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(Article begins on next page)

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Dual-Task Training in Older Adults: the Effect of Additional Motor Tasks on Mobility Performance

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ABSTRACT

Objectives

Dual-task (DT) performance is common to most activities of daily living and difficulties in DT activities may reduce quality of life in older adults. This study investigated the effect of DT training in a sample of older adults.

Methods

Sixty older adults (mean=74.4±3.1 years) participated in the study. Twenty-two older adults were included in the control (CG), 19 in the single-task (ST) training and 19 in DT training group. ST group received balance and walking training twice a week for16 weeks, while DT training group performed the same training with additional motor tasks. Data were gathered on 6 meter timed walk (6MTW), timed up and go test (TUG) and four square step test (FSST). DT conditions required participants to complete 6MTW, TUG and FSST, either (i) while carrying a glass of water or (ii) while carrying a ball on a round tray.

Results

A significant Group x Time interaction was found in TUG (F [2,57] = 29.5; $p < 0.01$; partial $\eta^2 = 0.51$) and in FSST (F [2,57] = 23.2; $p < 0.01$; partial $\eta^2 = 0.44$). After intervention DT showed better scores in overall TUG (mean difference = 1.21 s [95% CI, 0.82–1.60]; $p < 0.05$) and FSST (mean difference = 2.51 s [95% CI, 1.67–3.35]; $p < 0.01$), whereas CG and ST did not exhibit significant changes.

Conclusion

Our results suggested that 16 weeks of motor DT training, using motor additional tasks as manipulation of common objects of everyday life, could improve mobility in older age.

Keyword: Dual-task training; Physical exercise; Mobility; Aging

INTRODUCTION

Physical and cognitive functions are important domains for successful mobility performance. Indeed, mobility, defined as the ability to move independently in the environment (Shumway-Cook & Woollacott, 2012), requires a complex system of control that can adapt to internal and external changes (Azadian, Torbati, Kakhki, & Farahpour, 2016; Shumway-Cook & Woollacott, 2012). However, the deterioration of physical (Brustio, Magistro, & Liubicich, 2015; Magistro, Candela, Brustio, Liubicich, & Rabaglietti, 2015) and cognitive domains (Park, O'Connell, & Thomson, 2003) commonly observed in old age may lead to mobility impairments, which in turn, may result in difficulties managing activities of daily living and independence.

The interplay between physical and cognitive domains is evaluated using the dual-task (DT) paradigm, which refers to the ability to perform two tasks simultaneously (Agmon, Belza, Nguyen, Logsdon, & Kelly, 2014; Chu, Tang, Peng, & Chen, 2013). Specifically, the two tasks refer to mobility tasks (e.g. a walking task) and a simultaneous additional attention task, of either the cognitive (e.g. an arithmetic task) or motor type (e.g. holding a glass of water).

Several studies (Al-Yahya et al., 2011; Boisgontier et al., 2013; Brustio, Magistro, Zecca, Rabaglietti, & Liubicich, 2017; Coelho, Fernandes, Santos, Paul, & Fernandes, 2016; Nankar et al., 2017; Yogev-Seligmann, Hausdorff, & Giladi, 2008) have reported age-related changes in motor skills under DT conditions. For instance, when walking, older adults showed lower velocity, cadence, stride length, swing phase and amplified gait variability (Al-Yahya et al., 2011; Yogev-Seligmann et al., 2008), as well as increased postural and velocity sway in balance tasks (Boisgontier et al., 2013) compared with younger adults. Interestingly, changes in gait and balance pattern under DT conditions have been associated with the declines in cognitive function and linked with the increased fear (Brustio, Magistro, Zecca,

Liubicich, & Rabaglietti, 2017) and risk of falls (Chu et al., 2013). Furthermore, a reduced performance in additional tasks (i.e. cognitive or motor tasks) was observed in older adults (Nordin, Moe-Nilssen, Ramnemark, & Lundin-Olsson, 2010; Srygley, Mirelman, Herman, Giladi, & Hausdorff, 2009).

