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Minimally Supervised Multi-Modal Exercise to Reduce Falls Risk among Economically and Educationally Disadvantaged Older Adults

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Abstract

Few studies have evaluated the benefit of providing exercise to underprivileged older adults at risk for falls. Economically and educationally disadvantaged older adults with previous falls (mean age 79.06, $SD=4.55$) were randomized to four months of multi-modal exercise provided as fully supervised center-based (FS, $n=45$) or as minimally supervised home-based (MS, $n=42$) or to non-exercise controls (C, $n=32$). Comparing groups on the mean change in fall-relevant mobility task performance between baseline and four months and compared to the change in C, both FS and MS had significantly greater reduction in Timed Up and Go $F(2,73)=5.82, p=.004, \eta^2_{partial}=0.14$ and increase in Tandem Walk Speed $F(2,73)=7.71, p<.001, \eta^2_{partial}=0.17$. Change in performance did not statistically differ between FS and MS. In community dwelling economically and educationally disadvantaged older adults with a history of falls, minimally supervised home-

based and fully supervised center-based exercise programs may be equally effective in improving fall-relevant functional mobility.

Keywords

Elderly; Falls; Multi-modal Exercise; Minimally Supervised; Fully Supervised; Balance

Falls in older adults are a growing worldwide concern given the serious consequences and high cost to healthcare systems. In western countries, more than one third of adults over age 65 experience a fall each year and in half of these cases falls are recurrent (Blank et al., 2011; Moura et al., 1999). Falls lead to severe consequences including fractures or serious injuries in 10% of the cases (Resnick, 1999; Tinetti, & Kumar, 2010). Aside from these physical outcomes, falls have important psychological effects by reducing confidence in one's motor skills and, therefore, inducing inactivity (Hauer et al., 2002). Inactivity has numerous health consequences in itself, including loss of muscle mass and functionality, reduction of independency, increased risk of institutionalization, and lower quality of life, which further enhances health utilization and costs. After a fall, the risk of institutionalization increases from three to ten times (Tinetti & Kumar, 2010).

Gait disorders, diminished strength, and impaired balance are among the most common causes of falls in older adults (Ades, 2001; Ishizuka, Mutarelli, Yamaguchi, & Jacob Filho, 2005; McInnes, Gibbons, & Chandler-Oatts, 2005).

There is strong evidence that exercise interventions reduce fall risk in older adults, especially among those at high risk of falling (Gillespie et al., 2009; Michael et al., 2010; Province et al., 1995; Sherrington et al., 2008.). However, studies vary considerably in terms of the kind of the intervention, duration of programs, number of patients, settings and type of population. In 2010, a systematic review for the U.S. Preventive Services Task Force was published (Michael et al., 2010) showing that exercise was effective in reducing fall risks in the majority of trials, although there was a large heterogeneity in tested approaches.

Few studies target a segment of the population that is difficult to train, the economically and educationally disadvantaged. Demographic, behavioral, and functional characteristics make this population more susceptible to falls (Andresen et al., 2006; Kressig et al., 2001.).

Furthermore, in regard to adherence, they are less available for exercise programs due to transport difficulties, family responsibilities, the lack of someone to accompany them to the health center, or even the need to continue working.

Thus, attending and adhering to a center-based exercise program may be extremely difficult for older adults with some level of incapacity, socioeconomic problems and those who lack family support (Jette et al., 1999; Tinetti & Kumar, 2010; Yardley et al., 2006.). Moreover, supervised programs require appropriate facilities, professional assistance, and possibly more resources for implementation and maintenance, which may make such programs impractical for widespread community distribution in some countries (Davis et al., 2010). On the other hand, home-based, minimally supervised exercise requires fewer resources and

infra-structure and thus seems to be a rational and economical alternative, as long as it is proven to be effective and, above all, safe.

The purpose of the present study is to compare two different means of delivering exercise programs to economically and educationally disadvantaged older adults with a history of falls, and specifically evaluate the exercise effect on factors previously recognized as related to falls risk. The authors hypothesized that in this particular older adult population, a four month minimally supervised home-based multi-modal exercise program can be as effective as a fully supervised center-based program in improving mobility tasks that relate to falls risk.

