Author(s): Edgren, Johanna; Salpakoski, Anu; Rantanen, Taina; Heinonen, Ari; Kallinen, Mauri; von Bonsdorff, Mikaela; Portegijs, Erja; Sihvonen, Sanna; Sipilä, Sarianna

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BALANCE CONFIDENCE AND FUNCTIONAL BALANCE ARE ASSOCIATED WITH PHYSICAL DISABILITY AFTER HIP FRACTURE

Johanna Edgren MSc[1], Anu Salpakoski MSc[1], Taina Rantanen PhD[1], Ari Heinonen PhD[2], Mauri Kallinen MD, PhD [3], Mikaela B von Bonsdorff PhD[1], Erja Portegijs PhD[1], Sanna Sihvonen PhD[4], Sarianna Sipilä PhD[1,2]

[1]Gerontology Research Center and Department of Health Sciences, University of Jyväskylä, Finland*

[2]Department of Health Sciences, University of Jyväskylä, Finland

[3]Department of Physical and Rehabilitation Medicine, Central Finland Central Hospital, Jyväskylä, Finland

[4] JAMK University of Applied Sciences, Jyväskylä, Finland

Corresponding author:

Johanna Edgren, MSc

Gerontology Research Centre and Department of Health Sciences

University of Jyväskylä

P.O.Box 35 (Viv)

40014 University of Jyväskylä

FINLAND

E-mail: johanna.edgren@jyu.fi

Telephone: +358-40-8053565

Fax: +358-40-8053565

Anu Salpakoski: anu.salpakoski@jyu.fi; Taina Rantanen: taina.rantanen@jyu.fi; Ari Heinonen: ari.heinonen@jyu.fi; Mauri Kallinen: mauri.kallinen@ksshp.fi; Mikaela von Bonsdorff: mikaela.vonbonsdorff@jyu.fi; Erja Portegijs: erja.portegijs@jyu.fi; Sanna Sihvonen: sanna.sihvonen@jamk.fi; Sarianna Sipilä: sarianna.sipila@jyu.fi

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Key words: Functional capacity, Fracture, Aging, Fear of falling, Postural balance

ABSTRACT

Background: This cross-sectional study investigated the associations between balance confidence, functional balance, and physical disability among older people after hip fracture. **Material and methods:** The study utilizes baseline data of two randomized controlled trials (ISRCTN34271567 and ISRCTN53680197). The participants were 159 community-dwelling over 60-year-old people. Health, fracture status, the date and type of surgery, and contraindications for participation were assessed in a clinical examination. Balance confidence was assessed by the Activities-specific Balance Confidence Scale (ABC) and functional balance by the Berg Balance Scale. Physical disability was assessed by a questionnaire containing 14 questions on perceived difficulty in basic (ADL) and instrumental activities of daily living (IADL). Two sum scores were composed: ADL score (range 0–6) and IADL score (range 0–8). Isometric knee extension force was measured using a dynamometer. Pain and use of walking aids were assessed by a questionnaire. The negative binomial regression analysis was used to analyze the associations. **Results:** A higher ABC score was associated with a lower risk for ADL (IRR 0.99, 95% CI 0.98–0.99) and IADL disability (0.99; 0.98–0.99) in the fully adjusted models. Also a higher BBS score was associated with a lower risk for ADL (0.98; 0.96–0.99) and IADL disability (0.98; 0.97–0.99) in the fully adjusted models. **Conclusion:** Decreased balance confidence and impaired functional balance are associated with physical disability in older people after hip fracture.

INTRODUCTION

Hip fracture is a common and severe trauma in older people, leading to balance impairments, decreased muscle strength, and loss of independence in daily activities [1,2]. It's also known that only half of the hip fracture patients regains their pre-fracture level of functional ability [2] and 15% will be institutionalized permanently [3]. Long-lasting mobility limitation after hip fracture may lead to prolonged physical disability as well as new injurious falls and fractures [2]. The incidence of hip fractures increases with age and the total number of fractures is expected to rise due to ageing of the population [4].