DT performance is common and relevant to most activities of daily living, and the inability of older adults to efficaciously perform two different tasks may have several implications. For this reason, physical training (e.g. fall prevention programmes) should incorporate exercises to enhance DT performance (Pellecchia, 2005). Recently, several studies in healthy older adults (Agmon et al., 2014; Kitazawa et al., 2015; Pichierri, Wolf, Murer, & de Bruin, 2011; Wollesen & Voelcker-Rehage, 2014) or in individuals with neurodegenerative diseases (e.g., Parkinson's disease) (Yogev-Seligmann, Giladi, Brozgol, & Hausdorff, 2012) showed an improvement in balance and gait ability, using DT training. Examples of DT training included balance or gait exercises with the concurrent performance of an additional cognitive task such as spelling words backwards, computing mental arithmetic counting or naming (Silsupadol, Lugade, et al., 2009; Silsupadol, Shumway-Cook, et al., 2009) or motor tasks such as manipulation of objects (Kim & Park, 2015; Shin & An, 2014; Yang, Wang, Chen, & Kao, 2007). DT exercises that incorporate balance or gait tasks and additional cognitive tasks might reduce the attentional resources required for mobility tasks. Consequently, additional central resources would be available for carrying out additional attention tasks (Pellecchia, 2005). For example, Silsupadol and colleagues (2009) conducted an intensive balance DT training with three sessions per week for 1 month and reported improvements and benefits in motor and cognitive performance under DT conditions compared with single-task (ST) training. Similarly, using aerobic exercises combined with cognitive tasks (i.e. phonetic and verbal fluency and arithmetic tasks), Gregory and

colleagues (2016) demonstrated an improvement in gait characteristics (i.e. gait velocity, step length, stride time variability) under DT conditions compared with aerobic exercises alone.

The aim of this study was to investigate the effect of physical exercise and DT training on mobility performance in a sample of older adults. Specifically, we sought to examine the impact of combined walking and balance exercises with DT training including additional motor tasks (e.g., manipulation of objects) on mobility performance under ST and DT conditions in healthy, independent older adults. Specifically, we hypothesized to find a general improvement in mobility performance both in ST and DT conditions after 16 weeks of DT training. Furthermore based on previous studies, (e.g., Gregory et al., 2016; Silsupadol, Lugade, et al., 2009) we expected that participants who underwent DT training would show greater improvements in DT performance as result of task-specific training.

METHODS

Participants

Study participants were recruited from a private senior social center in the neighbourhood of Vercelli in North Italy. All subjects lived independently. Participants were eligible for the study if they were aged 70–80 years, were independent with activities of daily living and were able to process the information provided during the testing and training sessions. Participants were excluded if they were unable to walk 6 m independently without a walking aid, had scored < 24 on the Mini-Mental State Examination (Folstein, Folstein, & McHugh, 1975) and had any acute diseases (e.g., recent fractures or surgical operation) and/or chronic diseases (e.g., history of severe cardiovascular condition, dialysis, respiratory insufficiency, severe osteoarthritis) preventing the practical requirements for study participation or test administration.

Participants were informed that their participation in the study was voluntary and confidential. They provided written informed consent to participate in the study, in accordance with the ethical standards of the 1964 Declaration of Helsinki. The Ethical Committee of the University of Torino approved the study. Fig. 1 summarizes the recruitment process of the study population.

< Insert Fig.1 about here>

In total, 60 older adults including 18 men (30%) and 42 women (70%) with an average age of 74.4 years (standard deviation [SD] = 3.1 years) were recruited for the study.

Study design

The study design was a blocked randomised, controlled, single-blind, parallel group pre-test /post-test trial. Participants were randomly assigned to one of the three groups: (1) DT training, (2) ST training or (3) the control group (CG). The two intervention groups (i.e. DT and ST training groups) followed two different types of physical training, based on balance and walking exercises, twice a week for16 weeks, whereas the CG maintained their usual lifestyle without additional training. A power analysis, using G*Power version 3.1.9.2 (Franz Faul, Universitat Kiel, Germany), revealed that a sample size of 46 participants was needed ($\alpha = 0.05$; Power = 0.80; effect size: $f = 0.25$). We obtained 60 participants which were a statistically adequate sample size. Specifically, the DT group consisted of 19 participants (mean age, 74.3 years and SD, 2.6), the ST group included 19 participants (mean age, 75.2 years and SD, 3.4) and the CG consisted of 22 participants (mean age, 71 years and SD, 3.2). To allow for possible dropout, the CG was increased by three participants (estimated rate: 10%). The participants were not blinded to the group assignment of the other participants. All participants were assessed before (pre-test) and after (post-test) the 16-week training period. The study was conducted in Italy from January to June 2016.

