ORIGINAL ARTICLE

Postural control and the fear of falling in frail elderly and the role of a falls prevention program

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ABSTRACT

Objective: To investigate and analyze the effects produced by a multisensorial exercise program associated with instructions on falls prevention, on postural control and fear of falling in the frail elderly, treated at a rehabilitation service. **Methods:** A sample of 105 individuals aged over 60 years of both sex were recruited during a screening at the Polyclinic which verified their osteoarticular comorbidities. The volunteers were subjected to evaluations: Timed Up and Go (TUG); Unipedal stance test; Berg Balance Test; and the Falls Efficacy Scale International (FES-I). Those with fragility and risk of falling were invited to participate in a therapeutic program. The falls prevention program consisted of two orientation sessions on prevention and risks of falls and 10 sessions of Multisensorial exercises. Data were analyzed with the help of statistical package Graphy Pad In Stat using the Student *t* test or Wilcoxon ($p < 0.05$). **Results:** Of the 28 elderlies who entered the program, 24 concluded all sessions. Reevaluated after completion of the program, the elderlies showed significant improvements in tests: TUG, Unipedal stance test, Berg Scale, and FES-I. **Conclusion:** It can be concluded that the intervention program for preventing falls provided improvements on postural control and reduced the fear of falling of these elderlies.

Keywords: Frail Elderly, Exercise, Balance Postural, Accidental Falls/prevention & control

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INTRODUCTION

The aging process may cause changes in the sensoria systems: vestibular, visual, and somatosensorial, as well as musculoskeletal changes possibly leading to decrease of postural control. Moreover, some aspects, as the fragility that starts in this phase of life, may facilitate the occurrence of falls.[1,2]

A preventive method for this situation of decreased postural control and the propensity for falls is the physical exercise. Evidences suggest that the regular, controlled, and adequate practice of exercises, can diminish or prevent the risk for falls in aged individuals.[3-5]

According to Borges et al.,[6] healthy elderlies, who reside in communities that are physically active, present better mobility results and, consequently, lower risk for falls, when compared to those who do not practice physical activities regularly.

However, a systematic review,[7] reports that there is little evidence about the effects of interventions or preventions for frail elderly who live in the community, what is associated with the small number of studies and the lack of standardization in the classification of frailty syndrome. This review emphasizes that it was possible to find concordance among muscle strength gain, balance and functional capacity, however, it was not possible to suggest a treatment program that was efficient for stopping or reverse the progression of the frailty syndrome.

Concerning the effects of the interventions of physical exercises in frail elderlies, by analyzing randomized clinical trials, a review[5] found nine studies performed only with elderly population in Brazil. This study has reported that physical training executed with frail elderly subjects produced positive results in many aspects of the physical function, especially in the functional capacity. Nonetheless, as before, it was not possible to verify or suggest an ideal program of exercises and the authors recommended that new studies should be performed as to determine the most suitable exercise program.

Although there is no consensus in its definition, the frailty can be described as a clinical, biologically driven, multifactorial syndrome resultant from the diminishing of the physiological system resources and from the lack of resistance to stressful factors.[8]

In the clinical practice, the frailty is a term normally used for identifying vulnerable aged people who bear increased risk for negative health conditions, what is observed in the occurrence of several different pathological events, such as multiple comorbidities, hip fracture, immobility, disability and death.[2]

To provide care for this type of elderly, a program named *Unidade de Queda* is applied in frail elderly in a university hospital at Terrassa/Barcelona, Spain. The participants are individually assisted by a trained multiprofessional team. It is composed of advices for fall prevention, review of intrinsic and extrinsic risk factors, and of a physical exercises program. This program has provided the patients with improvements of some aspects of postural balance of frail elderlies.[9,10]

Therefore, the identification of the frailty syndrome and the management of risk factor for falls in elderly subjects represent an emerging field which has increasingly brought attention of researchers and health professionals of several areas. However, there is a gap in the Brazilian literature on studies that analyze the benefits of physical exercise in preventing falls of frail elderlies of those with risk of frailty.

For this reason, there is a need to encourage efforts for protection and promotion of health of Brazilian elderlies, either frail or with frailty risk, as well as investigations on the effects of training programs applied in the clinical practice. Hence, performing a physical exercise program for elderlies with risk for falls assisted by a rehabilitation service has not only become desirable, but also necessary.

