To What Extent is Walking Ability Associated with Participation in People after Stroke?

Ilona J.M. de Rooij, MSc,[a,b] Marissa M.R. Riemens, MSc,[a] Michiel Punt, PhD,[c] Jan-Willem G. Meijer, MD, PhD,[a,b,d] Johanna M.A. Visser-Meily, MD, PhD,[b,e] and Ingrid G.L. van de Port, PhD[a]

Objectives: This study aims to 1) identify the relation between walking ability and participation after stroke and 2) explore whether change in walking ability is associated with change in participation over time in community living-people after stroke. *Materials and Methods:* Fifty-two people after stroke were assessed at baseline and after a 6-week gait training intervention. People were included between two weeks and six months after stroke. The Utrecht Scale for Evaluation of Rehabilitation-Participation was used to measure participation. Assessment of walking ability included the six-minute walking test for walking endurance, Timed-up & Go test for functional mobility, Mini Balance Evaluation Systems Test for dynamic balance, and total duration of walking activity per day to measure walking activity. *Results:* At baseline, six-minute walking test, Timed-up & Go test, and Mini Balance Evaluation Systems Test were univariately associated with participation ($P < 0.001$). Backward multiple regression analysis showed that the Mini Balance Evaluation Systems Test independently explained 55.7% of the variance in participation at baseline. Over time, only change in the six-minute walking test was positively associated with change in participation ($R^2 = 0.087$, $P = 0.040$). *Conclusions:* Cross-sectional associations showed that walking ability, and especially dynamic balance, contributes to participation after stroke. Dynamic balance, as underlying variable for walking, was an important independently related factor to participation after stroke which needs attention during rehabilitation. Longitudinally, improvement in walking endurance was significantly associated with improvement in participation, which indicates the relevance of training walking endurance to improve participation after stroke.

Key Words: Stroke—Walking—Participation—Rehabilitation

From the [a]Revant Rehabilitation Centres, Breda, the Netherlands; [b]Center of Excellence for Rehabilitation Medicine, UMC Utrecht Brain Center, University Medical Center Utrecht, and De Hoogstraat Rehabilitation, Utrecht, the Netherlands; [c]Research Group Lifestyle and Health, Utrecht University of Applied Sciences, Utrecht, the Netherlands; [d]De Hoogstraat Rehabilitation, Utrecht, the Netherlands; and [e]Department of Rehabilitation, Physical Therapy Science & Sports, UMC Utrecht Brain Center, University Medical Center Utrecht, the Netherlands.

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Corresponding author at: University Medical Center Utrecht, Department of Rehabilitation, Physical Therapy Science and Sports, PO Box 85500, 3508 GA Utrecht, the Netherlands. E-mail: j.m.a.visser-meily@umcutrecht.nl.

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Introduction

Worldwide, nearly 14 million people suffer from a stroke each year.[1] As a result, people after stroke cope with a wide range of impairments affecting motor, sensory, and cognitive function.[2,3]

Due to these impairments on function level, people after stroke are often restricted in their ability to participate optimally in the community.[4-7] In the International Classification of Functioning, Disability and Health (ICF), participation is defined as "the person's involvement in a life situation".[8] Previous studies have shown that many community-living people after stroke experience restrictions in participation, even on the long term after stroke.[9-12] Participation restrictions limit people regarding work, household, and social and leisure activities.[13] As a result of these restrictions, participation is decreased compared with their life before the stroke, and a majority of the people are dissatisfied with their level of participation.[9] Therefore, improving participation is considered a primary goal in stroke rehabilitation.[14] Better understanding of factors that influence the improvement in participation can help to further direct the content of stroke rehabilitation.

