



Effects of a multimodal exercise program on balance, functional mobility and fall risk in older adults with cognitive impairment: a randomized controlled single-blind study

É. KOVÁCS¹, I. SZTRUHÁR JÓNÁSNÉ^{1,2}, C. K. KARÓCZI¹, Á. KORPOS¹, T. GONDOS¹

Background. Exercise programs have important role in prevention of falls, but to date, there are conflicting findings about the effects of exercise programs on balance, functional performance and fall risk among cognitively impaired older adults. Aim. To investigate the effects of a multimodal exercise program on static and dynamic balance, and risk of falls in older adults with mild or moderate cognitive impairment.

Design. A randomized controlled study.

Setting. A long-term care institute.

Population. Cognitively impaired individuals aged over 60 years.

Methods. Eighty-six participants were randomized to an exercise group providing multimodal exercise program for 12 months or a control group which did not participate in any exercise program. The Performance Oriented Mobility Assessment scale, Timed Up and Go test, and incidence of falls were measured at baseline, at 6 months and at 12 months.

Results. There was a significant improvement in balance-related items of Performance Oriented Mobility Assessment scale in the exercise group both at 6 month and 12 month ($P < 0.0001$, $P = 0.002$; respectively). There was no statistically significant increase in gait-related items of Performance Oriented Mobility Assessment scale after the first 6-month treatment period ($P = 0.210$), but in the second 6-month treatment period the POMA-G score improved significantly ($P = 0.001$). There was no significant difference between groups regarding falls.

Conclusion. Our results confirmed that a 12-month multimodal exercise program can improve the balance in cognitively impaired older adults.

Clinical Rehabilitation Impact. Based on our results, the multimodal exercise program may be a promising

¹Faculty of Health Science, Semmelweis University
Budapest, Hungary

²Old Age Home of the Municipality of Budapest
Budapest, Hungary

fall prevention exercise program for older adults with mild or moderate cognitive impairment improving static balance but it is supposed that more emphasis should be put on walking component of exercise program and environmental fall risk assessment.

KEY WORDS: Postural balance - Mild cognitive impairment - Accidental falls.

Approximately 30% of adults aged 65 years and over experience at least one fall annually.¹ The risk of falls in older adults with cognitive impairment is more than twice as high as that among cognitively intact elderly.² It has been proved that cognitively impaired older adults recover less well after a fall than cognitively intact counterparts.³ Cognitive impairment is a prevalent age-related condition affecting 3% of people aged between 65 and 18.7% of people aged between 75 and 84, and 47% of people aged over 85.⁵ It is estimated that 24.3 million people suffer from dementia worldwide today, and this amount will double in every 20 years, to 42.3 million by 2020, and 81.1 million by 2040.⁶ As the number of older people continues to rise, more and more people will be affected by the cognitive impairment or dementia and its consequences such as falling and fall-related injury. So, we should put more emphasis on improving

Corresponding author: Dr. É. Kovács, Faculty of Health Science, Semmelweis University, 17 Vas street, H 1088 Budapest.
E-mail: kovacs@se-etk.hu

physical functions, preventing falls and fall-related injuries among cognitively impaired older adults. In systematic reviews it is stated that exercise programs have an important role in the prevention of falls, but their results are based on studies focusing on cognitively intact older adults.^{7, 8} To date, there are conflicting findings about the effects of exercise programs on balance, functional performance and fall risk among cognitively impaired older adults. In their systematic review, Hauer *et al.*⁹ could not show strong evidence for effectiveness of physical training on motor performance and fall prevention in older adults with cognitive impairment. Suttanon *et al.*¹⁰ did not state conclusively either that exercise program improves balance and balance-related physical performance in individuals with CI. In their meta-analysis, Forbes *et al.*¹¹ concluded that there is insufficient evidence to state that physical activity programs are beneficial for cognitively impaired people. Conversely, Blankevoort *et al.*¹² in their review stated that the multicomponent exercise programs (for 12 weeks or more, at least 3 times a week) are beneficial for all stages of dementia. Among cognitively intact older persons with high risk, the multimodal exercise programs have proved to be effective.^{7, 8} Multimodal exercise programs are those that include at least two components of fitness from the following modalities: strength, balance, flexibility, endurance training.⁸ In cognitively intact older adults aged 80 years or over with comorbidities, the Otago Exercise Program (included balance, strength exercises, and walking exercises) decreased the fall risk by 30%.¹³

Based on Otago Exercise Program, we have developed a multimodal exercise program consisting of strength, balance exercises and walking training for cognitively impaired older adults. Unlike the home-based Otago Program, our program was group-based and supervised. Furthermore, walking training was delivered only once a week (in the Otago Exercise Program three times a week).

