderly as a result of falling.[1] With one out of three adults over age 65 falling in a given year,[2] the costs to the health care system and to individuals are a major public health concern. A recent Canadian study found that one in four adults who sustain a hip fracture (one type of fall-related injury) after age 50 will die within 5 years.[3] The economic burden of hip fractures has been estimated as approximately $2.8 billion per year,[4] and the human costs for survivors of fall-related injuries include such serious consequences as loss of independence, pain, permanent disability, activity limitations, and, for some, an extreme fear of falling again.[5] The incidence of falls is higher in populations with mobility restrictions, including lower-extremity osteoarthritis (OA). A review of 16 studies of fall risk[2] identified the presence of arthritis as having a higher mean relative risk than either age or cognitive status of predicting future falls.

OA, which is the most common type of arthritis and affects over one-third of the adult population over age 65, accounts for 55% of all arthritis-related hospital admissions and is one of the leading causes of disability in the elderly.[6] Hip OA, affecting approximately 5% of the elderly, results in lower-limb weakness, slower gait, decreased mobility, and pain, which are established risk factors for falls.[7,8] There is also evidence of diminished balance, strength, and reaction time in older adults with hip and knee OA, resulting in increased fall risk.[9] In addition to these physical fall-risk factors, fear of falls, a social-psychological risk factor, is significantly higher in individuals with higher levels of pain,[10] including individuals with arthritis.[11] Fear of falls can impede the ability to participate in physical activity,[12] which is a crucial behavioural strategy to mitigate the aforementioned physical fall-risk factors.[13] Therefore, reducing fear of falling among adults with established fall-risk factors, such as those with hip OA, could have important implications for public health.

One strategy to reduce individuals' fear of falling is to target improvements in *falls efficacy*, meaning beliefs in one's skills and abilities to successfully perform a task and avoid a fall.[14] According to self-efficacy theory,[15] as one becomes more confident that one can avoid a fall, associated outcomes due to behavioural changes (i.e., physical fall risk) should improve. This theoretical tenet has received support from the research on falling. For example, falls efficacy was positively correlated with performance on balance tests in older adults[16,17] and has independently predicted balance and mobility, after controlling for other fall-risk factors such as age, vision, and activity level, in a sample of older women with osteoporosis.[18] Despite the positive associations between falls efficacy and physical fall-risk outcomes, only minimal research has attempted to manipulate falls efficacy. Falls efficacy may be improved by enhancing individuals' success in moving through risky environments and learning how to avoid a fall.[14] Such mastery experiences may be achieved through participation in a falls-prevention exercise programme. Individuals' falls-efficacy beliefs may also be affected through verbal persuasion, vicarious experiences, and attention to physiological and affective states.[15]

In healthy populations of older adults, group educational interventions have incorporated such sources of self-efficacy and resulted in improvements in falls efficacy, intended future activity, social function, and perceived mobility.[19,20] Although educational programmes have improved falls efficacy, the effects on physical fall-risk outcomes such as balance and strength is unclear.[21] In contrast, exercise-only interventions have shown a positive impact both on falls efficacy and on physical fall-risk outcomes. Older adults participating in a community-based tai chi exercise class 3 days per week for 6 months benefited through decreased fear of falls and improvement in functional balance and physical performance,[22] an improvement mediated by associated gains in falls efficacy.[23] Other researchers[24] found that following a 3-month exercise intervention for older adults that consisted of progressive resistance and balance training, a significant relationship existed between lower levels of falls efficacy at baseline and greater post-intervention improvement in function, as measured by walking velocity and knee strength. This finding suggests that older adults with lower baseline levels of falls efficacy may greatly decrease their fall risk through an exercise intervention and are therefore an important target group to identify and refer to structured exercise programming. In particular, the impact of an exercise intervention on physical function outcomes may be greater among older adults whose falls efficacy is initially lower.

As a result of both physical and social-psychological factors, older adults who have lower-extremity arthritis present with higher fall risk relative to their asymptomatic counterparts; therefore, this population in particular may benefit from an exercise intervention with the addition of education to target falls efficacy specifically and functional outcomes more generally. In a previous study,[25] we reported that an intervention involving aquatic exercise plus education positively affected both physical and social-psychological risk factors in older adults with hip OA and at least one risk factor for falls. Both falls efficacy and functional ability in chair-stand performance improved in the aquatic-exercise-plus-education group relative to the control group by the end of the 11-week intervention period. Results from other studies support the benefit of educational interventions alone, based on self-efficacy theory, in enabling individuals with arthritis to achieve an improved sense of well-being, coping skills, and perceived function as well as diminished pain.[14]

