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Research Article

Effect of Balance Training on Gait With and Without Dual-Tasks in Elderly: Randomized Clinical Trial

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Abstract

During challenging tasks, such as dual-tasks, there is an increased risk of falls in the elderly, so it is essential besides to seek for an effective balance training, also to study the effect of different therapeutic strategies in order to prevent falls.

Objective

The aim of this study was to evaluate the effects of balance training, supervised and home-based, on gait with and without dual-task in elderly.

Method

Older adults were randomly assigned to: supervised group (n= 15); home-based group (n= 15) or control group (n= 15). The gait was assessed in three situations: normal walking, functional dual-task and cognitive dual-task. The balance training protocol lasted 10 weeks for both, supervised and home-based group, including warm up, stretching, semi-static and dynamic balance and cool down. Data were treated by intention-to-treat method. For parametric variables ANOVA two-way and post hoc Bonferroni were applied. For non-parametric variables, Friedman analysis was applied. The level of statistical significance was set at $p \leq 0.05$.

Results

The balance training, regardless of whether supervised or home-based, did not improve any gait variable after 10 weeks of exercise. In the control group, it was observed a decrease of cadence in cognitive dual-task and an increase of percentage of double support in functional and cognitive dual-task, after 10 weeks.

Conclusion

The protocol predominantly based on balance training was not efficient to improve gait parameters with and without dual-task, in the young-old dwelling adults.

Keywords: Aging; Balance Exercise; Kinematic; Variability; Walking

Introduction

Aging is considered a heterogeneous process that affects each individual differently, and the decrease of balance control makes gait, a dynamic task, more complex [1]. Multiple factors are responsible for these impairments, including sensory, motor and cognitive processing reductions and muscle function impairment [2]. These factors explain the gait instability and may increase risk of falling in older adults [3,4].

Falls are strongly associated with attention ability reduction, instability in standing position and during dynamic daily activities, as gait [5]. Fifty five percent of falls occur during gait, 32% of falls occur due to balance impairments and only 13% occur due to extrinsic factors related to environmental barriers, such as the presence of a step [6].

Regarding gait alterations, older persons tend to reduce gait speed and increase their base of support in order to attain greater postural stability during walking [6,7]. The gait speed, the base of support and other gait parameters change sharply during dual-tasks conditions, when older adults need to divide their attention to keep their balance [8]. Moreover, age-related to the dual-task deficits have been associated with poor executive function in community-elderly [9], which demonstrate that gait ability is influenced by cognitive functions. Therefore, dual-task has been largely used to evaluate interaction between cognition, gait and risk of falls [9-11].

Intervention protocols have been performed to improve gait parameters during dual-tasks and consequently to avoid risk of falls in older adults. According to Hiyamizu et al [12], studies using motor dual-task in the balance training reported positive results. However, few studies have been done to clarify clinical evidence about the effect of balance training on dual-task ability.

Exercise protocols including muscle strength, balance and tai-chi-chuan exercises are effective to prevent falls, highlighting the benefits of a multi-component training [13]. However, it is important to perform exercise protocols that involve specific balance training in order to investigate if balance improvement can be reach more quickly and efficiently, i.e. bringing faster resoluteness for balance in older adults. The faster resoluteness can be an important strategy to keep the elderly adherence and to prevent dropouts, a relevant aspect in health promotion approaches. In addition, a home-based training can be a good alternative to perform an exercise program for those who have difficulties to attend a supervised training at a rehabilitation center.

The hypothesis of this study was that a training including predominant balance exercises could improve functional balance, spatio-temporal gait parameters and gait variability. In additional, if training protocol has been appropriately instructed to perform at home (e.g., available booklet and DVD of the exercises), supervised and home-based modalities could induce similar effects on gait variables of older adults.

Therefore, the purpose of the present study was to evaluate: I) the effect of a balance training protocol on gait, with and without dual-tasks (functional and cognitive) regarding the gait spatio-temporal parameters and the intra-individual gait variability; II) whether there is a better therapeutic strategy to apply the training protocol, considering the exercise performed through supervised group or at home individually.

Methods

This randomized clinical trial, blind to evaluators, followed recommendations of the Consolidated Standards of Reporting Trials (CONSORT) [14] and participants signed a consent term that was approved by the local Human Research Ethics Committee.

Participants

Forty-five older adults, noninstitutionalized, both sex, independent to walking and without cognitive impairment were recruited at random from the local community (Ribeirão Preto, SP, Brazil) to participate voluntarily in the study.

