Title: Dual-task exercise reduces cognitive-motor interference in walking and falls after stroke: a randomized controlled study

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Abstract

Background and Purpose: Functional community ambulation requires the ability to perform a mobility and cognitive task simultaneously (dual-tasking). This single-blinded randomized controlled study aimed to examine the effects of dual-task exercise in chronic stroke patients.

Methods: Eighty-four chronic stroke patients (24 women; age: 61.2±6.4 years; time since stroke onset: 75.3±64.9 months) with mild to moderate motor impairment (Chedoke-McMaster leg motor score: median=5; interquartile range=4-6) were randomly allocated to the dual-task balance/mobility training group, single-task balance/mobility group, or upper-limb exercise (control) group. Each group exercised for three 60-minute sessions per week for 8 weeks. The dual-task interference effect was measured for the time to completion of three mobility tests (forward walking, Timed-up-and-go, and obstacle-crossing), and for the correct response rate during serial-3-subtractions and verbal fluency task. Secondary outcomes included the Activities-specific Balance Confidence Scale, Frenchay Activities Index, and Stroke-specific Quality of Life Scale. The above outcomes were measured at baseline, immediately after, and 8 weeks after training. Fall incidence was recorded for a 6-month period post-training.

Results: Only the dual-task group exhibited reduced dual-task walking time post-training [forward walking combined with verbal fluency (9.5%, p=0.014), forward walking with serial-3-subtractions (9.6%, p=0.035), and the timed-up-and-go with verbal fluency (16.8%, *p*=0.001)]. The improvements in dual-task walking were largely maintained at the 8-week follow-up. The dual-task cognitive performance showed no significant changes. The dual-task program reduced the risk of falls and injurious falls by 25.0% (95%CI: 3.1-46.9%, *p*=0.037) and 22.2% (95%CI: 4.0-38.4%, *p*=0.023), respectively during the 6-month follow-up period compared with controls. There was no significant effect on other secondary outcomes (*p*>0.05).

Conclusions: The dual-task program was effective in improving dual-task mobility, reducing falls and fall-related injuries in ambulatory chronic stroke patients with intact cognition. It had no significant effect on activity participation or quality of life.

Clinical trial registration-URL: http://www.clinicaltrials.gov. Unique identifier: NCT02270398

Introduction

During dual-tasking, individuals with stroke have shown more pronounced performance decrements in either the cognitive, mobility, or both tasks, compared to healthy older adults (i.e., cognitive-motor interference).[1,2] A link between poor dual-task mobility and falls has also been identified following stroke.[3] Therefore, falls may not be a result of balance deficits in isolation, but the inability to effectively allocate attention to balance in dual-task contexts.[1,2]

Increasing research has examined the effect of dual-task balance and mobility interventions among individuals with stroke in the past decade.[4] It is thought that these interventions promote the automatization of tasks by improving the capacity to process information.[5] Only three studies have incorporated dual-task mobility outcome measures following dual-task training in individuals with stroke; however, the concurrent cognitive task performance was not measured in these studies.[6-8] This is a major limitation because it is unclear whether the improvement in dual-task walking performance was indicative of a true increase in dual-task ability or simply a change in prioritization strategy (i.e., cognitive-motor trade off).[1] Furthermore, the sample sizes were small (≤30), and there were no long-term follow-ups.[6-8] Thus, the value of dual-task exercise training on dual-task balance/mobility function in individuals after stroke remains largely unclear.

The objective of this study was to evaluate the effects of an 8-week dual-task balance/mobility exercise program on dual-task interference during walking, fall incidence, balance self-efficacy, participation in daily activities, and quality of life in individuals with chronic stroke. It was hypothesized that the dual-task program would be effective in improving these outcome measures, relative to the single-task balance/mobility and the upper limb exercise (control) programs.

