**Research**

Treadmill training provides greater benefit to the subgroup of community-dwelling people after stroke who walk faster than 0.4 m/s: a randomised trial

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**ABSTRACT**

**Question:** After stroke, does treadmill training provide greater benefit to the subgroup of community-dwelling people who walk faster than 0.4 m/s than those who walk more slowly? **Design:** Subgroup analysis of a randomised trial: the AMBULATE trial. **Participants:** 68 people with stroke living in the community. **Intervention:** The experimental group received 30 minutes of treadmill and overground walking, three times a week for four months; the control group received no intervention. **Outcome measures:** The primary outcome was walking distance covered during the six-minute walk test. Other outcomes were comfortable and fast walking speed and health status. **Results:** At four months, in the subgroup of participants with a baseline comfortable walking speed of \(> 0.4 \text{ m/s}\), treadmill training produced an extra distance of 72 m (95% CI 23 to 121) and an increased comfortable speed of 0.16 m/s (95% CI 0.00 to 0.32), compared with the subgroup with a speed of \(\leq 0.4 \text{ m/s}\). There was also a trend towards an extra fast speed of 0.17 m/s (95% CI −0.04 to 0.36). There was no extra effect of treadmill training in the faster walkers in terms of EuroQol 5Q-5D. There were no differences between the experimental and control groups between subgroups in the long term. **Conclusion:** Treadmill training is more likely to benefit people who walk at a speed of \(> 0.4 \text{ m/s}\). Clinicians should use comfortable walking speed to predict the potential for improvement and to guide intervention. **Trial registration:** ACTRN12607000227493. [Dean CM, Ada L, Lindley RI, (2014) Treadmill training provides greater benefit to the subgroup of community-dwelling people after stroke who walk faster than 0.4 m/s: a randomised trial. *Journal of Physiotherapy 60: 97–101*](http://dx.doi.org/10.1016/j.jphys.2014.03.004) © 2014 Australian Physiotherapy Association. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/3.0/).

**Introduction**

Losing the ability to walk independently is one of the most disabling consequences of stroke.\(^1\) Despite some stroke survivors regaining the ability to walk, their walking speed and distance may remain significantly reduced. Treadmill training is increasingly being used as a method for increasing walking speed and distance in stroke survivors, both for ambulatory\(^2\) and non-ambulatory\(^3\) individuals. Treadmill training has been shown to be effective at improving walking speed and distance in ambulatory stroke survivors, although meta-analysis shows that the size of the effect is moderate, with an improvement of 40 m in six-minute walking distance and 0.12 to 0.14 m/s in walking speed.\(^2\) These moderate improvements may be due in part to the heterogeneous nature of stroke, which has the potential to dilute the effect of intervention.

Although randomised trials assume an equal effect of the intervention for all participants in the sample, the effect of intervention for stroke survivors may differ, depending on individual characteristics. For example, people with acute\(^4\) or chronic\(^5\) stroke with poor levels of ambulation appear to have an increased risk of falling following exercise interventions, compared with those with higher levels of ambulation. Moreover, the study of people with chronic stroke by Dean and colleagues\(^5\) found a greater effect of intervention on walking speed and distance for those able to walk faster than 0.8 m/s at baseline. The heterogeneous nature of stroke presentation and recovery makes it difficult to establish guidelines for rehabilitation and to predict who is likely to improve as a result of intervention. Establishing relevant subgroups of stroke survivors may allow therapists to determine which individuals are likely to benefit most from a specific intervention.

The AMBULATE trial\(^6\) was a randomised trial that investigated the effect of treadmill walking training in people with chronic stroke living in the community. This trial showed that participants who undertook four months of treadmill training improved significantly more than a no-intervention control group on several outcomes: increased comfortable walking speed by 0.12 m/s,
increased fast walking speed by 0.15 m/s and increased walking distance by 38 m. Although the participants all walked slower than normal at baseline (≤ 1.1 m/s), ambulatory levels were heterogeneous (mean walking speed 0.50 m/s, SD 0.26). This raises the possibility that the effect of treadmill training in this group of ambulatory stroke survivors may differ, based on their baseline walking speed.

Walking speed has been shown to be associated with community ambulation and participation following stroke. There is evidence that people who walk very slowly (ie, gait speed ≤ 0.4 m/s) rarely venture outside their homes, while those who walk faster (ie, gait speed > 0.4 m/s) have some ability to ambulate around their community. As the current study is a secondary analysis of the AMBULATE trial, investigating whether baseline walking speed in people with chronic stroke has a differential effect on mobility outcomes following treadmill training, a cut-off of 0.4 m/s was used to subdivide participants from the AMBULATE trial into faster versus slower walkers. Therefore, the specific research question for this study was:

After stroke, does treadmill training to improve walking speed and distance have a greater effect on community-dwelling people who walk faster than 0.4 m/s than those who walk more slowly?