Study sample was made up from 179 elderly contacted; 134 elderly were excluded because did not attend evaluation or did not meet the inclusion and exclusion criteria of the study (Figure 1). Therefore, 45 subjects were evaluated. Simple randomization was performed using opaque envelopes from which three groups of options: Supervised group (n=15), Home-based group (n=15) and Control group (n=15). Researcher who performed randomization did not participate in the evaluations and in the protocol training, keeping the blind design of the study.

Inclusion criteria comprised: elderly aged 60 to 80, independent to walking (without assistive devices), able to understand and to execute commands, independent to perform activities of daily living and instrumental life (subjects with mild or no difficulty) measured by BOMFAQ questionnaire [15] and, finally, elderly that reside in the local community.

Exclusion criteria comprised: cognitive impairment traced by the Mini-Mental State Examination (MMSE), taking into consideration each subject's level of education (Unlettered: 20 points, 1-4 years: 25 points, 5-8 years: 26,5 points, 9-11 years: 28 points, Above 11 years: 29 points) [16], decreased

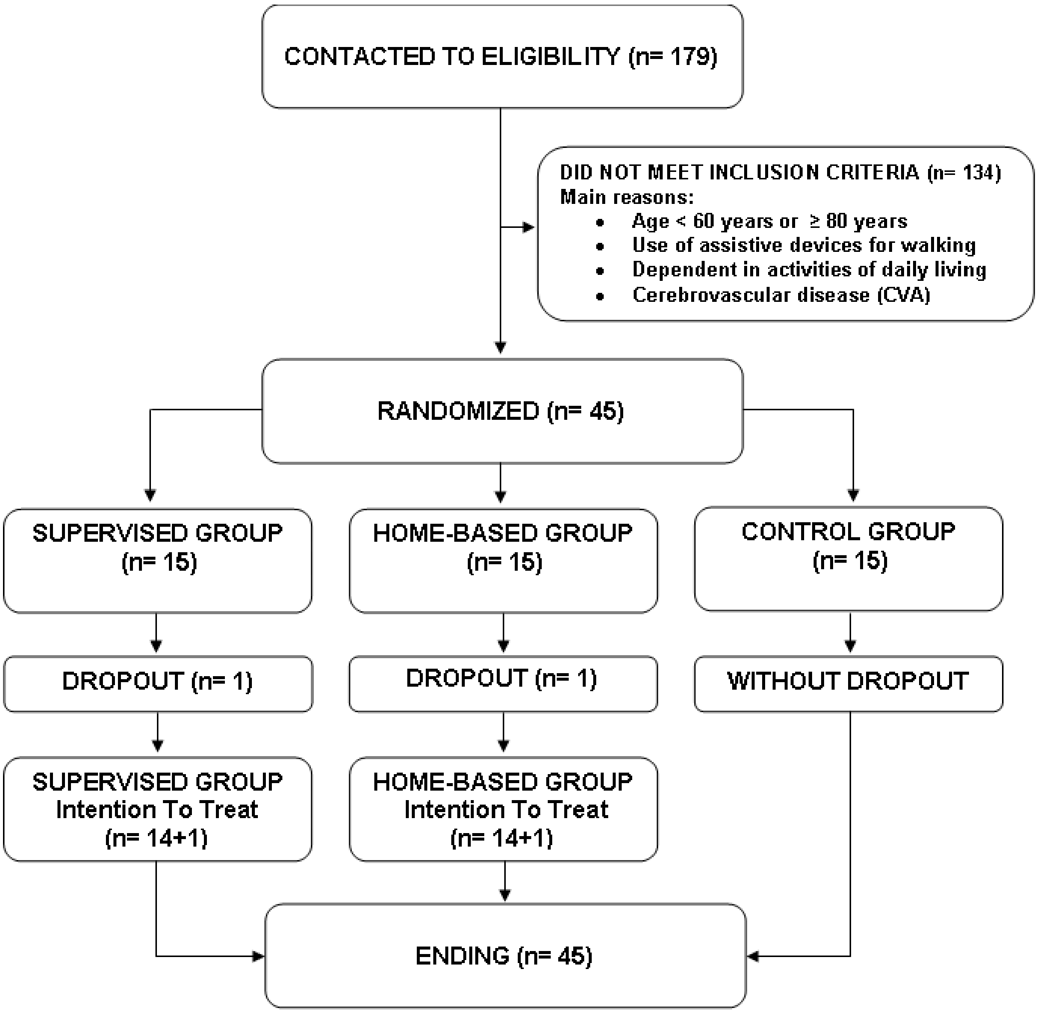

Figure 1. Flowchart of randomized study design (supervised group, home-based group and control group).

sensitivity to foot's sole identified by Semmes-Weistein [17], presence of cardiovascular disease, neurological or musculoskeletal that would compromise the static or dynamic balance, recent episodes of dizziness or chronic dizziness [18], lack of visual or auditory acuity, previous surgery in the last 6 months, pain in lower limbs that interfere in gait, medication that compromises balance or cognitive abilities, and medical restrictions to any of performed procedures in this study.