In summary, both exercise and educational programmes independently affect falls efficacy; however, educational programmes alone have not succeeded in mitigating physical risk factors for falling.[21] The literature suggests that older adults with established fall-risk factors (in this case, hip OA) may benefit most from an exercise-plus-education intervention. Furthermore, their levels of falls efficacy heading into such interventions may affect the extent of the improvement realized.[24] It is plausible that combining an exercise intervention with a self-efficacy-building educational component yields greater functional gains related to decreasing fall risk, especially among those with lower falls-efficacy beliefs at baseline. Understanding the relationship between baseline levels of falls efficacy and outcomes for an exercise-plus-education intervention is important in determining the population most likely to exhibit positive changes and benefit from a more intensive intervention involving health professional contact and education, as opposed to a community-based exercise-only programme.

The objectives of this study were, first, to explore differences in fall-risk outcomes, comparing low- and high-falls-efficacy older adults with hip OA and at least one fall-risk factor who participated in either an exercise-plus-education intervention (EE) or an exercise-only intervention (EO); and, second, to identify the relationship between high versus low baseline falls-efficacy status and changes in physical and social-psychological fall-risk outcomes after EE or EO. Because of the exploratory nature of the study, no hypotheses were developed; however, identifying factors that may affect fall-risk outcomes following different types of interventions is important for developing more specific, testable hypotheses in subsequent studies.

METHODS

Participants

The institution's biomedical ethics review board granted approval of the study, and informed consent from each participant was obtained prior to testing. Eligible participants were aged 65 years or older, with hip pain for 6 months or longer, diagnosed with hip OA and presenting with at least 1 fall-risk factor (defined as timed up-and-go [TUG] test[26] $\geq$10 s or a history of one or more falls in the past 12 mo). Participants were excluded if they met any of the following exclusion criteria: any joint surgery within the last 6 months, current participation in a group exercise programme incorporating balance training or aquatics twice or more per week, or the presence of any medical or neurological condition that significantly affected independence in mobility. The 54 participants included in this study had been randomly assigned to one of two interventions – EE (28 participants) or EO (26 participants) as part of a larger trial.[25] The two intervention groups did not differ in the number of participants who had both of the screening fall risk factors (TUG $\geq$10 seconds and one or more falls in past 12 mo; $n = 10$ in EE, $n = 11$ in EO).

Measures and Test Procedure

The purpose of this study was to compare changes in fall-risk outcomes between the two intervention groups (EE and EO) for participants with varying levels of baseline falls efficacy. The fall-risk outcomes measured are discussed in detail below.

Balance

Since balance is complex, with contributions from sensory, central nervous, and neuromuscular systems, two tests were used to capture deficits in three balance strategies (ankle, hip, and stepping) in a variety of different environmental and functional circumstances.

The primary balance measure was the Berg Balance Scale (BBS),[27] which consists of a series of daily tasks that progressively challenge balance. A modified version of this test containing only the last nine tasks in the original scale was used, as the first five tasks are typically performed with no difficulty by community-dwelling older adults.[28] Each task is rated on a four-point scale, for a maximum score of 36 (vs. the original maximum score of 56). This scale has excellent inter- and intrarater reliability (intra-class correlation coefficient [ICC] $= 0.98$ and 0.99) and high internal consistency (Cronbach's $\alpha = 0.96$).[27] The BBS is correlated with other functional and balance tests and has been shown to predict falls in the elderly.[29,30]

The Modified Clinical Test of Sensory Interaction and Balance (MCTSIB)[31,32] was used as a secondary balance measure. This instrument tests standing balance under four sensory conditions: eyes open on stable surface, eyes closed on stable surface, eyes open on compliant surface (foam), and eyes closed on compliant surface. Unlike the BBS, the MCTSIB measures the impact of sensory systems on balance. Impairments often not detected in functional tasks, such as those on the BBS, may become apparent in more challenging environments. The MCTSIB has been correlated with other tests of balance, and studies have demonstrated comparable reliability and validity with footwear on and off and with the feet placed in different positions.[31–33] Total time for all conditions (30 s for each condition, maximum 120 s) was recorded.