The aim of this study was to assess whether a multimodal exercise program including individually-tailored strength training targeted the major lower limb muscles, and progressive balance exercises supplemented with walking program were effective in improving balance, functional mobility and reducing fall risk among older adults with cognitive impairment.

Materials and methods

Design

This study was a randomized controlled, assessor-blind trial with parallel groups of cognitively impaired participants in a long-term care institute in Budapest, Hungary.

Study sample

First, the 544 residents were screened for cognitive impairment with Mini-Mental-State-Examination test.¹⁴ The maximal score was possible 30. A score from 21 to 24 was considered as mild intellectual impairment. A score below 24 was considered as cognitive impairment.¹⁵ A total of 234 older individuals having cognitive impairment were contacted for including into this study. Subjects were excluded if they had lived in the nursing home for less than 2 months, were younger than 60 years of old, were unable to walk at least 6 meter with or without walking aid, were unable to follow simple verbal exercise instructions, had unstable cardiovascular or pulmonary diseases that would limit participation in exercise program, were in terminal state of an illness, planned moving from the nursing home during the study period, or he/she or his/her guardian did not give consent to participate in the study. Enrollment lasted 4 days. After baseline assessment, eligible participants were assigned to one of two groups: the exercise group (multimodal exercise) or the control group (usual care) using a stratified randomization method. Participants were grouped based on severity of cognitive impairment. Then they were allocated into exercise or control group separately within each group using blocked randomization with a block size of four. Consecutively numbered opaque identical sealed envelopes were used for allocation.

Subjects or their guardians were informed about the purpose, procedure, and measures of the study and their right to withdraw from the study at any time. Written informed consent was obtained from participants or their guardians. The study was conducted from February 2011 to April 2012 and approved by the Local Ethics Committee of the nursing home where the study took place.

Interventions

The multimodal exercise program was designed and delivered by two physiotherapists (with extensive experience in geriatric physiotherapy) with 2-4 participants in each group, twice a week for 12 months. The exercise class consisted of a five minutes of warm-up period with flexibility exercise of hips, knees and ankles followed by a progressive exercise program including strengthening and balance exercise and ended with cooling down for five minutes. The exercise program was based on Otago Exercise Program described by Gardner et al.¹⁶ apart from that in our trial the exercises were assisted because of participants' cognitive impairment. The strengthening exercises directed to lower limb muscles playing role in the postural control such as knee extensors, hip extensors, hip abductors and ankle muscles, using the patients' body weight and ankle cuff weight starting with 0.5 kg (Thera-Team 0.5-1.0-2.0 kg). The resistance increased after the participants could complete sets of ten repetitions for three consecutive serials. Two minutes rest period was between sets, if needed. The balance exercises were closely related to everyday activity, including stepping forward, sideway, and backward, walking with and without changing direction, timed stand practice (standing on one leg, tandem stance) and sit to stand practice. Originally, the Otago Exercise Program developed for cognitively intact older persons was supplemented with a 30-minute walking training on the days between exercise programs. Our exercise program included a supervised walking program to practice gait elements for once a week. All subjects assigned to the control group received usual care which meant participation in social activities such as simple board games, viewing pictures or films, listening to music, arts and crafts activities: embroidery, needlework, conversations.

Measurements

The measurements were performed at baseline, at 6 months and at 12 months by two trained physiotherapists who were uninformed about group allocation and were not involved in proceeding the interventions. The variables measured were: static and dynamic balance, functional mobility and fall incidence.¹⁷ The static and dynamic balance were measured by the Performance Oriented Mobility As-