Initially, personal contact information and history of falls in the last 6 months were collected. Also, anthropometric data (body mass and height) and gait analysis were performed.

Gait Analysis

Gait analysis was performed at the Motion Analysis Laboratory of the Rehabilitation Center of the Clinical Hospital, School of Medicine of Ribeirão Preto, University of São Paulo, Brazil (FMRP-USP).

The tridimensional kinematic analysis of gait was performed using a system with eight Qualisys Pro-Reflex Oqus 300® infrared cameras (Qualisys AB, Sweden). These cameras were placed approximately 2.5 meters above the ground, supported by fixed tripods. The cameras were connected to the computer and the captured images were processed with the Qualisys Track Manager program. Data were registered at 120Hz and acquisition time corresponded to an average of two gait cycles. The collected data were interpolated, when needed, for a maximum of 10 frames gap and filtered used a fourth-order Butterworth low-pass, at the cutoff frequency of 6Hz [19] to reduce noise produced by the markers. Subsequently, data were exported to MAT-Files format and were worked in a specific MATLAB® routine environment to extract values of the gait analysis.

The four passive spherical markers that were used for gait analysis were coated with reflective paint, fixed on the feet of each participant on the back of the heel bone (calcaneus) and on the dorsum of the foot between the 2nd and 3rd metatarsal axes, bilaterally, following Helen Hayes model [20]. Prior to kinematic analysis, we gathered static data, needed for generating an anatomical model of subjects in the Qualisys system. For this procedure, subjects were placed in stationary position, previously delimited on a carpet rubber used to gait.

For dynamic tasks, subjects were barefoot and instructed to execute normal gait and two dual-task situations on carpet rubber.

Three gait conditions were randomly assessed: I) *Normal gait* – the participant was instructed to walk at a self-selected speed; II) *Functional dual-task* – walking at a self-selected speed while transferring a coin from one pocket to another in a bag that measured 19 x 20 cm, attached in a belt, in front of the belly of each subject [21]; III) *Cognitive dual-task* – walking while say the days of the week aloud and backwards, beginning with Saturday [22]. Each task was repeated three times sequentially. For data analysis, the initial and the final 1.5m of gait were disregarded, in order to exclude the acceleration and deceleration phases.

	Period (week)	Parameter	Description
Warm up (5 minutes)	1st – 10th	10 repetitions	**Exercises:** - Abduction and adduction of shoulders with triple flexion of the lower limbs - Flexion and Extension Shoulders with triple flexion of the lower limbs
Stretching (10 minutes)	1st - 3rd 4th - 6th 7th -10th	10 seconds 20 seconds 30 seconds	**Muscles:** - Abdomen rectus - Abdomen Oblique - Pectoralis - Gluteus (maximums and medium) - Quadriceps - Hamstrings - Tibialis Anterior - Triceps Surae
Semi-Static and Dynamic Balance (35 minutes)	1st - 3rd 4th - 6th 7th -10th	3 times/ 30 seconds 3 times/ 60 seconds 3 times/ 90 seconds	**Exercises:** - Seated, transferring of weight to both legs - Seated, trunk rotation with the rise of velocity - Seated, knee extension alternately - Sitting and Standing (reducing the base of support) - Standing, transferring of weight to both legs - Standing, swinging the trunk to front and to backwards - Single leg stance - Walking forward with cervical movements on firm and unstable floor - Walking forward with arms and legs dissociation - Walking with raised heelpiece (on toes) - Walking with raised toes (on heelpiece) - Walking with direction shifts - Walking sideways - Walking overcoming obstacles on the floor - Tandem Walking (toes meet the heel every other step) - Walking backwards - Walking with motor second task (throwing a ball) - Walking with cognitive second task (saying fruits names and animals names)
Cool down (5 minutes)	1st – 10th	–	- Seated, hearing a relaxing music

Table 1. Balance Training Protocol performed for supervised group and home-based group during twenty sessions, two times a week.

For each gait conditions above cited the follow spatio-temporal gait variables were analyzed: gait speed, step length, step width, stride length, double support time and single support time in percentage of the gait cycle, cadence and toe clearance (distance from the floor to toes). The intra-individual gait variability was also analyzed.

The assessments were performed at baseline and after 10 weeks.

