Association between reliance on devices and people for walking and ability to walk community distances among persons with spinal cord injury

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Objective: To identify and describe the frequency of reliance on assistive devices and/or people for ambulating distances and stair climbing.

Design: Survey.

Setting: A total of 429 adults with traumatic spinal cord injury who were able to walk at least 10 m were identified through inpatient and outpatient hospital databases at a specialty hospital in the southeast United States.

Outcome measure: Data were collected using a self-report questionnaire including items related to distances walked and devices used for ambulation.

Results: Participants best able to ambulate community distances were those who were independent with ambulation and those who used one cane or crutch. Reliance on people or use of a walker was associated with walking shorter distances. Regression analysis indicated reliance on devices or people for walking predicted variation in ability to ambulate community distances after controlling for demographic and injury characteristics.

Conclusion: This study suggests that reliance on devices or a person for assistance is important to consider when assessing potential for achieving functional community ambulation.

Keywords: Spinal cord injuries, Incomplete, Walking, Self-help devices, Ambulation, Assistive technology, Pain, Depression

Introduction

In recent years, the portion of persons with neurologically incomplete spinal cord injury (SCI) has increased.¹ A substantial number of those with neurologically incomplete injury and lower-level lesions retain or develop the ability to walk to varying degrees.²⁻⁴ Studies of ambulation training have documented benefits of walking such as increased gait speed and walking endurance,^{5,6} increased lower-extremity strength,⁷ and improved lower-limb coordination.⁸ Improved walking ability has also been linked to increased life satisfaction and physical function.⁹ Those with incomplete SCI also experience significant improvement in physical self-concept scores and decreased depression subsequent to ambulation training.¹⁰

Although ambulation may be achieved for some persons with incomplete SCI, the quality and amount of ambulation may be affected by multiple factors including spasticity, diminished or absent sensation, muscle weakness, and difficulty with timing and sequence of muscle activation.¹¹ Thus, ambulation may be restricted to certain locations such as the home, may be limited to shorter distances, and may require lower-extremity braces or assistive devices such as canes, crutches, and walkers. Assistive devices may be used alone, in combination with lower-extremity braces, or in combination with assistance of another person to achieve optimal walking outcomes.

With recovery of ambulation being a primary goal for many with incomplete SCI, several measures of ambulation have been developed using various distances as criteria. The Walking Index for Spinal Cord Injury (WISCI)¹² is a 21-level hierarchical scale developed specifically for those with incomplete SCI. This

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measure incorporates the use of assistive devices, braces, and assistance of other people to ambulate a *distance of 10 m*. The functional independence measure (FIM) includes criteria for evaluating locomotion and stair climbing and has been used to evaluate mobility after acute SCI.¹³ A score of 1 indicates the need for total assistance (able to perform less than 25% of effort or requires assistance of two people or does not walk 50 ft (15.24 m)) and a score of 7 indicates complete independence (ability to safely walk 150 ft (45.72 m) without assistive devices). Thus, the FIM allows assessment of ambulation for household and short community distances and stairs.

Recent research with older adults indicates that community ambulation requires the ability to walk longer distances than measured by either the WISCI or the FIM. Brown *et al.*¹⁴ found that older adults walked a minimum of 200 m or about 722 ft to visit essential locations such as the bank, doctor's office, and grocery store. Shumway-Cook *et al.*¹⁵ noted that older adults walked an average distance of 300 m (900–1000 ft) when performing activities such as shopping or visiting a health care practitioner. Stair climbing was also identified as being important for community ambulation for this group. Andrews *et al.*¹⁶ found that the shortest mean distance required for community ambulation was about 66 m (216 ft) for ambulation to physician offices and the longest distance was almost 677 m (2221 ft) for ambulation in club warehouses.

Although numerous factors are important for community ambulation, most clinical tools used for those with incomplete SCI emphasize the use of braces, assistive devices, assistance of other people, or a combination thereof, and assess walking ability over household or short community distances.^{12,13,17} However, it has not been determined whether the use of braces, assistive devices, and assistance of others may be associated with successful community ambulation, which requires the ability to walk longer distances and often to climb stairs. The purpose of this study was as follows: (1) identify frequency of reliance on devices and people for ambulation and (2) identify the association between reliance on devices and people for ambulation and ability to walk functional distances and climb stairs. Unlike the more typical emphasis on the time immediately after SCI onset, we assess ambulation among a community sample averaging 9.8 years post-injury. Therefore, the results reflect relationships between reliance on devices and people for assistance with ability to walk distances and climb stairs among participants who have lived a substantial amount of time with SCI.

Methods

Participants

With approval from the Institutional Review Board, participants were identified through three different sources of records at a large specialty hospital in the southeastern United States: (1) SCI Model Systems patient database, (2) Model Systems registry, and (3) outpatient directory. Participants met three inclusion criteria: (1) traumatic SCI, (2) 18 or older at assessment, and (3) minimum of 1 year post-injury. Of the 2480 potential participants meeting these criteria, 1549 returned the survey (62.5% response rate). For these specific analyses, only participants who reported that they were able to walk at least 10 m (~33 ft) were included ($n = 429$).