Method

Participants

The study sample was selected from community dwelling older adults receiving outpatient care at a healthcare center that serves approximately 600 older adults per day in Sao Paulo-SP, Brazil (Centro de Referência do Idoso da Zona Norte). Potential participants were screened from a pool of 2,047 adults aged 70 years or older by kinesiologists and psychologists of their search staff during the period of 16 months, from January, 2008 to May, 2009.

Eligible patients were those non-institutionalized, able to walk independently, had at least one fall in the previous year, and were not enrolled in a regular exercise program. Of these 2,047 approached, 540 reported a fall in the past year and 493 were not enrolled in regular exercise, and 362, who reported a fall and no regular exercise, agreed to come in for the first interview.

Of the 362 who agreed to come in for the first interview, only 223 actually attended the interview. At this interview, potential participants were not enrolled if they self-reported any conditions that would preclude exercise prescription in the elderly, as listed by the American College of Sports and Medicine and American Heart Association (No author listed, 1998). Such conditions included severe neurological or heart conditions, uncontrolled diabetes, severe lung or liver disease, dialysis for end-stage renal disease, or disabling musculoskeletal disease. Other exclusions included systolic or diastolic blood pressures over 170 and 130 mm Hg, respectively, as well as any other high-risk condition that might prevent participation in physical activity. Additionally, participants were not enrolled if they lacked the ability to follow written instructions and were unable to obtain constant support for that task.

Following this final screening, 177 were accepted for assessment but only 119 completed the baseline assessment and were then randomized into three intervention groups: fully supervised exercise (FS, instructed in all sessions, $n = 45$), minimally supervised exercise (MS, instructed once every other week and performing exercises at home, $n = 42$) or a non-exercise control group (C, $n = 32$) (see Figure 1).

Participants were considered dropouts and were not reassessed at follow up if they discontinued the exercise program for any reason, enrolled in another exercise program or refused to go through the reassessment.

Measures

After detailed explanation of the study conditions, participants signed consent previously accepted by the competent ethical committee.

Subjects answered about general health with questions based on American College of Sports Medicine guidelines for exercise safety (Nelson et al., 2007). They also completed a multidimensional functional assessment questionnaire (BOMFAQ) (Cockrell & Folstein, 1988), which is the validated Brazilian version of the OARS (Older Americans Resources Services) that includes Mini-mental State Examination and demographic data including years of formal education, income, and level of independence for 15 activities of daily living.

Participants also underwent the following functional tests: The 400-meter walk (Chang et al., 2004), the Berg Balance Scale (Miyamoto et al., 2004), the Timed Up and Go (Mathias, Nayak & Isaacs, 1986), and a three test protocol using a 1.5 meter force plate (Balance Master, Neurocom®), which consisted of the following tests with respective variables: 1) Tandem Walk across the force plate (walk speed, step width and end sway); 2) Sit to Stand from a 40.6 cm high pedestal (weight transfer, which is the time to transfer the body weight to the feet; rising index, which is the amount of force exerted by legs during the rising phase; and center of gravity sway velocity after standing); and 3) Limits of Stability when leaning forward, movement towards a target on a screen, using visual feedback (movement velocity; maximum excursion, which is the maximum distance reached in all movements of the trial; directional control, which is the percentage of movement towards the requested direction).

After baseline assessments, participants were randomly assigned to one of the 3 groups and assessments were repeated at the end of the 4-month exercise training period.

Procedure

All groups received orientation on home hazards and were encouraged to modify their home environment as needed. Multi-modal physical training was to be performed in 50-minute sessions three times a week for four months. The FS group was supervised in all sessions at a hospital center. The MS group attended the center for one supervised session every other week, and they were encouraged to comply with sessions at home 3 times a week, according to illustrated instructions in a brochure provided which contained the same exercise sequence delivered in the center-based sessions. The set of exercises included, stretching, dynamic and static balancing, and resistance and dual task exercises. The C group had no exercise intervention and participants were asked not to engage in any other exercise program during the study.

The training sessions consisted of a warm-up with gait and proprioception exercises; followed by: 1) lower limb muscle low-resistance exercises using only their body weight for

resistance (from two to three sets of 15 repetitions each), 2) static and dynamic balance exercises; and 3) stretching.

Monthly phone calls were made to all participants to check program compliance, answer possible doubts, and assure that they were not enrolled in other exercise program.

Statistical Analysis

The sample size was based on the dispersal of the data obtained at baseline, and was defined as 32 participants per group, predicting statistical error of 5% and nominal error representing 1/5 of Standard Deviation. However, dropout rates exceeded predictions and out of the 119 included 76 participants were analyzed at follow-up.