Participation after stroke is shown to be associated with demographic and stroke-related factors (e.g. age, stroke severity) and various stroke-related impairments, including impaired cognitive functioning, emotional functioning, and mobility.[13,15,16] Regarding mobility, regaining sufficient walking ability is a requisite to promote participation in daily life and is a main focus in post-stroke physical therapy.[17] Improving walking ability seems to be even more important as participation restrictions are especially present during activities that involve walking.[13] Cross-sectional studies found that walking ability was generally moderately correlated with participation.[18-23] In addition, four prospective studies found walking ability to be a predictor for short and long-term participation after stroke.[24-27] However, few longitudinal studies are performed, which are important to identify causal relationships between walking ability and participation.[15] Also, little is known about how different aspects of walking ability (e.g. walking endurance, walking speed, and walking activity) are related to participation. Greater understanding of the extent to which walking ability variables and participation are associated over time can help to guide rehabilitation approaches. If improvement in participation appears to be strongly dependent on the improvement in walking ability, rehabilitation might focus even more on improving walking skills. Therefore, this study explored the cross-sectional and longitudinal relation between walking ability and participation in community-living people included between two weeks and six months after stroke. Walking ability was determined with four commonly used outcomes: walking endurance (six-minute walking test), functional mobility (Timed-up & Go test), dynamic balance (Mini Balance Evaluation Systems Test), and walking activity using accelerometer monitoring. The specific aims of this study were:

1) To identify the cross-sectional relation between walking ability and participation at baseline.
2) To explore whether change in walking ability variables is associated with change in participation over time.

We hypothesized that improvement in walking ability is positively associated with improved participation.

Methods

Design and procedure

The data for this study is collected as part of the ViRTAS study,[28] which is an assessor-blinded randomized controlled trial. The ViRTAS study examined the effect of virtual reality gait training on participation in community-living people between two weeks and six months after stroke. Participants followed a six-week training intervention in addition to usual care and rehabilitation. The training intervention consisted of a virtual reality gait training (intervention group) or a non-virtual reality gait training (comparison group) that combined conventional treadmill training and functional gait exercises. Both interventions contained 12 training sessions of 30 minutes. People after stroke were recruited between April 2017 and July 2019.

Assessments for the ViRTAS study took place at baseline (T0), post intervention (T1, 6 weeks), and follow-up (T2, 3 months post intervention). The current study reports data from the assessments at baseline (T0) and post intervention (T1) because most change in walking ability is expected during the six-week intervention. The ViRTAS study protocol has been approved by the Medical Ethics Review Committee of Slotervaart Hospital and Reade, Amsterdam, The Netherlands (P1668, NL59737.048.16) and the study is registered in the Netherlands National Trial Register (NTR6215).

Participants

Participants were enrolled in the ViRTAS study if they (1) were diagnosed with stroke according to the World Health Organization (WHO) definition;[29] (2) suffered from stroke two weeks until six months ago; (3) were able to walk without physical assistance for balance and coordination (i.e. patient may require verbal supervision or stand-by help from a person or may use a walking aid) (Functional Ambulation Category $\geq$ 3); (4) experienced self-perceived constraints with walking in daily life; (5) lived in the community and (6) were in the age from 18 to 80 years. Potential participants were excluded if they (1) had insufficient cognitive skills or understanding of the Dutch language to reliably answer simple questions; (2) suffered from severe visual impairments, severe forms of ataxia, or uncontrolled epileptic seizures; and (3) suffered from orthopedic disorders or other co-morbidities that may limit current walking ability. Written informed consent was obtained from all participants.

Dependent variable

The Restrictions subscale of the Utrecht Scale for Evaluation of Rehabilitation-Participation (USER-P) was used to measure participation.[6] The Restrictions subscale of the USER-P consists of 11 items and evaluates the participation restrictions that a patient experiences in daily life activities. Questions can be answered with NA (not applicable), not possible (1), with assistance (2), with difficulty (3), and without difficulty (4). The not applicable score is recorded in case an item is not relevant or if the restriction is not attributed to the stroke. An example of a question is

"Does your stroke currently limit you in sports or other physical exercise?". The total score of the USER-P Restrictions subscale is calculated by the sum of all items that are applicable, converted into a scale ranging from 0 to 100. A higher score corresponds with less experienced participation restrictions. The USER-P is a valid measure, with satisfactory reproducibility and high responsiveness.[30-32]

Independent variables

Demographic and stroke-related variables were assessed during the baseline assessment. Information about age, gender, type of stroke (ischemic or hemorrhagic), site of stroke (left hemisphere, right hemisphere, or brainstem), and time since stroke onset were taken from the data collected in the randomized controlled trial. Walking ability was measured by three performance tests for walking endurance, functional mobility, and dynamic balance and using daily life activity monitoring. Use of a walking aid or ankle-foot orthosis was permitted during the tests.