OBJECTIVE

The objective of this study was to verify and analyze the effects of a program of multisensorial physical exercises combined with guidance about falls prevention, postural control, the fear of falling for frail elderlies assisted by a rehabilitation service.

METHODS

This is a prospective clinical research which complied with the requirements of the Resolution 466/2012 of the Brazilian *National Council of Health (CNS)*. It was approved by the Ethics Review Board of the *Centro Universitário Adventista de São Paulo*, and received the approval number 1.212.356. The patients who participated in this research signed the informed consent form and authorized data arisen from it to be published.

The study was executed at the *Policlínica Universitária, Centro Universitário Adventista de São Paulo, campus São Paulo, UNASP-SP* - Brazil.

In the first step of the study, according to the convenience of the researchers, between October 2015 and January 2016, a sample of 105 volunteers were recruited and selected during the institutional screening.

Consequently, the volunteers of this research were patients with some type of osteoarticular comorbidity who were initiating their physiotherapeutic treatment.

The inclusion criteria of this research were: subjects of both sex, above 60 years of age; independent gait; and absence of medical contraindication for physical exercises practice. The subjects not included in the study presented the following exclusion criteria: hearing impairment as to hinder or withhold the volunteer to hear the voice commands; fecal or urethral incontinence; open wounds and/or contagious cutaneous diseases; hemodynamic instability (uncontrolled arterial pressure); severe cardiac failure and/or dyspnea to minimum efforts; use of psychoactive medical drugs (sedative, hypnotics and/or anxiolytic); gait disability.

The 105 recruited volunteers were evaluated by the following tests:

Teste Timed Up and Go (TUG): This test evaluates the mobility level of the subject, by measuring, in seconds, the time the volunteer spends to stand up from an armless chair, walk three meters, return, and sit again at the initial position. In the beginning of the test, the elderly must lay his back on the back of the chair and, at the end, he or she must lay his back again.[11]

Unipedal Stance Test: this test is used for evaluating the balance by requesting the subject to stand in one foot with opened eyes, followed by closed eyes, for at most 30 seconds. The time the volunteer manages to stand on one foot was measured in three trials for each visual condition, and the best of the three trials was recorded, i.e. the one with the biggest value. Along the test, the evaluator stood by the patient to prevent and avoid the patient to fall.[12]

Berg Balance Scale. It is a functional balance scale composed of 14 usual tasks that comprise the static and dynamic balances,

such as: reaching, turning, standing, standing up, and transfering. This instrument was validated and possess reliability for evaluating Brazilian elrderlies.[13,14]

Falls Efficacy Scale - International (FES-I). For evaluating how concerned about the possibility of falling the volunteers are, the Falls Efficacy Scale - International (FES-I) was applied. This scale evaluates the fear of falling along the execution of 16 daily activities. The score ranges from 1 (Not concerned at all) to 4 (Very concerned). The total score may vary from 16 to 64 points, in which the lowest value represents the absence of concern, and the highest, a greater concern about falling.[15]

After the evaluations, the subjects who presented frailty and falls risk, as screened by interview and the evaluations themselves, were selected and invited to participate in a preventive and therapeutic program. However, in this step, the inclusion criteria were: history of falls 12 months prior to the inclusion; presence of one or more chronic diseases; continuous use of medicine; and TUG time above 10 seconds.

Out of the 105 total volunteers, 41 subjects fit the inclusion criteria of this second step, hence they were invited to participate in an educational and therapeutic program or preventing falls.

This educational and preventive program for preventing falls consisted on the establishment of an intervention group in which the volunteers were assisted for 10 sessions of multisensorial exercises. The subjects were divided in groups of five who participated in two weekly sessions of approximately one hour.

Each intervention group started and ended the program participating in a session designed for instructions on falls prevention given by a nurse. The initial instructions introduced the elderlies to intrinsic and extrinsic factors, by simulating activities of daily living with simple and ludic language. The objective here was to identify and correct such factors, starting with home related aspects. In the last session, the elderlies would share their experiences gathered along the intervention period by reporting to the nurse which actions were done as to prevent falls. In this moment, a folder was given to the elderlies with the summary of the exercises they practiced along the program so that they could continue in their homes.

Succeeding the first educational session, the 10-session multisensorial exercises begun. These sessions were performed during the entire program and were conducted by a physiotherapist who, along each session, monitored the activities of the elderlies.