The data are presented as mean $\pm$ SD (for tables) or *M*, *SD* (for description). At baseline, one-way analysis of variance (ANOVA) was used to compare the three groups. F and p-values are presented in Table 1. Paired t test was used to compare within-group values before and after intervention (pre vs. post). To compare groups according to the mean change (post-pre) one-way analysis of variance (ANOVA) was used. In case of ANOVA significance, Scheffé's post-hoc comparison was used to determine which groups were significantly different. The F-values and P-values are presented, as well as effect size (partial eta- squared) for significant differences.

Variables with skewed distributions, such as income, mini-mental score, and years of education were analyzed using the non-parametric Kruskal-Wallis test. The chi-square test was used for comparison of number of dropouts between the FS and MS groups. Participants who enrolled in other exercise program, dropped out, refused, or were ineligible for final testing were not included in the final statistical analysis. The statistical analyses were performed using SPSS and Statistic 5. Statistical significance was considered at $p < .05$.

Results

Enrollment and Attrition

The sample completing both the baseline and 4-mo assessments included 76 participants, 28 in the FS group, 22 in the MS group, and 26 in the C group (see Figure 1). Mean age of the sample was 79 years ($SD = 5$) and did not differ between groups (FS $M = 78$, $SD = 4$, MS $M = 79$, $SD = 5$, and C $M = 80$, $SD = 5$), $F(2,73) = 1.05$, $p = .49$. Participants had, on average, less than 4 years of formal education (FS $M = 3.9$, $SD = 2$, MS $M = 3.8$, $SD = 3$, and C $M = 4$, $SD = 4$), $F(2,73) = 0.04$, $p = .96$. They also had very low monthly income (FS $M = 487$, $SD = 367$, MS $M = 415$, $SD = 423$ and C $M = 457$, $SD = 638$) $F(2,73) = 0.27$, $p = .52$, placing them in the lowest 21% of income in the city of Sao Paulo ¹(values in Brazilian "Reais"). Approximately two thirds of each group reported at least 3 falls in the past 12 months, suggesting a group at high risk for further falls.

The dropout rates by group were; C 19 %; MS 48 %; and FS 38%. No statistically significant difference was found in dropouts between the FS and MS groups $\chi^2(1, N=50) =$

¹SEADE foundation, www.seade.gov.br

0.007, $p = .35$. The main reasons for drop ping out included lack of interest ($n = 16$), followed by health problems not related to the exercise program ($n = 14$); enrollment in other exercise programs ($n = 4$), familial issues ($n = 4$), transportation problems ($n = 4$) and death ($n = 1$). There was no significant difference at baseline between those who dropped out and those who completed study participation in regards to previous falls, age, gender, income, level of education, marital status or comorbidities.

Baseline data

Baseline demographic characteristics of the participants, as well as clinical, functional and balance measurements are described in Table 1. The MS group had a lower Rising Index in the Sit to Stand test compared to the other two groups ($p = .05$ vs. FS and $p = .04$ vs. C). The three groups did not differ significantly in any other parameters measured at baseline.

Follow-up

There were no adverse events or falls during activities period in any of the three groups. The Table 2 describes the clinical assessments at completion of the study (4-months). The FS group decreased the 400 meter walk time $t(27) = -5.73$, $p < .001$ and increased score in the Berg Balance Scale $t(27) = 2.51$, $p < .02$, while Timed Up and Go was reduced significantly in both trained groups, FS $t(27) = -6.40$, $p < .001$ and MS $t(21) = -3.98$, $p < .001$.

In balance tests (Table 3), the MS group decreased End Sway $t(21) = -2.51$, $p = .02$ and increased Speed $t(21) = 2.95$, $p = .01$ on Tandem Walk, while the C group decreased Speed $t(25) = -2.26$, $p = .03$.

On the Sit to Stand test, FS group reduced significantly the Weight Transfer time $t(27) = -1.30$, $p = .04$. On the Limits of Stability test, both trained groups, FS and MS, increased Directional Control FS $t(27) = 1.31$, $p = .004$ and MS $t(21) = 1.16$, $p = .01$, as well as Movement Velocity FS $t(27) = 3.82$, $p < .001$ and MS $t(21) = 2.45$, $p = .02$, and Maximal Excursion FS $t(27) = 1.10$, $p < .001$ and MS $t(21) = 2.25$, $p = .035$.