Training Protocol

The balance training protocol was performed at Integrated Center of Rehabilitation at State Hospital of Ribeirão Preto (CIR-HE/RP).

The supervised group carried out 20 sessions of supervised balance training protocol, twice a week. The home-based group performed the balance training protocol with 2 supervised sessions at CIR-HE/RP and 18 sessions conducted at home, twice a week, following instructions in a booklet and in a DVD that included the same training protocol of supervised group (Table 1).

The training of supervised group and the 2 sessions of home-based group were conducted by physiotherapists, who were blinded for the baseline assessments. In addition, the home-based group received phone calls to keep adherence to training and to clear possible doubts.

We designated other researchers to call weekly the subjects of home-based group. As soon as the supervised and home-based groups finished the training protocol, which lasted 10 weeks, the volunteers were reassessed.

The control group did not perform exercise protocol or any other exercise.

Statistical Analysis

The initial sample size calculation was 15 participants per group, considering gait speed as main variable, power of 0.96, an alpha level of 0.05, and effect size of 1.16 (data of a pilot study), using the G*Power Software, version 3.1.92 (Universitat Kiel – Germany).

Analysis of gait variability were conducted with a minimum of six steps [21], and the coefficient of variation (CV) calculation was applied to the raw data, which consists of dividing the standard deviation (SD) by the mean (M) and then multiplying the result by 100 [23].

Missed data were adjusted by intention-to-treat analysis that is a statistical approach to deal with dropouts, non-compliant participants and equal groups, like imputation method the Extreme Case Analysis was used [24].

Data were expressed as mean and standard deviation. Shapiro-Wilk and Levene test were applied to evaluate the normality and homogeneity of the results, respectively. For data that did not present a non-normal distribution, logarithmic transformation was carried out.

For data with non-normal distribution, Kruskal-wallis test was used to determine possible differences between groups before and after exercise of each group for single support time, double support time, stride length and toe clearance. Friedman test was used to determine possible differences when compared each group before and after exercise to evaluate the influence of intervention in gait parameters for single support time, double support time, stride length and toe clearance.

For data with normal distribution, ANOVA two way followed by Bonferroni post-hoc test were used to determine possible differences when compared each group before and after exercise to evaluate the influence of intervention in gait parameters for step length, step width, cadence and speed gait for supervised group; step length, step width, cadence and speed gait for home-based group; and step length, step width, stride length, double support time and speed gait for control group.

For variability data with non-normal distribution, Kruskal-wallis test was used to determine possible differences between groups before and after exercise for step length, step width, stride length, single support time, double support time, cadence and toe clearance. Friedman test was used to determine possible differences when compared each group before and after exercise to evaluate the influence of intervention in gait parameters for stride length and cadence for supervised group; single support time for home-based group; and step length for control group.

All analyzes were performed using SPSS (SPSS for Windows, V16.0, SPSS Inc. USA) and the significance level maintained at 0.05 ($p \leq 0.05$).

Results

Table 2 presents the characteristics of the studied population. According to anthropometric data, there were no significant differences ($p > 0.05$) in sex, age, height, weight and Body Mass Index (BMI) among the three groups. Descriptive analysis was used to cognitive screening, education level, BOMFAQ questionnaire and number of falls.

Gait Variables

In Supervised and home-based groups, there were no significant differences for any of gait parameters ($p > 0.05$), considering the different gait conditions in the baseline versus after 10 weeks (Table 3).

In Control group, after 10 weeks, there was a significant increase in the percentage of double support time ($p < 0.05$)

Variables	Group			
	Supervised	**Home**	**Control**	***p***
Sex	F=15 / M=0	F=14 / M=1	F=12 / M=3	--
Age (years)	66.40 ± 3.48	64.60 ± 4.14	66.20 ± 4.51	0.32
Height (m)	1.57 ± 0.08	1.56 ± 0.06	1.58 ± 0.11	0.937
Weight (kg)				
Pre-intervention	69.05 ± 13.06	66.61 ± 11.39	65.41 ± 11.91	0.833
Post-intervention	68.41 ± 13.49	67.12 ± 11.70	65.24 ± 11.92	0.636
BMI (kg/m²)				
Pre-intervention	28.02 ± 4.86	27.36 ± 3.75	26.19 ± 3.48	0.856
Post-intervention	27.75 ± 4.99	27.55 ± 3.76	26.12 ± 3.43	0.599
MMSE	27 ± 2.2	27 ± 2.1	28 ± 2.0	--
Education (No. Subjects, %)				
Unlettered	0 (0.0%)	0 (0.0%)	0 (0.0%)	--
1-4 years	3 (20.0%)	3 (20.0%)	1 (6.6%)	--
5-8 years	4 (26.7%)	4 (26.7%)	5 (33.3%)	--
9-11 years	5 (33.3%)	4 (26.7%)	0 (0.0%)	--
Above 11 years	3 (20.0%)	4 (26.7%)	9 (60.0%)	--
BOMFAQ (No. Subjects, %)				
No difficult	9 (60.0%)	10 (66.6%)	7 (46.6%)	--
Mild difficult	6 (40.0%)	5 (33.4%)	8 (53.4%)	--
Moderate difficult	0 (0.0%)	0 (0.0%)	0 (0.0%)	--
Several difficult	0 (0.0%)	0 (0.0%)	0 (0.0%)	--
Number of Falls (in past 6 months)				
Pre-Intervention	>4	>4	1	--
Post-intervention	3	2	3	--