Walking endurance

The six-minute walking test (6-MWT) assesses walking endurance by measuring the maximal distance a participant is able to walk in six minutes. Participants were asked to walk at the fastest pace they felt they could maintain for six minutes.[33] The 6-MWT was performed in a 40 m-long corridor with a marking every five meters. Each minute, the participant was told how much time has elapsed or was left. Participants were allowed to stand still or sit on a chair to rest during the test. The 6-MWT is a valid and reliable test in people after stroke.[34]

Functional mobility

The Timed-up & Go test (TUG) is a valid and reliable measure for functional mobility in people after stroke.[35-37] The test measures the time it takes to accomplish the following actions: rise from an armchair, walk three meters, turn around, walk back, and return to sitting.[38] The TUG is performed three times.

Dynamic balance

The Mini Balance Evaluation Systems Test (Mini-BESTest) is a reliable test to assess dynamic balance, including balance during walking.[39-41] The test consists of 14 items divided into four subdomains: anticipatory postural adjustments, reactive postural responses, sensory orientation, and dynamic gait. The items are scored with a scale ranging from 0 (unable to perform or requiring help) to 2 (normal performance). Higher scores indicate a better balance performance. The maximum total score is 28.[42]

Walking activity

Daily-life walking activity was measured by a tri-axial accelerometer (DynaPort MM, McRoberts BV, The Hague, The Netherlands) for five consecutive days. The accelerometer was placed at the middle of the lower back (above or underneath the clothes) using an elastic strap. Walking activity was preferable measured during 24 hours per day, but participants were allowed to take off the accelerometer during the night. A stroke-specific algorithm was used to analyze the walking activity data in Matlab (The MathWorks Inc., Natick, MA, USA).[43] In this study, walking activity was expressed as the total duration of walking activity per day (minutes). This variable was averaged over the days on which the participants wore the accelerometer for at least eight hours. To be included in the analysis, participants had to wear the accelerometer for at least three days and had to walk at least five minutes per day.[44]

Data analysis

Analyses were performed in SPSS version 25 (IBM Corp., Armonk, New York). Change scores between baseline and post-intervention assessments were calculated for the USER-P and the walking ability variables. To determine if both intervention and comparison group from the ViRTAS study could be included in the analyses, we tested for differences in the change scores on the USER-P and walking ability variables between the groups. Normal distribution of the data was checked visually and was assessed based on skewness values > -2 and < 2. Participant characteristics and descriptive outcome measures were described using mean (standard deviation), median (25th, 75th percentile), or n (%).

The USER-P Restrictions items scores were dichotomized to give more insight into the presence of experienced participation restrictions. Scores not possible (1), with assistance (2), and with difficulty (3) were classified as "restrictions" and without difficulty (4) was defined as "no restrictions".[13] The proportion of people after stroke who are restricted is presented per item of the USER-P Restrictions subscale.

Linear regression analyses

The cross-sectional relation between walking ability and participation was assessed at baseline using univariate regression analyses. The USER-P Restrictions score was the dependent variable. Independent variables included the walking ability variables (TUG, 6-MWT, Mini-BESTest, duration of walking activity per day) and demographic and stroke-related variables (age, gender, stroke type, site of stroke, time since stroke). Variables demonstrating P values < 0.20 were included in a linear multiple regression analysis using the backward method to determine which walking ability variables were significantly ($P < 0.05$) related to participation (aim 1).

The association between change in walking ability variables and change in participation was analyzed using univariate regression analyses. Change in USER-P Restrictions score was the dependent variable and change in the walking ability variables (TUG, 6-MWT, Mini-BESTest, duration of walking activity per day) were the independent variables. Backward multiple regression was performed with variables demonstrating P values < 0.20 in the univariate analysis to identify a significant relationship (P < 0.05) between change in walking ability and change in participation (aim 2).

The assumptions for linear regression analyses, including independent and normally distributed errors, linearity, homoscedasticity, and multicollinearity, were checked and fulfilled. Multicollinearity of the independent variables was determined based on VIF < 10, Tolerance > 0.1, and correlations between the variables < 0.7. If the correlation coefficient was equal to or above 0.7, the independent variable with the lowest association with the dependent variable was excluded from the multiple regression analysis. Missing values in the regression analyses were excluded pairwise. Results were considered significant when P values are < 0.05.