Dual-Task Function

The TUG_{cog} test was used as a measure of dual task function. The TUG is a well-known screening test for fall risk[26] that requires the participant to stand up from a standard chair, walk at his or her usual quick but safe walking pace for 3 m, then return and sit down in the chair. The TUG_{cog} adds a cognitive subtraction task (in this case, counting backward by twos) to the standard walking test, and the total time to complete the walk and the subtraction task is recorded.[34] This test provides a measure of dual-task function, which has been found to negatively affect balance.[35] The TUG_{cog} has demonstrated sensitivity and specificity in fall prediction.[34]

Functional Performance

The functional task of moving from sitting to standing (30-second chair stand) was the measure of physical function in this study. The 30-second chair stand is a reliable and valid measure of lower-body strength, endurance, general mobility, and balance[36] that discriminates between active and inactive older adults.[37] A participant sits in a standard chair, with arms crossed over the chest, and is asked to move to a full standing position and back to full sitting (buttocks touching the chair) as many times as possible in 30 seconds. The number of complete movements from sitting to standing during the 30 seconds is recorded.

Walking Speed and Endurance

The 6-minute walk test (6MWT) was the primary measure for gait speed and endurance. The 6MWT is a functional walking test used in a variety of clinical and healthy populations, has high test–retest reliability (ICC $= 0.95$), and is correlated with other balance and function measures.[38] The total distance walked (in m) during the 6 minutes was recorded for each participant.

Falls Efficacy

Falls efficacy was assessed using the Activities-specific Balance Confidence (ABC) Scale. The ABC Scale has demonstrated excellent internal consistency ($\alpha = 0.96$; test–retest reliability $r = 0.92$)[39] and can discriminate between higher and lower functional status.[40] The ABC Scale is a self-report questionnaire that has been used extensively for community-dwelling older adults and asks the participant to rate his or her confidence in completing 16 common tasks without losing balance, on a scale from 0% (no confidence) to 100% (complete confidence). An overall mean score was calculated for each participant.

Other Measures

Height was measured as stretch stature in centimetres, and weight was recorded using a standard scale in kilograms. Body mass index (BMI) was calculated as kg/m^2. A medical history and demographic questionnaire was administered to determine the history of OA, location of hip pain, type of residence, a list of medications, and a checklist of medical conditions. The Physical Activity Scale for the Elderly (PASE) was used to assess activity levels.[41] The Arthritis Impact Measurement Scale (AIMS–2) is a reliable and valid self-report questionnaire that measures the impact of arthritis on daily function using 15 different scales;[42] the three-component model (physical, affect, and symptoms), where lower scores indicate better health status, was also used in the present study.

Balance and functional testing was conducted before and after the 11-week intervention by two experienced physical therapists who were blinded to group assignment.

Interventions

EE

The 28 participants in the EE group exercised twice per week for 11 weeks at a community pool with zero-depth entry (i.e., gradual sloping entry) and variable pool depth. Most participants exercised at chest depth. Each exercise session lasted 45 minutes, and the goal was to improve mobility, strength, and balance. The exercise protocol consisted of warm-up exercises (variations of walking in the water, stretching upper and lower body); lower- and upper-extremity strengthening exercise (using floats, noodles, sponges, and paddles for added resistance); trunk-control exercises (abdominal strengthening in floating positions, trunk control in standing positions); posture practice and balance exercises (mobility games, variations in walking, standing balance activities); and cool-down (gentle stretching and breathing). Further information on the exercise programme can be obtained from the corresponding author (CMA).

In addition, participants received a 30-minute educational session preceding one of the aquatic classes each week for 11 weeks. The educational sessions were held in the recreational facility where the pool was located and were conducted by a physical therapist with 20 years' experience working with an elderly population. The goals of the education sessions were to (1) improve self-efficacy in the ability to avoid a fall and recover from a fall at home and in the community by (2) increasing the transfer of exercises learned in the pool to ability to successfully perform activities of daily living on land and (3) increasing the knowledge of individual fall-risk factors and fall-prevention strategies. Participants received a booklet with information for each education session and were given an opportunity to set individual goals relating to exercise and fall-prevention strategies.

The delivery and goals of the educational component were based on self-efficacy theory[15] and prior research by Brawley and colleagues in which self-efficacy beliefs involved in self-regulation of exercise, such as confidence to overcome barriers and to set goals, were targeted for improvement in group-based exercise interventions with education (termed "group-mediated cognitive-behavioural interventions") across various populations.[43–45] The education component in the present study included three determinants of self-efficacy: enactive mastery experience, verbal persuasion, and physiological and affective states.[15]

Mastery experience was developed by participants' learning strategies to prevent falls and consistently applying these strategies in day-to-day tasks. Participants also practised tasks in the class setting, such as getting up from the floor, reaching, and stepping over obstacles, which contributed to mastery experiences.

