Effectiveness of a multimodal exercise rehabilitation program on walking capacity and functionality after a stroke

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The aim of this study was to determine the effectiveness of a 12-week multimodal exercise rehabilitation program on walking speed, walking ability and activities of daily living (ADLs) among people who had suffered a stroke. Thirty-one stroke survivors who had completed a conventional rehabilitation program voluntarily participated in the study. Twenty-six participants completed the multimodal exercise rehabilitation program (2 days/wk, 1 hr/session). Physical outcome measures were: walking speed (10-m walking test), walking ability (6-min walking test and functional ambulation classification) and ADLs (Barthel Index). The program consisted on: aerobic exercise; task oriented exercises; balance and postural tonic activities; and stretching. Participants also followed a program of progressive ambulation at home. They were evaluated at baseline, postintervention and at the end of a 6-month fol-low-up period. After the intervention there were significant improvements in all outcomes measures that were maintained 6 months later. Comfortable and fast walking speed increased an average of 0.16 and 0.40 m/sec, respectively. The walking distance in the 6-min walking test increased an average of 59.8 m. At the end of the intervention, participants had achieved independent ambulation both indoors and outdoors. In ADLs, 40% were independent at baseline vs. 64% at the end of the intervention. Our study demonstrates that a multimodal exercise rehabilitation program adapted to stroke survivors has benefits on walking speed, walking ability and independence in ADLs.

Keywords: Exercise, Physical activity, Stroke rehabilitation, Walking speed, Activities of daily living

INTRODUCTION

As life expectancy increases, a larger number of persons may suffer from stroke. Stroke mortality rates have decreased, but the burden of stroke is increasing in terms of stroke survivors per year, correlated deaths and disability-adjusted life-years lost. These deficiencies are further highlighted by a trend towards more strokes in younger people (Feigin et al., 2014). Stroke not only causes permanent neurological deficits, but also a profound degradation of physical condition, which worsens disability and increases cardiovascular risk. Stroke survivors are likely to suffer functional decline due to reduction of aerobic capacity. This may involve fur-ther secondary complications such as progressive muscular atrophy, osteoporosis, peripheral circulation worsening and increased cardiovascular risk (Ivey et al., 2006). All these factors cause increased dependency, need of assistance from third parties in activities of daily living (ADLs) and a restriction on participation that can have a profound psychosocial impact (Carod-Artal and Egido, 2009). Gait capacity is one of the main priorities of persons who have suffered a stroke, but is often limited due to the high energy demands of hemiplegic gait and the poor physical condition of these persons (Ivey et al., 2006). Gait speed is a commonly used measure in patients who have suffered a stroke to differentiate the functional capacity to walk indoors or outdoors. Gait speed has

been classified as: allowing indoor ambulation (< 0.4 m/sec), limited outdoor ambulation (0.4–0.8 m/sec), and outdoor functional ambulation (> 0.8 m/sec) (Perry et al., 1995). Gait speed can also help to establish the functional prognosis of the patient. It has been stated that improvements in walking speed correlate with improved function and quality of life (QoL) (Schmid et al., 2007). It is essential to achieve a proper gait speed for outdoors functional ambulation.

Falls are common among stroke survivors and are associated with a worsening of disability and QoL. Balance is a complex process that involves the reception and integration of afferent inputs and the planning and execution of movement. Stroke can impact on different systems involved in postural control. Multifactorial falls risk assessment and management, combined with fitness programs, are effective in reducing risk of falls and fear of falling (Stroke Foundation of New Zealand and New Zealand Guidelines Group, 2010). Falls often occur when getting in and out of a chair (Brunt et al., 2002). The 2013 Cochrane review (Saunders et al., 2013) recommends the repetitive practice of sit-to-stand in order to promote an ergonomic and automatic pattern of this movement. Recent studies demonstrate that exercises that improve trunk stability and balance provide a solid base for body and leg movements that entail an improved gait in people affected by stroke (Sharma and Kaur, 2017). Conventional rehabilitation programs after stroke focus on the subacute period. The aim is to recover basic ADLs, but they do not provide maintenance exercises to provide long-term health gains. Cardiac monitoring demonstrates that conventional physiotherapy exercises do not regularly provide adequate exercise intensity to modify the physical deconditioning, nor sufficient exercise repetition to improve motor learning (Ivey et al., 2006). Therapeutic physical exercise to optimize function, physical condition and cardiovascular health after a stroke is an emerging field within neurorehabilitation (Teasell et al., 2009). The wide range of difficulties experienced by stroke survivors justify the need to explore rehabilitation programs designed to promote an overall improvement and to maintain the gains obtained after rehabilitation programs. Numerous studies have demonstrated the efficacy of aerobic exercise (Saunders et al., 2016), but there are few data on the long term effects of multimodal programs that incorporate aerobic exercise, complemented by task-oriented training and balance exercises. Consequently, the aim of this study is to analyse the impact of a multimodal exercise rehabilitation program tailored to stroke survivors on walking speed, walking ability and ADLs.