Table 2. Population's characteristics of present study.

during functional dual-task and cognitive dual-task. Also, a significant decrease was observed (p> 0.05) in cadence during cognitive dual-task after 10 weeks (Table 3).

Gait Variability

In gait variability (step length, step width, percentage of single support time, percentage of double support time, stride length, cadence and toe clearance), there were no significant differences (p> 0.05) in any gait parameters (p> 0.05) regarding after 10 weeks for supervised group, home-based group and control group (Table 4).

At baseline, for supervised group, stride length had a significant increase (p= 0.015) during functional dual-task (6.43% ± 6.58) when compared to normal gait (2.19% ± 1.39). Also, cadence variability had a significant increase (p= 0.023) during functional dual-task (3.97% ± 2.90) when compared to normal gait (1.99% ± 1.43).

Besides, at baseline, for home-based group, the percentage of single support time variability presented a significant increase (p= 0.019) during cognitive dual-task (6.16% ± 3.40) when compared to functional dual-task (2.78% ± 1.64). For control group, the step length variability increased significantly

VARIABLE	SUPERVISED		HOME-BASED		CONTROL	
	Pre	Post	Pre	Post	Pre	Post
	mean ± Sd	mean ± Sd	mean ± Sd	mean ± Sd	mean ± Sd	mean ± Sd
Gait Speed (m/s)						
Cognitive dual-task	0.91 ± 0.23	0.92 ± 0.19	0.85 ± 0.22	0.82 ± 0.13	0.88 ± 0.18	0.92 ± 0.15
	p= 0.966		*p*= 0.157		*p*= 0.263	
Normal Gait	1.06 ± 0.17	1.03 ± 0.14	0.96 ± 0.17	0.94 ± 0.12	1.08 ± 0.16	1.06 ± 0.15
	p= 0.390		*p*= 0.711		*p*= 0.542	
Functional dual-task	0.91 ± 0.22	0.93 ± 0.16	0.82 ± 0.20	0.80 ± 0.14	0.87 ± 0.17	0.90 ± 0.17
	p= 0.873		*p*= 0.383		*p*= 0.356	
Step Length (m)						
Cognitive dual-task	0.54 ± 0.07	0.53 ± 0.06	0.52 ± 0.05	0.50 ± 0.04	0.54 ± 0.05	0.54 ± 0.05
	p= 0.407		*p*= 0.512		*p*= 0.964	
Normal Gait	0.55 ± 0.04	0.55 ± 0.05	0.53 ± 0.05	0.52 ± 0.04	0.55 ± 0.05	0.56 ± 0.06
	p= 0.546		*p*= 0.666		*p*= 0.755	
Functional dual-task	0.51 ± 0.07	0.51 ± 0.06	0.48 ± 0.04	0.48 ± 0.04	0.50 ± 0.05	0.51 ± 0.06
	p= 0.816		*p*= 0.469		*p*= 0.265	
Step Width (m)						
Cognitive dual-task	0.12 ± 0.05	0.11 ± 0.04	0.11 ± 0.05	0.10 ± 0.04	0.12 ± 0.06	0.12 ± 0.04
	p= 0.793		*p*= 0.577		*p*= 0.876	
Normal Gait	0.13 ± 0.03	0.12 ± 0.09	0.10 ± 0.04	0.11 ± 0.03	0.11 ± 0.05	0.12 ± 0.05
	p= 0.853		*p*= 0.229		*p*= 0.308	