Methods

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Participants

Participants were recruited from the community stroke patient groups via convenience sampling. Inclusion criteria consisted of: a diagnosis of stroke; 6 months or more after stroke onset; aged 50 years or above; community-dwelling (defined as living in one's own home or the home of a relative, friend, or caregiver); medically stable; having balance deficits (a Mini-Balance Evaluation System Test (mini-BESTest) score ≤25);[9] ability to follow 3-step commands; and able to walk at least 10 m without manual assistance. Exclusion criteria involved: having neurological conditions other than stroke; not community-dwelling prior to the stroke event; significant receptive or expressive aphasia; substantial cognitive impairment (Montreal Cognitive Assessment (MoCA) score <21);[10] and other serious illnesses that precluded participation in the study. A researcher with background in rehabilitation was responsible for screening and enrolling the participants.

The Human Ethics Research Subcommittee of the involved institution approved this study. All participants provided written informed consent prior to data collection. The study was conducted in accordance with the Declaration of Helsinki. The trial was registered in ClinicalTrials.gov (NCT02270398).

Study design

This was a single-blind randomized controlled trial. After the baseline evaluation, participants were randomized in blocks of 12 using a 1:1:1 allocation ratio to one of the following three groups: (1) the dual-task training group, (2) the single-task training group, or (3) the upper limb exercise group (controls). Group allocation was concealed in sealed sequentially numbered envelopes, which were not opened until the baseline assessments were completed. All randomization procedures were performed by an off-site researcher who was not involved in other aspects of the study. The baseline assessments were performed by two researchers who were blinded to group allocation.

Intervention

Dual- and single-task training were explored in order to determine whether a specific training approach was superior in decreasing dual-task interference. While single-task training is typically implemented during conventional rehabilitation, it may not address decreasing fall risk in attention-demanding environments. The dual-task training also has the potential to improve the ability to allocate attentional resources when a dual-task situation is encountered.[5] The upper limb exercise group served as an active control group, enabling us to determine whether the observed improvement in the dual-or single-task group was a function of maturation or repeated testing. Each group received their respective training (three 60-minute sessions per week) for 8 weeks. Each training session was supervised by two instructors with physical therapy background, with an instructor to participant ratio of 2:4. All training sessions took place in an exercise room located in the university. The timing of the exercise sessions for each group was dependent on the availability of the participants, space, and equipment. Nevertheless, the training sessions for the three groups were conducted at different times of the day and/or on different days so that participants would not be exposed to observing other treatments. The details of the training protocol for the three groups are provided in Supplemental Methods and Supplemental Table I and II (please see http://stroke.ahajournals.org).

Measurements

Demographic information was obtained during a baseline interview. The Oxfordshire Stroke Classification tool was used to classify stroke subtypes.[11] Participants completed the Geriatric Depression Scale (GDS short form)[12] and the Chedoke-McMaster Stroke Assessment (CMSA)[13], and the Stroop Color-Word test.[14] They were also asked whether they had experienced any falls in the past year. A fall is defined as “inadvertently coming to rest on the ground or other lower level with or without loss of consciousness and other than as the consequence of sudden onset of paralysis, epileptic seizure, excess alcohol intake or overwhelming external force”.[15]

The outcomes detailed below were measured in a university research laboratory within 1 week before intervention initiation, within 1 week after the intervention, and 8 weeks after the intervention by blinded researchers.

Dual-task effects

Dual-task interference was the primary outcome. Three mobility tasks of varying levels of difficulty (i.e., simple, intermediate, advanced) were employed in the dual-task testing paradigm, namely, forward walking, the timed-up-and-go test (TUG), and an obstacle crossing test.[16] For the forward walking test, participants walked along a 14-meter walkway. For the TUG, participants stood up from a chair, walked 3 meters, turned, walked back to the chair, and sat down. The time to completion was recorded by a stopwatch. For the obstacle crossing task, the same 14-meter walkway was used as in the forward walking test, and 7 obstacles (length 80 cm, width 5 cm, height 4 cm) were placed 1.5 m apart from one another. For both the forward walking and obstacle crossing tasks, only the time taken to walk the middle 10 meters of the 14-meter walkway was measured. For all three tests, participants were instructed to complete the task as quickly as possible while maintaining safety. A shorter walking time indicated better mobility performance.