Verbal persuasion included helping participants develop individual goals to decrease fall risk factors at home and in the community. The group facilitator provided constructive feedback as well as information on the potential losses resulting from non-adherence to exercise and the potential long-term gains from adherence. The additional influence of verbal persuasion from other group members was targeted by focusing on active group discussion and the sharing of experiences, goals, and obstacles to adherence.

The educational component also highlighted how the exercises learned in the water could translate into improving daily function on land and, thus, help to prevent falls (i.e., verbal persuasion). Emphasizing the latter benefit of exercise may enable individuals to better understand and cope with the connection between physiological and affective states. People may interpret physiological responses to aquatic exercise, such as increased muscle soreness and joint pain, breathing harder, and fatigue, as signs of inefficacy, dysfunction, or failure; if this state further arouses affective responses such as stress, anxiety, or fear, perceived falls efficacy may also diminish. Consistent education and feedback on reasons for arousal states, the purpose of the exercise, and a supportive environment were used in this intervention as mechanisms to help individuals increase their falls efficacy and help them remain motivated to continue with exercise and thus to make physical gains in mobility tasks.

EO

The 26 participants in the EO group participated in a separate 45-minute aquatic fitness class twice per week for 11 weeks, as described above, but received no additional education.

Three group sessions of EE and EO were run consecutively over a 36-week period. There were two instructors, one for the first two sessions of EE and EO and one for the final sessions. Both instructors were experienced aquatic fitness instructors and were given a training session and a written manual of programme goals and sample exercises. Independent reviews of the standardization of the programme were conducted by three individuals not directly involved in the research project. There were no discrepancies in delivery, progression of exercises, intensity, duration, or frequency of exercise between EE and EO or between the two instructors.

Statistical Analyses

Baseline falls efficacy was split at the median value for the ABC Scale, dividing EE and EO groups into low falls efficacy (<71.88 ABC score) and high falls efficacy (≥71.88 ABC score). We chose to use the conventional method of splitting the groups based on median value because there is no "gold standard" cut-point to identify fall risk using the ABC. The median split used in this study resulted in similar mean values (mean 52.4 for low falls efficacy; mean 87.0 for high falls efficacy; $n = 54$) to those in other studies evaluating ABC mean values for fallers versus non-fallers.[29] Further, the high- and low-falls-efficacy sub-group means in the present study significantly differed from each other ($p < 0.001$) within both EE and EO groups, illustrating that distinctly different falls-efficacy sub-groups at baseline were being compared within each intervention group. Differences in baseline fall-risk scores and other socio-demographic factors between high- and low-falls-efficacy sub-groups within each intervention group were also explored using independent *t*-tests. The relationships of low versus high baseline falls efficacy to fall-risk change scores were evaluated with Spearman rank correlation coefficients. Differences between fall-risk change scores for low- and high-falls-efficacy sub-groups in each intervention group were compared using independent *t*-tests. Both uncorrected ($p < 0.05$) and Bonferroni corrected ($p = 0.05/6 = 0.008$) results are reported. Effect size (ES; delta index)[46] and percent change scores for balance, dual-task function, functional performance, walking speed and endurance, and falls efficacy were calculated for low- and high-falls-efficacy sub-groups within both EE and EO groups. Percent change was calculated as change score divided by baseline score; effect sizes were calculated as change scores divided by the pooled standard deviations of change scores for the low- and high-falls-efficacy sub-groups. Pooled standard deviations were used because not all variables exhibited homogeneous variances. Magnitude of effect size was defined as either moderate (>0.50) or large (>0.80).[46]

RESULTS

Participants

A flowchart of participants and reasons for study dropout has been published elsewhere.[25] Of the 54 participants randomly assigned to EE or EO, 42 individuals completed the intervention and were post-tested ($n_{EE} = 23$; $n_{EO} = 19$). The last observation carried forward (LOCF) was used for intervention dropouts ($n_{EE} = 5$; $n_{EO} = 7$), with an intention-to-treat analysis (ITT). LOCF and ITT are standard methods recommended for RCTs to avoid the problem of ignoring the impact that dropouts may have on the outcome.[47] The mean percentage of class attendance was 74% for EE and 65% for EO; this increased to 81% and 82%, respectively, when dropouts were not considered in calculating attendance. No significant differences in attendance ($p = 0.29$) were found between the two intervention groups using an independent samples *t*-test. There were no significant differences between low- and high-falls-efficacy groups for baseline physical activity level as measured by the PASE; however, there was a trend for those with low falls efficacy to have lower levels of physical activity.