essment (POMA) scale. The POMA described by Tinetti consisted of two parts: balance scale (POMA-B) and gait scale (POMA-G).^{18,19} The balance-related items scored the sitting balance, rising from a chair and sitting down, standing balance (with eyes open then closed) and turning balance. The gait-related items scored gait initiation, step length, height, symmetry and continuity, as well as path direction and trunk sway. Each item was scored based on a 2 or 3 point scale. Balance and gait elements were scored separately, then were summarized for a total score (POMA-T). A maximum score of 16 on POMA-B, a maximum score of 12 on the POMA-G and a maximum score of 28 on POMA-T could be achieved. The tests interrater reliability is good (85% agreement).¹⁷ The Timed Up and Go (TUG) test is a measure for functional mobility.²⁰ We asked the participants to stand up from a standard arm chair (approximate seat high of 46 cm, arm height 65 cm) with use the arms if needed, walk 3 metres with a comfortable but secure pace, turn back, walk back and sit down to the chair. They were allowed to wear their regular footwear, and use walking aid if needed. A stopwatch was started on the „go” and stopped when fully sitting position with back against the backrest was reached again. The time taken to complete the test was measured and two consecutive trials were averaged. Between the trials there was a 30-second rest time, if needed. The subjects performed a trial once before testing. A longer time indicates a worse functional mobility. The TUG test has high inter-rater (Interclass Correlation Coefficients =0.99) and intrarater (Interclass Correlation Coefficients =0.99) reliability.²¹ The subjects' independency in everyday physical activities was assessed with Katz Index which measures the level at which an individual can perform basic everyday activities including bathing, dressing, using toilet, transferring, bowel and bladder control, and feeding, using a dichotomous scoring (0=dependent, *i.e.* with supervision, direction, personal assistance or total care; 1=independent *i.e.* no supervision).²² A total score of 6 indicates the total independency. Incidence of falling was assessed with a fall calendar for 12 months. Fall calendar was given the care persons at baseline who were asked to record each day if participants had fallen, where they had fallen and if they had suffered any injuries. Fall was defined as “an unexpected event in which the participants come to rest on the ground, floor or lower level”.²³ Demographic, anthropometric

data, comorbidities, medications as well as number of falls in the previous 12 months were obtained from nursing and medical documentations.

Statistical analysis

Statistical procedures were performed by using SPSS version 15.0 for Windows software. The statistical significance level was set at 0.05. First, Kolmogorov-Smirnov test was used to test normality of data. Participants' characteristics and baseline values of the outcome measures are reported as means with standard deviations (SD) for normally distributed continuous data, and as medians with interquartile ranges (IQR) for skewed data and numbers and percentages for categorical data. Independent-sample t-tests, Mann Whitney U tests or chi-square tests were used to compare baseline values between groups. Because of non-normally distribution of outcome parameters, Friedman ANOVAs were used to analyze the longitudinal changes in outcome parameters within each group. In case of significance, post hoc analysis was conducted. Wilcoxon Signed Ranks tests with Bonferroni's correction resulting in significance level at $P < 0.017$ were applied to investigate differences among the outcome variables at different time points. Primarily, we conducted per protocol analyses (using only the data from those who completed the study) to determine the maximal potential benefits of our multimodal exercise program on outcome variables. In addition, we reanalyzed the outcomes according to the intention-to-treat (ITT) principle (using data from all participants regardless of whether they completed the intervention or subsequent outcome assessments). Missing data were replaced with the individuals' last available data. The number of falls over the first and the second training periods was compared by calculation the incidence rate ration (IRR) using negative binomial regression models with adjustment for observation time. This model takes into account not only number of falls during training periods but also the overdispersion of falls.²⁴ The observation time was calculated in weeks from the start to the end of the training periods or until the participants dropped out. Finally, relative risk and 95% confidence interval (RR and 95% CI) were used to report difference between groups in number of participants who fell. The calculation of required sample size was based on the assumption that the exercise program would

reduce the incidence of fall from 65% (the incidence of fall in the previous year collecting from nursing and medical documentation) to 30% (the incidence of fall among cognitively intact older adults). To detect this result (assuming a power of 80% with two-tailed p value of 0.05 and a drop-out rate of 20%) 37 subjects per groups would be needed.

Results

Two hundred and thirty four residents were screened for eligibility. Of them, 148 (63%) did not meet inclusion criteria. The 86 remaining subjects were assigned to the exercise group (N.=43) or the control group (N.=43). Thirty two participants (78%) in the exercise and 30 participants (73%) in the control group completed the study. During the first 6-month period six participants discontinued their participation and did not complete the second assessment. During the second 6-month period 14 participants dropped out and did not completed the final assessment. These 20 participants' data were excluded from the outcome analysis. There were no statistically significant differences between those who did and did not complete the study for any of the baseline measures except for the Katz index. Older adults who dropped out had a lower Katz index compared to those who did not dropped out (median: 4 points *vs.* 4.5 points; $P = 0.035$). The flow of participants through the study is summarized in Figure 1.