Two cognitive task domains, namely, verbal fluency and mental tracking, were evaluated. For the verbal fluency task, participants were asked to name as many words as possible in a specific category (e.g., fruit). For the mental tracking task, participants performed serial-3-subtractions from a random number between 90 and 100. The number of correct answers generated was recorded.

The sequence of the three mobility tests was randomized first, followed by randomization of the sequence of the two cognitive tasks. Participants started with one of the randomized mobility tasks in the single-task condition, then performed the same mobility task in the dual-task condition (in conjunction with one of the cognitive tasks, in randomized sequence). Subsequently, the cognitive tasks were performed in a sitting position (single-task condition). The time given to perform the cognitive task in single-task condition was matched to the participant's time taken to complete the cognitive task in the corresponding dual-task condition. The correct response rate (CRR) of the cognitive tasks was calculated as follows:

CRR = (number of correct responses ÷ time) × 100

Where a higher CRR value indicated better performance.

When the tasks were performed in the dual-task condition, participants were instructed to perform both tasks as well as possible. Participants performed one practice trial of each task before data collection. Good reliability of the dual-task assessments has been established.[16]

The degree of dual-task interference was represented by the percent dual-task effect (DTE%) of the walking time and CRR and were calculated as follows.

DTE% in walking time = (dual-task walking time – single-task walking time)/single-task walking time × 100%.[1]

DTE% in CRR = (single-task CRR – dual-task CRR)/ (single-task CRR) × 100%.

Therefore, a greater positive value for both variables indicated greater performance deterioration under the dual-task condition compared with the single-task condition (i.e., greater dual-task interference).[17]

Secondary outcomes

The secondary outcomes included the Activities-specific Balance Confidence (ABC) scale,[18] the Frenchay Activities Index (FAI),[19] and the Stroke-Specific Quality of Life Scale (SS-QOL).[20]

After the end of the 8-week intervention period, the incidence of falls and fall-related injuries was recorded monthly for 6 months via telephone interviews by blinded researchers. Participants' responses were cross-validated with their respective caregivers whenever possible.

Statistical analysis

The estimated sample size was 84 individuals with stroke (details of sample size calculation in Supplemental Methods, please see http://stroke.ahajournals.org).

Data entry was performed by two independent researchers to ensure accuracy. SPSS version 20 (IBM, Armonk, USA) was used to conduct data analysis. The alpha was set at 0.05. Intention-to-treat analysis was performed. The last observation carried forward method was used to handle missing data. Normality of data was assessed using Shapiro-Wilk test. The baseline characteristics of the three groups were compared with one-way ANOVA, Kruskal-Wallis test, or Chi-square test, depending on whether the criteria for parametric statistics were fulfilled. For each outcome of interest, 3×3 two-way ANOVA (mixed design) was performed to determine whether the group × time interaction effect was significant. A Greenhouse-Geisser correction was applied if sphericity was violated. Post-hoc analyses with Bonferroni adjustments were also performed if significant results were found. Effect sizes were denoted by partial eta-squared values (η_p^2; small=0.01, medium=0.06, large=0.14).[21] Finally, the above analyses were repeated after removing the drop-outs (i.e., per-protocol analysis).

The proportion of fallers and those who sustained fall-related injury identified during the 6-month follow-up period were compared across groups by using Chi-square test, or Fisher's exact tests if the criteria for Chi-square tests were not fulfilled. By comparing the above fall-related outcomes of the control group with each of the dual-task and single-task groups, the respective absolute risk reduction (ARR) and number needed to treat (NNT) values were obtained. Lastly, the number of falls and injurious falls (per 100 persons) were compared between groups using Mann-Whitney U tests.

Results

The patient recruitment period was from October 2014 to February 2016. Eighty-four out of 240 individuals with chronic stroke screened met the eligibility criteria. Participants were randomly allocated into one of the three groups. The last group of participants completed their training in May 2016, while all data collection was completed in November 2016. Six participants withdrew from the study for reasons not related to the training (CONSORT flowchart in Figure 1).