Although only five percent of all falls cause a fracture, approximately 95% of all hip fractures are caused by a fall [5,6]. The risk factors for falls interact with each other and large individual variation exists. The risk of falling increases rapidly with the number of risk factors. Impaired functional balance is considered the most common risk factor for further falls and fractures after a previous hip fracture [7]. Balance control has also a fundamental role in various activities of daily living, especially in those that require independent standing or walking. Furthermore, those who have had a fall with a traumatic consequence often experience fear of falling even years after the incident [7]. Additionally, fear of falling has been strongly associated with future falls [8,9].

One method of operationalizing fear of falling is to assess self-reported balance confidence using the Activities-specific Balance Confidence Scale (ABC) described by Powell et al. [10]. Decreased balance confidence has been associated with poor functional balance, increased disability, and reduced quality of life in community-dwelling older people [8,11,12]. Individuals with low balance confidence and balance impairments are also likely to reduce their physical and social activity, which in turn predicts the onset of disability

[13]. Based on our clinical experience, self efficacy and balance confidence are low in hip fracture patients who have suffered a traumatic fall accident, which might drastically slow down or disable the rehabilitation process. At the moment the scientific evidence regarding the association between balance confidence and rehabilitation outcome after hip fracture is insufficient.

To our knowledge there are no other studies that have simultaneously examined associations of low balance confidence and balance impairments in relation to physical disability, in older people who have suffered a hip fracture. However, these associations should be studied to better understand the factors potentially affecting the recovery and rehabilitation processes after hip fracture. The purpose of this study was to investigate the associations between decreased balance confidence, impaired functional balance, and physical disability among older people who have sustained a previous hip fracture.

MATERIAL AND METHODS

Participants

This cross-sectional study pooled the baseline data of two randomized controlled trials (ISRCTN34271567 and ISRCTN53680197). In both studies the participants were recruited from the Central Finland health care district with identical inclusion and exclusion criteria [14, 15]. Patient records at the Central Finland central hospital were reviewed (in the fall of the years 2004-2005 and throughout the years 2008-2010) to recruit over 60-years-old, ambulatory and community-dwelling people who were living in the city of Jyväskylä or the neighboring municipalities, and had been operated for femoral neck or trochanteric

fracture (ICD code S72.0 or S72.1). All potential participants (n=748) were informed of the study by a written information letter. Those willing to participate (n=293) were interviewed over the telephone or met during the inpatient period at the health care centre to ensure their suitability for the study. The exclusion criteria were: inability to move outdoors without assistance of another person, amputation of a lower limb, severe progressive or neurological diseases, alcoholism and severe memory problems (Mini Mental State Examination, MMSE<18 [16]). The pooled analysis includes information collected from 159 participants (113 women, 46 men) who had sustained a hip fracture on average 1.7 years earlier. Measurements were performed in the same research center using the same equipment and protocols. The Ethical Committee of the Central Finland health care district approved both studies. Before the laboratory assessments all participants gave their written informed consent.

Methods

Review of the medical data and health status

During a medical examination performed by a nurse and physician, the presence of chronic conditions, the use of prescription medication, fracture status, and the date and type of surgery were confirmed according to a pre-structured questionnaire, current prescriptions, and medical records obtained from the local hospital and health care centers. Contraindications for participation in muscle strength and balance assessments were evaluated by the physician [17].

Balance confidence

A modified Finnish version of the Activities-specific Balance Confidence Scale (ABC [10,18]) was used to assess confidence in performing specific activities without becoming unsteady. Balance confidence can be regarded as a measure of fear of falling [10]. The modified ABC scale consists of 16 items. Subjects are requested to describe, how confident they are in carrying out different tasks, indoors and outdoors. Answers for each question were rated from 1 (no confidence) to 10 points (total confidence). The total score ranges from 16 to 160 and higher scores indicate better balance confidence.

