


Task-specific balance training improves self-assessed function in community-dwelling older adults with balance deficits and fear of falling: a randomized controlled trial

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Abstract

Objective: To evaluate the effects of a 12-week balance training programme on self-assessed function and disability in healthy community-dwelling older adults with self-perceived balance deficits and fear of falling.

Design: A prospective, randomized controlled trial.

Setting: Stockholm County, Sweden.

Participants: A total of 59 community-dwelling older adults (42 women and 17 men) aged 67–93 were randomized to either an intervention group ($n = 38$) or to serve as controls ($n = 21$) after baseline testing.

Intervention: The intervention was a 12-week, three times per week, progressive, specific and individually adjusted group balance-training programme.

Main measures: Self-perceived function and disability measured with Late Life Function and Disability Instrument.

Results: The intervention group reported improvement in overall function ($p = 0.016$), as well as in basic ($p = 0.044$) and advanced lower extremity function ($p = 0.025$) compared with the control group. The study showed no improvement in overall disability or upper extremity function.

Conclusion: This group balance training programme improves self-assessed function in community-dwelling older adults with balance deficits and fear of falling.

Keywords

Balance deficits, elderly, training, late life function and disability instrument

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Introduction

Only limited evidence exists for the effects of balance training on function and disability in older adults, which are important concepts when discussing health. According to Guralnik and Ferrucci,¹ disability is defined as the gap between personal capability and environmental and/or social demands, while function is concerned with the individual's capacity to carry out activities relevant to effective community living, such as walking, climbing, reaching, lifting and handling everyday objects.

The limited evidence for the effects of exercise on balance function in older adults is probably owing to the lack of standardization in regard to both exercise and evaluation methods. A review by Cochrane from 2011² concluded that there is weak evidence that exercises for gait, balance, co-ordination and functional tasks, as well as strengthening exercises, three-dimensional exercises and other multiple exercise types are moderately effective, immediately postintervention, in improving clinical balance outcomes in the elderly. However, it has been found that specific balance training programmes have a greater effect on balance function than general exercise programmes.³ Specific balance training programmes should, consequently, include dual-task exercises that imitate daily life. Thus, there is a need to develop comprehensive balance training programmes for the elderly that are individually adjusted. These programmes must be progressive and task-specific, and yet meet the demand for well described and standardized exercise methods.

A new comprehensive group balance training programme for older adults has been described by Halvarsson and co-workers.⁴ The programme decreased fear of falling, shortened the time to take a rapid step during a dual-task and increased gait speed; it was also found to be feasible and appreciated. The effects of the programme have not yet been evaluated with regard to self-reported function and disability.

The aim of the present study was, therefore, to evaluate the short-term effects of a 12-week progressive, task-specific and individually adjusted

group balance training programme in community-dwelling older adults with balance deficits and fear of falling, with regards to self-reported function and disability using the Late Life Function and Disability Instrument.

Materials and methods

The method has been described in our companion article.⁴ In brief, this is a prospective, randomized controlled trial with a 12-week follow-up. Sample size was set to a minimum of 20 subjects/group based on an estimation from a pilot study.⁵ Participants were recruited by advertising in the local newspapers of six suburbs in the Stockholm area of Sweden. The inclusion criteria were age ≥ 65 years, fear of falling and/or experience of a fall during the previous 12 months, ability to walk unaided indoors and a Mini-Mental State Examination (MMSE) score ≥ 24 .⁶ The exclusion criteria were severely impaired vision or hearing, severe cancer, severe pain, neurological disease or damage with symptoms, dizziness requiring medical care or heart and respiratory problems that might affect participation. At baseline, testing subjects were randomized to either the intervention group or control group by drawing an allocation slip from an envelope, in blocks, with a 2:1 allocation in favour of the intervention group.

The Late-Life Function and Disability Instrument (LLFDI) protocol was filled out at baseline and at the 12-week follow-up by interviewer-administered, self-assessment. Test leaders were experienced physiotherapists, and were blinded to group allocation at baseline but not at follow-up.

The intervention studied was a 12-week programme of progressive, task-specific and individually adjusted group balance training.⁴ Training was carried out three times per week, in 45-minute sessions, in groups of six to seven subjects, led by two physiotherapists to guarantee safety. A minimum of 70% attendance during the 12-week programme was needed to be able to evaluate the effects of training. The balance training programme followed the concept according to the manner of Oddsson et al.,⁷ and was carried out with varying levels of complexity.