The intervention program of multisensorial exercises included the following steps: warmup and flexibility (10 minutes); stretching exercises (5 minutes); active strengthening exercises (10 minutes); balance exercises (30 minutes); and relaxation exercises (5 minutes). Balls, sticks, and parallel bars were used for the execution of these exercises.

For the warmup, the volunteers performed ball games exercises with their hands and feet combined with hip dissociation exercises at the orthostatic position.

The muscle stretching exercises were executed on mats, on orthostatic position at backrest and supine, when the following muscle groups were trained: hip flexors, extensors, and adductors; knee flexors and extensors; and plantar and paravertebral flexors.

Some active exercises for strengthening were performed against the gravity force, i.e. active free exercises. The patients performed exercises for plantar flexors and dorsiflexion muscles, knee and hip extensors and flexors muscles, as well as abdominals, either standing or in spine position.

Regarding the balance exercises, the volunteers executed movements between the lower and the upper limbs, combined with different positions of head and neck (inclination, rotation, flexion and extension), with and without visual stimulation, on different surfaces, such as mats and rubbers of different thickness.

All the subjects performed the exercises matching the sensorial stimulation of the plantar surface with the dynamic balance. These exercises were provided by forward, backward and sideward walk with opened eyes, and some movements with closed eyes over different types of surfaces, textures, and densities such as mats, different densities rubbers, pool floats, and hula hoop. Moreover, the volunteers were requested to pass obstacles as sticks, rope, and cones. Each subject received voice command for performing the gait training without obstacles.

Later, other exercises were executed over some devices for stimulating the balance. Over a jump, the volunteer stood with bipedal and unipedal stance with the eyes alternately opened and closed during 5 to 20 seconds, according to the level of individual ability the volunteer possessed. Over this elastic surface, small displacements were done (short steps forward, backward, and sideward with and without visual stimulation).

Over gel disk for proprioception, balance board, proprioception disk, and shuttle balance, the volunteers initially remained on bipedal stance for 5 to 20 seconds, with their eyes alternately opened and closed, repeating this procedure on unipedal stance. Side to side and anteroposterior displacement movements were performed, within the elderly individual ability. After the adaption, which was executed in the first session, the volunteers performed the following sitting exercises over a therapeutic ball (65cm): side to side and anteroposterior displacements, circumduction, and vertical displacements. For relaxation, respiratory exercises were applied.

This multisensorial exercise protocol was developed upon the considerations suggested by the literature.[3,10,16]

Data analysis

The data was analyzed with the statistical pack Graphy Pad in Stat. (GraphPad Software, San Diego, California, USA, www.graphpad.com). The data was reported as mean and standard deviation. The descriptive analysis was done for evaluating the clinical and demographical characteristics of the elderlies. The normality of the variables was tested with the Kolgomorov-Smirnov statistics. For comparing the clinical tests data and the FES-I results collected before and after the intervention, the Student and Wilcoxon statistics were used according to the data characteristics. In all cases, the $p < 0.05$ was considered statistically significant.

RESULTS

105 subjects of both sex were screened for this study. Among them, 41 presented risk for falls and only 28 accepted participating in the therapeutic program. 24 elderlies completed the program.

The Table 1 presents the results of the screening interview in which the risk factors of the health history of the subjects were identified. 53.3% of the elderlies reported having one or more falls episodes, and all of them underwent consequences from the falls.

Concerning their clinical history, 70.5% reported hypertension and 78.1% reported using one or more continuous medication.

Evaluation of the risk for falls

Concerning the clinical evaluation which verified the propensity and the risk for falls, the TUG time was superior to 10 seconds for 39.04% of the subjects. Regarding the unipedal stance test, in 61.9% (opened eyes) and 93.3% (closed eyes) of the subjects remained less than 21 seconds, therefore most of the elderlies stood less than half of the time at unipedal stance with opened eyes as compared with unipedal stance with closed eyes. The Berg scale nearly reached the maximum score in 84.76% of the subjects and the FES-I reported values of rare falls in 53.23 of the elderlies. The Table 2 presents the mean and the standard deviation of the clinical tests and the FES-I questionnaire that were applied in the sample population.