Table 1 displays descriptive characteristics and baseline fall-risk factors for the EE and EO groups, comparing

Table 1 Comparison of Exercise plus Education vs. Exercise Only, High- and Low-Falls-Efficacy Groups

	Group; mean (SD)			
	EE		EO	
Variable	High FE; $n = 15$	Low FE; $n = 13$	High FE; $n = 12$	Low FE; $n = 14$
Age, y	71.9 (4.7)	74.7 (4.6)	70.2 (5.2)*	78.0 (7.4)
Duration of hip pain, y	6.0 (8.1)	9.1 (6.0)	7.7 (10.6)*	9.3 (12.5)
No. of other conditions	1.9 (0.9)	2.8 (1.4)	1.2 (1.2)	2.6 (1.3)
No. of prescription medications	2.1 (2.1)	3.9 (2.9)	1.8 (1.4)*	3.9 (2.9)
BMI, kg/m^2	29.3 (6.3)	28.9 (3.7)	29.8 (4.1)	30.9 (4.9)
AIMS-2 total score	9.3 (1.7)*	11.1 (2.7)	8.3 (1.6)*	12.2 (3.2)
PASE total score	106.2 (34.2)	84.4 (27.5)	124.8 (60.1)	91.6 (35.6)
ABC, /100	85.0 (7.1)*	50.9 (12.4)	89.6 (7.2)*	53.8 (15.5)
Chair stand, s	8.2 (3.3)	7.0 (2.6)	8.8 (2.9)*	5.3 (4.7)
TUG$_{cog}$, s	13.2 (3.9)	16.9 (6.7)	12.1 (4.2)	18.9 (11.1)
MCTSIB, s /120	103.5 (17.2)*	82.8 (19.3)	103.9 (16.3)*	83.6 (30.1)
BBS, /36	32.5 (2.7)*	28.0 (3.4)	31.6 (2.5)*	27.4 (6.1)
6MWT, m	395.3 (63.4)*	308.9 (103.8)	411.6 (99.9)*	310.9 (115.6)

*Significant difference between high- and low-falls-efficacy sub-groups within EE or EO group ($p < 0.05$), using independent t-tests.
Note: Higher values for all functional outcomes represent better performance, except for AIMS-2 and TUG$_{cog}$.
EE = exercise plus education; EO = exercise only; FE = falls efficacy; BMI = body mass index; AIMS-2 = Arthritis Impact Measurement Scale, Version 2; PASE = Physical Activity Scale for the Elderly; ABC = Activities-specific Balance Confidence Scale; TUG$_{cog}$ = timed up-and-go test with cognitive subtraction test added; MCTSIB = Modified Clinical Test of Sensory Interaction and Balance; BBS = Berg Balance Scale; 6MWT = 6-minute walk test.

Table 2 Spearman Rank Correlation Coefficients for Falls-Efficacy Split (Low vs. High) and Fall-Risk Change Pre to Post Intervention for Exercise plus Education and Exercise Only

	Low vs. high falls efficacy	
Fall-risk Change	EE; $n = 28$	EO; $n = 26$
BBS	−0.30	−0.02
TUG$_{cog}$*	0.21	−0.08
MCTSIB	−0.45†	−0.11
6MWT	−0.22	0.03
Chair stand	0.04	−0.07
ABC	−0.63‡	−0.16

*Lower scores on the TUG$_{cog}$ indicate improvement.
†$p < 0.05$.
‡$p < 0.01$.
EE = exercise plus education; EO = exercise only; BBS = Berg Balance Scale; TUG$_{cog}$ = timed up-and-go test with cognitive subtraction test added; MCTSIB = Modified Clinical Test of Sensory Interaction and Balance; 6MWT = 6-minute walk test; ABC = Activities-specific Balance Confidence Scale.

high- and low-falls-efficacy sub-groups. No significant differences were found between the two intervention groups on socio-demographic factors or baseline fall-risk variables; as Table 1 shows, however, significant differences were found between low-and high-falls-efficacy sub-groups within each intervention condition, such that participants with low baseline falls efficacy in both EO and EE groups showed lower baseline functional status on several of the fall-risk measures. We found no significant differences in reported falls for either EE or EO, using a Mann-Whitney U test; in the EE condition, 5 participants in the low-falls-efficacy sub-group reported a fall in the past year, compared to 9 in the high-falls-efficacy sub-group, while for EO, 11 participants with low falls efficacy had fallen in the past year, compared to 5 with high falls efficacy. There were also no differences in the use of walking aids across the four groups.