MATERIALS AND METHODS

We conducted an observational study with a repeated measures design to evaluate changes on walking speed, walking ability and ADLs after a multimodal exercise rehabilitation program. Assessments were performed at baseline, postintervention and at the end of a 6-month follow-up.

Subjects

Thirty-one participants were recruited from Hospital-Consorci Sanitari de Terrassa (Barcelona, Spain) over a period of 1 year. All of them had suffered a stroke and had completed a conventional rehabilitation program.

Inclusion criteria were: to be diagnosed of ischemic or hemorrhagic stroke; age ≥ 18 years; functional ambulation classification (FAC) ≥ 3; Barthel Index [BI] ≥ 45. Exclusion criteria were: to be diagnosed of cognitive impairment (Mini Mental State Examination ≤ 24); unstable cardiovascular disease (acute heart failure, recent myocardial infarction, unstable angina, and uncontrolled arrhythmias) (American College of Sports Medicine, 2013; Gordon et al., 2004); alcohol or other toxic substances abuse and decompensated psychiatric disorders that prevented from following a group session.

Before the enrollment, participants underwent a medical examination to ensure that there were no circumstances that prevented their participation in the program, following the guidance of the American College of Sports Medicine (ACSM) for patients with cardiovascular disease (American College of Sports Medicine, 2013) and the guidelines of the American Heart Association (AHA) for stroke survivors (Gordon et al., 2004).

All experimental procedures were conducted according to the Declaration of Helsinki. The study was approved by the Ethics and Clinical Research Committee of Hospital-Consorci Sanitari de Terrassa. Written informed consent was obtained from each participant.

Measurement tools
Walking speed

Walking speed was assessed by the 10-m walking test (10MWT). According to the Locomotor Experience Applied Post-stroke guidelines (Duncan et al., 2007), the time that each participant takes to walk 10 m at a comfortable pace and at their maximum speed was registered. Each measure was repeated twice and the average of the two distances was calculated in m/sec. Walking speed measurements were established to be highly reliable and with a high

test-retest reliability (intraclass correlation coefficient [ICC], 0.90) (Bohannon, 1997).

Walking ability

The 6-min walking test (6MWT) was validated as a submaximal oxygen consumption test for individuals with cardiac or pulmonary disease (Guyatt et al., 1985). It has been considered as a measurement of maximum aerobic capacity (Kelly et al., 2003). The 6MWT is an assessment of the distance walked over a period of 6 min and is also considered a useful measure of walking capacity after a stroke (Fulk et al., 2008). It was performed over a 25-m straight walkway. The test was standardized according to the American Thoracic Society Guidelines (ATS Committee on Proficiency Standards for Clinical Pulmonary Function Laboratories, 2002). Several authors have reported the 6MWT, applied to people with chronic stroke living in the community, to be highly reliable and with a high test-retest reliability (ICC, 0.99) (Eng et al., 2004; Flansbjer et al., 2005).

FAC classifies people according to basic motor abilities necessary for functional ambulation (Holden et al., 1984). It has been used to assess the degree of manual assistance required for ambulation as follows: level 0 (unable to walk); level 1 (dependent level II: requires manual assistance during ambulation on level surfaces. Manual contact is continuous and necessary to support body weight and/or to maintain balance or assist coordination); level 2 (dependent level I: requires manual assistance during ambulation on level surfaces. Manual contact is continuous or intermittent light touch to assist balance or coordination); level 3 (ambulation occurs on level surfaces without manual contact of another person, but requires supervision); level 4 (independent ambulation indoors or on level surfaces); level 5 (independent ambulation on all kind of outdoors surfaces and stairs).