Just over two-thirds of the sample were male (68.2%), and 74.6% were white. Average age at injury was 36.3 ± 14.5 (range 12.7–77.3) years, and average number of years since injury was 9.8 ± 6.9 (range 1.0–36.6). Just under half (48.7%) had non-cervical injuries, 25.9% had low cervical injuries (C5–C8), and 25.4% had high cervical injuries (C1–C4).

Procedures

Prior to receiving an initial packet of study materials, participants were sent preliminary letters describing the intended research and the method by which they would receive the materials. The initial packet included a letter describing the study which served as implied consent, as well as the survey to be completed and returned by mail. A second mailing was sent if the initial survey was not returned. If the participant did not respond, a phone call was made to engage in active conversation with the potential participant. A third mailing was then used for those who consented by phone to receive another packet. Participants received \$50 in remuneration.

Measures

Specific measures used were related to walking distances and devices used for ambulation. Participants were asked to answer a series of questions about the distances they are able to walk, with the following milestones: (1) 10 m, (2) 150 ft (45.72 m), (3) 1000 ft (304.8 m). These distances were chosen as they correspond with distances on the WISCI (10 m),¹⁷ the FIM (150 ft),¹³ and identified distances required for community ambulation (1000 ft).¹⁵ To increase the reliability of self-report, the following qualifiers were used: 'Are you able to walk 10 m (*10 m is just more than 10 yards or almost 33 ft*)?'; 'Are you able to walk 150 ft (*half a football field*)?'; and 'Are you able to walk 1000 ft (*over 3*

football fields)? Participants were also asked whether they could walk up a flight of 12–14 stairs.

In addition to questions about distances walked, we asked about devices used to assist in walking. Participants were asked to respond to all questions about devices such as: walker (yes, no), crutches (none, 1, or 2), canes (none, 1, or 2), short leg braces (yes, no), and long leg braces (yes, no). Additionally, participants were asked if they required assistance from people to walk.

Analyses

SAS version 9.2 was used for all analyses. Descriptive statistics were generated for assessing both participant characteristics and the use of devices with the ability to ambulate distances and stairs. χ^2 -tests were used for categorical variables and analysis of variance for continuous variables.

The relationship of walking distance with devices was assessed through polychotomous generalized logistic regression models. Our outcome, walking distance, was categorized as less than 150 ft (45.72 m), 150–1000 ft (45.72–304.8 m), and more than 1000 ft (304.8 m). Walking less than 150 ft was used as the reference. We assessed these relationships using a two-stage approach. First, a base model was created including only demographic (gender, race, age, and years post-injury) and injury characteristics (injury level). Second, all devices (including reliance on people) were added to the base model simultaneously (only results from the second stage are presented in the results). Odds ratios and 95% confidence intervals are presented. The max rescaled R^2 was compared for the two regression analyses to look at improvement in the second model

over the base model with only demographic and injury characteristics.

Results

Descriptive

Just over half of the participants (53.4%) could walk 1000 ft (304.8 m) or more; 26.9% could walk 150 ft (45.72 m) but not 1000 ft (304.8 m), and the remaining 20.7% reported being able to walk 10 m but not 150 ft (45.72 m). In all, 72.1% reported being able to walk a flight of 12–14 stairs. Just over a third of the participants (33.4%) reported not using any devices or people to assist in ambulation, 30.2% reported using one device or personal assistance, 22.7% reported using two devices or personal assistance, and 13.7% reported using three or more devices or personal assistance. The most frequently reported device used was the cane (29.9%), followed by a walker (27.7%), short leg braces (22.6%), crutches (19.5%), long leg braces (12.5%), and people (11.2%). When combining canes and crutches, 29.9% used one cane or crutch, and 14.5% used two canes or crutches.

Except for chronological age and race, demographic and injury variables were not significantly related to maximum walking distance and ability to climb a flight of stairs (Table 1). Persons who were able to walk further and able to climb stairs were younger. Also, white participants were more likely to be able to walk 1000 ft or more than non-white participants.

Reliance on devices and people: relationship with distances and stair climbing

When looking at specific devices and their relationship with maximum walking distance, participants who

Table 1 Characteristics of participants by maximum walking distance and ability to climb a flight of stairs

Specific devices	Maximum walking distance			P value	Able to walk stairs		P value*
	Row%				Row%		
	10 m	150 ft	1000 ft		Yes	No	
Gender							
Male	19.1	28.9	52.0	0.2797	72.9	27.1	0.5862
Female	24.1	22.6	53.3		70.4	29.6	
Race							
White	20.9	23.1	55.9	0.0166	72.1	28.3	0.9422
Non-white	20.2	36.7	43.1		71.7	27.9	
Injury severity							
C1–C4	14.3	28.5	56.2	0.2827	77.9	22.1	0.2987
C5–C8	26.2	22.4	51.4		71.2	28.9	
Non-cervical	20.9	27.4	51.7		69.5	30.5	
	m (sd)				m (sd)		
Age	52.1 (14.5)	45.9 (14.7)	43.8 (14.2)	<0.0001	45.0 (14.2)	48.6 (9.7)	0.0254
Years post-injury	11.7 (8.0)	8.6 (6.8)	9.7 (6.3)	0.1765	9.8 (6.7)	9.7 (7.3)	0.8216