Relationship of Falls Efficacy to Fall-Risk Change Scores

Lower falls efficacy at baseline was significantly associated with balance improvement as measured by the MCTSIB (Spearman $\rho = 0.45$; $p < 0.05$) and with falls-efficacy improvement as measured by the ABC ($\rho = 0.63$; $p < 0.01$) for EE participants, but not for EO participants (see Table 2). Table 3 portrays the actual change scores, effect sizes, and percent change in fall-risk scores in the EE group, subdivided into low- and high-falls-efficacy sub-groups. Significant differences in fall-risk change scores were found between the low- and high-falls-efficacy participants in the EE group, but no significant differences were found among participants in the EO group. Specifically, EE participants with low falls efficacy demonstrated a significant balance improvement, as measured by MCTSIB ($p = 0.03$), and an improvement that approached significance in BBS scores ($p = 0.05$), as well

Table 3 Raw Change-Score Values, Percent Change, and Effect Sizes for Fall-Risk Variables for Exercise plus Education (EE) Group, Divided into Low- and High-Falls-Efficacy Sub-groups

Variable	Falls efficacy: Low; $n = 13$	Falls efficacy: High; $n = 15$	*p*-value for difference in change score
BBS			
Change score; mean (SD)	2.31 (4.23)	−0.20 (2.14)	0.05
% change	8.25	−0.62	
Effect size	0.74	−0.06	
TUG_{cog}			
Change score; mean (SD)	−3.71 (6.42)	−1.10 (3.42)	0.18
% change	21.95	8.33	
Effect size	0.77	0.23	
MCTSIB			
Change score; mean (SD)	15.79 (19.41)	0.21 (16.61)	0.03*
% change	19.07	0.20	
Effect size	0.91	0.01	
6MWT			
Change score; mean (SD)	63.23 (75.00)	26.00 (48.26)	0.13
% change	20.47	6.58	
Effect size	1.06	0.43	
Chair stands			
Change score; mean (SD)	1.08 (1.12)	1.73 (2.52)	0.39
% change	15.43	21.10	
Effect size	0.57	0.91	
ABC			
Change score; mean (SD)	13.56 (12.69)	−0.87 (7.47)	0.001†
% change	26.64	−1.02	
Effect size	1.37	−0.09	

*Significant at $p < 0.05$ with no correction.
†Significant with Bonferroni correction ($p < 0.008$).
Note: Positive change-score values indicate improvement on all measures except the TUG_{cog}, where a negative value indicates improvement.
BBS = Berg Balance Scale; TUG_{cog} = timed up-and-go test with cognitive subtraction test added; MCTSIB = Modified Clinical Test of Sensory Interaction and Balance; 6MWT = 6-minute walk test; ABC = Activities-specific Balance Confidence Scale.

as a significant improvement in falls efficacy ($p = 0.001$) relative to the high-falls-efficacy EE participants. Effect sizes for low-falls-efficacy EE participants were moderate to large for all six fall-risk factors, whereas only one moderate effect size was observed for the high-falls-efficacy EE participants. In contrast, for the same variables in the EO group (see Table 4), although there was a similar trend of greater mean change-score values for low- versus high-falls-efficacy participants, these differences were not significant.

DISCUSSION

The purposes of this study were (1) to examine the differences in fall-risk improvement between high- and low-falls-efficacy participants in two different interventions and (2) to examine the relationship between falls efficacy and improvement in fall risk. Although some studies have demonstrated no relationship between improvements in falls efficacy and reduced fall risk following exercise intervention,[48,49] others have shown a mediating effect of falls-efficacy improvement on physical gains[23] or have demonstrated a relationship between baseline falls efficacy and physical performance.[24] There has been little research examining whether individuals with lower falls efficacy respond differently to varying types of fall-prevention exercise interventions. The results of our study show that individuals who had at least one risk factor for falling and a mobility restriction (hip OA) and who had a lower level of falls efficacy were more likely to make gains in both falls efficacy and balance performance than those with higher levels of falls efficacy when they received an intervention combining aquatic exercise with education enhancement.

Despite controversy with respect to the role that improvement in falls efficacy plays in improved physical function, several studies report an association between level of falls efficacy and level of physical performance. Higher levels of falls efficacy are related to better balance performance,[16,17] and falls efficacy independently predicts balance and mobility after controlling for other risk factors such as age, vision, and activity level.[18,50] A meta-analysis of fear-of-falling treatment programmes for the elderly (1966–2006)[51] found a small positive effect in terms of decreasing fear of falls for interventions that

Table 4 Raw Change-Score Values, Percent Change, and Effect Sizes for Fall-Risk Variables for Exercise Only (EO) Group, Divided into Low- and High-Falls-Efficacy Sub-groups