Activities of daily living

Independence in basic ADLs was measured with the BI (Mahoney and Barthel, 1965). BI is composed of 10 items related to personal hygiene, eating, bladder and bowel control and walking capacity. Response ranges from independent activity, minimum assistance, intermediate assistance, maximum assistance, and impossible to perform the activity. Participants were categorized into: moderately dependent (40–55/100), mildly dependent (≥60/100), and independent (100/100).

Exercise program

The multimodal exercise rehabilitation program was conducted at Hospital-Consorci Sanitari de Terrassa (Barcelona) and delivered as a supervised program at the Rehabilitation Unit. It consisted of a 12-week intervention of two alternate days a week, in sessions of one hour (24 sessions in total). The intervention was performed in groups of 4–6 participants with a physical therapist who guided the session.

The multimodal program was adapted to the characteristics and capacity of each participant. It consisted of four workstations:

(a) Warm up and aerobic exercise (stationary bicycle/pedalier, walking as fast as possible on a circuit with obstacles, ramps, stairs, and irregular ground)

(b) Task-oriented exercises to strengthen muscular groups that participate in different tasks performed in rapid series to improve aerobic capacity:
- Steps: short bouts of stair climbing to train the task of climbing stairs
- Sit-to-stand: to train the task of sitting down and getting up from a chair
- Balance on tiptoe: to train the propulsion phase of gait.

(c) Balance in standing position and postural tonic activities (on the floor and on unstable ground planes)

(d) Stretching exercises

Furthermore, participants received indications on progressive daily ambulation to achieve a high rate of adherence. The aim was to reach physical activity levels recommended by the World Health Organization (World Health Organization, 2017) of 150 m/wk of moderate physical activity. Table 1 shows the program progression and exercise dose.

To calculate the intensity of exercise, based on the recommendations of the ACSM (American College of Sports Medicine, 2013) and the AHA (Gordon et al., 2004), participants were trained to work at 50%–60% maximum heart rate (MHR). Participants were also trained to use the Borg's scale (Borg, 1990). The objective was to achieve patients' self-regulation of their own exertion level and effort, especially in those taking beta-blockers, thyroid hormone or with a pacemaker. Participants were trained at an intensity of 6–7/10 in the Borg's scale with a self-perceived effort of "difficult-hard" and rest periods as needed. The physiotherapist asked regularly how intense was the effort for the participant. This measure has been used in patients who have suffered myocardial infarction at the beginning of a cardiac rehabilitation program (Brazzelli et al., 2011; Ilarraza et al., 2004). The objective was to achieve self-efficacy in the ambulation program at home and, therefore, adherence to the rehabilitation program.

Postintervention, participants answered a satisfaction scale. During

Table 1. Progression of procedure and exercise dose

Multimodal exercise rehabilitation program (weeks 1–4)

Program	Week 1		Week 2		Week 3		Week 4	
	S1	S2	S3	S4	S5	S6	S7	S8
1. Warming-aerobic-stretching exercises (25 min) Intensity: 50%–60% MHR								
Stationary bicycle/pedalier	10'	10'	12'	12'	12'	12'	12'	12'
Stairs and ramp circuit	5'	5'	4'	4'	4'	4'	4'	4'
Gait training in parallel and different surfaces	5'	5'	4'	4'	4'	4'	4'	4'
2. Task-oriented activities (8 series of repetitions) Intensity: 50%–60% MHR								
Sit-to-stand	5'	5'	5'	5'	5'	5'	5'	5'
Steps	5'	5'	5'	5'	5'	5'	5'	5'
Balance on tiptoe (plantar flexors)	5'	5'	5'	5'	5'	5'	5'	5'
3. Balance and tonic postural activities (15 min)								
Base position	5'	5'	5'	5'	3'	3'	1'	1'
Bipodal step forward	3'	3'	3'	3'	3'	3'	2'	2'
Unipodal step forward	3'	3'	3'	3'	3'	3'	2'	2'
Bipodal step backward	3'	3'	3'	3'	3'	3'	2'	2'
Unipodal step backward	-	-	-	-	3'	3'	4'	4'
Bipodal lateralizations on u.s.	-	-	-	-	-	-	4'	4'
4. Stretching	5'	5'	5'	5'	5'	5'	5'	5'
5. Independent work at home								
Home ambulation program	10/12 min	10/12 min	10/12 min	10/12 min	14/16 min	14/16 min	14/16 min	18/20 min