The programme included exercises aimed at keeping balance in sitting and standing positions, during walking and while reacting to loss of balance. Exercises included combined cognitive and motor challenges (dual- and multi-tasking); in other words, subjects performed a cognitive and/or motor exercise at the same time as they performed advanced balance exercises. Exercises were individualized and varied by adjusting the area of the support base, changing the positioning of the arms, adding concomitant head movements, varying the exercise speed and by adding dual- or multi-tasks.

Participants in the control group were encouraged to continue living as before (i.e. same activity level), and were offered a chance to participate in the training programme after the study was finished.

LLFDI has a function component and a disability component, in which function refers to the person's ability to perform activities requiring motor actions, and disability refers to the person's performance of socially defined life tasks.^{8,9} The 32 items in the function component rate task difficulty by asking how much difficulty one has in performing daily activities. Response options range from 'none' to 'cannot do', and score from 5 to 1, respectively (i.e. the higher the score, the less the difficulty). The function component is summarized in an overall function subscale, as well as the three subscales: upper extremity, basic lower extremity and advanced lower extremity.⁸

The 16 items in the disability component rate task difficulty and task frequency by asking how limited one feels in performing socially defined life tasks, and how frequently they are performed. Frequency response options range from 'very often' to 'never'. Limitation response options range from 'not at all' to 'completely'. Both frequency and limitation response score from 5 to 1, and the higher the score, the less disabled one is. Frequency is summarized in overall frequency and limitation is summarized in overall limitation.⁹

Sum scores are calculated by adding up item scores from each dimension and their subscales, and are transformed to scaled scores (0–100) based on a one-parameter Rasch model, in order to have a linear scale that is easier to interpret. Use of the

scaled scores requires a response on all items.^{8,9} Missing values were, therefore, replaced by calculating the sum score of the items that had been completed divided by the number of completed items, and then multiplying by the number of items in the component (function 32 and disability 16). One questionnaire was incomplete at follow-up regarding the function component, with several missing values (16/32 items), and was therefore excluded from the analysis.

All statistical analyses were performed using PASW Statistics, version 20.0 (SPSS Inc., Chicago, IL, USA). Scaled scores of the LLFDI were used; hence parametric statistical methods were chosen for the analyses. Data are presented as mean, median, SD, number (*n*), minimum–maximum (min–max) and frequency (%). Differences between groups regarding LLFDI were analysed with a two-factor repeated-measures analysis of variance (ANOVA), using the main effect of factor 1 (time), factor 2 (group) and interaction effects of both factors (time × group). *P*-value was set to ≤0.05. Effect size for independent samples was calculated with Cohen's *d* (Cohen's *d* = difference between sample means/pooled standard deviation)¹⁰ and guidelines for interpretation of effect size according to Cohen, i.e. 0.20 = "small effect size", 0.50 = "medium effect size" and 0.8 = "large effect size".¹¹ The study protocol complied with Helsinki rules on human research, and was approved by the Local Ethics Committee in Stockholm, Sweden, D.Nr: 2006/151-31.

Results

There were 146 responses to the advertisements. Out of these, 87 did not meet the inclusion criteria, resulting in a total of 59 older adults included in the study. Of these, 38 were randomized to the intervention group and 21 to the control group (Figure 1). Demographic data of the participants are presented in Table 1.

There were no differences between the two groups at baseline regarding age, gender, social situation, body composition, mental status, education, medication or morbidity (see Table 1).