Functional balance

Functional balance was assessed by the Berg Balance Scale (BBS [19]) which evaluates the ability to perform 14 different tasks such as standing up, sitting down, reaching and turning around oneself, looking over the shoulders and standing on one foot. The ability to perform each task is rated from 0 (incapable) to 4 (safe and independent). The total score ranges between 0–56 and higher scores indicate better functional balance.

Physical disability

Physical disability was assessed by a validated questionnaire [20] estimating perceived difficulties in basic (ADL) and instrumental activities of daily living (IADL). The questionnaire included six questions on ADL (eating, transferring from/to bed, dressing, bathing, cutting toe nails, and toileting [20,21]) and eight questions on IADL (preparing food, doing laundry, coping with light house work, coping with heavy house work, handling medication, using the telephone, using public transportation, and handling finances [20,22]). There were five response categories: 1) I manage without difficulties, 2) with some difficulties, 3) with lots of difficulties, 4) I can’t manage without assistance of

another person, and 5) I can't manage even when assisted. The original categorical variables were dichotomized; a) Without difficulty (category 1) and b) Difficulty (categories 2–5). Subsequently, two sum scores were composed: ADL score (ranging from 0–6) and IADL score (ranging from 0–8). Higher scores indicate more difficulty.

Confounders

Isometric muscle force (Newton) for knee extension was measured on the fractured side by an adjustable dynamometer chair (Metitur Ltd, [23]. During the measurement the ankle was attached to a strain-gauge system with the knee angle fixed at 60° from full extension. Participants were encouraged to extend the leg as hard as possible. After two to three practice trials, measurements were performed at least three times until no further improvement occurred. Each contraction was maintained for two to three seconds. The inter-trial rest period was 30 seconds. The performance of the highest maximal force was used for analysis.

Pain on the fractured side was assessed by two questions "Have you experienced pain in the lower back, hip, knee, ankle or foot on your left/right side? Has the pain compromised your mobility?" The response alternatives were 1) No, 2) Yes, but it is not offending, 3) Yes, and it is offending. A new variable "offending pain of the fractured side" was composed based on the answers. The use of walking aids outdoors was assessed by the question: "Do you use walking aids when going outdoors? Response alternatives were Yes/No.

Statistical analysis

The means, standard deviations, frequencies, and percentage values were calculated for the background variables. The associations between balance confidence and physical disability as well as between functional balance and physical disability were assessed by negative binomial regression which is a generalization of the Poisson regression that accounts for the over dispersion detected in Poisson models. The negative binomial regression model takes into account that disability tends to be a cumulative phenomenon and that having difficulty in one activity makes it more likely to have difficulty in two or more activities. Thus, the observations of the increasing number of difficulties are non-independent of each other. With this approach, it is possible to enter the Poisson-distributed count variable for the number of difficulties in the models. The risk values are expressed as incidence rate ratios (IRR) obtained by exponentiation of the regression coefficients (exp[β]), and their 95% confidence intervals (CI). The expression 100*(IRR-1) indicates the percentage change in ADL and IADL scores relative to ABC or BBS score. The crude model was adjusted for age and gender and the second model additionally for time since fracture, offending pain on the fractured side, number of chronic diseases, maximal force of the fractured leg, and the use of walking aids outdoors. Finally, both ABC and BBS scores were included simultaneously in the negative binomial regression model.

The Kolmogorov-Smirnov test was used to test the normality of distributions. Only the ABC score was normally distributed. Thus, the Spearman correlation was used to analyze the association between the ABC and BBS. The Spearman ρ was raised to the second power to express the coefficient of determination (R^2) for ABC relative to BBS. Regression modeling was performed using STATA 12 statistical software. All other analyses were performed using PASW Statistics 18.

RESULTS

The average age of the participants was 77.4 (SD=7.2) years and the mean time elapsed since the fracture was 1.7 (2.1) years. Seventy-three percent was female, 47 % had an internal fixation and 53 % an arthroplasty operation. The mean ABC score was 91.5 (32.3) points, i.e. 58 % of the maximum score. Furthermore, the mean BBS score was 44.1 (9.3) points, i.e. 79 % of the maximum. The median values of ADL and IADL score were one and three, respectively. The participant characteristics are presented in Table 1.