Comparing groups on the mean change between baseline and four months (one-way ANOVA and Scheffé's post-hoc comparisons), the FS group change exhibited a significant greater increase in Movement Velocity on Limits of Stability ($M = 3.71$, $SD = 1.28$), than did the C group ($M = 2.57$, $SD = 1.09$), $F(2,73) = 5.88$, $p = .004$, $\eta^2_{\text{partial}} = 0.14$ as presented in Figure 2.

In the Timed Up and Go test, compared to C ($M = -0.60$, $SD = 3.76$), both, FS ($M = -3.61$, $SD = 2.98$) and MS ($M = -3.62$, $SD = 4.27$), had significantly greater reduction in time $F(2,73) = 5.82$, $p = .004$, $\eta^2_{\text{partial}} = 0.14$. The Post Hoc analyses showed differences between C and the two trained groups, $p = .01$ for C vs. FS and $p = .02$ for C vs. MS. Both trained groups, FS ($M = 2.57$, $SD = 6.28$) and MS ($M = 3.41$, $SD = 5.43$), increased the Speed in the Tandem Walk test when compared to the C group ($M = -2.68$, $SD = 6.03$) $F(2,73) = 7.71$, $p < .001$, $\eta^2_{\text{partial}} = 0.17$. The post Hoc analyses showed differences between C and the two trained groups, $p = .007$ for C vs. FS and $p = .003$ for C vs. MS), as presented in Figures 3 and 4.

Discussion

The present study found that a minimally supervised exercise program maybe as safe and effective as a fully supervised exercise program in improving fall-risk relevant mobility task performance in older adults with a high risk of falls. Although much has been published regarding falls prevention, the most effective means to deliver these programs in the community is not clear (Michael et al., 2010; Orr, Raymond & Fiatarone Singh, 2008), and more importantly, little is known about the potential participation of populations of highly underprivileged older adults.

Importance of Improvement in Fall Risk-Relevant Mobility Tasks

When compared to the C group, FS and MS had greater improvement sin the Timed Up and Go time and Tandem Walk speed. According to previous studies, both variables have been strongly associated with falls (Miyamoto et al., 2004). In addition, only the FS and MS groups had significant improvements in all three variables of the Limits of Stability test (Movement Velocity, Maximum Excursion and Directional Control). FS also had improvements on the 400m walk, Berg Balance Scale and Weight Transfer time in Sit to Stand, while MS had greater improvements on Speed and End sway in the Tandem Walk. These results suggest that this specific population may have benefited from physical training with improvements in parameters closely related to falls risk in a particularly underprivileged population. The level of supervision, full or minimal, did not alter the effect of exercise in most of these improvements.

Balance and falls risk have multiple dimensions and their measure requires a comprehensive approach. In order to assess the effects of the intervention, simple clinical tests were performed, but also sophisticated measures were taken. Additionally, questionnaires were applied with the purpose of characterizing the population in terms of demographic, social, economical and physical conditions.

The Timed Up and Go test has recognized clinical importance in the literature and it is considered to be a good measure of the risk of falls. Scores above 12 to 13 seconds, depending on how strongly verbally stimulated elders are in the test, are indicators of high risk for falls (Kamide, Shiba & Shibata, 2009; Sai, Gallagher, Smith & Logsdon, 2010; Steffen, Hacker & Mollinger, 2002). In the present study, all groups had mean TUG test scores above 13 seconds at baseline. After intervention, both trained groups, FS and MS, reduced their mean time to less than 13 seconds, suggesting lower risk for falls.

Other test improvements may have less clinical impact. Only FS reduced 400m walking time significantly, possibly reducing fall risk. The ability to complete the 400 meter walk test is associated with lower risk for disability and death for the following 6 years. Gait speed is associated with independence and other geriatric endpoints, including falls. However, this relation does not seem to be linear: while lower speed is associated with falls at home, higher speed is associated with falls outside of home (Newman et. al., 2006; Zdrenghea, Beudean, Pop & Zdrenghea, 2010).

A previous study has defined a 45-point score (out of the possible 56) in Berg Balance Scale as a threshold below which, there is a higher risk of falls (Thorbahn & Newton, 1996). Though, in the present study, the test was not sensitive enough to define risk of falls since the majority of participants had scores too close to the 56 possible points, thereby likely causing a “ceiling effect” with no room for improvement.