Results

In total, 55 participants were included in the ViRTAS study. Three participants were excluded from the analysis of the current study because they did not attend the baseline or post-intervention assessment due to a recurrent stroke (n = 2) or unknown reason (n = 1). Fifty-two participants with complete data for the USER-P Restrictions subscale were included in this study. At baseline, 24 participants lacked Mini-BESTest scores, since this test was introduced after the start of the study.[45] In addition, five participants had no results for duration of walking activity per day because they refused to wear the accelerometer (n = 2), wore the accelerometer less than three days (n = 2), or walked less than five minutes per day (n = 1). At post intervention, results of one TUG, three 6-MWT, one additional Mini-BESTest and five additional measurements for duration of walking activity per day were missing. The change scores of the USER-P and walking ability variables did not significantly differ between the intervention and comparison group, allowing to include both groups in the analysis.

Table 1 illustrates the demographic and stroke-related characteristics of the participants. The study included 36 male and 16 female participants with a mean age of 61.58 (10.48) years and time since stroke onset of 85.15 (37.63) days. Mean USER-P Restrictions score at baseline was 61.65 (17.29), with none of the participants receiving the maximum score (Table 2). At post intervention, three participants scored maximally. Change scores between baseline and post intervention showed a significant improvement in participation. Participation improved in 44 participants (84.6%), deteriorated in three participants (5.8%), and did not change in five (9.6%) participants. Furthermore, all walking ability variables improved significantly between baseline and post intervention (P < 0.05), except for duration of walking activity per day. The decline in duration of walking activity per day is strongly influenced by three participants who walked on average 57 to 69 minutes less per day during the post-intervention assessment. However, there was no justifiable reason to exclude these results in the analyses.

Table 1. *Demographic and stroke-related characteristics of the participants (N = 52).*

Characteristics	Values
Demographic variables	
Age (years)	61.58 (10.48)
Height (m)	1.74 (0.09)
Weight (kg)	78.19 (11.36)
Sex	
Men	36 (69.2)
Women	16 (30.8)
Partner	
Yes	43 (82.7)
No	9 (17.3)
Living situation	
Alone	9 (17.3)
With partner	42 (80.8)
With other family members	1 (1.9)
Stroke-related variables	
Time since stroke (days)	85.15 (37.63)
Type of stroke	
Ischemic	44 (84.6)
Hemorrhagic	8 (15.4)
Site of stroke	
Left hemisphere	27 (51.9)
Right hemisphere	20 (38.5)
Brainstem	5 (9.6)
Previous stroke	
Yes	6 (11.5)
No	46 (88.5)
Functional Ambulation Category score	
FAC 3	3 (5.8)
FAC 4	13 (25.0)
FAC 5	36 (69.2)
Intervention	
Virtual reality gait training	28 (53.8)
Non-virtual reality gait training	24 (46.2)

Note: Values are displayed as mean (SD) or n (%).

Fig. 1 illustrates the proportion of people after stroke who experience restrictions in participation items at baseline and post intervention. At baseline, many people experienced restrictions in items that involve walking, for example housekeeping (90.4%), mobility (88.5%), physical exercise (84.6%), going out (77.1%), and outdoor activities (86.5%). Furthermore, 97.1% of the people who had a job or received education at stroke onset were restricted in performing their work or receiving education. Between baseline and post intervention, the percentage of people who are restricted decreased with 19.5% for housekeeping, 19.8% for mobility, 23.7% for physical exercise, 19.7%

Table 2. *Results of participation and walking ability variables at baseline and post intervention (N = 52).*