Multimodal exercise rehabilitation program (weeks 5–8)

Program	Week 5		Week 6		Week 7		Week 8	
	S9	S10	S11	S12	S13	S14	S15	S16
1. Warming- aerobic-stretching exercises (25 min) Intensity: 50%–60% MHR								
Stationary bicycle/pedalier	14'	14'	14'	14'	14'	14'	14'	14'
Stairs and ramp circuit	3'	3'	3'	3'	3'	3'	3'	3'
Gait training in parallel and different surfaces	3'	3'	3'	3'	3'	3'	3'	3'
2.Task-oriented activities (8 series of repetitions) Intensity: 50%–60% MHR								
Sit-to-stand	5'	5'	5'	5'	5'	5'	5'	5'
Steps	5'	5'	5'	5'	5'	5'	5'	5'
Balance on tiptoe (plantar flexors)	5'	5'	5'	5'	5'	5'	5'	5'
3. Balance and tonic postural activities (15 min)								
Base position	2'	2'	1'	1'	1'	1'	1'	1'
Bipodal step forward	2'	2'	2'	2'	1'	1'	1'	1'
Unipodal step forward	2'	2'	2'	2'	1'	1'	1'	1'
Bipodal step backward	2'	2'	2'	2'	2'	2'	1'	1'
Unipodal step backward	2'	2'	2'	2'	2'	2'	1'	1'
Bipodal lateralizations on u.s.	2'	2'	2'	2'	2'	2'	2'	2'
Bipodal lateralizations on a.s.	3'	3'	2'	2'	2'	2'	2'	2'
Unipodal lateralizations on u.s.	-	-	2'	2'	2'	2'	2'	2'
Unipodal lateralizations on a.s.	-	-	-	-	2'	2'	2'	2'
Base position on unstable surface	-	-	-	-	-	-	2'	2'
4. Stretching	5'	5'	5'	5'	5'	5'	5'	5'
5. Independent work at home								
Home ambulation program	18/20 min	18/20 min	18/20 min	22/24 min	22/24 min	22/24 min	22/24 min	26/28 min

(*Continued to the next page*)

Table 1. (*Continued*) Multimodal exercise rehabilitation program (weeks 9–12)

Program	Week 9		Week 10		Week 11		Week 12	
	S 17	S18	S19	S20	S21	S22	S23	S24
1. Warming-aerobic-stretching exercises (25 min)								
Intensity: 50%–60% MHR								
Stationary bicycle/pedalier	14′	14′	14′	14	14′	14′	14′	14′
Stairs and ramp circuit	3′	3′	3′	3′	3′	3′	3′	3′
Gait training in parallel and different surfaces	3′	3′	3′	3′	3′	3′	3′	3′
2. Task-oriented activities (series of 8 repetitions)								
Intensity: 50%–60% MHR								
Sit-to-stand	5′	5′	5′	5′	5′	5′	5′	5′
Steps	5′	5′	5′	5′	5′	5′	5′	5′
Balance on tiptoe (plantar flexors)	5′	5′	5′	5′	5′	5′	5′	5′
3. Balance and tonic postural activities (15 min)								
Base position	1′	1′	1′	1′	1′	1′	1′	1′
Bipodal step forward	1′	1′	1′	1′	1′	1′	1′	1′
Unipodal step forward	1′	1′	1′	1′	1′	1′	1′	1′
Bipodal step backward	1′	1′	1′	1′	1′	1′	1′	1′
Unipodal step backward	1′	1′	1′	1′	1′	1′	1′	1′
Bipodal lateralizations on u.s.	2′	2′	2′	2′	2′	2′	2′	2′
Bipodal lateralizations on a.s.	2′	2′	2′	2′	2′	2′	2′	2′
Unipodal lateralizations on u.s.	2′	2′	2′	2′	2′	2′	2′	2′
Unipodal lateralizations on a.s.	2′	2′	2′	2′	2′	2′	2′	2′
Base position on unstable surface	2′	2′	2′	2′	2′	2′	2′	2′
4. Stretching	5′	5′	5′	5′	5′	5′	5′	5′
5. Independent work at home								
Home ambulation program	26/28 min	26/28 min	26/28 min	30 min	30 min	30 min	30 min	30 min

S, session; MHR, maximum heart rate, calculated according to the World Health Organization formula 220-age); u.s, unaffected side; a.s, affected side.

the 6-month monitoring period, participants were contacted by phone monthly to promote adherence to the multimodal exercise rehabilitation program and solve any problem or question that might arise.

