Exersise programs for prevention of falls in geriatrics

PhD thesis

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INTRODUCTION

Balance control is due to coordinated and integrated interaction of several systems. Motor coordination regulates the balance strategies used for controling the displacement of center of gravity. These are the ankle, hip or step strategy. The musculoskeletal system makes sure that the muscles contract at the adequate time and the joints have adequate flexibility. Perception of orientation and sensory organisation are also important. The former means the perception of the body position in the space which is based on visual, somatosensory and vestibular information. During the sensory organisation the nervous system interprets and prioritizes the three kind of incoming sensory information and constructs an internal picture about the body position. Based on this picture, the nervuous system develops the adequate motor response to the disturbance of balance. Furthermore, temporal relationship between sensorial perception and motor response is also important: the feedforward balance control anticipates the disturbance of balance and triggers muscles in advance. The feedback control means that nervous system percepts the disturbance of balance and corrigates it subsequently.

All of these systems are needed for maintenance of balance consequently impairment of any systems aforementioned will influence balance control.

As proper functioning of the aforementioned systems declines with aging, balance abnormality and falling have become a serious health problem among elderly people.

Several movement programs have been developed to improve balance and prevent falls among older adults. The multimodal exercise programs are the most effective ones, these focuse on several systems of the balance control at the same time with flexibility, muscle strengthening, balance and walking exercises.

One of the most promising multimodal program is the Otago exercise program which was developed for older adults without visual or mental impairments being at high risk because of their age of over 80 years.

To date, the effects of this exercise program have not been investigated among older adults at high risk because of visual or mental impairment.

The multimodal exercise programs developed for community-living older adults have been performed in the Health Care. This raises the question whether these programs are effective even if they are performed as leisure activities outside the context health care.

OBJECTIVES

- to investigate whether a 25-week standard osteoporosis exercise program for osteoporosis which was supplemented with an Otago-based multimodal exercise program was more effective in improving balance, functional mobility and independency in everyday physical activities and in reducing fall risk than the standard osteoporosis exercise program alone among institutionalized older postmenopauzal women with low vision.
- to assess whether a 12-month multimodal exercise program was effective in improving balance, functional mobility, independency in everyday physical activities and reducing fall risk among institutionalized older adults with cognitive impairment.
- to investigate the effects of a 25-week Adapted Physical Activity programme that addressed postural control, functional mobility, quality of life as well as fall risk in community-dwelling older women.

METHODS

Participants and interventions

Our studies were conducted on three sites and in three different populations: institutionalized older women with age-related visual problems (first study), institutionalized older people with cognitive impairment (second study), and community-living older women (third study).

The inclusion criteria were: aged at least 60 years, being able to walk with or without walking aids, and lacking unstable or untreated cardiopulmonal or progressive neuromuscular diseases.

In the first study, of 200 residents of a home, 41 partially sighted persons who met inclusion criteria were randomized into the combined training group or the standard osteoporosis group. All of them completed the study.

In the second study, of 544 residents 86 persons could be randomized into the training or the control group. The study included two training periods. The first period was completed by 88 and 88 percent of participants (training and control group; respectively), the second period was completed by 74 and 70 percent of participants (training and control group; respectively).

In the third stuy, of the 88 women that replied to the advertisement in the local newspaper,76 person could be randomized into the training or the control group. The study was completed by 92 and 89 percent of them (training and control group; respectively).

The first study included a 6-month intervention period after enrollment. Subjects assigned to combined training group, participated twice a week for 30 minutes in an Otago multimodal exercise program and twice a week for 30 minutes in a standard osteoporosis exercise program.

Subjects assigned to the control group participated in the standard osteoporosis exercise program alone four times a week for 30 minutes.

The Otago multimodal exercise program consisted of progressive, individually-tailored muscle strengthening exercises (focused on lower limb muscles), balance and walking exercises.

The standard osteoporosis exercise program included strengthening and flexibility exercises focusing on trunk, upper and lower extremities which were performed in axial weight-bearing position. These standard osteoporosis exercises included some stepping and weight transfer to different directions but exercises were neither progressive nor individually-tailored.

The second study included two 6-month intervention periods after enrollment.

Subjects assigned to the training group participated twice a week in an Otago multimodal exercise program for 30 minutes. 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, conversation.

In the third study, enrollment was followed by a 6-month training period.

Women in the training group participated in an Adapted Physical Activity program twice 60 minutes a week for 25 weeks. Adapted Physical Activity sessions consisted of two parts. The first part of the session included structured exercises focusing on strengthening lower limb muscles and trunk muscles as well as balance exercises simulating everyday activities (such as rising from a chair, reaching above head or picking up something from the floor). The second part of the session included competition games on a pre-designed course with obstacles or adapted ball games according to the participant's choice. The exercises were adapted to the participant's abilities, and were progressive in repetitions and difficulties over time.