Interventions

The ST and DT trainings consisted of a twice-weekly intervention of 60 min per session. In total, 32 intervention sessions were carried out. Graduate students in Physical Activity and Sport Sciences who were specialised in physical activity training for older adults conducted the ST and DT training.

A specific protocol, designed for the purpose of this study, was followed for both the ST and DT group. The ST group practised a balance and walking intervention, while the DT group performed additional motor tasks combined with balance and walking exercises (described below).

For both ST and DT groups, each exercise session began with a 10-min warm-up that included breathing and flexibility exercises for upper and lower body and ended with a 10-min cool down that included breathing and stretching exercises.

ST program focused on balance and walking exercises. Balance exercises included static and dynamic exercises, such as progressively difficult static postures (e.g., semi-tandem stand, tandem stand or one leg stance with or without eyes open). Gait exercises included continuous walking, such as walking on a circular route, walking and turning, backwards and forwards walking, walking along a straight line on toes with or without support or walking and obstacle negotiation tasks.

The key components of DT training involved the same exercise protocol as was used in ST training, plus the concurrent performance of an additional task. Specifically, the participants enrolled in DT group carried out additional motor tasks that involved a range of abilities relating to everyday life. For this purpose, DT training included the use of different objects that are common and available in activities of daily living, such as a sweater, shirt, sweatshirt with zipper, scarf, twine, nut and bolt. For example, balance activities in DT training required participants to maintain semi-tandem, tandem stand or one leg stance positions, while concurrently unscrewing and screwing the bolt, making a knot or a bow with

the twine or inserting the twine into the nut either with the left or right hand. Again, the walking exercises required participants to walk on a circular route, to walk and turn or to walk backwards and forwards while wearing a sweater, buttoning and unbuttoning a shirt, wrapping the scarf around the neck or closing a zipper. Specific additional tasks are described in Table 1.

<Insert Table 1 about here>

The trainers explained and demonstrated all the proposed exercises at each session both in ST and DT training groups. The participants were asked to repeat aloud the required sequence of movements in detail during all exercises. The ST and DT programs followed a detailed exercise manual. All proposed exercises had various levels of progression as regards the complexity and were tailored according to individual capability.,.

Measures

Socio-demographic data (e.g. age, gender, previous employment and level of education) were self-reported. Before testing, each participant was assessed for his or her height, weight and body mass index (BMI). Testing was carried out in the same location each time. Approximately, the same time-span was required to perform the physical test. The same investigators conducted all tests and were blind to the group allocation.

Mobility tests were investigated in CG, ST and DT training groups by means of following tests: the 6 meter timed walk (6MTW), timed up and go test (TUG) and four square step test (FSST). The above tests were conducted both in single- and in dual-task conditions (described below).

The 6MTW is a measure of gait ability and independent functioning in older adults (Bohannon, 1997). The test required participants to walk at a self-selected speed and comfortable pace down a 10-m-long hallway. In accordance with Montero and colleagues (2009) the first two and last two metres were not included in the analysis and were considered

warm-up and deceleration phases. Walking speed was therefore measured as the time to walk, at usual speed and comfortable pace, the middle six of 10 m (Montero-Odasso et al., 2009). Time, in seconds (s), taken to complete the trail was recorded as the final score.

The TUG is a measure of functional mobility and includes commonly performed functional activities of daily living, such as standing and sitting, walking and turning (Daly et al., 2015; Podsiadlo & Richardson, 1991). The TUG measured the time (s) taken to stand up from a chair, walk at a comfortable speed for 3 m, turn around a cone, return to the chair and sit down.

The FSST provides a measure of dynamic balance and stepping speed in four directions (Dite & Temple, 2002), which are important components of mobility performance. The test required participants to rapidly change direction while stepping forwards, backwards and sideways (in a predetermined sequence) over four walking sticks placed in a cross configuration on the ground (Dite & Temple, 2002). Time (s) taken to complete the sequence was recorded as the final score.