Data analysis

Data analysis was performed using IBM SPSS Statistics ver. 21.0 (IBM Co., Armonk, NY, USA). Participants' demographic, clinical and functional data were analyzed using descriptive statistics: quantitative variables with the mean, standard deviation, and range (minimum–maximum); frequencies and percentages were used to define qualitative and dichotomous variables. A repeated-measures analysis of variance was carried out on the data. Assumptions of normality, homogeneity of variance, and sphericity were met with Koplmogrov–Smirnov test. Statistical significance was set at $P < 0.05$. The effect size was estimated using Cohen d for quantitative variables as follows: values up to ≤0.2 low, 0.5–0.8 moderate and >0.8 high (Coe and Soto, 2003).

RESULTS

Characteristics of participants

A total of 31 participants were enrolled. Five participants withdrew (one underwent eye surgery and four due to transportation difficulties). Twenty-six participants completed the intervention but one participant was excluded due to the diagnosis of a neurodegenerative disease. Adherence rate was 95.67%. Twenty participants completed all the assessments. No adverse effects were observed during the intervention. Sociodemographic and clinical data are shown in Table 2.

Outcome variables

Table 3 shows the results of the intervention on the outcome measures. Statistically significant improvements were observed in all variables

Table 2. Sociodemographic and clinical data of the participants (n=26)

Characteristic	Value
Age (yr)	66±11 (33–86)
Sex	
Male	19 (76)
Female	6 (24)
Weight (kg)	76.82±12.87 (55–112)
Height (m)	1.65±0.069 (1.51–1.79)
Body mass index (kg/m²)	28.09±3.77 (22.80–38.92)
History of previous falls	10 (40)
Stroke characteristics	
Time since stroke (mo)	6.95±5.58
Ischemic stroke	22 (88)
Hemorrhagic stroke	3 (12)
Cardiovascular risk factors	
Systolic blood pressure (mmHg)	150.08±21.29 (109–183)
Diastolic blood pressure (mmHg)	83.72±8.81 (49–107)
Arterial hypertension	20 (80)
Diabetes mellitus II	11 (44)
High cholesterol	21 (84)
Smoker or smoking in last 6 mo	11 (44)
Alcoholism or alcohol consumer in last 6 mo	10 (40)
Metabolic syndrome	18 (72)
Comorbid conditions	
None	10 (40)
Cardiac	5 (20.8)
Respiratory	2 (8.3)
Renal	3 (12)
Musculoskeletal	1 (4)
Psychiatric	2 (8)
Neurological	1 (4)

Values are presented as mean standard ± deviation (range) or number (%).

Gait speed

Comfortable gait speed, assessed with the 10MWT, significantly improved, with an increase of 0.16 m/sec at the end of the intervention and 0.23 m/sec 6 month later ($P \leq 0.05$).

Fast gait speed ($P \leq 0.001$) increased 0.40 m/sec at the end of the intervention and 0.44 m/sec 6 month later. Cohen d effect size found in comfortable and fast walking speed between pre- and post-intervention was moderate. At 6-month follow-up, the effect was high at comfortable speed and moderate at fast speed (Table 3).

Walking ability

Walking ability measured with the 6MWT significantly improved ($P \leq 0.001$) with an increase in walking distance of 59.8 m at the end of the intervention and of 43.5 m 6 months later. Cohen d effect size was high post intervention and moderate at 6

months.

Improvements in the basic motor abilities necessary for functional ambulation were evaluated with FAC ($P \leq 0.05$). At baseline, 24% of participants needed supervision for walking, 8% could only walk independently on level ground indoors, and 68% were independent on all types of surfaces. After the intervention, 100% of participants were independent for walking outdoors on all types of surfaces. Six months later, only 5% participants stopped walking independently outdoors and 95% remained independent on all types of surfaces. Cohen d effect size found in ambulation capacity was high after the intervention and it was maintained 6 month later (Table 3).