Table I presents demographic and clinical characteristics of study participants.

There were no significant differences between groups on any baseline characteristics except for using frame. There were more older adults who used frame in the control group compared to the exercise group.

Table II presents the outcome data from ITT analyses. There were statistically significant differences among POMA-B scores measured across three time points in exercise group ($P < 0.0001$) but not in the control group ($P = 0.640$). In the exercise group, there was statistically significant increase in POMA-B score after the first 6-month training period ($P < 0.0001$). In the second 6-month training period the POMA-B score further improved significantly ($P = 0.002$). There were significant changes in POMA-G score over time in the exercise group

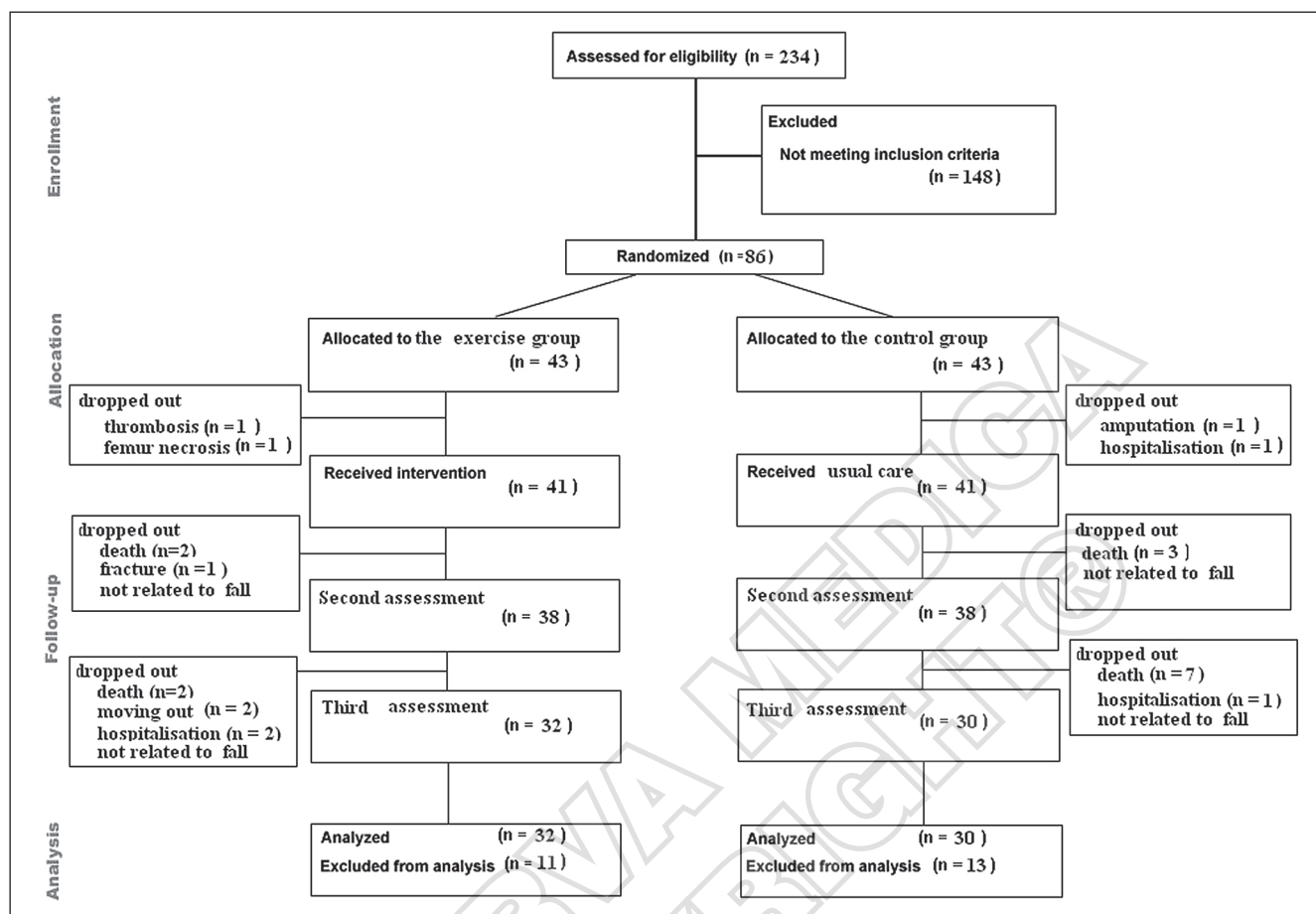


Figure 1.—Flow of participants through the study.