Functional dual-task	0.12 ± 0.03	0.12 ± 0.04	0.12 ± 0.05	0.11 ± 0.05	0.14 ± 0.05	0.14 ± 0.05
	p= 0.872		*p*= 0.371		*p*= 0.982	
Stride Length (m)						
Cognitive dual-task	1.14 ± 0.16	1.12 ± 0.14	1.09 ± 0.16	1.05 ± 0.11	1.12 ± 0.12	1.12 ± 0.10
	p= 1.000		*p*= 0.251		*p*= 0.960	
Normal Gait	1.17 ± 0.13	1.17 ± 0.11	1.11 ± 0.13	1.07 ± 0.15	1.17 ± 0.12	1.15 ± 0.08
	p= 1.000		*p*= 1.000		*p*= 0.332	
Functional dual-task	1.03 ± 0.18	1.07 ± 0.13	1.00 ± 0.14	0.98 ± 0.12	1.02 ± 0.13	1.04 ± 0.13
	p= 1.000		*p*= 1.000		*p*= 0.199	
Double Support Time (%)						
Cognitive dual-task	0.17 ± 0.07	0.17 ± 0.05	0.20 ± 0.09	0.17 ± 0.03	0.17 ± 0.04	0.19 ± 0.07
	p= 1.000		*p*= 1.000		*p*= 0.012*	
Normal Gait	0.14 ± 0.03	0.15 ± 0.03	0.16 ± 0.04	0.15 ± 0.03	0.14 ± 0.03	0.14 ± 0.03
	p= 1.000		*p*= 1.000		*p*= 0.809	
Functional dual-task	0.17 ± 0.05	0.17 ± 0.05	0.19 ± 0.08	0.17 ± 0.05	0.17 ± 0.04	0.18 ± 0.05
	p= 1.000		*p*= 1.000		*p*= 0.035*	
Single Support Time (%)						
Cognitive dual-task	0.44 ± 0.07	0.44 ± 0.06	0.46 ± 0.08	0.44 ± 0.04	0.45 ± 0.06	0.43 ± 0.06
	p= 1.000		*p*= 1.000		*p*= 1.000	
Normal Gait	0.39 ± 0.02	0.41 ± 0.03	0.41 ± 0.03	0.40 ± 0.02	0.38 ± 0.05	0.39 ± 0.03
	p= 0.604		*p*= 1.000		*p*= 1.000	
Functional dual-task	0.40 ± 0.07	0.41 ± 0.04	0.42 ± 0.05	0.43 ± 0.04	0.42 ± 0.04	0.41 ± 0.04
	p= 1.000		*p*= 1.000		*p*= 1.000	
Cadence (steps per minute)						
Cognitive dual-task	102.26 ± 16.27	102.81 ± 14.90	96.39 ± 18.92	96.29 ± 11.08	101.91 ± 13.80	96.98 ± 14.77
	p= 0.650		*p*= 0.142		*p*= 0.046*	
Normal Gait	114.83 ± 10.21	111.67 ± 10.73	107.73 ± 11.56	108.62 ± 10.62	114.83 ± 11.89	113.29 ± 11.61
	p= 0.178		*p*= 0.759		*p*= 0.599	
Functional dual-task	105.85 ± 16.21	108.01 ± 10.65	100.54 ± 16.60	99.94 ± 11.52	105.81 ± 12.27	102.43 ± 13.45
	p= 0.944		*p*= 0.603		*p*= 0.541	
Toe Clearance (m)						
Cognitive dual-task	0.04 ± 0.02	0.05 ± 0.02	0.05 ± 0.01	0.05 ± 0.02	0.05 ± 0.01	0.06 ± 0.01
	p= 1.000		*p*= 1.000		*p*= 1.000	
Normal Gait	0.07 ± 0.08	0.07 ± 0.07	0.06 ± 0.01	0.05 ± 0.02	0.06 ± 0.01	0.06 ± 0.01
	p= 1.000		*p*= 1.000		*p*= 1.000	
Functional dual-task	0.05 ± 0.01	0.05 ± 0.02	0.05 ± 0.01	0.05 ± 0.02	0.05 ± 0.01	0.06 ± 0.01
	p= 1.000		*p*= 1.000		*p*= 1.000	

Table 3. Data are expressed as mean ± standard deviation. Spatio-temporal gait variables in supervised, home and control groups during three gait conditions (normal, functional dual-task and cognitive dual-task), pre- and post-intervention.