Table 1. General characteristics of the sample population on healthy history and frailties

Variable	Total
N	105
Age (years)	67.1 ± 6.5
Sex M/F	21/84
Falls	
Y/N	56/49
1	38
2	12
3+	5
Consequences	
Excoriation	22
Ankle sprain	12
Bruise/local pain	11
TBI	3
Arm fracture	2
Femur fracture	1
Finger fracture	1
Ankle fracture	1
Shoulder dislocation	1
Spinal injury	1
Legs weakness	1
Previous diseases	
Arterial hypertension	74
Osteoarthritis	52
Low back pain	42
Type 2 DM	18
Fibromyalgia	10
Hypothyroidism	8
Hypercholesterolemia	7
Osteoporosis	6
Stoke sequelae	4
Others	11
Use of medicine	
Y/N	96/9
Single prescription	14
2+	82

Y: yes; N: no; F: female; M: male; TBI: Traumatic brain injury; DM: *diabetes mellitus*; Others: The disease with a single report were grouped.

The characteristics of the 28 elderlies how were included in the therapeutic program are presented in the Table 3.

After the 10-session multisensorial physical exercises, the 24 patients who concluded the therapeutic program presented significant improvements, as shown in Table 4.

DISCUSSION

The results obtained from the sample of 105 elderly subjects have shown that, as for the general characteristic of the volunteers, there was prevalence of females who participated in this study, agreeing with results of similar studies, who assessed the same population, found in the literature.[4,17-20] Regarding the Brazilian conjuncture, this phenomenon can be explained once women live longer than man and, historically, women request health services more frequently than men.[21,22]

The results of the screening concerning the health history and the identification of frailties have shown that the elderlies possesses adverse clinical history. Most of the patients reported falls within the 12 months prior to the screening, physical consequences due to the falls, several chronic morbidities, and the routine use of one or more medicines. The combination of these factors demonstrated that the sample population of this study included individuals with high potential of frailty. Although there is no consensus in the literature regarding the definition of frailty,[2,8,23-25] some evidences suggest that non-intentional weight loss, muscle strength decrease, fatigue, physical activity reduction, gait speed reduction, immobility due to fractures after accidental falls (especially of ilium and femur), chronic diseases, and polypharmacy are all markers of frailty syndrome in elderly individuals.[5,7,26,27]

Regarding the performance of the tests applied along this study, the TUG execution time, which was superior to 10 seconds, identified that the elderly subjects may begin to have balance problems, once independent subjects, without balance problems complete the TUG in less than 10 seconds.[11] As for the Berg scale, the score of almost 50 points suggests a ceiling effect of the score.[14,17,28] The mean punctuation of 23.95 in the FES-I scale exhibit an association with occasional falls.[15]

The results of the clinical evaluations identified that 39% of the elderly subjects presented risk for falls. The TUG was chosen for the

Table 2. Results (mean and standard deviation) of the clinical tests and the FES-I questionnaire of the entire sample (N = 105)

Evaluations	Mean and Standard Deviation
TUG (s)	10.73 ± 3.69
Unipedal stance (OE) (s)	17.47 ± 10.16
Unipedal stance (CE) (s)	7.94 ± 7.40
Berg (points)	50 ± 5.71
FES-I (points)	23.95 ± 6.81

TUG: Timed Up and Go; s: seconds; OE: opened eyes; CE: closed eyes; Berg: Berg Balance Test; FES-I: Falls Efficacy Scale - International.

Table 3. Frailty characteristics of the subjects who accepted to participate in the therapeutic program (N = 28)

Variables	Total
N	28
Age (years)	66.8 ± 5.7
Sex M/F	4/24
ICD 10	
M 54/54.5	14
M 17	12
M 19	5
M 75/75.1	3
M 23	2
M 51	2
M 53.1	1
M 65.8	1
M 77.8	1
Falls 12 months prior to inclusion	
Yes	28
1	14
2	11
3+	3

M: male; F: female; ICD 10: International Statistical Classification of Diseases and Related Health Problems; M 54: Dorsalgia; M 54.5: Low back pain; M 17: Knee osteoarthritis; M 19: Other osteoarthritis; M 75: Shoulder injuries; M 75.1: Rotator cuff tear or rupture; M 23: Internal derangement of knee; M 51: Thoracic, thoracolumbar, and lumbosacral intervertebral disc disorders; M 53.1: Cervicobrachial syndrome; M 65.8: Other synovitis and tenosynovitis; M 77.8: Other enthesopathies, not elsewhere classified.