Activities of daily living

At baseline, results of BI ($P \leq 0.001$) showed that 4% of participants were moderately dependent, 56% mildly dependent, and 40% independent; after the intervention 36% were mildly dependent and 64% were independent. Six months later, 40% were mildly dependent and 60% were independent. Cohen d effect size found in ADLs was moderate (Table 3).

Satisfaction questionnaire

Participants had high rates of satisfaction (94%). They reported a general improvement in all items: physical condition, balance and walking ability, accomplished expectations, satisfaction with the rehabilitation program, with own self-efficacy and learning strategies to improve QoL.

DISCUSSION

The main finding of this study was that participants obtained a meaningful increase in walking speed, walking skills, and ADLs. Furthermore these improvements were maintained in the long term.

Our program targeted on stroke survivors who had already finished conventional rehabilitation programs and were living at home with chronic neurological deficits. It should be noted, however, that all participants were independently ambulant.

Resources to provide treatment when patients are discharged after a stroke are often limited. There is a need of community-based rehabilitation programs for stroke survivors to maintain the gains obtained after conventional rehabilitation programs and to prevent secondary complications.

People who walk faster improve their ambulation function and tend to be more skilled to walk outdoors (Fulk et al., 2017). It has

Table 3. Effects or the multimodal exercise rehabilitation program

Program	Baseline (n=26)	Postintervention (n=26)	Follow-up (n=20)	P-value	Cohen d	
					B-P	B-R
Walking speed						
m/seccomfor	0.83±0.24	0.99±0.18	1.06±0.23	0.004*	0.75	0.97
m/secfast	1.10±0.39	1.50±0.64	1.54±0.86	0.000**	0.75	0.65
Walking ability						
6MWT (m)	315.75±64.40	373.55±68.30	359.25±91.31	0.000**	0.87	0.55
FAC	4.44±0.87	5±0	4.95±0.22	0.012*	0.91	0.80
Independent (5/5)	17 (68)	25 (100)	19 (95)			
I. indoors (4/5)	2 (8)	0 (0)	1 (5)			
Supervision (3/5)	6 (24)	0 (0)	0 (0)			
Activities of daily living						
Barthel	91.25±10.24	97.25±4.12	96.00±0	0.000**	0.76	0.56
Independent (100/100)	10 (40)	16 (64)	12 (60)			
Mildly dependent (≥60/100)	14 (56)	9 (36)	8 (40)			
Moderately dependent (40–55/100)	1 (4)	0 (0)	0 (0)			

Values are presented as mean±standard deviation or number (%).
m/secconfor, m/second at comfortable walking speed; m/secfast, m/second at fastest speed; 6MWT, 6-min walking test; FAC, functional ambulation classification; I, independent; B-P, baseline-postintervention; B-R, baseline-retention.
Test: repeated measures analysis of variance.
*$P \leq 0.05$, **$P \leq 0.001$, statistically significant difference; Cohen d.

been reported that the transition from supervised walking indoors to independent walking outdoors is associated with improved functionality and QoL, as it allows the return to everyday life and reintegration in the community (Schmid et al., 2007). The improvement in gait speed relates to a faster and higher gait quality, and therefore more effective. Participants increased comfortable and fast walking speed. These improvements allowed participants to move from a limited gait capacity for outdoors walking to a functional gait capacity for outdoors walking, thus promoting community participation. Gains in our study were clinically meaningful and agree with reference authors who estimated that an increase in gait speed ≥0.175 m/sec after an outpatient rehabilitation program, in people with stroke (Fulk et al., 2011). Tilson et al. (2010) considered that an increase in walking speed of 0.16 m/sec can be interpreted as a clinically relevant change in stroke rehabilitation and may be a cutoff point to define goals and evaluate progress in patients with subacute stroke. One of the strengths of this study is the evaluation 6 months after the intervention. The increase observed in gait speed not only remained, but participants also continued to improve six months later. We consider that it may, partly, be due to the fact that participants were contacted by phone monthly, to promote self-efficacy and adherence to the multimodal exercise rehabilitation program and to solve any problems or questions that arised.