While not as widely used clinically, the Balance Master® force plate provides a more quantitative method to assess balance and mobility, that was proven to be statistically correlated to clinical methods (Ben Archour Lebib et al. 2006). In the present study, significant balance effects were found in Limits of Stability test (leaning forward), with improvements in all three variables (Movement Velocity, Maximal Excursion and Directional Control) for both trained groups, FS and MS, but not for the controls, group C.

Directional control development has been considered an outcome of strength training (Lord, Ward & Williams, 1996). Improvements in Directional Control found in this study are consistent with two experiments previously demonstrated by Ryushi et al. (2000) and Burke, França de Menezes, Cardozo and Marques (2010). Ryushi (2000) demonstrated increments in directional control by 32% applying a 10-week strength exercise program in older individuals, and Burke (2010), demonstrated significant improvements in directional control after an 8-week strength exercise program.

The Sit to Stand test is commonly used in the clinical setting to determine a person's ability to transfer and can be an indicator of lower extremity strength (Bohannon, 1995). In senior athlete Sit to Stand performance, age and sex are related to rising power but not with Weight Transfer and End Sway (Bohannon, 1995). In this study, the FS group reduced significantly Weight Transfer Time to stand up, which might indicate an increase in mean lower extremity strength.

Finally, Tandem Walk speed has been shown to be lower among older adult fallers, compared to non-fallers (Lark & Pasupuleti, 2009). Therefore, the improvements in Tandem Walk Speed and End Sway found in MS might represent significant fall risk reduction.

Level of supervision

Literature is controversial when comparing levels of supervision and effectiveness of exercise programs. While some studies found better physical outcomes in supervised programs applied to patients with intermittent claudication (Ben Archour Lebib et al., 2006), obesity (Nicolai et al., 2009), and after hip surgery (Binder, Brown & Sinacore, 2004; Carmeli, Sheklow & Coleman, 2006), others have found home-based and group-based exercise programs to both be effective.

According to the most recent recommendations from meta-analysis and systematic reviews, individual preferences should be considered when determining the training program (Gillespie et al., 2009, Sherrington et al., 2011).

This individualized approach is already the current physical therapy option, according to a recent study that assessed clinical decision making in prescription for fall prevention (Haas et al., 2012).

In this study, despite the potential risk of unassisted exercise, no falls during practice or other adverse effects were reported in our study; this is possibly due to the highly preserved independence level of the population, and also to the fact that the training brochure included information about safety when executing the prescribed exercises. Also, the study was able to demonstrate a significant effect of both interventions over controls and show that the results of both groups were statistically not different.

Attrition

As often found in community-based exercise programs for older adults, a high dropout rate was observed. The main reason for interruption was lack of interest (n=16), followed by health problems unrelated to exercises (n=14), family issues (n=4), enrollment in other exercise program (n=4), transportation issues (n=4), and death (n=1). There was no significant difference in the percent of dropouts between the FS and MS groups. Although no differences were found between completers and dropouts with regard to socioeconomic variables, such as family support, income, and level of education the studied sample was highly underprivileged in terms of the aforementioned characteristics and that could have led to some difficulty in following written instructions or session attendance, as it has been suggested by previous studies (Findorff, Wyman & Gross, 2009; Pascucci, Leasure, Belknap & Kodumthara, 2010).

Reduced adherence and attrition in exercise programs is frequently problematic, as reaffirmed by a recently published augment to the Cochrane systematic review that found the average adherence to be 52% in a 12-months subset of 99 studies (Nyman & Victor, 2012). In 2010, a study assessed long-term adherence to cardiac rehabilitation resistance exercise programs investigating retrospectively 518 patients. Among the 69% that returned a mailed questionnaire, 50% continued complying with the recommended exercises 38 months after rehabilitation (Marzolini, Mertens, Oh, & Plyey, 2010). However, participants' age and education level were different from those found in the present study. Another study with over 30,000 cardiac rehabilitation participants showed that only 18% complied with the recommended 36 sessions despite the public health system's financial support for the program. The main characteristics predicting their adherence were gender, general health conditions, and socioeconomic profile (Hammill, Curtis, Shulman & Whellan, 2010). Two systematic reviews comparing home and center-based cardiac rehabilitation programs observed a better adherence for home-based programs (Ashworth et al., 2005; Dalal et al., 2010). However, one review studied walking, not resistance training (Ben Archour Lebib et al., 2006) thereby skewing results because of resistance training complexity. The other review included professional supervision in the home-based exercise program (Ben Archour Lebib et al., 2006), which may have facilitated participants' adherence.