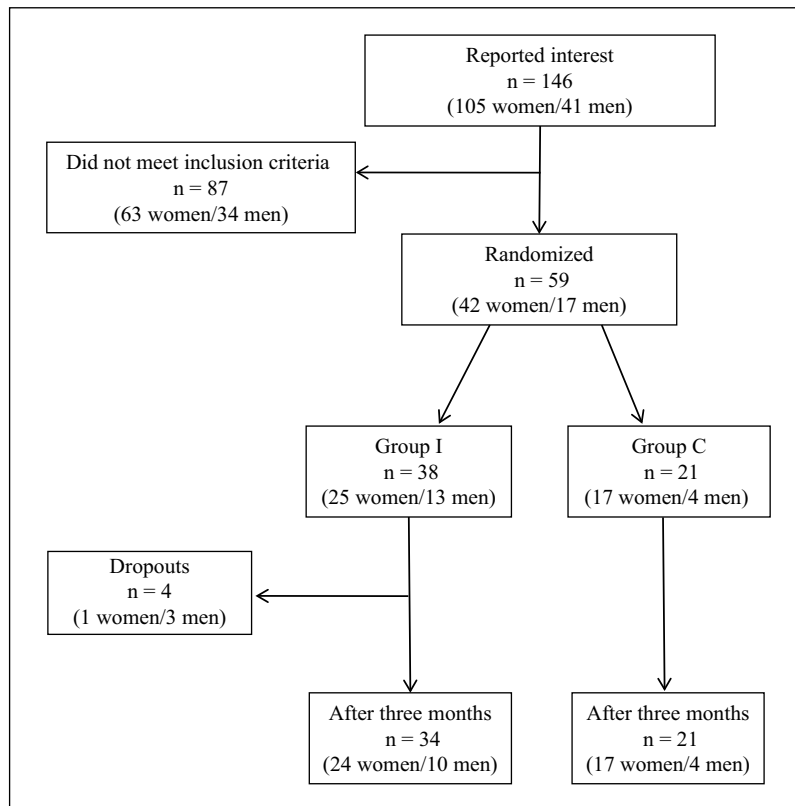


Figure 1. Persons reporting interest in study, assigned at random to intervention or control group and drop-outs.⁴

A total of 55 participants followed through with the study. Four were lost to follow-up given: low compliance ($n = 1$), disease ($n = 1$) and discontinued training ($n = 2$). Attendance at balance training sessions was, on average, 87% (71%–100%).

The LLFDI mean outcome for the two components and their subscales, at baseline and follow-up, in both the intervention group and control group are presented in Table 2. Analysis over time and between groups, for the function component, revealed a significant increase in overall function ($p = 0.016$) and for subscales basic lower ($p = 0.044$) and advanced lower extremity ($p = 0.025$) all with a medium effect size (0.57–0.69). For within-group comparison from baseline to follow-up, the intervention group had significantly increased their overall function ($p < 0.001$, 5 points), upper extremity ($p = 0.004$, 4.6 points),

basic lower extremity ($p < 0.001$, 6.7 points) and advanced lower extremity ($p < 0.001$, 6.2 points) (Table 2).

Analysis over time and between groups for the disability component showed no significant differences. A significant difference over time in the intervention group was, however, found in the overall frequency subscale ($p = 0.012$). The intervention group improved their overall frequency value by 2.4 points, and the control group improved their value by 0.3 points.

Discussion

The present study showed that task-specific balance training improved overall function as well as basic and advanced lower extremity function in older adults. The mean improvement exceeded the

Table 1. Demographic data of participants in intervention group and control group at time of randomization.

Variable	Intervention group (n = 38)	Control group (n = 21)
Age (years; mean (min–max))	76 (67–93)	78 (69–91)
Gender female/male (n (%))	25 (66)/13 (34)	17 (81)/4 (19)
Living alone/together (n (%))	18 (47)/20 (53)	12 (57)/9 (43)
House/apartment (n (%))	2 (5)/36 (95)	1 (5)/20 (95)
Education		
Elementary school (n (%))	11 (29)	3 (14)
High school (n (%))	8 (21)	5 (24)
College or university (n (%))	19 (50)	13 (62)
Body Mass Index (kg/m ² , median (min–max))	26 (21–41)	25 (20–39)
Mini Mental State Examination (median (min–max))	28 (24–30)	29 (26–30)
Prescribed medications (n; median (min–max))	2 (0–9)	1 (0–9)
Fear of falling (n (%))	32 (84)	18 (86)
Experienced a fall during the last 12 months (n (%))	34 (89)	19 (90)
Diagnosis		
Diabetes mellitus (n)	6	2
Hypertension (n)	18	9
Stroke (n)	3	1
Myocardial infarction (n)	2	2
Heart failure (n)	1	2
Angina (n)	2	4

measurement error of the instruments as well as the effect size, and can, therefore, be considered clinically relevant. Improvement in physical function contributes to a more physically active lifestyle and independence in daily life.