Variable	Falls efficacy: Low; $n = 13$	Falls efficacy: High; $n = 15$	p-value for difference in change score
BBS			
Change score; mean (SD)	1.14 (2.88)	1.17 (1.59)	0.98
% change	4.16	3.70	
Effect size	0.50	0.51	
TUG_{cog}			
Change score; mean (SD)	−0.30 (4.09)	−1.10 (1.53)	0.53
% change	1.59	9.09	
Effect size	0.10	0.36	
MCTSIB			
Change score; mean (SD)	14.90 (30.44)	7.34 (14.53)	0.44
% change	17.82	7.06	
Effect size	0.63	0.31	
6MWT			
Change score; mean (SD)	20.50 (53.93)	7.58 (87.81)	0.65
% change	6.59	1.84	
Effect size	0.30	0.11	
Chair stands			
Change score; mean (SD)	0.86 (2.18)	0.25 (.87)	0.38
% change	16.23	2.84	
Effect size	0.52	0.15	
ABC			
Change score; mean (SD)	4.63 (19.77)	−7.08 (21.61)	0.16
% change	8.61	−7.90	
Effect size	0.23	−0.36	

Note: Positive change-score values indicate improvement on all measures except the TUG_{cog}, where a negative value indicates improvement.
BBS = Berg Balance Scale; TUG_{cog} = timed up-and-go test with cognitive subtraction test added; MCTSIB = Modified Clinical Test of Sensory Interaction and Balance; 6MWT = 6-minute walk test; ABC = Activities-specific Balance Confidence Scale.

included a combination of education (information on reducing the risk of a fall) and some degree of exercise (balance, walking, or weight training) or consisted of education only. However, only six studies met the authors' eligibility criteria. The authors recommended that future research examine different types of intervention programmes, such as those involving cognitive–behavioural restructuring.

The educational component used in this study was developed based on tenets of self-efficacy theory,[15] which emphasizes that building self-efficacy and diminishing fear of an event (in this case, falls) requires a process of education and knowledge building, followed by building confidence in the execution of movements where falls may occur. The education component was also based on prior theory-based, group-mediated cognitive–behavioural interventions in which education to increase self-efficacy, albeit in different domains of performance (i.e., self-efficacy to regulate barriers, to set goals, to schedule/plan exercise), has been shown to be effective in increasing exercise adherence.[43–45] The impact of the educational component included in the EE condition, which was designed to address the primary sources of self-efficacy (including mastery, social persuasion, and knowledge of physiological and affective states), may have been greater than that of the basic information typically included in fall-prevention educational sessions. As well, participants in this study presented with a mobility restriction and at least one other fall-risk factor; individuals with hip OA who also have lower levels of falls efficacy may present with a unique set of physical and social characteristics that increase their receptiveness to a combined programme of exercise and self-efficacy-enhancing education. Adults with lower-extremity arthritis tend not to participate in regular physical activity as much as those without lower extremity arthritis;[52] flare-ups of pain following activity combined with lower confidence in the ability to overcome barriers to exercise may be one factor influencing this finding.[53] It is possible that the addition of support from others and an experienced health care professional in an educational context may help individuals with lower levels of falls efficacy cope with exercise and realize greater functional gains.

The 27% gain in falls efficacy following the EE intervention that was observed for individuals who entered with low baseline falls efficacy represents an improvement substantial enough to move someone from a high to a low fall-risk category through a short 11-week intervention. By comparison, our study found an 8% improvement for participants with lower falls efficacy in the EO condition, and a decline in falls efficacy for individuals who had higher levels of falls efficacy at baseline in both EE and EO conditions. Those with lower falls efficacy at baseline also presented with lower scores for functional status (i.e., balance, AIMS-2, ABC, and 6MWT) relative to individuals with high falls efficacy. This finding was expected, since previous studies have found similar results where there are differences in mobility levels and fall history between low- and high-falls-efficacy groups.[29,39] Although participants with low falls efficacy at baseline had more room to improve on the 0–100 ABC Scale than those who started with higher scores, it is interesting that a substantial improvement was noted for the low-falls-efficacy sub-group in EE. If individuals with lower falls efficacy can make significant gains in their confidence with a combined exercise and education programme, then they may substantially reduce the risk of future falls. As well as improving their falls efficacy, individuals with lower falls efficacy at baseline also showed greater improvement in balance scores in the EE intervention. Although the potential ceiling effect for the BBS and MCTSIB may have made it less likely for participants with higher baseline falls efficacy to realize much improvement (although improvement was still possible), relationships were found between levels of falls efficacy and balance change scores for the EE intervention that were not apparent for the EO intervention. These gains have the potential to be clinically relevant in diminishing future fall risk.[54] Similarly, Arai and colleagues[24] found a significant relationship between lower levels of falls efficacy at baseline and greater improvement in functional change (as measured by walking velocity and knee strength) in an exercise-only intervention among older adult participants. Our study found a stronger relationship between baseline falls efficacy and fall-risk outcome than was observed by Arai and colleagues,[24] which may suggest that adding education to an exercise intervention produces a greater impact on functional change than exercise alone. This finding may be important to consider when screening individuals for fall risk and subsequent programme referral: individuals with lower falls efficacy may respond better to exercise programmes with additional education and health professional support.