Subjects in the control group were asked not to start any type of regular exercise programs and maintain their usual daily activities.

Measurements

In studies conducted among visually disabled older women and community-living older women, the measurements were performed at baseline and after the 6-month intervention period. In study conducted among cognitively disabled older adults, outcome variables were measured at baseline, at 6 months and at 12 months. The outcome variables were static and dynamic balance, functional mobility, independency in everyday physical activities or health-related quality of life and falls.

The static and dynamic balance were assessed with standard ordinal scales scoring balance in everyday activities, such as standing from sitting, transfer to another chair, stepping up a stair, tandem standing, pick up an object from the floor and reaching forward with outstretched arm. We used the test in comliance with population abilities. For visually disabled people Berg Balance Scale was used which scored 14 everyday activities. A total score is 56 points which indicates excellent balance.

For cognitively disabled people the Tinetti Performance Oriented Mobility Assessment (POMA) scale was used which consisted of two parts: balance scale (POMA-B) and gait scale (POMA-G). A maximum score of 16 on POMA-B, a maximum score of 12 on the POMA-G, thus a maximum score of 28 on POMA-T could be achieved.

For community-living older adults the timed one-leg stance test was used. The participant was asked to stand on one leg with arms by her side for maximum testing time of 30 seconds.

In all of three studies, the functional mobility was evaluated with Timed Up and Go (TUG) test. This test measures how long time (in seconds) it takes for a person to stand up from a standard arm chair (approximate seat height of 46 cm, arm height 65 cm), walk 3 metres with a comfortable but secure pace, turn back, walk back and sit down to the chair. The subjects were allowed to wear their regular footwear and use the arms of the chair to get up. We calculated the average time of two consecutive performances, and the participants were allowed to rest for 30 seconds between the trials if needed.

The independency in everyday physical activities were assessed with Barthel ADL Index for visually disabled persons (which scores feeding, chair transfer, grooming, using toilet, bathing, ambulation, stair climbing, dressing, bowel control, bladder control) or with Katz Index for mentally disabled persons (which scores bathing, dressing, using toilet, transferring, bowel and bladder control and feeding).

To assess community-living womens health related quality of life the Medical Outcomes Study 35-Item Short-Form Health Survey (SF-36V2) was used which consists of 36 items grouped into eight domains (Physical Functioning, Role Physical, Bodily Pain, General Health, Vitality, Social Functioning, Role Emotional, and Mental Health.

Falls during training periods was recorded in a pre-designed fall log (similar to a calendar).

Statistical Analysis

Baseline values of groups were compared using independent-sample t-tests or Mann Whitney U tests for continuous data and χ^2 test for categorical data.

Based on the quality of data, the within-group differences between baseline and postintervention were investigated by

- analysis of covariance (ANCOVA) with the baseline scores of the dependent variables as a covariate (in the first sudy).
- Friedman ANOVAs and 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 (in the second study)
- paired t-test or Wilcoxon Rank Signed test (in the third study).

Furthermore, relative risks and 95% confidence intervals (RR and 95% CI) were used to assess difference between groups in number of participants who fell. Finally, the number of falls over the training periods was compared by calculation the incidence rate ration (IRR) using negative binomial regression models with adjustment for observation time.

A p value <0.05 was considered to indicate statistical significance.

RESULTS

There were no significant between-group differences on any baseline characteristics in any studies.

Visually disabled older adults

In Berg Balance score, the combined training group showed a statistically significant improvement (p = 0.036), while the control group did not change significantly (p = 0,317).

The between-group difference did not reach the statistical significance (p = 0,130).

In the training group, the Timed Up and Go improved significantly (p < 0,0005), while there was no statistically significant change in the control group (p = 0,317). At the end of the exercise program, the between-group difference was significant (p = 0,001).

With regards to the Barthel Activity Index, there was no significant change in any groups.

Regarding the number of fallers after the training period, there was no significant difference between groups (RR: 0,54; 95% CI: 0,29-1,07). There was also no significant difference between groups regarding fall incidence rate (IRR: 0,52; 95% CI: 0,19-1,07).

Cognitively disabled older adults

There were statistically significant differences among POMA-B scores measured across three time points in the training group (p<0.0001) but not in the control group (p=0.640). In the exercise group, there was a 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 training group ($p<0.0001$) but not in the control group ($p=0.530$). In the training group, there was no statistically significant increase in POMA-G score after the first 6-month treatment period ($p=0.189$), but in the second 6-month treatment period the POMA-G score improved significantly ($p=0.0021$).