The 6MTW, TUG and FSST were performed under both ST and DT conditions. DT conditions required participants to complete the 6MTW, TUG and FSST, either (i) while carrying a glass of water (filled to 10 mm from the rim) with the preferred hand (defined as 6MTWW, TUGW and FSSTW, respectively; Taylor, Delbaere, Mikolaizak, Lord, & Close, 2013) or (ii) while carrying a ball (weight: 100 g and diameter: 7 cm) on a round tray (weight: 50 g and diameter: 17 cm) with the dominant hand only (defined as 6MTWT, TUGT and FSSTT, respectively; Asai, Misu, Doi, Yamada, & Ando, 2014).

For all tests, participants wore their regular footwear. All the tests were performed in a randomised order. A digital stopwatch was used to record the time (s) taken to complete each test. During DT performance, no instructions were given regarding which task to prioritise (Brustio, Magistro, Rabaglietti, & Liubicich, 2017).

Statistical Analysis

Results are presented as mean (SD) or frequency (%). Socio-demographic data and baseline test performance were compared among CG, DT and ST groups using independent analysis of variance (quantitative variables) or chi-squared test (qualitative variables).

Repeated measures analysis of variance with a between-factor Group (Control group, ST and DT trainings) and within-factor Time (Baseline and post-test) and Task (ST, DT while carrying a glass of water and DT while carrying a ball on a round tray) was performed for each dependent variable (6MTW, TUG and FFST). Differences between treated groups were determined by significant group × time interactions. Post hoc analysis was performed with a Bonferroni adjustment. The level of significance was set at 5% ($p < 0.05$). The Statistical Package for Social Sciences (SPSS Inc., version 24.0 for Windows, SPSS Chicago, IL, USA) was used for all statistical analyses.

RESULTS

No complications and adverse events occurred during the training period, and all of the participants who engaged in the training completed the study.

Table 2 displays the mean (SD) or frequency (%) of baseline socio-demographic characteristics among the CG, DT and ST groups. No significant difference was observed among the three groups in age (F [2, 57] = 0.81; p = 0.45), education (years) (F [2, 57] = 0.21, p = 0.81), BMI (F [2, 57] = 2.40; p = 0.1), gender (χ^2 [2] = 0.7; p = 0.72), family status (χ^2 [6] = 0.1; p = 0.07) or previous employment (χ^2 [2] = 3.8; p = 0.15).

<Insert Table 2 about here>

Table 3 displays the mean scores and SDs of baseline test performance for the CG, DT and ST groups.

<Insert Table 3 about here>

No significant difference was observed among the three groups on 6MTW (F [2, 57] = 1.3; p = 0.29), TUG (F [2, 57] = 2.8; p = 0.07) or FSST scores (F [2, 57] = 0.3; p = 0.74). Moreover, no significant difference was observed in DT performance either while carrying a glass of water on 6MTWW (F [2, 57] = 0.8; p = 0.46), TUGW (F [2, 57] = 1.4; p = 0.26) or FSSTW scores (F [2, 57] = 0.5; p = 0.64), or while carrying a ball on a round tray on 6MTWT (F [2, 57] = 1.3; p = 0.27), TUGT (F [2, 57] = 1.3; p = 0.29) or FSSTT scores (F [2, 57] = 0.21; p = 0.82).

Table 4 shows the mean scores and SDs for the CG, DT and ST groups at post-test.

<Insert Table 4 about here>

The ANOVA outcomes are summarized in Table 5.

<Insert Table 5 about here>

No significant group × time interactions were observed in 6MTW both for ST and DT conditions (F [2, 57] = 2.7; p = 0.07; partial η^2 = 0.09). See Table 5.

Differently, considering TUG both in ST and DT conditions, statistically significant group × time interactions were observed (F [2,57] = 29.5; p < 0.01; partial η^2 = 0.51). Specifically, in DT group, post hoc analysis with Bonferroni adjustment showed an overall statistically significantly lower score between post-test and pre-test in TUG (mean difference = 1.21 [95% CI, 0.82–1.60] s; p < 0.05). Differently, no significant differences were observed in CG and ST groups. For more details see Table 5.