The balance training programme focuses on activities and tasks including lower and upper extremity engagement and dual-task activities, such as walking while carrying a tray with filled glasses, closing buttons or climbing over obstacles, i.e. relates to functions commonly used in typical daily activities. According to the definition of function by Guralnik and Ferrucci,¹ the participants in the present study improved their individual capacity to carry out activities relevant to effective community living.

Specific exercises pertaining to arm function were not specifically emphasized in the balance training programme. This is confirmed in the results, showing improvement only in lower extremity functions ($p = 0.044/0.025$) and not in upper extremity functions ($p = 0.661$).

As anticipated, no significant effect was found on disability ($p = 0.120/0.536$) in the present study. The participants had slight to no disability prior to participating in the study according to the classification of Jette and co-workers.⁹ They were healthy, community-dwelling elderly using no individual community services and probably, therefore, had no or little potential to improve. Also, the training programme included balance training, primarily aimed at improving body functions, and structures and activities according to the International Classification of Functioning, Disability and Health (ICF),¹² with limited potential to influence disability as such. To do so, hindrances and facilitators in the physical, social and attitudinal world of the individuals probably had to be addressed; this was not the aim of the present study. Our findings are in accordance with Motl and McAuley,¹³ who conclude that the literature shows less conclusive evidence for effects of physical exercise on disability than function.

Table 2. Mean and SD for the two components of the LLFDI. The function component includes the subscales: overall function, upper, basic lower and advanced lower extremity. The disability component includes the subscales: overall limitation and overall frequency. Improvement in mean outcome (points) for the two components of the LLFDI and values marked by bold are exceeding standard error of measurement (SEM). A two-factor repeated-measure ANOVA was used to analyse differences over time and between groups. A significant level at ≤ 0.05 is marked by bold type. Effect size calculated for independent samples with Cohen's *d*.

LLFDI	Intervention group <i>n</i> = 34		Control group <i>n</i> = 21		P-value time	P-value time × group	Effect size
	Baseline	Follow-up	Baseline	Follow-up			
<i>Function component*</i>							
Overall function, mean (SD)	58.3 (6.4)	63.3 (8.4)	55.5 (6.6)	57.4 (6.2)	<0.001	0.016	0.69
Upper extremity, mean (SD)	73.8 (11.4)	78.4 (11.7)	68.3 (12.8)	71.9 (10.8)	0.001	0.661	0.12
Basic lower extremity, mean (SD)	65.8 (8.9)	72.5 (13.0)	62.6 (8.5)	64.9 (7.7)	<0.001	0.044	0.57
Advanced lower extremity, mean (SD)	50.9 (9.6)	57.1 (15.3)	48.3 (10.4)	49.3 (11.7)	<0.001	0.025	0.64
<i>Disability component</i>							
Overall limitation, mean (SD)	78.7 (12.4)	83.0 (12.5)	74.3 (10.0)	76.3 (13.3)	0.075	0.536	0.17
Overall frequency, mean (SD)	49.2 (5.0)	51.6 (4.6)	51.6 (4.6)	51.9 (7.1)	0.012	0.120	0.44

*One missing value (intervention group).

LLFDI: Late-Life Function and Disability Instrument.

The mean improvement in the present study was 5, 6.7 and 6.2 points, respectively, for overall function, basic lower extremity and advanced lower extremity in the intervention group. These values exceed the SEM values, with 2.9, 4.4 and 4.3 points, respectively, presented by Roaldsen and co-workers¹⁴ who conclude that these reasonably small improvements (5–9%) are enough to detect changes on a group level. Effects on the function component can, therefore, be considered not only statistically significant, but also clinically relevant on a group level, also shown by the effect sizes (Table 2). Changes on the individual level must be slightly higher, 14%–24% and 14%–16%, respectively, for the function and disability components, to exceed the measurement error (smallest real difference, SRD) and thus be seen as clinically relevant. In regard to the disability component, improvement in the overall

limitation subscale was 4.3 points, which exceeded the SEM value 4.1,¹⁴ but with a small effect size (0.17).