[Table 1]

Table 2 shows the IRR's and 95% CI's for ADL and IADL disability relative to balance confidence and functional balance. A higher ABC score was associated with a lower risk for ADL disability (fully adjusted IRR 0.99, 95% CI 0.98–0.99). This indicates that e.g. a 10-point increase in ABC score decreased the risk for ADL disability with 10 percent. The association between balance confidence and IADL disability was similar (0.99; 0.98–0.99). Furthermore, a higher BBS score was associated with a lower risk for ADL (0.98; 0.96–0.99) and IADL disability (0.98; 0.97–0.99) in the fully adjusted models. This indicates that e.g. a 10-point increase in BBS score decreased the risk for ADL and IADL disability with 20 percent.

[Table 2]

The ABC and BBS scores correlated highly but not fully (Spearman ρ=0.69) and the ABC score explained 48% of the variation in BBS score (R^2=0.476). However, placing the ABC and BBS scores together in the same regression model with ADL or IADL did not

materially change their individual IRR's (Table 2). This implies that the ABC and BBS represent partly different phenomena and they cannot be considered as surrogate measurements. However, in the fully adjusted models the associations between the BBS score and ADL as well as IADL disability were attenuated.

DISCUSSION

This cross-sectional study investigated the associations between balance confidence, functional balance, and physical disability in community-dwelling older men and women who had sustained a previous hip fracture. We found an independent association between decreased balance confidence and ADL/IADL disability as well as between impaired functional balance and ADL/IADL disability. To our knowledge, this is the first study which has simultaneously examined the associations of balance confidence and functional balance with disability in this group of older people with high risk of losing independence.

Balance confidence and functional balance both have an essential role in coping with daily activities. Moreover, among older hip fracture patients, reduced balance confidence and impaired functional balance may complicate and delay the rehabilitation process. In the present study examining older people with a history of traumatic fall accident, we showed that decreased balance confidence was significantly associated with ADL disability. The association between decreased balance confidence and IADL disability was similar. Our results are in line with previous studies pointing out that fear of falling is associated with increased physical disability in community-dwelling older people [8,11,13]. The majority of hip fractures are a consequence of falls [5,6] and falls with traumatic consequences often generate long-lasting fear of falling [8]. On the other hand, fear of falling leads to

activity restriction and exercise avoidance, which in turn results in more severe functional limitations and disability. Few randomized controlled trials that have concentrated on methods of reducing fear of falling among hip fracture patients have yielded inconsistent results [24-26]. Thus, there is need for further research in order to develop better rehabilitation practices.

Additionally, our results indicate that also impaired functional balance was significantly associated with both ADL and IADL disability, and adjusting for several known confounders marginally changed the associations. Our findings are consistent with prior studies showing that functional balance is strongly associated with independence in daily activities after hip fracture [27,28]. Thus, our study together with prior studies indicate that hip fracture patients comprise a special group of older people who have impaired functional balance and a greater risk for increased physical disability.

As far as we know, this is the first study to show a strong association between decreased balance confidence and physical disability together with impaired functional balance and physical disability in this important clinical group of older people. In our study, balance confidence was strongly associated with functional balance explaining half of the variation in functional balance. However, including both of them simultaneously in the regression model did not materially change the individual IRR´s. This suggests that the Activities-specific Balance Confidence Scale and Berg Balance Scale cannot be considered equivalent for each other. Thus, when new rehabilitation practices are developed for hip fracture patients, it should be taken into account that balance training by itself may not be successful without balance confidence management.

The strengths of the present study include firstly that we recruited a unique clinical group of community-dwelling older people who had sustained a hip fracture. The patient records of the Central Finland central hospital were used for this purpose. Secondly, we included a comprehensive battery of laboratory based physical and functional assessments as well as medical review for health and fracture status. By these assessments we were able to design a valid statistical model, with relevant and necessary confounders, to estimate the association between physical disability, balance, and balance confidence.