Finally, considering FSST both in ST and DT conditions, statistically significant group × time interactions were observed (F [2,57] = 23.2; p < 0.01; partial η^2 = 0.44) Specifically, in DT group post hoc analysis with Bonferroni adjustment showed an overall statistically significantly lower score between post-test and pre-test (mean difference = 2.51 [95% CI, 1.67–3.35] s; p < 0.01). No significant interaction differences were observed in CG and ST groups.

DISCUSSION

The aim of this study was to investigate the effect of a DT training program on mobility performance in a sample of older adults. For this propose, we examined the effects of a 16-week DT training with additional secondary motor tasks in a sample of older adults to assess the impact of DT on mobility. Specifically, we evaluated the walking and balance performance both in ST and DT conditions using an additional motor task (i.e. carrying a glass of water with the preferred hand and carrying a ball on a round tray with the dominant hand only).

The main implication of our results is the potential use of DT training with additional motor tasks to improve overall mobility performance in older adults. Indeed, per our hypothesis, we found a general improvement in mobility performance both in ST and DT conditions after 16 weeks of DT training. Using the motor DT training (i.e. walking while holding a tray containing a paper cup filled with water), Kim and Park (2015) found an improvement in foot pressure during the walking task. Similarly, after motor DT training, significant improvements both in ST and DT conditions were found in balance (An et al., 2014) and walking tasks (Yang et al., 2007). Again, our results highlighted that DT training, rather than ST training only, improved mobility performance with a concurrent additional motor task (i.e., while carrying a glass of water or while carrying a ball on a round tray). These findings corroborated the results of previous studies (Gregory et al., 2016; Silsupadol, Lugade, et al., 2009; Wongcharoen, Sungkarat, Munkhetvit, Lugade, & Silsupadol, 2017) using DT training with additional cognitive tasks (e.g. calculation or verbal fluency tasks). Here we extended previous work and demonstrated that DT training, using motor secondary tasks such as manipulation of common objects of everyday life (e.g., buttoning and unbuttoning a shirt, closing a zipper or tying a thread) might effectively improve mobility

performance both in ST and DT in older adults. These findings could be applied to everyday life, as object manipulation is among the most common tasks we perform.

Performing two concurrent tasks requires attentional resources and integrity of executive function (Leone et al., 2017); thus, we might speculate that older adults enrolled in our DT training might have learnt to manage their attention between the two tasks (Wongcharoen et al., 2017). Indeed, two independent streams of visual information, one related to the walking task and the other related to the secondary task, should be coordinated at the same time (Beurskens & Bock, 2012). Older adults enrolled in DT training might successfully improve the automatization of tasks, and the coordination skills needed to perform the two concurrent tasks (Silsupadol, Lugade, et al., 2009). Thus, our results suggested that DT training might have modified the DT strategy, leading to a better and efficient integration of the two tasks (Gregory et al., 2016).

Several potential limitations of this study must be considered. First, the relatively small sample size did not allow us to generalise our results to a larger older population. Moreover, our secondary task included only the performance of a specific motor task (i.e. carrying a glass of water with the preferred hand or carrying a ball on a round tray with the dominant hand only). Again, we only focused on the mobility performance of the subjects under DT conditions and not on the assessment of the secondary task. Finally, a follow-up evaluation was not performed. Measurements at 6 and 12 months would better determine the long-term effects of this intervention.

CONCLUSIONS

In conclusion, our results suggested that 16 weeks of motor DT training could improve both ST and DT mobility performance in older age. However, further studies using larger sample sizes are needed to expand this study and make solid inferences on the benefits

of our DT training. Our results underlined as a DT training including motor secondary tasks might improve mobility performance in older adults. To understand the role of specific types of exercise training, focusing on DT performance for older adults, may be useful for the development of practical strategies and guidelines for specific interventions for older populations.

Conflicts of interest

The authors declare no conflicts of interest.