Outcome measures	Baseline Mean (SD)	Post intervention Mean (SD)	Change score Mean (SD)	*P* value
Utrecht Scale for Evaluation of Rehabilitation-Participation (0-100)[a]				
Restrictions	61.65 (17.29)	73.49 (16.41)	11.84 (10.99)	< 0.001*
Frequency	27.03 (9.62)	32.75 (7.51)	5.71 (7.24)	< 0.001*
Satisfaction	57.08 (17.19)	69.16 (15.75)	12.08 (12.86)	< 0.001*
Timed-up & Go (s), median (25th, 75th percentile)	10.94 (9.67, 14.05)	10.28 (8.10, 11.53)[†]	-1.36 (-2.72, -0.69)[†]	< 0.001*
Six-minute walking test (m)	358.73 (114.30)	417.29 (118.08)[❖]	57.12 (46.30)[❖]	< 0.001*
Mini Balance Evaluation Systems Test (0-28)	18.64 (5.59)[+]	21.00 (5.81)[•]	2.30 (2.33)[•]	< 0.001*
Total duration of walking activity, per day (min)	45.52 (25.20)[^]	43.99 (22.51)[#]	-2.66 (20.38)[#]	0.403
Wearing time accelerometer (h)	18.15 (3.16)[^]	18.79 (3.03)[#]	0.12 (2.86)[#]	0.795

[a]USER-P: Higher scores indicate better participation outcome.
*Significant difference between baseline and post intervention (6 weeks) based on Paired Samples T-test or Wilcoxon Signed Rank Test ($P < 0.05$).
Deviating participant numbers: [†]n = 51, [❖]n = 49, [^]n = 47, [#]n = 42, [+]n = 28, [•]n = 27.

for going out, and 21.6% for outdoor activities. The item regarding visits to family and friends showed the largest decrease in participation restrictions (28.9%).

Cross-sectional relation between walking ability and participation

Univariate regression analyses showed that time since stroke, TUG, 6-MWT, and Mini-BESTest were significantly associated with the USER-P Restrictions subscale at baseline ($P < 0.20$, Table 3).

In the multiple regression analysis the 6-MWT, the Mini-BESTest, and time since stroke were included. The TUG was not included because of multicollinearity with the 6-MWT and Mini-BESTest. The analysis showed that only the Mini-BESTest was statistically significantly related to the USER-P Restrictions subscale ($P < 0.05$). A one-point increase on the Mini-BESTest was associated with a 2.31 (95% CI 1.48 to 3.14) increase in USER-P Restrictions subscale. In this final model, the Mini-BESTest explained 55.7% of the variance in participation ($F(1,26) = 32.705$, $P < 0.001$).

Relation between change in walking ability and participation over time

Change in TUG, Mini-BESTest, or duration of walking activity per day was not associated with change in participation. A change of one meter on the 6-MWT was