Individuals affected by stroke suffer a severe deterioration of their cardiovascular fitness and it has been suggested that modest improvements in cardiovascular capacity may significantly influence indices of functional mobility (Ivey et al., 2006). It has been advocated that integrating aerobic training in individualized programs is feasible and necessary (Biasin et al., 2014). In our study, participants increased walking distance in the 6MWT 57.8 m at the end of the intervention and 43.5 m 6 month later. An increase of more than 50 m in the 6MWT is accepted as a relevant change in walking capacity (Holland et al., 2010). As a measure of exercise tolerance, the 6MWT correlates with both aerobic capacity and muscle strength. The ability to walk greater distances may be associated to an improvement on endurance and mobility. The use of a home ambulation program as part of the multimodal program has, probably, promoted the increase of walking distance in the 6MWT and it has potential benefits for outdoors ambulation. Other studies have reported that walking capacity as a cause of improved participation (Mayo et al., 2014). In a recent study that investigated resting and physical activity time in people with stroke, authors recommended clinicians to advice their patients to substitute some resting time with low intensity activity daily (English et al., 2016). Walking tolerance and walking speed are key components for outdoors ambulation (Barclay et al., 2015). We observed a trend towards a decrease in walking distance at 6 month,

which could be explained by a decrease in adherence to home-based unsupervised exercise programs. Participants obtained significant functional improvements in ambulation capacity and ADLs independence. After the multimodal rehabilitation program, all participants were independent for outdoors walking on all kind of surfaces and stairs climbing. Significant improvements in autonomy for ADLs were also found. These results are similar to other studies including similar multimodal interventions performed in an outpatient rehabilitation unit (Marsden et al., 2016; Pang et al., 2005). Our results showed our multimodal exercise rehabilitation program to be more effective than other studies with similar interventions, but delivered in a home-based rehabilitation program (Duncan et al., 2003). One explanation may be that the participation in a rehabilitation group program led by a professional facilitates engagement and adherence to the multimodal exercise rehabilitation program, including the ambulation program at home. At baseline, participants identified significant limitations that prevented them from maintaining independent living. At the end of the intervention, we observed positive changes in patients' ADLs. They perceived a reduction in limitations in ADLs and an increase in functional ability (gait speed and walking distance), that determines a positive effect that enhances ADLs independence. These findings coincide with authors who established the relationship between physical function (walking ability and autonomy in ADLs) and QoL (Carod-Artal, 2012); and others confirmed that an improvement of the physical condition promotes health, well-being, autonomy, QoL, self-efficacy and coping strategies (García González et al., 2014). We consider that improvements in physical fitness achieved during the multimodal exercise rehabilitation program could lead to improvements in QoL and this coincides with authors (Resnick, 2014). A recent study recommended to include physical activity programs as a therapeutic strategy to prevent, lessen or treat poststroke depression (Hong et al., 2017) and to improve resilience and ADLs (Lee et al., 2015). We agree with the Korean Society of Exercise Rehabilitation who encourages to expand and provide knowledge of exercise and to explore the possibility of exercise to move into new therapeutic area (Kim, 2017).

This intervention was very efficient in terms of personnel resources involving only one therapist who led a session with 4–6 participants. Moreover, it is a clinically feasible wide-ranging exercise protocol aimed at improving upright physical mobility in people with stroke. It is also remarkable the participants' satisfaction rate with the program.

The main limitation of the present study is the absence of randomization. Improvements at the end of the intervention could be partially due to a spontaneous recovery. For further studies, randomized trials would be required to confirm the benefits of multimodal exercise rehabilitation programs.

The sample is small due to the difficulty of recruiting participants, as they had transport difficulties to come to the rehabilitation unit on their own. Nevertheless, the adherence rate was high. Given the difficulty of recruiting larger samples in a single centre, it would be interesting for future research to conduct multicenter randomized trials and to explore the effects of multimodal rehabilitation programs on QoL.

In conclusion, multimodal exercise may be an important component of the rehabilitation process. Physical exercise is associated with enhanced gait speed, walking ability and independence for ADLs. Exercise programs for community people who have suffered stroke and self-managed rehabilitation strategies should be implemented to maintain the gains made in rehabilitation programs and adherence to exercise programs.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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