Limitations

One limitation of this study was the sample size, which was too small to allow for an evaluation of the impact of multiple factors on fall-risk outcomes. The study results should be interpreted with caution, as participants with low falls efficacy were found to be older, with more comorbidities and lower functional status; as such, they had more room to improve on the measures of interest, particularly balance. In contrast, those with higher falls efficacy exhibited a near potential ceiling effect, with smaller room for improvement. This information is valuable, however, because those with low falls efficacy are those most in need of improvement in functional status, which appears to be achieved through the EE intervention used in the present study. Further, some of the socio-demographic and comorbid factors that distinguished individuals with lower and higher levels of falls efficacy may be just as important as falls efficacy itself in screening individuals. Further study is warranted to evaluate the effects of such factors in fall-risk change with different interventions. Another limitation was that participants already presented with at least one risk factor for falling plus a mobility restriction (hip OA), which limits the extent to which our findings can be generalized to a broader population of community-dwelling older adults at risk of falls. However, the advantage of limiting the study sample was that it was possible to identify sub-groups of older adults at risk of falls and the type of intervention that would be of optimal benefit. It may be prudent for clinicians to screen individuals for several fall risk factors, including falls efficacy, and streamline individuals with higher risk into interventions that combine exercise with self-efficacy-enhancing education sessions. Another limitation of the study design was the extra time allotted to the educational component in the EE group, which the EO group did not receive. EE participants received an additional half-hour once per week; it is difficult to conclude whether the impact of EE was due to the education received or to the additional time spent with a health professional and interacting with the group. The addition of a social component to the EO condition would have helped to alleviate this concern.

Finally, although the relationship between falls efficacy and several measures of fall risk was evaluated in this study, this is only a small part of a complex relationship of physical and social-psychological factors that affect fall risk. The complex and integrative relationship between mind and body has been identified and discussed for centuries.[55] The complex function of the brain, integrating emotion, cognition, and behaviour, has a strong influence on physical performance throughout the lifespan and in a variety of environmental contexts.

CONCLUSIONS

Our study results demonstrate that individuals with lower levels of falls efficacy respond differently than those with higher levels of falls efficacy to an intervention targeted at building confidence in movement. Based on this finding, we recommend further study of the impact of falls efficacy on risk factors for falling and the effect of programming designed to address falls-efficacy concerns. Specifically, studies with larger samples should test the moderating and mediating effects of falls efficacy on change in risk factors and fall rates in populations with known fall risk. As well, interventions combining exercise and education need to incorporate theory in their design and the accompanying strategies to enhance self-efficacy beliefs. Individuals with higher levels of falls efficacy may not need this type of more intensive intervention, and thus could be directed to community-based exercise programmes. Future work should also identify which specific component(s) of the education sessions in an EE intervention produce the strongest impacts on outcomes. Understanding this could lead to more streamlined interventions that include only those components that result in the desired changes. Finally, research on fall-prevention strategies needs to consider the multifarious nature of social-psychological parameters and physical performance and their composite impact on fall risk in a variety of higher-risk populations.

KEY MESSAGES

What Is Already Known on This Topic

Lower levels of falls efficacy are associated with lower levels of physical function and increased fall risk. Individuals with chronic pain conditions, such as hip osteoarthritis, present with higher fall risk because of the additive impact of both physical and social-psychological fall risk factors. Targeting populations known to be at higher risk and tailoring combined theory-based educational and exercise interventions to address these factors may result in improved physical and social-psychological function, although currently there is insufficient evidence to support this claim. Diminishing an individual's fear of future falls can improve his or her ability to participate in physical activity and thus create a behavioural change that will lead to maintaining a lower fall-risk status.

What This Study Adds

This study examined the impact of falls-efficacy status on subsequent reduction in fall risk following two interventions. The results support the argument that falls efficacy is an important risk factor to consider prior to making decisions about the best intervention for individuals at higher risk of falls. Combining self-efficacy-enhancing education with exercise may be a successful strategy, particularly for older adults identified as having lower levels of falls efficacy.

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