($P < 0.0001$) but not in control group ($P = 0.530$). In the exercise group, there was no statistically significant increase in POMA-G score after the first 6-month treatment period ($P = 0.210$), but in the second 6-month treatment period the POMA-G score improved significantly ($P = 0.001$). There were statistically significant changes in POMA-Total score over time in the exercise group ($P < 0.0001$) but not in the control group ($P = 0.624$). In the exercise group, the POMA-Total score increased statistically significantly during the first 6-month training period ($P < 0.0001$) and the second 6-month training period ($P < 0.0001$). Result from analysis of TUG time was significant only in the exercise group ($P < 0.0001$) but not in the control group ($P = 0.171$). In the exercise group, there was no significant difference between baseline 6-month measure ($P = 0.061$) while

difference between 6-month and 12-month measure was significant ($P = 0.004$). There was no significant between groups difference in the Katz index at 12 months (median in the exercise group: 5, IQR: 3-5, in the control group: 5 IQR: 3-5; $P = 0.754$).

Results of the ITT analyses of POMA-B and TUG were similar to those from per protocol. As regard the POMA-G and POMA-Total, in the ITT analyses less improvement was seen in the exercise group at the end of the second 6-month training period (per protocol: POMA-B 8 points, POMA-Total 19.5 points; ITT: POMA-B 7 points, POMA-Total 17 points).

There was no significant difference between groups regarding the number of fallers either after the first or the second training periods. There was also no significant difference between groups regarding fall incidence rate after the first 6-month

TABLE I.—*Baseline characteristics of the participants.*

Variables	Exercise group N.=43	Control group N.=43
Age (years), mean ($\pm$ SD ^a)	76.39 (9.63)	79.29 (12.67)
Female, number (%)	36 (83)	34 (79)
BMI ^b (kg/m ²), mean ($\pm$ SD ^a)	27.3 (5.7)	25.1 (4.7)
MMSE ^c mean ($\pm$ SD ^a)	20.85 (3.2)	20.93 (3.8)
Severity of dementia		
Mild, number (%)	30 (69.5)	29 (67.4)
Moderate, number (%)	13 (30.2)	14 (32.6)
Medication >4, number (%)	30 (69.8)	33 (76.7)
Medical history		
Cardiological disease, number (%)	23 (53.5)	27 (62.8)
Pulmonological disease, number (%)	12 (27.9)	9 (20.8)
Hypertension, number (%)	32 (74.4)	35 (81.4)
Diabetes mellitus, number (%)	11 (25.6)	14 (32.6)
Lower limb arthritis, number (%)	14 (32.16)	17 (39.5)
Using eye glasses, number (%)	14 (32.6)	10 (23.3)
Hearing problems, number (%)	13 (30.2)	19 (44.2)
Using walking aids		
Stick, number (%)	6 (14)	9 (20)
Frame, number (%)	9 (20.9)	18 (41.9)
Persons who fell in last year, number (%)	25 (58.1)	28 (63.4)

^aStandard Deviation
^bBMI: Body Mass Index
^cMini Mental State Examination
^dIQR: Interquartile Range

TABLE II.—*Functional balance, functional mobility at baseline and after the intervention periods in groups.*

	Exercise group			Control group		
	At baseline	At 6 months	At 12 months	At baseline	At 6 months	At 12 months
POMA-B (point)	7 (5-10)	10 (7-14)	11 (8-14)	6 (4-9)	6 (5-9)	7 (4-9)
P value ^a	<0.0001		0.002	0.490		0.855
POMA-G (point)	5 (3-8)	6 (4-9)	7 (5-10)	4 (3-6)	4 (3-8)	4 (3-7)
P value ^a	0.198		0.001	0.472		0.261
POMA-T (point)	14 (9-18)	16 (12-22)	17 (14-24)	10 (8-15)	11 (9-15)	11 (8-15)
P value ^a	<0.0001		<0.001	0.464		0.515
TUG (sec)	32.6 (24-38.1)	32.4 (23.-38.2)	31.06 (21.4-37.1)	32.1 (25.-42.2)	33.5 (26.4-43.4)	33.3 (27.1-45.4)
P value ^a	0.061		0.004	0.075		0.098

^abetween-group difference

training period. After the second 6-month training period, there was still no significant difference between groups (Table III).