Demographics

Participant characteristics are displayed in Table 1. The mean time since stroke onset was 75.3 months (range: 6-336 months). The median and interquartile range of CMSA score for paretic leg and foot were 5 (4-6) and 3 (2-5), respectively, indicating mild to moderate impairment in lower limb motor function. No significant between-group differences were found in any of the demographic (Table 1) or outcome variables (Figure 2-4 and Supplemental Figure I, please see http://stroke.ahajournals.org) at baseline (p>0.05). The results were similar in per-protocol analysis.

Compliance and adverse events

The mean number of sessions attended per participant was 21±6 out of 24 sessions (87.5%), with no significant between-group difference (p=0.957). No adverse events were reported during the training period.

Effect on Dual-task interference

In the intention-to-treat analysis, a significant group × time interaction effect on DTE% in walking time was found for (1) forward walking + verbal fluency task (F=2.986, p=0.024, η_p^2=0.069) (Figure 2A) (2) forward walking + serial-3-subtractions (F=2.714, p=0.036, η_p^2=0.063) (Figure 2B), and (3) TUG + verbal fluency task (F=2.640, p=0.037, η_p^2=0.061) (Figure 3A), all with medium effect sizes. For these three dual-task conditions, post-hoc analyses revealed that only the dual-task group experienced reduced DTE% in walking time after the intervention [forward walking + verbal fluency: mean difference=-9.5%, 95%CI=-17.4%, -1.5%; forward walking + serial-3-subtractions: mean difference=-9.6%, 95%CI=-18.6%, -0.5%; TUG + verbal fluency: mean difference=-16.8%, 95%CI=-27.9%, -5.6%]. The treatment effect was largely maintained as there were no significant changes from post-test to 8-week follow-up (p>0.05). The single-task group demonstrated a trend (i.e., 0.05≤p≤0.10) for improved DTE% in walking time for the TUG + verbal fluency (p=0.054) and TUG + serial-3subtractions (p=0.082) between baseline and the 8-week follow-up (Fig. 3A and B). The DTE% in walking time for the obstacle crossing task did not show a group × time interaction effect, regardless of the cognitive task used (p>0.05) (Supplemental Figure IA & B, please see http://stroke.ahajournals.org).

In all 3 groups, no differences in the DTE% for cognitive performance (i.e., CRR of the verbal fluency and serial-3-subtractions tasks) emerged following training or at the 8-week follow-up across the dual-task conditions (p>0.05) (Figure 2C & D, Figure 3C & D, and also Supplemental Figure IC & D, please see http://stroke.ahajournals.org). The conclusion remained the same in per-protocol analysis (not shown).

Effect on other outcomes

The intention-to-treat analysis revealed a significant time effect on ABC (F=8.989, p=0.001, η_p^2=0.100) and SS-QOL (F=5.031, p=0.009, η_p^2=0.058). However, no group × time interaction effect was identified for the ABC, FAI or SS-QOL scores (p>0.05) (Supplemental Figure II, please see http://stroke.ahajournals.org). The per-protocol analysis generated similar results (not shown).

Seventy-eight participants provided data on falls (Figure 1). A total of 3, 4, and 10 participants reported at least one fall during the 6-month follow-up period in the dual-task, single-task, and control groups, respectively, accounting for a total of 33 fall episodes. Approximately one third (33%) of the falls occurred outdoors (Figure 4A). The most common fall-related activities were weight-shifting while standing (36%) and walking (24%) (Figure 4B). The most common perceived cause of falls was related to problems with divided attention (27%), followed by the leg(s) giving way (15%) and slipping (15%) (Figure 4C).

The dual-task group had significantly lower proportion of individuals who sustained at least one fall [NNT=4.0 (95%CI=2.1, 32.2)] or fall-related injury [NNT=4.5 (95%CI=2.6, 16.6)] during the 6-month follow-up period (Table 2). The single-task group also tended to have a lower proportion of fallers or individuals who sustained fall-related injury than the control group, but the results did not reach statistical significance ($0.05 \leq p \leq 0.10$). Similar results were found when the number of falls and injurious falls (per 100 persons) were analyzed. Only the dual-task group was significantly different from the control group in these variables ($p<0.05$)

Discussion

The key finding was that the 8-week dual-task program was effective in improving dual-task walking function and reducing fall incidence in chronic stroke patients with independent ambulatory function and intact cognition.