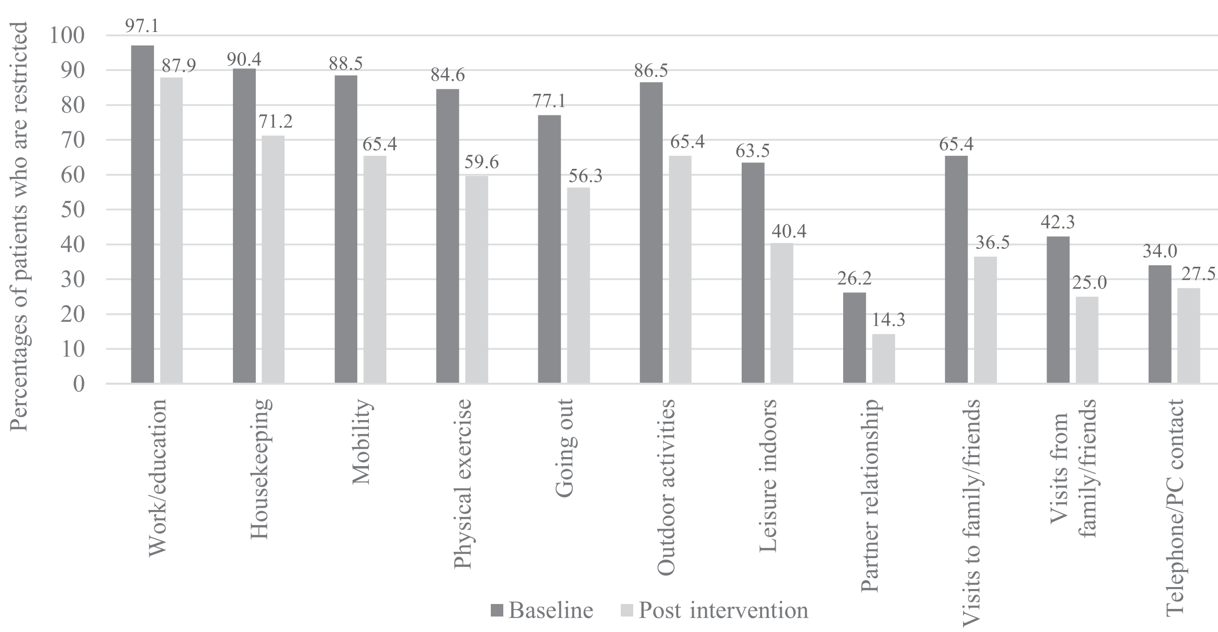

Fig. 1. *The presence of participation restrictions in items of USER-P.*
Note: items include only those participants for which the items are applicable (baseline: work/education n = 35, going out n = 48, partner relationship n = 42 and telephone/PC contact n = 50; post intervention: work/education n = 33, going out n = 48, partner relationship n = 42 and telephone/PC contact n = 51).

Table 3. *Univariate regression analyses: cross-sectional relation between variables at baseline and USER-P Restrictions subscale (N = 52).*

	B	95% CI	β	*P*	R^2
Age	-0.223	-0.687; 0.241	-0.135	0.340	0.018
Gender (male = 0, female = 1)	-4.976	-15.416; 5.464	-0.134	0.343	0.018
Type of stroke (ischemic = 0, hemorrhagic = 1)	0.738	-12.737; 14.214	0.016	0.913	0.000
Site of stroke					0.013
Left vs. right	2.304	-8.084; 12.692	0.065	0.658	
Left vs. brainstem	-4.464	-21.606; 12.679	-0.077	0.603	
Time since stroke	-0.096	-0.224; 0.031	-0.209	0.137*	0.044
TUG	-1.214	-1.854; -0.573	-0.474	< 0.001*	0.225
6-MWT	0.080	0.043; 0.116	0.528	< 0.001*	0.279
Mini-BESTest#	2.307	1.478; 3.136	0.746	< 0.001*	0.557
Total duration of walking activity, per day^	0.064	-0.141; 0.269	0.094	0.530	0.009

TUG: Timed-up & Go; 6-MWT: six-minute walking test; Mini-BESTest: Mini Balance Evaluation Systems Test.
P values are used to determine inclusion in multiple regression analysis.
#n = 28, ^n = 47, *$P < 0.20$.

statistically significantly associated with a change of 0.07 in USER-P Restrictions subscale between baseline and post intervention (Table 4). Change scores on the 6-MWT could explain 8.7% of the variation in change scores in participation between baseline and post intervention ($F(1,47) = 4.472$, $P = 0.040$).

Discussion

This study showed that considerable restrictions in participation were experienced in people within six months after stroke, especially in activities involving walking such as housekeeping, mobility, and physical exercise. At baseline, univariate analyses revealed that walking endurance, functional mobility, and dynamic balance were significantly related to participation. However, only dynamic balance, as determined by the Mini-BESTest, was significantly related to participation in the multiple regression analysis, explaining a high proportion of variance in participation. Both participation and the variables for walking endurance, functional mobility, and dynamic balance improved significantly between baseline and post intervention (6 weeks, $P < 0.05$). Nevertheless, the change score of walking endurance was the only walking variable that was significantly associated with change in participation over time.

At baseline, greater walking endurance, better dynamic balance and functional mobility were univariately associated with a higher level of participation. Walking endurance, as determined by the 6-MWT, could explain 28% of the variation in participation, which is comparable to two studies with people in the chronic stage after stroke. These studies found that the 6-MWT explained respectively 30% and 28% of the variation in participation using the Participation domain of the Stroke Impact Scale.[19,20] Results for functional mobility were less consistent with a previous study in which the TUG explained 40% of the variance in participation.[20] However, in contrast to these previous studies, we assessed the relation between walking ability and participation in people within the first six months after stroke. In the multiple regression analysis, dynamic balance as measured with the Mini-BESTest independently accounted for 55.7% of the explained variance in participation at baseline. Despite the fact that the Mini-BESTest was examined in a lower number of participants, this proportion of explained variance shows that dynamic balance is an important factor related to participation after stroke. The Mini-BESTest consists of four domains of

Table 4. *Univariate regression analyses: association between change in walking ability and change in USER-P Restrictions subscale (N = 52).*