Discussion

In this randomized controlled assessor-blind study we evaluated the benefits of a 12-month individually-tailored, progressive multimodal exercise program including strength, balance and walking training on

balance, functional mobility and falls rate among older persons with cognitive impairment.

We found that static balance improved significantly after the first 6-month training period, and this continued to improve during the second 6-month training period. Dynamic balance and functional mobility significantly improved only by the end of the second 6-month training period. However improvement in functional mobility measured by TUG test did not reach the clinically relevant value of 4.09 seconds as identified by Ries.²⁵

TABLE III.—*Falls in the exercise and control group.*

	Exercise group N.=32	Control group N.=30	RR (95%CI) ^a
Number of persons who fell			
First 6-month period	9	9	0.974 (0.708 to 1.340)
Second 6-month period	7	11	0.811 (0.581 to 1.126)
Total	16	20	0.667 (0.361 to 1.231)
Number of single fallers			
First 6-month period	6	6	0.985 (0.771 to 1.257)
Second 6-month period	5	7	0.909 (0.710 to 1.164)
Total	11	13	0.863 (0.578 to 1.289)
Number of recurrent fallers			
First 6-month period	3	3	0.930 (0.844 to 1.169)
Second 6-month period	2	4	0.924 (0.783 to 1.092)
Total	5	7	0.909 (0.710 to 1.164)
Cumulative falls			
First 6-month period	12	13	1.026 (0.410 to 2.566) ^b
Second 6-month period	10	16	0.551 (0.218 to 1.393) ^b
Total	22	29	0.771 (0.338 to 1.498) ^b

^aRelative Risk

^bIncidence rate ratio (IRR) and 95% CI

Several randomized controlled studies evaluated the effects of multimodal exercise programs on balance and/or functional mobility among cognitively older adults, but to date, only four studies included a training period of 6 months or over.²⁶⁻²⁹ Kwak *et al.*²⁶ evaluated the effects of a 12-month exercise program. They assessed outcome parameters at 6 months and at 12 months. Similarly to us, in the exercise group, they also found significant improvement in balance at 12 months but not at 6 months. In a trial by Rolland *et al.*²⁷ it was reported that a 12-month exercise program resulted in significant improvement in walking speed both at 6 months and at 12 months. Christofoletti *et al.*²⁸ also reported significant improvement in balance and functional mobility after a 6-month exercise program. Burgener *et al.*²⁹ evaluated the effects of a 40-week multimodal exercise program on cognitive function and balance function. Their results are contrary to the results mentioned above, as well as our results. They found that following the first 20-week intervention period the exercise group improved, the control group declined, but within group and between group differences were not significant. From 20 to 40 weeks they did not find any further improvement in balance test.

The majority of studies focusing on improvement of the static, dynamic balance and functional mobility of demented older persons included only

12-week or shorter intervention periods.³⁰⁻³⁴ In a study by Aman and Thomas³⁰ it was showed that the walking speed improved significantly following a 12-week exercise program. Santana-Sosa *et al.*³¹ found significant improvement in balance following a 12-week exercise program. Netz *et al.*³² also evaluated the effects of a 12-week exercise program. In contrast to the previous studies, they could not identify significant improvement in TUG test and sit-to-stand test. Shaw *et al.*³³ and Steinberg *et al.*³⁴ found no significant improvement in gait and balance tests either after completing a 12-week exercise program each.

Besides controlled trials, one-group trials were also conducted among demented older adults, although generalisability of results from these studies was limited by lack of control group. In a recent study of seven older persons with Alzheimer disease, Ries *et al.*³⁵ found improvement in both balance and functional mobility following an 8-week functional balance exercise program.