Some study limitations should be noted. The results of this study can't be generalized to all hip fracture patients because the participants in the present study were all relatively healthy. They were all community-dwelling, and those who were unable to walk independently outdoors or had severe diseases or cognitive problems were excluded. Thus, our results probably underestimate the association between functional balance, balance confidence, and physical disability among older hip fracture patients. If we had been able to study also more frail patients, the association would have been even stronger. Additionally, because of the cross-sectional study design, the causality between balance confidence, functional balance, and physical disability remains unclear. Therefore, it is possible that disability caused a sedentary lifestyle and was followed by low balance confidence and impaired functional balance. Either way, there is need for effective physical rehabilitation.

In conclusion, decreased balance confidence and impaired functional balance are important determinants of physical disability in older people who have sustained a hip fracture. Additionally, the ABC scale complements the functional balance assessment and may potentially be used as a screening tool for impaired functional balance in clinical practice when instant assessment of functional balance is not possible. Furthermore, it is essential

to examine what kind of interventions are effective in enhancing functional balance and especially balance confidence among older hip fracture patients. It is also important to study what kind of rehabilitation is effective to reduce physical disability and how older people can be encouraged to be physically active even in the presence of fear of falling, balance impairments, and increased physical disability. In the future, long-enough follow-up studies with adequate sample size are needed to assess the effects of different kind of rehabilitation programs as well as the determinants of physical disability after hip fracture.

CONFLICT OF INTEREST STATEMENT

The authors of this manuscript have no financial or personal relationships with other people or organizations that could inappropriately bias this work.

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Table 1. Characteristics of older people with a previous hip fracture

	n=159
Age (yr)	77.4 ± 7.2
Gender: female, n (%)	116 (73)
Time since fracture (yr)	1.7 ± 2.1
Number of chronic diseases	3 ± 2
Operation type, n (%)	
Internal fixation	74 (47)
Arthroplasty	85 (53)
Offending pain/fractured side, n (%)	93 (59)
Maximal force/fractured limb (N)	208,3 ± 96.3
Use of walking aids outdoors, n (%)	110 (69)
BBS (total score)	44.1 ± 9.3
ABC (total score)	91.5 ± 32.3
Median of the ADL sum score (range)	1 (0-6)
Median of the IADL sum score (range)	3 (0-8)

All means are expressed: ± SD

BBS = Berg Balance Scale

ABC = Activities-spesific Balance Confidence Scale

ADL = activities of daily living

IADL = instrumental activities of daily living

Table 2. IRR's and 95% CI's for physical disability (ADL and IADL) in negative binomial regression model with ABC and BBS scores

	ADL				IADL			
	Model 1.*	p	Model 2.**	p	Model 1.*	p	Model 2.**	p
ABC	0.99 (0.98–0.99)	<0.001	0.99 (0.98–0.99)	<0.001	0.99 (0.98–0.99)	<0.001	0.99 (0.98–0.99)	<0.001
BBS	0.96 (0.95–0.98)	<0.001	0.98 (0.96–0.99)	<0.001	0.96 (0.95–0.97)	<0.001	0.98 (0.97–0.99)	<0.001
ABC	0.99 (0.98–0.99)	<0.001	0.99 (0.98–0.99)	0.009	0.99 (0.98–0.99)	<0.001	0.99 (0.98–0.99)	<0.001
BBS	0.98 (0.96–0.99)	0.015	0.98 (0.97–1.00)	0.055	0.99 (0.97–0.99)	0.009	0.99 (0.97–1.00)	0.118

ABC = Activities-specific Balance Confidence Scale

BBS = Berg Balance Scale

* Adjusted for age and gender

** Adjusted for age, gender, time since fracture, offending pain on the fractured side, number of chronic diseases, maximal force of the fractured leg, and the use of walking aids outdoors