Training effect on dual-task interference

The dual-task group exhibited a significant treatment effect on reducing dual-task interference in the time to completion of forward walking combined with verbal fluency, forward walking combined with serial-3-subtractions, and the TUG combined with verbal fluency, while there were no changes in the single-task group or the upper-limb exercise group. Given that the dual-task group exhibited similar cognitive task performance in dual-task contexts post-training, the reduction in the DTE% of walking time was likely due to improved dual-tasking, rather than a cognitive-motor trade-off.[1] These improvements were largely sustained at the 8-week follow-up.

Interestingly, the DTE% for the forward walking task was reduced after dual-task training regardless of the cognitive task used, whereas the DTE% of the more challenging TUG task was only reduced when it was performed simultaneously with the verbal fluency task. Perhaps the dual-task group was exposed to more verbal fluency-type exercises during training, compared to other cognitive domains, leading to improved performance (Supplemental Table I, please see http://stroke.ahajournals.org). A case series by Plummer et al.[22] also showed more improvements if the types of cognitive activities used in the dual-task training and those used in the assessment belonged to the same domain of cognitive function. Our results showed that when the walking task increased in difficulty (i.e., the obstacle crossing task), no significant training effect was observed. In all dual-task conditions, the DTE% in CRR also did not show any significant changes immediately after training and at the 8-week follow-up. It is possible that more frequent training (>3 sessions per week) or a longer training duration (>8 weeks) may be required to induce improvements in more advanced dual-task mobility function and also dual-task cognitive performance but further investigation is needed to confirm this postulation.

Interestingly, reduced dual-task interference was only observed after dual-task training. The participants in the dual-task group were exposed to various dual-task situations within the training program where they learned to properly allocate attentional resources to the two component tasks under dual-task conditions. While single-task training may have the potential to improve automaticity in mobility and/or cognitive performance during single-tasking, it did not induce any significant treatment effect on dual-task mobility function. Thus, the observed improvement in the dual-task group may be more related to the acquisition of a better ability to allocate attentional resources in different dual-task scenarios.[23] The results suggest that it may be necessary to train dual-tasking to improve dual-tasking. This highlights the importance of increasing attention demand during balance and mobility training.

Training effects on other outcomes

The dual-task program reduced the risk of falls and injurious falls by 25% and 22% respectively, when compared with the control intervention. While an association between dual-task mobility function and falls has been identified in individuals with stroke,[3] our study is the first to provide evidence that cognitive-motor dual-task training reduces the incidence of falls and fall-related injuries. Moreover, the most common perceived cause of falling in the control group was related to problems with managing distractions while walking or weight-shifting during standing (i.e., cognitive-motor dual-tasking). These data indicate that dual-task training may be successful in reducing the risk of falling in attention-demanding contexts. This study can therefore be used to inform the design of fall-prevention interventions in community-dwelling individuals with chronic stroke. The dual-task program did not involve expensive equipment. The exercises involved were also simple enough so that family members/caregivers of the stroke patients could carry out the exercise sessions as a home program after proper training by physical therapists. This program has the potential for widespread, economical, and sustainable applications in community- and home-based settings. This is particularly important in light of the limited health care resources and increasing emphasis on preventive care in both the home and community.[24]

While the ABC and SS-QOL scores showed improvement over time, there were no between-group differences, indicating that engaging in regular exercise may induce benefits in these outcomes. Additionally, no significant change in the FAI scores was observed; perhaps a longer training duration or more intensive program is required to provoke improvements in higher-level functioning.