VARIABLE	SUPERVISED		HOME-BASED		CONTROL	
	Pre	Post	Pre	Post	Pre	Post
	mean ± Sd	mean ± Sd	mean ± Sd	mean ± Sd	mean ± Sd	mean ± Sd
Step Length (CV%)						
Cognitive dual-task	3.58 ± 2.29	3.05 ± 2.13	3.89 ± 2.28	2.51 ± 1.69	4.55 ± 2.85	4.07 ± 2.92
	p= 0.968		p= 0.254		p= 1.000	
Normal Gait	2.43 ± 2.10	2.96 ± 2.03	3.05 ± 1.65	2.48 ± 1.72	2.88 ± 1.44	3.96 ± 4.65
	p= 1.000		p= 0.214		p= 0.604	
Functional dual-task	4.87 ± 3.96	3.95 ± 3.17	4.67 ± 3.13	3.37 ± 2.83	5.73 ± 3.95	4.41 ± 3.45
	p= 0.777		p= 0.288		p= 1.000	
Step Width (CV%)						
Cognitive dual-task	8.79 ± 6.17	9.76 ± 7.81	11.26 ± 9.81	7.96 ± 6.84	10.41 ± 8.99	10.74 ± 10.48
	p= 0.780		p= 0.456		p< 1.000	
Normal Gait	10.75 ± 7.36	12.24 ± 9.59	10.40 ± 8.51	8.07 ± 7.90	7.87 ± 5.97	9.66 ± 8.74
	p= 0.330		p= 0.654		p= 0.503	
Functional dual-task	12.53 ± 7.24	10.27 ± 8.23	12.64 ± 8.28	7.17 ± 4.56	10.34 ± 6.97	7.98 ± 4.92
	p= 0.348		p= 0.401		p= 0.222	
Stride Length (CV%)						
Cognitive dual-task	4.74 ± 4.49	2.96 ± 2.25	4.21 ± 3.74	3.30 ± 1.63	4.86 ± 2.93	3.83 ± 2.27
	p= 1.000		p= 0.222		p= 0.076	
Normal Gait	2.19 ± 1.39	2.71 ± 2.38	2.51 ± 1.70	2.73 ± 1.41	2.76 ± 1.48	2.42 ± 2.04
	p= 1.000		p= 0.927		p= 1.000	
Functional dual-task	6.43 ± 6.58	4.22 ± 3.58	3.86 ± 3.49	3.83 ± 2.82	5.93 ± 6.58	4.39 ± 4.08
	p= 1.000		p= 1.000		p= 0.654	
Double Support Time (CV%)						
Cognitive dual-task	7.61 ± 4.51	6.91 ± 4.13	6.94 ± 4.84	5.39 ± 5.15	8.55 ± 7.49	6.91 ± 4.52
	p= 0.988		p= 0.888		p= 0.167	
Normal Gait	7.16 ± 4.44	6.55 ± 3.18	5.78 ± 3.88	5.99 ± 3.81	7.03 ± 3.73	7.14 ± 3.89
	p= 1000		p< *1.000*		p= 0.999	
Functional dual-task	8.03 ± 5.97	6.96 ± 5.88	8.27 ± 6.09	6.45 ± 4.48	10.88 ± 9.78	7.23 ± 5.54
	p= 0.769		p= 0.503		p= 0.088	
Single Support Time (CV%)						
Cognitive dual-task	5.05 ± 3.48	3.96 ± 2.08	6.16 ± 3.40	3.68 ± 2.12	4.91 ± 4.70	3.64 ± 3.22
	p= 0.567		p= 1.000		p= 0.987	
Normal Gait	2.98 ± 2.06	2.58 ± 1.56	3.62 ± 3.48	2.39 ± 1.76	2.39 ± 1.75	2.50 ± 1.50
	p< 1.000		p= 1.000		p< 1.000	
Functional dual-task	7.23 ± 12.07	2.66 ± 1.29	2.77 ± 1.64	3.37 ± 1.92	3.54 ± 2.56	2.76 ± 1.95
	p= 0.210		p= 1.000		p= 0.863	
Cadence (CV%)						
Cognitive dual-task	3.79 ± 2.57	3.68 ± 2.10	5.70 ± 3.34	3.65 ± 2,57	3.32 ± 3.52	3.16 ± 1.97
	p= 1.000		p= 0.069		p< 1.000	
Normal Gait	1.99 ± 1.43	3.37 ± 5.26	3.55 ± 3.00	3.28 ± 5.39	2.24 ± 1.01	2.31 ± 0.99
	p= 1.000		p< *1.000*		p< 1.000	
Functional dual-task	3.97 ± 2.90	3.10 ± 2.00	3.52 ± 2.40	3.28 ± 2.21	4.62 ± 3.63	3.53 ± 2.52
	p= 1.000		p< *1.000*		p= 0.105	
Toe Clearance (CV%)						
Cognitive dual-task	10.10 ± 7.14	9.53 ± 10.15	4.51 ± 2.42	2.88 ± 2.77	9.33 ± 5.04	6.39 ± 4.71
	p= 0.835		p= 0.365		p= 0.091	
Normal Gait	9.33 ± 8.01	6.31 ± 4.59	4.97 ± 3.33	4.34 ± 2.34	8.01 ± 4.98	3.91 ± 2.53
	p= 0.862		p= 1.000		p= 0.067	
Functional dual-task	8.88 ± 7.32	6.73 ± 4.24	3.51 ± 2.44	4.20 ± 2.84	6.99 ± 5.28	3.36 ± 2.21
	p= 0.634		p= 0.403		p= 0.143	