There are some limitations in the present study. First, the participants were recruited by advertisement, also called convenience sampling, which is commonly used though it is also a 'weak link',¹⁵ since participants might have already had positive feelings in favour of balance training from the start. It is, however, difficult to reach healthy community-dwelling elderly with balance deficits and fear of falling in any other way, since these persons do not commonly seek healthcare. As it was considered important to evaluate the effect of the programme on a population of healthy elderly individuals before moving onto other target-groups, this approach was still chosen.

The participants were recruited exclusively from Stockholm suburbs. Therefore, the results of

the present study might not generally apply to people living in rural settings, as community barriers and transport facilitators differ across urban and rural areas, and have a great impact on levels of functioning and disability. The population was healthy community-dwelling older adults, and the results are therefore likely to apply for this group of older adults. Further studies are needed to determine the general applicability of the effects of a group balance training programme on self-assessed function and disability.

Furthermore, sample size was based on estimation from a pilot study. It is conceivable that sample size affected the possibility of affecting the disabilities. It might have been better, therefore, to perform a power calculation to estimate the sample size to reduce the risk of type II errors.

Another limitation in the present study is that blinding of the test leaders and evaluators to group allocation was not successful. Participants were thoroughly and repeatedly instructed to keep group allocation a secret, but this turned out impossible to maintain, as participants were enthusiastic about their training and remarked about their experiences. Blinded test leaders were supposed to reduce the risk of expectations influencing the outcome, and it would, of course, have been better had the blinding been successful. Strategies such as treating the intervention group and control group as equally as possible, apart from the intervention, and using as objective outcome measures as possible to minimize bias when blinding, is not possible.¹⁶ In the present study, frequency of follow-up and instructions with regards to physical activity level, apart from intervention, were equal in both groups. Also, the chosen outcome measure, LLFDI, is a highly reliable self-report measure, and test leaders strictly followed the instructions in the manual. However, failure to blind test leaders and evaluators at follow-up might have reduced internal validity.

When interpreting the results of the present study, one should consider the fact that older adults in general overestimate their abilities to function physically, and that self-reported information and assessment by clinicians can differ substantially,

especially for upper extremity function.¹⁷ However, in the present study, interview-administered tests were used, giving the informants the ability to discuss the most appropriate scores with the physiotherapist data collector, hence minimizing the gap between self-report and clinician assessment.

The strengths in the present study are several. The chosen design – a randomized controlled trial – is regarded as a strong design for contributing to evidence-based knowledge.¹⁸ The comparison between groups makes it possible to conclude that the statistically significant improvements in overall function, as well as basic and advanced lower extremity function, were indeed owing to the intervention.

The standardization in regards to both exercise method and evaluation method, and the use of individually adjusted training are also strengths. The exercise method is well described,⁴ and the evaluation method has been found to be highly reliable, valid and suitable for research in the healthy elderly.¹⁴ Furthermore, baseline and follow-up interviews were carried out by experienced physiotherapists, and with few missing values in the LLFDI protocols. It is commonly known that interview-administered, self-report assessment produces less missing values than if the protocols are self-administered. Therefore, using trained data collectors and interview-administered tests rather than self-administered tests is recommended.¹⁴

Training attendance was high (71%–100%), which confirms that the participants experienced the training as worth the trouble. Expected personal gain from the training was considered to compensate for reduced leisure time during the intervention period. Only four subjects were lost to follow-up, and although all were in the intervention group, the drop-outs were considered as random and not owing to methodology. High compliance and having few drop-outs are valuable for the quality of the results.¹⁹

The lack of injuries during training sessions indicates that safety precautions, such as having two physiotherapists present at training, and only six to seven subjects in each group, were sufficient.

Some falls and near falls occurred during the training, but did not cause any injuries or interrupt the training.

Clinical message

- This 12-week, progressive, task-specific and individually adjusted group balance training programme improves overall function, as well as basic and advanced lower extremity function measured by the Late Life Function and Disability Instrument in community-dwelling older adults with balance deficits and fear of falling.

Contributors

AS conceptualized the study. AH and AS designed the study. AH and AS collected the data. KSR, AH and TS interpreted the data. KSR and TS drafted this manuscript. AH and AS provided critical review of the manuscript.

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Conflict of interest

The authors declare that there is no conflict of interest.

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Upon request we can provide any underlying research materials related to our article.

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