Limitations and future research directions

Only two cognitive domains were involved in our testing paradigm (verbal fluency, mental tracking). Other cognitive domains (e.g., reaction time, discrimination and decision-making tasks) were not examined due to concerns with physical and mental fatigue of our participants with repetitive testing. Because only dual-task interference was used in our sample size estimation, this study may be underpowered to detect significant difference in the secondary outcomes (e.g., ABC, FAI, SS-QOL). Further increasing the sample size would also improve the precision of the estimates of treatment effect on falls. The exercise sessions were not held at the same time of the day and so we could not completely eliminate the diurnal effects of exercise.[25,26]

However, previous research has shown no difference in reaction time, self-reported sleepiness, fatigue, or attention level between 11:00am, 2:00pm, and 5:00pm.[27] All exercise sessions in the current study were held between 10:00am and 4:00pm, and may have therefore limited the degree of diurnal effects. The findings are only generalizable to community-dwelling ambulatory individuals with chronic stroke who have mild to moderate motor impairment and intact cognition. In this study, a convenience sample was recruited from community self-help groups which held regular recreational and social activities for their members, leading to potential self-selection bias. Our participants may have been more physically and socially active, had a higher education level or socioeconomic status than their counterparts who did not participate in this study. Individuals in the acute or subacute stage of stroke were not included because many of these individuals often do not have adequate walking or cognitive ability to engage in dual-task training. Additionally, patients in the early stages of stroke typically receive other types of rehabilitative training concurrently, which may confound the results. Nevertheless, the effect of dual-task training in earlier stages of stroke warrants future investigation.

Summary/Conclusions

The 8-week dual-task exercise training was more effective in improving simple- and intermediate-level dual-task mobility in ambulatory and cognitively intact individuals with chronic stroke. The dual-task program may also be useful in preventing falls and fall-related injuries, and may inform the design of fall-prevention programs in this population. The dual-task program, however, had no significant effect on activity participation or quality of life.

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FIGURE CAPTIONS

Figure 1. CONSORT flowchart

Seventy-seven out of 84 participants completed all baseline and follow-up assessments. *Seventy-eight participants provided fall data (dual-task group=25, single-task group=26, controls=27), including one control participant who finished all the training sessions but did not attend the post-intervention and 8-week follow-up assessments due to illness.

Figure 2. Outcome assessments: Dual-task interference during forward walking

A significant group × time interaction effect on percent dual-task effect (%DTE) in walking time was identified when forward walking was combined with verbal fluency (A) or serial-3-subtractions (B). Post-hoc analysis revealed significantly reduced %DTE in walking time for these two dual-task conditions following dual-task training only. No significant change was observed in the %DTE in correct response rate (CRR) for the two cognitive tasks (C & D). *denotes significant difference from baseline. The error bar represents one standard error.

Figure 3. Outcome assessments: Dual-task interference during Timed-up-and-go (TUG) test

A group × time interaction on %DTE in walking time was identified when TUG was combined with verbal fluency (A), with only the dual-task group exhibiting a significant reduction in this variable at post-test. No interaction effect in %DTE walking time was observed when TUG was combined with serial-3-subtractions (B). There was also no interaction effect in %DTE in correct response rate (CRR) for the two cognitive tasks (C & D).

Figure 4. Circumstances of falls

The locations of falls (A), fall-related activities (B), and perceived causes of falling (C) are illustrated.