	B	95% CI	β	*P*	R^2
TUG change (per second)†	-0.084	-1.161; 0.994	-0.022	0.877	0.000
6-MWT change (per meter)❖	0.070	0.003; 0.137	0.295	0.040*	0.087
Mini-BESTest change (per one point)#	-0.424	-2.356; 1.508	-0.090	0.655	0.008
Total duration of walking activity per day change (per minute)^	-0.051	-0.223; 0.120	-0.095	0.549	0.009

TUG: Timed-up & Go; 6-MWT: six-minute walking test; Mini-BESTest: Mini Balance Evaluation Systems Test. Change is calculated from baseline to post intervention. *P* values are used to determine inclusion in multiple regression analysis.
Deviating participant numbers: †n = 51, ❖n = 49, #n = 27, ^n = 42, *$P < 0.20$.

dynamic balance tasks, including reactive postural responses and dynamic gait. These domains comprise a range of balance skills that are requisites for walking in daily life. The dynamic gait domain, especially, involves higher level walking ability by assessing the performance of a cognitive dual task and the ability to change walking speed, step over an obstacle, and walk with a pivot turn.

Although dynamic balance was strongly related to participation at baseline and significantly improved over time, longitudinal analysis showed that the change score of the Mini-BESTest was not associated with change in participation. Change in distance walked during the 6-MWT was the only walking variable that was significantly associated with a change in participation between baseline and post intervention (R^2 = 8.7%). These results might suggest that dynamic balance is a basic contributor to participation after stroke. When a sufficient level of dynamic balance is achieved, walking endurance may play a role to further improve participation. The positive association between change in walking endurance and participation suggests that training walking endurance may contribute to improvements in participation. Previous studies already showed that covering long distances can be a challenge for people after stroke, which emphasizes the need to improve walking endurance for daily life participation.[46,47]

While the current study focused on walking ability, other stroke-related impairments or personal and environmental factors may contribute to improvements in participation as well. Previous research showed that participation is a comprehensive and multidimensional concept that is associated with many factors.[14,48] To improve participation, therapists have to be able to understand the factors that influence participation and their relationships so they can focus interventions accordingly.[14] These factors will likely be dependent on the needs and interests of the person after stroke, which stresses the importance of patient-centered rehabilitation. A review of Ezekiel et al.[15] found that associations between biopsychosocial factors and participation varied at different time points post-stroke. Although no conclusions could be drawn about which factors were associated at which time point, our findings suggest that walking ability is a basic contributor to participation in daily life, which is especially important in the early phase of rehabilitation. When walking ability improves later in rehabilitation, participation may become less restricted by physical impairments and more by various degrees of cognitive impairments or personal and environmental factors. In addition, more aids may be used over time to assist people with physical impairments, such as a mobility scooter, taxi services, or help from a family care giver, which can facilitate participation.[49] To individually tailor rehabilitation programs, future studies should further investigate which factors contribute to improvement in participation, thereby considering possible differences in time since stroke.

Some limitations of the present study should be mentioned. First, although the people after stroke included in this study experienced self-perceived constraints with walking, they were living in the community and had a relatively good walking ability. This limits the generalizability of the results to a general stroke population, as there are many people after stroke with more severe walking impairments. Second, analyses of the Mini-BESTest included scores from 28 of the 52 participants because this measure was added after the start of the ViRTAS study. However, none of the participants scored more than three standard deviations from the mean Mini-BESTest score at baseline or post intervention and assumptions for linear regression analysis were fulfilled. Finally, there were many individual differences in the magnitude and direction of the change scores of both walking ability and participation. Improvements in walking ability variables were in some participants accompanied by deteriorations in participation and vice versa. This individual variability might have influenced the associations between change in walking ability and change in participation over time.

In conclusion, people after stroke experienced considerable restrictions in participation and improved their participation during the six-week gait training intervention (i.e. less experienced restrictions). We found that walking ability variables were significantly related to participation. The results suggest that especially dynamic balance is an important basic contributor to participation which needs attention during rehabilitation. In addition, improvement in walking endurance between baseline and post intervention was significantly associated with further improvement in participation, thereby indicating a role for walking endurance to improve participation after stroke.

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Data availability statement

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

Declaration of Competing Interest

The authors report no conflicts of interest.

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