Strengths and Limitations

The main limitation of this study is the relatively high dropout rate (over 36% overall), which led to a sample size smaller than previously calculated, and possibly to the reduction of the statistical power to detect other effects of the intervention for fall-risk related mobility task improvement. Also, even though previous studies had already suggested that minimally supervised programs have lower cost than fully supervised ones (Davis et al., 2010 and

Carmeli et al., 2006), the lack of data comparing costs between groups, not targeted by the present study, leaves an important gap to be filled by further research.

As for the intervention, in order to be feasible, the exercise program used the participants' own body weight and did not require any type of resistance training equipment. This could have potentially restricted the magnitude of its carry-over effects.

Lastly, some of the assessments used in the study were not the most up-to-date tools for this particular population due to a lack of a Brazilian-Portuguese validated version at the time of the study.

Despite these limitations and potential obstacles, our study demonstrated the feasibility of either a fully supervised or a minimally supervised multi-modal exercise program in a sample of older adults with an economic and educational disadvantage. Moreover, the functional improvements achieved by the trained subjects suggest beneficial effects of both trainings in improving several physical function parameters and, potentially reducing their risk for falls.

Further research would be helpful in identification of characteristics that can interfere with older adults' adherence to physical training, such as age, gender, familial structure, education level, health and cognitive status. It is still necessary to investigate the impact of minimally supervised exercise programs in different populations and to better define an ideal model of exercise that can be adhered to and is low cost and effective, particularly for low income older adults.

Conclusions

In conclusion, in a community-dwelling elderly population with preserved independence, an economic and educational disadvantage, and a history of multiple falls, a minimally supervised home-based and a fully supervised center-based multi-modal exercise program may be effective in improving variables previously recognized as highly related to falls risk. The similar results achieved by both trained groups suggest that a reduction in supervision and the use of a home program may be similarly effective and safe, thereby, more practical and potentially more cost-effective than a fully supervised program.

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Figure 1.
Participants' enrollment, dropouts, and follow-up

Figure 2.

Mean difference in change for Movement Velocity in LOS (cm/s)

*-significant difference in change between groups ($p < .05$) (Scheffé's post-hot comparisons)

FS-Fully Supervised; MS-Minimally Supervised; C-Control

Figure 3.

Mean difference in change for Timed Up and Go (s)

*-significant difference in change between groups ($p < .05$) (Scheffé's post-hot comparisons)

FS-Fully Supervised; MS-Minimally Supervised; C-Control

Figure 4.

Mean difference in change for Tandem Walk Speed (cm/s)

*-significant difference in change between groups ($p < .05$) (Scheffé's post-hoc comparisons)

FS-Fully Supervised, MS-Minimally Supervised, C-Control

Table 1

Demographics Characteristics and Functional Measures of Study Participants at Baseline