Method

Design

Data collected in the AMBULATE trial were used in this study. The AMBULATE trial was a three-arm randomised trial with concealed allocation, assessor blinding, and intention-to-treat analysis involving 102 people with stroke who could walk slowly, lived in the community and had ceased all formal rehabilitation. An experimental group undertook 30 minutes of treadmill and overground walking thrice per week for four months, a second experimental group undertook training for two months, while the control group had no intervention. At four months, the experimental group that had trained for four months walked further, faster and reported better health than those who received no training. However, this effect had disappeared by 12 months. The present study is a subgroup analysis of slow and fast walkers in the experimental group that trained for four months, and in the control group. Any differential effects of walking speed on the outcomes that demonstrated improvement in the primary analysis, ie, walking distance, walking speed (comfortable and fast) and health status were examined.

Participants

Participants with stroke were eligible for inclusion if they were within five years of their first stroke; were adults capable of providing consent (defined as having a Mini Mental State Exam score ≥ 23); had been discharged from formal rehabilitation; were community dwellers; walked slowly (defined as being able to walk 10 m in more than 9 seconds across flat ground in bare feet without any aids). Participants were excluded if they had: an unstable cardiac status precluding them from participation in a treadmill training program (ie, permission not granted by their medical practitioner); or had severe cognitive and/or language deficits (aphasia) precluding them from participation in the training sessions (ie, unable to follow two-step commands). Participants were divided into two subgroups according to baseline comfortable walking speed (> 0.4 m/s and ≤ 0.4 m/s), measured during a 10-m walk test. This cut-off was decided prior to analysis.

Intervention

The experimental group received training based on a previous treadmill walking program. Thirty minutes of walking was carried out three times a week for 16 weeks. Given that participants could already walk, treadmill training was conducted without any body-weight support. It was structured to increase step length, speed, workload, and automaticity. Overground walking was practised each session to reinforce the gains achieved during treadmill training. Overground walking initially comprised 20% of the intervention time and was progressively increased each week so that it comprised 50% of the 30-minute intervention time. Overground walking was defined as a whole-task practice involving propulsion forwards, backwards, sideways or up and down stairs. Guidelines were used to outline the progression of treadmill and overground walking training. The control group received no intervention.

Outcome measures

The primary outcome was walking, which was quantified by measuring the distance walked (in m) during a six-minute walk test. The instructions for the test were standardised according to Lipkin and colleagues.10 Participants were instructed to cover as much ground as possible in six minutes. They were told to walk as continuously as possible, but they could slow down or stop if necessary. No encouragement was given, but the investigator informed participants at the halfway point (three minutes) and when there was one minute remaining. Participants wore shoes and used aids if necessary.

Walking was also quantified by measuring speed (in m/s) during a 10-m walk test. Participants were timed while walking independently at their comfortable and fast speeds over the middle 10-m of a 15-m track (to allow for acceleration and deceleration). Health status was measured using the EuroQol EQ-5D-3L, which is a standardised instrument providing a single value for health status. The EQ-5D-3L records self-rated health on a vertical, 100-mm visual analogue scale where the endpoints are labelled ‘best imaginable health state’ and ‘worst imaginable health state’.

Data analysis

In the main AMBULATE Trial, all outcomes were analysed using an intention-to-treat analysis. Missing data were interpolated from the nearest measure taken to maintain all outcome measures from each participant. In the present study, the mean (SD) change of the outcome measures were calculated at four and 12 months for the experimental and control groups of the two subgroups (walking speed < 0.4 m/s and > 0.4 m/s). To determine whether treadmill training to improve walking has more effect on community-dwelling people after stroke who can walk faster (ie, baseline 10-m walk test of > 0.4 m/s), the mean difference (95% CI) between the experimental and control groups between subgroups (walking speed < 0.4 m/s and > 0.4 m/s) for outcomes in the short-term (four months) and the long-term (12 months) were calculated.