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Table 1. Description of additional motor tasks included in the dual-task training group

Equipment	General description	Duration
Sweater	Put on and take off the sweater	2 minutes
Shirt	Put on and take off the shirt[¥]	5 minutes
	Button the shirt[¥]	
	Unbutton the shirt[¥]	
	Button and unbutton the shirt[¥]	
Sweatshirt with zipper	Put on the sweatshirt with zipper; close the zipper[¥]	5 minutes
	Put on the sweatshirt with zipper; open the zipper[¥]	
	Put on the sweatshirt with zipper; close and open the zipper[¥]	
Scarf	Fold the scarf	5 minutes
	Roll and unroll the scarf	
	Put the scarf around the neck and remove it	
Twine	Tie the twine	3 minutes
	Tie and untie the twine	
Nut and twine	Insert the twine in the nut	3 minutes
	Insert the twine in the nut and tie the twine	
Bolt	Unscrew and screw the bolt[¥]	2 minutes
Bottle without water	Screw and unscrew the bottle cap in front of the body[¥]	3 minutes
	Screw and unscrew the bottle cap behind the body[¥,#]	
Screw and nut	Fasten the screw into the nut in front of the body[¥]	3 minutes
	Fasten the screw into the nut behind the body[¥,#]	

Note: [¥]the exercise was performed with both the right and left hands; [#] the exercise in this condition was performed only during side-by-side stand, while participants were looking straight ahead at a fixed point.

Table 2. Socio-demographic characteristics and results of baseline test performance in the different groups

			Group			
		Total	CG	DT	ST	
		(*n* = 60)	(*n* = 22)	(*n* = 19)	(*n* = 19)	*p*
Variables		*N* (%)	*N* (%)	*N* (%)	*N* (%)	
Gender	Male	18 (30)	8 (36.4)	5 (26.3)	5 (26.3)	0.72
	Female	42 (70)	14 (63.6)	14 (73.7)	14 (73.7)	
Family status	Never married	20 (33.3)	6 (27.3)	5 (26.3)	9 (47.4)	0.07
	Married	34 (56.7)	15 (68.2)	12 (63.2)	7 (36.8)	
	Widowed	4 (6.7)	1 (4.5)	0	3 (15.8)	
	Divorced	2 (3.3)	0	2 (10.5)	0	
Previous employment	Non-manual labour	23 (38.3)	11 (50)	8 (42.1)	4 (21.1)	0.15
	Manual labour	37 (61.7)	11 (50)	11 (57.9)	15 (78.9)	
Variables		M (SD)	M (SD)	M (SD)	M (SD)	*p*
Age (years)		74.4 (3.1)	74 (3.2)	74.3 (2.6)	75.2 (3.4)	0.45
Education (years)		8.6 (4)	9.0 (3.3)	8.22 (3.9)	8.7 (4.8)	0.81
BMI (kg/m^2)		27.5 (4.7)	29.3 (5.4)	26.1 (3.9)	27.3 (4.5)	0.10

Notes: CG, control group; DT, dual-task training group; ST, single-task training group; BMI, body mass index; M, mean; SD, standard deviation.

Table 3. Results of baseline test performance in the different groups

		Group			
	Total	CG	DT	ST	
	(*n* = 60)	(*n* = 22)	(*n* = 19)	(*n* = 19)	*p*
Variables	M (SD)	M (SD)	M (SD)	M (SD)	
6MTW	5.1 (1.1)	5.0 (0.9)	4.9 (0.9)	5.4 (1.4)	0.29
6MTWW	5.5 (1)	5.5 (1.1)	5.4 (0.7)	5.8 (1.1)	0.46
6MTWT	5.3 (1)	5.2 (1.1)	5.3 (0.8)	5.6 (1)	0.27
TUG	8.2 (1.8)	7.5 (1.5)	8.6 (1.3)	8.6 (2.3)	0.07
TUGW	9.2 (2)	8.7 (1.7)	9.3 (1.8)	9.7 (2.4)	0.26
TUGT	9.1 (1.9)	8.8 (1.9)	9.0 (1.6)	9.7 (2.2)	0.29
FSS	11.7 (2.7)	11.3 (2.9)	12.0 (2.6)	11.8 (2.8)	0.74
FSSW	12.3 (3.2)	12.2 (3.7)	11.8 (2.3)	12.8 (3.3)	0.64
FSST	11.8 (3.2)	11.6 (2.7)	12 (3.8)	12.0 (2.6)	0.82

M, mean; SD, standard deviation; CG, control group; DT, dual-task training group; ST, single-task training group; ST, single-task training group; 6MTW, 6 meter timed walk; 6MTWW, 6 meter timed walk with glass of water; 6MTWT, 6 meter timed walk while carrying a ball on a round tray; TUG, time up and go test; TUGW, time up and go test with glass of water; TUGT, time up and go test while carrying a ball on a round tray; FSST, four square step test; FSSTW, four square step test with glass of water; FSSTT, four square step test while carrying a ball on a round tray.