	Fully Supervised (N=28)	Minimally supervised (N=22)	Control (N=26)	One-way ANOVA $F(2,73)$	Significance p -value	Chi-square χ^2 (df, N)
Gender (Male/Female)	6/22	2/20	5/21	--	.35	1.45 (2,76)
Age (years)	78.1 $\pm$ 4.1	79.2 $\pm$ 5.1	79.9 $\pm$ 4.5	1.06	.49	--
Weight (kg)	66.9 $\pm$ 13.1	71.2 $\pm$ 14.5	66.9 $\pm$ 14.6	0.72	.17	--
IMC (kg/cm ²)	27.3 $\pm$ 5	29.9 $\pm$ 5.3	27.9 $\pm$ 4.1	1.83	.19	--
Schooling years (years)	3.9 $\pm$ 2.2	3.8 $\pm$ 2.55	4.0 $\pm$ 3.8	0.04	.96	--
Mini-mental (score out of 30)	26.5 $\pm$ 2.2	25.7 $\pm$ 3.2	26.6 $\pm$ 3.0	0.79	.92	--
Monthly Income (Brazilian Reals) [†]	487 $\pm$ 367	415 $\pm$ 423	457 $\pm$ 638	0.27	.52	--
Falls risk questionnaire (score out of 10)	7.5 $\pm$ 2.3	8.3 $\pm$ 2.6	7 $\pm$ 2.4	1.89	.16	--
Home Hazards Risk (score out of 30)	14.8 $\pm$ 3.9	14.5 $\pm$ 3.3	15.5 $\pm$ 3.7	0.43	.65	--
Independence in 15 ADL (BOMFAQ)						
ADL tasks without any difficulty (number among 15)	6.86 $\pm$ 3.1	6.27 $\pm$ 3.6	6.23 $\pm$ 3.3	0.30	.74	--
ADL tasks with low difficult (number among 15)	5.11 $\pm$ 2.8	5.27 $\pm$ 2.5	6.0 $\pm$ 2.5	0.86	.42	--
ADL tasks with night difficulty (number among 15)	3.04 $\pm$ 2.9	3.50 $\pm$ 2.7	2.77 $\pm$ 2.4	0.45	.63	--
Falls in the past 12 months						
Number of subjects reporting 1 fall	1 (3%)	0 (0%)	1 (4%)	--		
Number of subjects reporting 2 falls	10 (36%)	7 (32%)	7 (27%)	--	>0.05	5.43 (4,76)
Number of subjects reporting 3 or more falls	17 (61%)	15 (68%)	18 (69%)	--		
Clinical Functional Tests						
400 meters walking (s)	406.8 $\pm$ 81.4	452.8 $\pm$ 138.6	438.0 $\pm$ 98.2	1.26	.29	--
Timed up and Go (s)	13.4 $\pm$ 4.2	15.9 $\pm$ 6.6	14.2 $\pm$ 4.0	1.71	.19	--
Bag Balance Scale (score out of 56)	53.8 $\pm$ 2.0	53.3 $\pm$ 3.2	53.7 $\pm$ 1.8	0.36	.70	--
Balance Tests						
Tandem Walk						
Step Width (cm)	12.6 $\pm$ 4.4	13.9 $\pm$ 4.6	13.0 $\pm$ 5.5	0.47	.63	--
Speed (cm/s)	15.8 $\pm$ 6.4	13.8 $\pm$ 3.5	17.2 $\pm$ 6.9	1.96	.15	--

	Fully Supervised (N=28)	Minimally supervised (N=22)	Control (N=26)	One-way ANOVA <i>F</i> (2,73)	Significance <i>p</i> -value	Chi-square χ^2 (df, N)
End sway (°/s)	8 ± 3.3	7.5 ± 2.3	7.1 ± 3.4	0.52	.60	--
Sit to Stand						
Weight Transfer (s)	0.53 ± 0.51	0.58 ± 0.38	0.5 ± 0.33	0.23	.79	--
Rising Index (% of body weight)	16.5 ± 4.58	13.27 ± 4.19 §	16.65 ± 5.25	3.84	.03 *	--
End Sway (°/s)	4.63 ± 1.29	4.35 ± 1.39	4.27 ± 0.28	0.31	.74	--
Limits of Stability (Forward)						
Movement Velocity (cm/s)	2.83 ± 0.93	2.56 ± 0.86	2.36 ± 1.02	1.23	.31	--
Maximum Excursion (cm)	70.3 ± 24.7	58.5 ± 19.8	62.4 ± 23	1.83	.17	--
Directional Control (% of movement)	65.2 ± 16.5	62 ± 16.2	65.1 ± 15.9	0.99	.40	--

Note. Values are mean ± SD except for gender (presented as number of male/female individuals), Monthly Income (presented as Median ± SD), and Falls in the past 12 months (presented as number of individuals reporting one, two and three or more falls)

† One Brazilian Real is approximately \$0.50 dollars,

* p<0.05

§ p< .05 vs. both oilier groups; ADL-Activities of daily living

Table 2

Clinical functional measures at baseline and fourth month

	Baseline	4 months	df	t-value	p-value
WALK PERFORMANCE TEST (s)					
Fully Supervised	406.8 ± 81.4	357.2 ± 84.7	27	-5.74	<.001 *
Minimally Supervised	452.8 ± 138.6	448.5 ± 108.6	21	-0.18	.86
Control	438.0 ± 98.2	427.5 ± 117.1	25	-0.75	.46
TIMED UP AND GO (s)					
Fully Supervised	13.4 ± 4.2	9.7 ± 2.4	27	-6.41	<.001 *
Minimally Supervised	15.9 ± 6.6	12.3 ± 3.6	21	-3.98	.001 *
Control	14.2 ± 4.0	13.6 ± 3.3	25	-0.81	.43
BERG BALANCE SCALE SCORE					
Fully Supervised	53.8 ± 2.0	54.6 ± 1.1	27	2.51	.02 *
Minimally Supervised	53.3 ± 3.2	54.0 ± 1.8	21	1.41	.17
Control	53.7 ± 1.8	53.4 ± 2.0	25	-1.14	.27