Results

Flow of participants through the study

Sixty-eight community-dwelling people with stroke participated in this subgroup analysis. At baseline, all participants completed the six-minute walk test, a 10-m walk test at comfortable and fast speed, and the EuroQol 5Q-3L. However, five control participants did not complete the 10-m walk test at
Table 1  
Baseline characteristics of participants.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>WS &gt; 0.4 m/s (n=45)</th>
<th>WS ≤ 0.4 m/s (n=23)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exp (n=23)</td>
<td>Con (n=22)</td>
<td>Exp (n=11)</td>
</tr>
<tr>
<td>Age (years), mean (SD)</td>
<td>70 (11)</td>
<td>63 (13)</td>
</tr>
<tr>
<td>Gender, n males (%)</td>
<td>17 (74)</td>
<td>12 (55)</td>
</tr>
<tr>
<td>Side of weakness, n right (%)</td>
<td>12 (52)</td>
<td>9 (41)</td>
</tr>
<tr>
<td>Height (m), mean (SD)</td>
<td>1.66 (0.07)</td>
<td>1.65 (0.09)</td>
</tr>
<tr>
<td>Weight (kg), mean (SD)</td>
<td>80 (14)</td>
<td>73 (13)</td>
</tr>
<tr>
<td>BMI (kg/m²), mean (SD)</td>
<td>28.9 (4.5)</td>
<td>26.6 (3.5)</td>
</tr>
<tr>
<td>Chronicity (months), mean (SD)</td>
<td>22 (17)</td>
<td>17 (12)</td>
</tr>
<tr>
<td>Loss of sensation (0 to 2)</td>
<td>0.3 (0.5)</td>
<td>0.4 (0.6)</td>
</tr>
<tr>
<td>Neglect (0 to 2)</td>
<td>0.18 (0.39)</td>
<td>0.09 (0.29)</td>
</tr>
<tr>
<td>Spasticity (0 to 4)</td>
<td>0.72 (0.98)</td>
<td>0.78 (0.94)</td>
</tr>
<tr>
<td>Contracture (0 to 2)</td>
<td>0.26 (0.54)</td>
<td>0.59 (0.79)</td>
</tr>
</tbody>
</table>

Exp = experimental group, Con = control group, WS = walking speed. For Impairment measures: 0 = normal and positive values = greater impairment. Information about sensory loss was collected using the Nottingham Sensory Assessment, neglect using the Line Bisection Test, and spasticity and contracture using the Tardieu Scale.

The study showed that patients who walk slowly do worse on some outcomes at four months and 12 months than those with a moderate-to-fast walking speed. Whilst acknowledging the general limitations of post hoc secondary analyses, the chance of spurious findings was limited by dividing participants into subgroups based on previous evidence prior to analysis. At four months, treadmill and overground walking training for faster walkers (> 0.4 m/s) had a significant additional benefit in terms of walking distance and speed compared with slower walkers (≤ 0.4 m/s). However, the differential effects of the subgroup with a baseline speed of ≤ 0.4 m/s. There was also a trend towards an extra fast speed of 0.17 m/s (95% CI –0.04 to 0.36). There was no extra effect of treadmill training in the faster walkers in terms of EuroQol 5Q-5D-3L. There were no statistically significant differences between the experimental and control groups between subgroups in the long term for any outcome.

Discussion

This study has shown that patients who walk slowly do worse on some outcomes at four months and 12 months than those with a moderate-to-fast walking speed. Whilst acknowledging the general limitations of post hoc secondary analyses, the chance of spurious findings was limited by dividing participants into subgroups based on previous evidence prior to analysis. At four months, treadmill and overground walking training for faster walkers (> 0.4 m/s) had a significant additional benefit in terms of walking distance and speed compared with slower walkers (≤ 0.4 m/s). However, the differential effects of the
In conclusion, the results of this study demonstrate a differential effect of a treadmill and overground walking intervention based on initial walking speed. The additional benefit of the treadmill and overground walking intervention in walking distance and speed was greater for those who walked faster at the start of therapy. However, the additional benefit declined over time.

What is already known on this topic: Despite regaining the ability to walk, many survivors of stroke do not regain their original walking speed or distance, which affects participation in the community. Overall, treadmill training has moderately beneficial effects on walking speed and distance in stroke survivors. However, the variability in these outcomes suggests that different groups of stroke survivors may differ in their response to treadmill training.

What this study adds: Treadmill training typically provides greater benefits in walking speed and distance in stroke survivors whose comfortable walking speed before training is over 0.4 m/s. Clinicians should use comfortable walking speed to predict the potential for improvement with treadmill training.

Ethics approval: Sydney University Human Research Ethics Committee (02–2007/9665) approved this study. All participants gave informed consent before data collection began.

Competing interests: Nil
Source(s) of support: The Heart Foundation of Australia and The University of Sydney supported this study.

Acknowledgements: The authors would like to acknowledge the significant contribution in coordination and training during the AMBULATE trial by Gemma Lloyd, Wendy Robinson and Janine Vargas.

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References


Websites

http://www.euroqol.org/