Note: The time taken to complete all tests was recorded in seconds (s).

Table 4. Results of post-test performance in the different groups

	Group					
	CG		DT		ST	
	(*n* = 22)		(*n* = 19)		(*n* = 19)	
Variables	Post-test M (SD)	Change %	Post-test M (SD)	Change %	Post-test M (SD)	Change %
6MTW	4.9 (0.8)	-2.0%	4.6 (0.6)	-6.1%	5.3 (1.2)	-1.9%
6MTWW	5.5 (1.2)	0%	5.1 (0.7)	-5.6%	5.7 (1.2)	-1.7%
6MTWT	5.1 (1)	-1.9%	5.1 (0.7)	-3.8%	5.7 (1.1)	1.8%
TUG	7.5 (1.4)	0%	7.2 (1.3)	-16.3%	8.3 (2.4)	-3.5%
TUGW	8.7 (1.8)	0%	8.0 (1.2)	-14.0%	9.5 (2.3)	-2.1%
TUGT	8.9 (1.9)	1.1%	8.0 (1.3)	-11.1%	9.7 (2.4)	0%
FSS	11.3 (2.1)	0%	8.9 (1.4)	-25.8%	11.3 (2.1)	-4.2%
FSSW	11.8 (2.7)	-3.3%	10.2 (2.1)	-13.6%	11.9 (2.3)	-7.0%
FSST	11.8 (3)	1.7%	9.1 (1.6)	-24.2%	11.9 (2.1)	-0.8%