Table 1. Participant characteristics

	All (n=84)	Dual-task (n=28)	Single-task (n=28)	Control (n=28)	p-value*
Basic demographics					
Age (year) †	61.2±6.4	59.9±6.8	61.2±6.2	62.4±6.3	0.352
Sex, women (*n*)	24	6	8	10	0.497
Body mass index ($kg·m^{-2}$)†	23.6±3.3	23.7±2.7	23.5±3.2	23.7±3.9	0.975
Education level (primary/secondary/tertiary, *n*)	13/59/12	3/21/4	7/16/5	3/22/3	0.171
Socioeconomic status (USD per person in household per month) <$2,000/$2,000-$4,000/$>4,000	40/28/16	9/15/4	17/5/6	14/8/6	0.072
Cataract (*n*)	12	2	4	6	>0.250‖
No. of people with at least 1 fall within past year	24	8	7	9	0.879
No. of falls within past year *(per 100 persons)*	67	89	54	57	0.747
No. of people with injurious falls within past year	12	4	4	4	1.000
No. of injurious falls within past year (*per 100 persons*)	14	14	14	14	1.000
Dropouts (*n*)	6	3	2	1	0.584
Stroke characteristics					
Time since onset (months)†	75.3±64.9	71.9±63.6	66.6±41.6	87.5±83.3	0.460
Type (Ischemic/Hemorrhagic; *n*)	49/35	17/11	18/10	14/14	0.529
Location (TAC/PAC/LAC/POC; *n*)§	0/64/2/18	0/23/1/4	0/18/1/9	0/23/0/5	0.194
Hemiparetic side (left/right; *n*)	46/38	15/13	16/12	15/13	0.953
CMSA leg score (1-7)‡	5 (4, 6)	5 (4, 6)	5 (4.25, 6)	5 (4, 6)	0.636
CMSA foot score (1-7)‡	3 (2, 4.75)	3 (2, 4)	3 (2.25, 5)	3 (2, 4.75)	0.733
MoCA (0-30)†	26.0±2.8	25.9±2.7	25.6±2.6	26.4±2.9	0.595
GDS-SF (0-15)†	5.0±3.9	4.9±4.4	5.4±4.1	4.7±3.2	0.782
Stroop Interference Index	1.05±0.81	1.04±0.96	0.95±0.66	1.17±0.81	0.480
Mobility and balance status					
Use of walking aid outdoors (none/cane/quad cane, *n*)	21/50/13	9/14/5	6/20/2	6/16/6	0.409

Mini-BESTest (0-28)†	17.4±4.9	16.6±5.2	18.1±4.4	17.4±5.1	0.540
Total number of co-morbidities (*n*)	2.0±1.3	2.2±1.2	2.1±1.5	1.7±1.2	0.331
Total number of medications (*n*)	3.8±2.6	4.3±2.7	4.0±2.3	3.2±2.7	0.299
Number of sessions attended (*n*)	20.8±5.9	20.5±6.7	20.9±6.1	20.9±5.1	0.957

* *p* values for between-group comparisons at baseline

† Mean±SD presented for continuous variables

‡ Median (interquartile range) for ordinal variables

§ Oxfordshire Classification of Stroke (TAC=total anterior circulation; PAC=partial anterior circulation; LAC=lacunar; POC=posterior circulation)

‖ The original 3 ×2 Chi-square did not fulfill the assumptions for an accurate test. Fisher's exact test was used for pair-wise comparisons instead. All three comparisons showed no significant between-group difference, with *p*-values >0.250.

CMSA: Chedoke-McMaster Stroke Assessment; GDS-SF: Geriatric Depression Scale –Short Form; Mini-BEST: Mini-Balance Evaluation Systems Test; MoCA: Montreal Cognitive Assessment; USD: US Dollars

Table 2. Comparison of data on falls during the 6-month follow-up period

Variable	Dual-task (n=25)	Single-task (n=26)	Control (n=27)	Dual-task Vs control	Single-task Vs control
				Absolute risk reduction (95%CI)	
No. (%) of people with at least 1 fall	3 (12.0%)*	4 (15.4%)†	10 (37.0%)	25.0% (3.1%, 46.9%)	21.6% (-1.3%, 44.5%)
No. (%) of people with injurious falls	0 (0.0%)*	1 (3.8%)†	6 (22.2%)	22.2% (6.0%, 38.4%)	18.4% (1.1%, 35.7%)
				Mean difference (95%CI)	
No. of falls *(per 100 persons)*	20*	31†	74	54 (3, 105)	43 (-17, 104)
No. of injurious falls (*per 100 persons*) ‡	0*	1†	10	37 (2, 72)	33 (-2, 69)

*Significant difference from controls ($p \leq 0.05$)

†A trend of difference from controls ($0.05 \leq p \leq 0.10$)

‡ The injuries included bruising (single-task: n=1, control: n=8), fracture (control: n=1), and bleeding (control: n=1).