There were statistically significant changes in POMA-Total score over time in the training group ($p<0.0001$) but not in the control group (p=0,624). In the training group, the POMA-Total score increased statistically significantly during the first 6-month training period ($p<0.0001$) as well as the second 6-month training period ($p<0.0001$).

Result from analysis of TUG time was significant only in the training group ($p< 0.0001$) but not in the control group ($p=0.171$). In the training group, there was no significant difference between baseline and 6-month measure ($p=0.061$) while difference between 6-month and 12-month measuring was significant ($p=0.004$).

Regarding the number of fallers after the training period, there was no significant difference between groups (0,66; 95% CI: 0,36-1,23). There was also no significant difference between groups regarding fall incidence rate (IRR: 0,77 (95% CI: 0,34-1,49).

Community-living older women

In the training group, the one-leg stance time improved significantly (p < 0,001), while there was no statistically significant change in the control group (p = 0,317). At the end of the exercise program, the between-group difference was significant (p = 0,005).

In the training group, there was also a statistically significant improvement in TUG time (p < 0,001), but no significant change was found in the control group (p = 0,527). At the end of the exercise program, a significant between group difference was found (p = 0,001).

With regard to the SF-36V2, in the training group the Physical Functioning and the Vitality subdomain increased significantly (Physical Functioning $p < 0.001$, Vitality $p < 0.001$), while those in the control group did not show significant change (Physical Functioning $p = 0.192$, Vitality $p = 0.813$). The between-group difference was significant (Physical Functioning p = 0,004, Vitality p = 0,005). With respect to the General Health subdomain, a non-significant improvement was seen in the training group over time (p = 0.106), while a non-significant worsening was seen in the control group (p = 0.169) and at the end of the exercise period the between group difference was significant (p = 0,038). Both groups showed non significant improvement in Social Functioning subdomain, with a marginal significance between-group difference (p = 0,066). As for Mental Health, Bodily Pain, Role Physical, and Role Emotional subdomains, there were non-significant within-group changes with non-significant between-groups differences.

The number of participants who fell in the training group was significantly lower than that in the control group (RR: 0.40; 95% CI: 0.18 to 0.92). Furthermore, significantly fewer/less falls were recorded in this study (IRR: 0,37; (95% CI: 0,15-0,94).

CONCLUSIONS

The older population cannot be considered as a homogeneous population because of their life-style and comorbidities. Consequently, the balance and fall risk in various older populations can be influenced with different prevention programs.

In our randomized controlled studies we evaluated the effects of multimodal exercise programs on balance and fall risk in three different populations of older adults: institutionalized visually disabled older women, cognitivelly disabled older people and communitiy-living older women.

Our results of study conducted among visually-disabled older women showed that participants performing osteoporosis exercise program supplemented with multimodal exercise program improved significantly better in balance and functional mobility than those performing only osteoporosis exercise program. However, the effects on improving independency in everyday physical activities and fall risk have not proved.

In the study focusing on cognitively disabled older people we found that the multimodal exercise program improved the static balance already after the first 6-month training period, and this ability continued to improve during the second 6-month training period. The dynamic balance and functional mobility improved only by the end of the second 6-month training period.

These studies indicate that postural control can be improved by multimodal exercise program even among elderly with visual dysfunction or with cognitive impairment.

However, in these studies the number of fallers and prevalence of falls did not differ between groups. An explanation is that the assessment of physical environmental risk factors and their modification can play an important role in prevention of falls among older adults with visual dysfunction or cognitive impairment. Based on our results, it is recommended that environmental fall risk systematic assessment should be incorporated into fall prevention programs for these special populations.

In the study conducted among community-living older women, the balance the functional mobility and the four subdomains of quality of life were significantly better after the Adapted Physical Activity program composed of multimodal exercises. In this elderly population, the multimodal exercises favorably influenced not only balance but fall frequency.

Out studies showed that physiotherapists play an important role in multidisciplinary prevention of falls in the growing elderly population in order to extend the active independent age. Fall prevention exercises should be applied in not only geriatric physiotherapy (among older residents in health care or social care) anywhere where older adults were treated or cared for including psychiatric physiotherapy, orthopedic, rheumatotological, traumatological physiotherapy. Not only diseases-specific exercises but fall prevention exercises should be provided for older adults in these fields based of the results of a previous physical assessment.
Furthermore, leisure time balance exercise programs adapted to individual capabilities of „said-to-be healthy” older adults should be easily available.

Saját közlemények jegyzéke

Az értekezés alapjául szolgáló közlemények

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