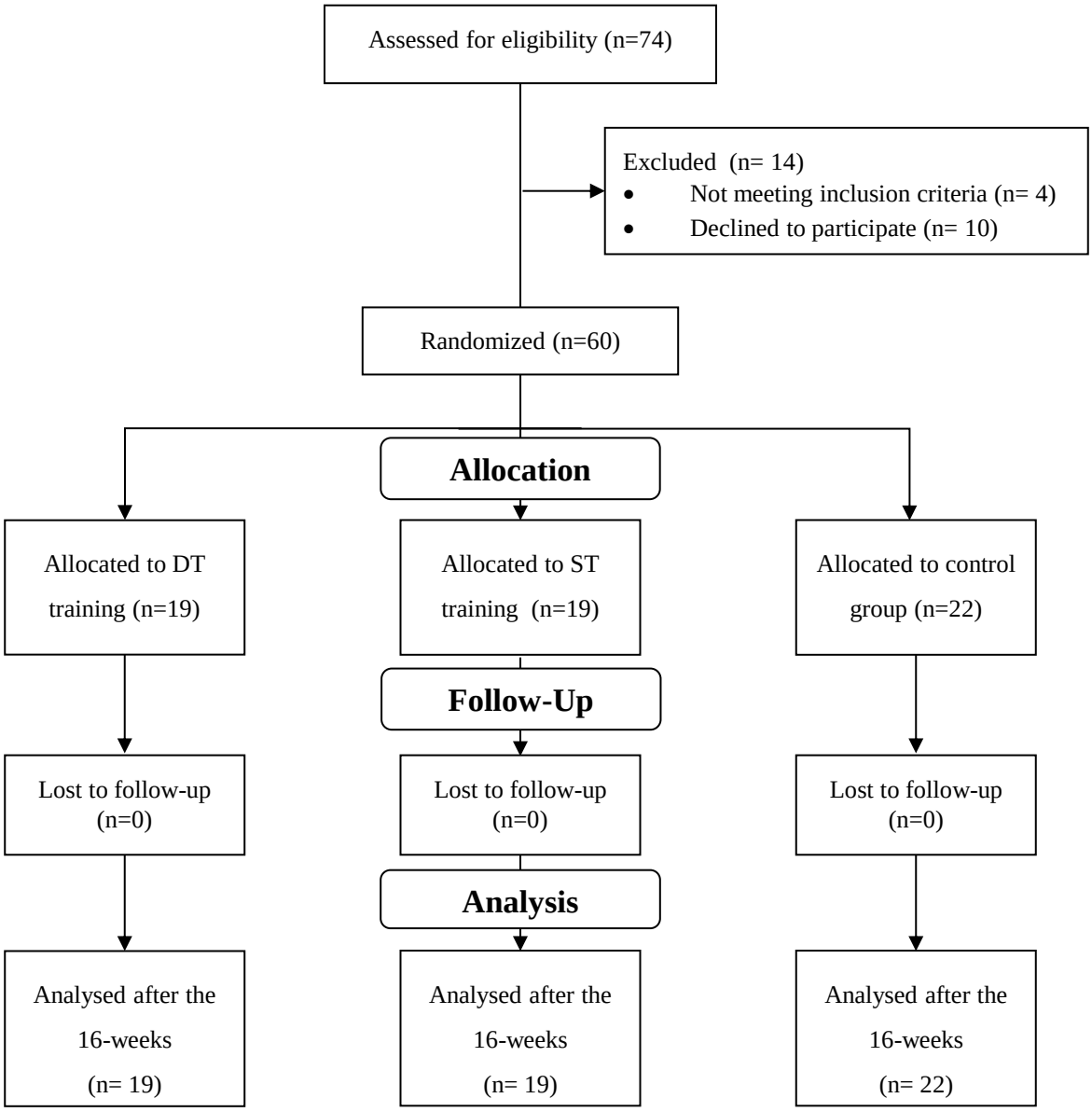
M, mean; SD, standard deviation; CG, control group; DT, dual-task training group; ST, single-task training group; 6MTW, 6 meter timed walk; 6MTWW, 6 meter timed walk with glass of water; 6MTWT, 6 meter timed walk while carrying a ball on a round tray; TUG, time up and go test; TUGW, time up and go test with glass of water; TUGT, time up and go test while carrying a ball on a round tray; FSST, four square step test; FSSTW, four square step test with glass of water; FSSTT, four square step test while carrying a ball on a round tray

Notes: The time taken to complete all tests was recorded in seconds (s). Relative percentage change is the difference of pre- vs. post-intervention.

Table 5 Outcome of three-way ANOVAS with the factors Time (Baseline and post-test), Task (ST, DT while carrying a glass of water and DT while carrying a ball on a round tray) and Group (Control group, ST and DT trainings). Rows represent dependent variables (Walking test, Time Up and Go Test and Four Square Step Test).

Variables	Time	Group	Task	Time × Task	Time × Group	Task × Group	Time × Task × Group
Walking test	F=9.4; p<0.01	F=1.7; p=0.19	F=22.8; p<0.01	F=0.1; p=0.93	F=2.7; p=0.07	F=1.1; p=0.35	F=0.3; p=0.894
Time Up and Go Test	F=39.0; p<0.01	F=1.5; p=0.23	F=63.0; p<0.01	F=4.9; p=0.01	F=29.5; p<0.01	F=2.4; p=0.06	F=0.5; p=0.72
Four Square Step Test	F=44.9; p<0.01	F=1.5; p=0.24	F=8.9; p<0.01	F=1.6; p=0.21	F=23.2; p<0.01	F=0.2; p=0.93	F=3.9; p=0.05

Figure 1


Assessed for eligibility (n=74)
Excluded (n= 14)
Not meeting inclusion criteria (n= 4)
Declined to participate (n= 10)
Randomized (n=60)
Allocation
Allocated to DT training (n=19)
Allocated to ST training (n=19)
Allocated to control group (n=22)
Follow-Up
Lost to follow-up (n=0)
Lost to follow-up (n=0)
Lost to follow-up (n=0)
Analysis
Analysed after the 16-weeks (n= 19)
Analysed after the 16-weeks (n= 19)
Analysed after the 16-weeks (n= 22)