Note. Values are mean ± SD

* p< .05 within group pre vs. post

Table 3

Balance Tests Measures at Baseline and Fourth Month

Tandem Walk Test	Baseline	4 months	df	t-value	p-value
STEP WIDTH (cm)					
Fully Supervised (n = 28)	12.6 ± 4.4	11.4 ± 4.3	27	-1.71	.19
Minimally Supervised (n = 22)	13.9 ± 4.6	12.2 ± 3.7	21	-2.01	.06
Control (n = 26)	13.0 ± 5.5	11.6 ± 4.1	25	-1.39	.18
SPEED (cm/s)					
Fully Supervised (n = 28)	15.8 ± 6.4	18.5 ± 5	27	2.17	.30
Minimally Supervised (n = 22)	13.8 ± 3.5	17.2 ± 5	21	2.95	.01 *
Control (n = 26)	17.2 ± 6.9	14.5 ± 5.3	25	-2.26	.03 *
END SWAY (°/s)					
Fully Supervised (n = 28)	8.0 ± 3.3	7.0 ± 2.5	27	-1.81	.08
Minimally Supervised (n = 22)	7.5 ± 2.3	6.2 ± 2.0	21	-2.51	.02 *
Control (n = 26)	7.1 ± 3.4	6.9 ± 2.6	25	-0.27	.79
Sit to Stand Test					
WEIGHT TRANSFER TIME (s)					
Fully Supervised (n = 28)	0.53 ± 0.51	0.41 ± 0.21	27	-1.30	.04 *
Minimally Supervised (n = 22)	0.58 ± 0.38	0.45 ± 0.28	21	-1.66	.11
Control (n = 26)	0.50 ± 0.33	0.43 ± 0.26	25	-0.90	.38
RISING INDEX (% of body weight)					
Fully Supervised (n = 28)	16.50 ± 4.58	20.25 ± 6.33	27	3.51	.06
Minimally Supervised (n = 22)	13.27 ± 4.19	14.68 ± 5.00	21	1.43	.17
Control (n = 26)	16.65 ± 5.25	18.19 ± 5.88	25	1.86	.08
END SWAY (°/s)					
Fully Supervised (n = 28)	4.63 ± 1.29	4.81 ± 1.24	27	0.83	.20
Minimally Supervised (n = 22)	4.35 ± 1.39	4.50 ± 1.23	21	0.62	.54
Control (n = 26)	4.27 ± 0.28	4.63 ± 1.22	25	0.55	.58
Limits of Stability Test-forward					
MOVEMENT VELOCITY (cm/s)					

Tandem Walk Test	Baseline	4 months	df	t-value	p-value
Fully Supervised (n = 28)	2.83 ± 0.93	3.71 ± 1.28	27	3.82	<.001 *
Minimally Supervised (n = 22)	2.56 ± 0.86	3.17 ± 1.28	21	2.45	.02 *
Control (n = 26)	2.45 ± 0.91	2.57 ± 1.09	25	1.0	.97
MAXIMUM EXCURSION (cm)					
Fully Supervised (n = 28)	70.3 ± 24.7	74.4 ± 17.9	27	1.10	<.001 *
Minimally Supervised (n = 22)	58.5 ± 19.8	68.3 ± 19.2	21	2.25	.03 *
Control (n = 26)	64.9 ± 19.6	62.8 ± 16.9	25	0.92	.51
DIRECTIONAL CONTROL (% of movement)					
Fully Supervised (n = 28)	65.2 ± 16.5	68.4 ± 13.9	27	1.31	.004 *
Minimally Supervised (n = 22)	62.0 ± 16.2	69.9 ± 13.3	21	1.16	.01 *
Control (n = 26)	67.7 ± 9.0	63.9 ± 10.5	25	0.89	.65

Note. Values are mean ± SD

* p< .05 within group pre vs. post.