Table 4. Clinical test and FES-I questionnaire results before and after the intervention program (N = 24)

Tests	Before	After	*p*
TUG (s)	13.06 ± 2.43	8.71 ± 0.84	< 0.0001
UNIPEDAL (O) (s)	6.83 ± 3.92	22.27 ± 8.46	< 0.0001
UNIPEDAL (C) (s)	3.04 ± 1.7	7.83 ± 6.07	0.003
BERG (points)	46 ± 6.17	55.08 ± 1.66	< 0.0001*
FES-I (points)	25.83 ± 7.26	17.16 ± 1.30	< 0.0001

TUG: timed up and go; O: opened; C: closed; S: seconds; * Wilcoxon statistics.

inclusion of the volunteers once it is easily applied in the daily clinics, it possesses considerable reliability intra and interrater, and a good correlation with the Berg scale, therefore being considered a consistent predictor of falls of elderlies.[14,17,28]

By measuring the efficacy of the 10-session therapeutic program of multidimensional physical exercises, it was possible to observe the positive results after the intervention, once it could improve the execution time of the clinical tests under conditions as dynamic and static balance, functional mobility and fear of falling.

By the analysis of the dynamic balance, improvements were observed by several researchers who reported a time decrease of TUG test of elderly volunteers who were evaluated at different intervention periods of multidimensional exercises,[17,29,30,31] however the number of sessions of these studies were superior to 10. Nonetheless, a similar study with a population of frail elderlies of residents of a community in Terrassa/Barcelona - Spain,[10] did not find improvements of balance in the clinical evaluations TUG and Guralnik tests, however the dynamic and static posturography evaluations resulted in improvements of subjects who underwent a multisensorial physical exercise program for 16 weeks. Once these results and the results of the present study are compared, this difference can be explained since the Terrassa subjects were older and probably more limited, what may have contributed to a superior time in the execution of the TUG test.[10]

Concerning the static balance, the improvement is relevant for this individuals, once this type of balance is a predictor of independence and risk for falls among elderlies.[16,32] This improvement allows the elderlies to have greater autonomy and safety for performing the activities that depend on this balance, such as using public transportation like bus or subway, or some other activity.

The functional balance as evaluated by the Berg scale has also shown improvements, once there were significant changes in the score of the elderlies after their participation in the program. Similar results were found by Bulat et al.[1] who evaluated elderly residents of a community with risk for falls and that participated in a brief therapeutic program composed of eight weeks of physical activities designed for balance strengthening. It is important to emphasize that the Berg scale bears a relevant aspect by evaluating functional situations that engage both dynamic and static balance features of daily routine, nonetheless this evaluation usually takes longer time than other clinical tests to be completed. In the elderly population, improvements in static and dynamic balances may represent an important

step towards the achievement of independence for a longer time, especially the execution of activities of daily living. Therefore, the Berg scale can be considered useful when applied in frail elderlies or in patients with some type of balance problem.[1,14]

Regarding the fear of falling, the results have shown that the 24 elderly individuals could be classified as fallers, once they presented a mean of 25.83 ± 7.26 at the FES-I scale.[15] After participating in the therapeutic program, all subjects presented improvements in the score and could be classified as non-fallers. The decrease in the fear of falling may probably be related to the confidence acquired, which, in its turn, may have been originated by the multisensorial physical exercises program.

It still relevant to reiterate that the therapeutic program applied in this study used simple and commonly adopted materials of a physiotherapy service, basic instructions on the risk factors for falls, what caused this program to be feasible and of easy access, even for those with some type of musculoskeletal disease.

Nonetheless, this study also presented limiting factors. One of them may be the absence of a direct measurement, such as a platform for measuring balance. However, it is believed that the lack of this measurement did not jeopardize the results of this study, once the clinical tests that were used are broadly applied and reported as validated tools by the national and international literature, which consider these tools can measure the balance improvement after this type of intervention. The lack of a control group could also be a limiting factor, still, this study is a series of cases which can be used as its own control, in which all elderly subjects had balance improvements. Nevertheless, the findings of this study suggest that other studies should be done with elderly population and a control group, or even with different modalities of exercises, with the use of direct measurements as a force platform for measuring the body oscillation.

CONCLUSION

The subjects included in this study presented strong markers of frailty, once 39% of the sample had high risk for falls and fear of falling. Also, it is possible to conclude that the multisensorial exercises program applied in elderlies, considered frail, provided significant gains of dynamic and static balance, and functional mobility measured by the clinical tests that evaluated this population, as well as decreased the fear of falling of these frail elderlies.

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