In the majority of the studies conducted in cognitively impaired older population, fall incidence was not measured. This dependent parameter was measured in only two recent studies. Shaw *et al.*³³ could not show evidence for positive effect of a multifactorial intervention on fall incidence or number of persons who fell. Jensen *et al.*³⁶ found that only higher MMSE group responded to a multifactorial fall pre-

vention program, but lower MMSE group did not. Regarding the fall rate, the majority of studies focusing on cognitively intact older adults have found that Otago Exercise Program was effective. Campbell *et al.* reported that number of falls reduced by 31% after a 2-year exercise program (IRR 0.69 95% CI 0.49-0.97).¹³ Robertson *et al.* found a similar reduction after a 1-year exercise program (IRR 0.60 95% CI 0.59-0.84).³⁷ Skelton *et al.* observed a 31% reduction in number of falls following a 36-week Otago-based exercise program including more demanding balance exercises (IRR 0.69 95% CI 0.50-0.99).³⁸ In a recent meta-analysis, Thomas *et al.* stated that Otago Exercise Program significantly reduced fall rates (IRR 0.68 95% CI 0.56-0.79).³⁹ Unlike studies above-mentioned, Liu- could not show fall reduction after a 1-year Otago Exercise Program (IRR 0.68 95% CI 0.26-1.70).⁴⁰ In our study, the falls did not differ statistically significantly in the exercise group and the control group. An explanation for our nonsignificant results in falls would be the fact that although PO-MA-Total score improved during training periods, it remained in the range of high fall risk (less than 19 points).^{19, 21} Another possible explanation is that the assessment of physical environmental risk factors and their modification play an important role in prevention of falls in older adults with cognitive impairment. But this fact has not been proved by Shaw *et al.*³³ who found no significant reduction in fall incidence after a multifactorial intervention program including management of medical problems, multimodal exercises, and modification of environmental fall hazards. In an other article of Shaw's⁴¹, her argumentation was that dementia might result in an additional set of risk factors for falls which are not addressed by fall prevention programs initially designed for cognitively intact population. In their systematic review, Härlein *et al.*⁴² have revealed eight categories of risk factors of falls and fall-related fractures of demented people, including disease-specific motor impairments, impaired vision, severity of cognitive impairment, behavior disturbances (such as wandering and agitation), functional impairments (such as muscular weakness, balance, gait problems), previous falls, taking neuroleptics and having low bone mineral density. The third explanation can be that once a week walking program practicing gait elements is not sufficient to prevent falls in this special population. In Hungary, the ratio of physical therapist – patients makes it impossible

that exercise programs include a walking program more than once a week. But in the future, we should increase the frequency of the walking programs up to 3 times a week, as it is originally described by Gardner *et al.*¹⁶ However, further controlled studies should be conducted to determine the optimal rate of components in the multimodal fall prevention exercise program or compare the benefits of different types of exercise programs for demented persons in two- or three-armed design including two active groups and an inactive control group.

Further studies are also recommended to evaluate the effects of a combination of the multimodal exercise program, environmental fall risk assessment and cognitive intervention.

As for ADL activity, we did not found improvement. Contrary to us, Kwak *et al.*,²⁶ Rolland *et al.*,²⁷ and Shaw *et al.*³³ identified improvement in ADL, while Aman and Thomas³⁰ could not show any improvement. Our result would be due to the fact that functional mobility did not improve sufficiently for independence in everyday activities.

Our study has some limitations. First, we failed to conduct a subgroup analysis to compare the outcomes of subjects with mild cognitive impairment and those with moderate cognitive impairment. In their study, Jensen *et al.*³⁶ found that the group with higher MMSE (≥ 19) experienced fewer falls after a multifactorial fall prevention program than the group with lower MMSE (< 19). For subgroup analysis, further studies should include larger sample, maybe as a multicenter study. Furthermore, we did not measure the cognitive function as outcome parameter, albeit recent studies support the fact that exercise has positive effect on cognitive functions even in older adults.^{43, 44} Besides this, in a future study it would be useful to measure the longitudinal changes of Katz Index not only pre- and postintervention but after the first 6-month training period as well. Finally, therapists and participants were not blinded to group allocation.

Conclusions

Our results confirmed that a 12-month multimodal exercise program can improve the balance in cognitively impaired older adults. Based on our results, it is supposed that environmental fall risk assessment and walking training twice a week or more should

be incorporated into fall prevention program for this special population. At the same time, the fact should be taken into account that cognitive impairment and dementia is a progressive condition. So, if a physical function which does not improve but remains stable following an intervention, can be considered as a positive effect of that intervention in this special population.

We hope that our results stimulate further research on fall prevention exercise programs among cognitively impaired older adults with two or three blinded design and extended outcome measures.

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