Table 4. Data are expressed as mean ± standard deviation. Gait parameters variability calculated by coefficient of variation (CV%) for supervised, home-based and control groups during three gait conditions (normal, functional dual-task and cognitive dual-task), pre- and post-intervention.

(p= 0.047) during functional dual-task (5.74% ± 3.95) when compared to normal gait (2.88% ± 1.44).

Discussion

The hypothesis of the present study was not confirmed, because the training protocol, regardless of supervised or domiciliary strategy, based predominantly in balance exercises did not improve gait parameters during normal gait and during dual-task gait conditions.

There are evidences that balance training improves the postural control during dual-task conditions [25], however, our study did not find significant changes in gait pattern after balance training protocol, which corroborates with Hiyamizu et al [12], who did not find improvement after training protocol (strength training and balance training, two times a week, during 24 session) on dynamic balance associated to cognitive tasks in older adults.

Studies included in the systematic review conducted by Agmon et al [25] have performed different dual-tasks, different balance training protocols, with diversified duration and frequency, evaluating different gait variables. Also, those studies emphasize that the magnitude of changes in the gait variables after the training protocol variates according to gait parameters analyzed, type of tasks and task difficulty [26].

Plummer et al [27] showed a lack of consensus about frequency training, types of training, type of dual-tasks and variables analyzed, discussing the need of a minimal standard training to allow the comparison among studies. This approach is important to help in the choice of an efficient training protocol to improve gait parameters associated to dual-tasks performance.

Speed gait is a variable extensively discussed in the literature, and studies have shown an interaction between age, speed gait and dual-task [28]. The present study did not find significant differences in gait speed before and after intervention program among evaluated groups. However, it is possible to observe that the mean of the gait speed *among* the three groups during Normal gait was higher than during dual-tasks, as observed in other studies [9-11]. Also, the values of the gait speed during dual-task conditions are within the recommended gait speed of a successful aging process, defined as 0.80 m/s by Studenski et al [29].

In the control group, the percentage of double support time increased during dual-task conditions (functional and cognitive dual-task) and it is known that the older adults remain more time in double support as a strategy to maintain stability [6]. Also in the control group, the cadence decreased during cognitive dual-task corroborating to the literature that reports that the gait parameter changes during dual-task in elderly [26]. In addition, the increase in percentage of double support time and the decrease in the cadence can be a compensatory strategy due to a challenge task. Studies [11,27] have reported that during cognitive dual-task, elderly change gait parameters, increasing the percentage of double support time, because the attention is focused on the second task.

The gait variability has been identified as a major intrinsic risk factor for falls in the old age and there is evidence that gait variability further deteriorates in dual-task conditions [23]. The results related to the gait variability have shown differences only at baseline. In the supervised group, the stride length variability and cadence were higher during the functional dual-task condition. In the home-based group, the percentage of single support variability was higher during the functional dual-task condition. In the control group, the step length variability was higher during the functional dual-task condition.

After 10 weeks, there were no significant differences in the gait variability among gait tasks for any group, which can suggest a subtle influence provided by the training protocol. However, the same effect was observed after 10 weeks in the control group that did not perform the training program.

The training protocol used in the present study met the requirements in order to induce a positive influence on results as mentioned in the review conducted by Lauenroth, Loannidis and Teichmann [30], which include blind design, intention-to-treat analysis, increase of training level difficult and frequency of 1 to 3 hours weekly. However, our protocol lasted 10 weeks instead of 12 to 16 weeks, which is more likely to reach detectable improvements. Therefore, the lack of balance improvement in the present study may be related to the population's characteristic, which included young old adults [31] (range 60-72 years) and independent elderly living in the community.

Conclusion

We conclude that the training with predominantly balance exercises was not efficient to improve gait performance during single task and dual-task conditions in young-old dwelling adults.

Limitation of The Study

The present study has some limitations: the inclusion of young-old and the restrained exercise progression in balance training protocol, because the same protocol was performed at home, without supervision.

Conflicts of Interest

No conflicts of interest.

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