*P value from χ^2 -tests for categorical variables and analysis of variance for continuous variables.

used assistance from another person to walk had the lowest percentage of those who could ambulate 1000 ft (304.8 m) or more (12.5%), followed by those who used a walker (15.8%, Table 2). A higher portion of those with short-leg braces (35.4%) reported ability to walk 1000 ft (304.8 m) or more compared with those who used long-leg braces (18.7%). Among the devices, persons who used one cane or crutch were the most likely to be able to walk 1000 ft (304.8 m). Participants who used assistance from another person and those who used a walker for ambulation were least likely to be able to climb a flight of stairs. Participants who used one cane or crutch were the most likely to climb a flight of stairs.

Regression

When only accounting for demographic and injury characteristics the max rescaled R^2 was 0.11. The addition of the actual responses to the items on reliance on devices and people further increased the max-rescaled R^2 to 0.51.

Assistive devices were significantly related to walking distance after controlling for demographic factors and injury characteristics (Table 3). When looking at devices, participants who did not use braces were five times as likely to ambulate community distances (1000+ ft) compared with those who used braces. Among those who used cane(s) or crutch(es), those who used no cane or crutch were more likely to report being able to walk 1000+ ft compared with those who

used two canes/crutches, but there were no differences in ambulatory distance between those who used one vs. two canes/crutches. Lastly, not using a walker was associated with increased odds of walking both 150–999 and 1000+ ft.

Discussion

This study examined the association between reliance on devices and people and the ability to ambulate distances and climb stairs for ambulatory persons with SCI. The results are helpful for rehabilitation professionals to better understand community ambulation of distances that differentiate 150 and 1000 ft. By identifying the relationship of reliance on other people and devices for assistance, rehabilitation professionals are better able to assess those with SCI and understand the limits of ambulation.

As would be expected, those who did not rely on any type of device or assistance from others reported the greatest likelihood of ability to transverse the longest distances. Reliance on a single cane or crutch was associated with longer distances than when bilateral devices were required. The probability of functional community distances, as defined by 1000 ft or more, was particularly low for those who required walkers or were dependent on others for assistance.

Rehabilitation professionals in clinical settings should work to help those who are ambulatory understand the limits of ambulation and evaluate whether ambulation is functional. This may vary by setting, such as in the

Table 2 Relationship among participants of specific devices with maximum walking distance and ability to climb a flight of stairs

Specific devices	Maximum walking distance			P value	Stairs	
	Row%				Row% %Yes	P value*
	10 m	150 ft	1000 ft			
Walker						
Yes	49.1	35.1	15.8	<0.0001	30.3	<0.0001
No	8.9	24.2	67.0		87.8	
Cane/crutches						
2	29.0	45.2	25.8	<0.0001	63.8	0.1617
1	18.0	36.9	46.1		77.2	
None	19.3	17.2	63.5		71.6	
Braces						
Yes	40.0	30.3	29.7	<0.0001	53.9	<0.0001
No	18.1	23.2	58.7		80.8	
Short-leg braces						
Yes	33.3	31.3	35.4	<0.0001	61.7	0.0064
No	15.9	26.2	57.9		75.9	
Long-leg braces						
Yes	41.5	39.6	18.7	<0.0001	38.0	<0.0001
No	17.0	25.1	57.8		77.1	
People						
Yes	60.4	27.1	12.5	<0.0001	31.1	<0.0001
No	15.3	25.9	57.8		77.3	

*P values are for χ^2 -tests.

Table 3 Regression models of walking distance with individual walking devices

Characteristics/devices	Maximum walking distance		<i>P</i> value***
	150–999 ft*	≥1000 ft**	
	Odds ratios (95% confidence intervals)		
Race (vs. white)			0.0178
Non-white	1.70 (0.77–3.75)	0.70 (0.30–1.63)	
Gender (vs. male)			0.7634
Female	0.78 (0.37–1.62)	0.92 (0.44–1.93)	
Injury severity (vs. non-cervical)			0.7420
C1–C4	1.33 (0.52–3.41)	1.04 (0.40–2.70)	
C5–C8	0.72 (0.29–1.75)	0.86 (0.35–2.11)	
Age	0.96 (0.94–0.99)	0.95 (0.92–0.97)	0.0003
Years since injury	0.94 (0.90–0.99)	0.96 (0.91–1.01)	0.0672
Walker (no vs. yes)	3.12 (1.42–6.85)	19.96 (8.42–47.31)	<0.0001
Cane/crutch (vs. 2)			<0.0001
1	0.89 (0.33–2.40)	1.74 (0.58–5.22)	
0	0.48 (0.20–1.19)	3.57 (1.28–9.96)	
Braces (no vs. yes)	2.19 (1.03–4.66)	4.88 (2.21–10.79)	0.0004
Person (no vs. yes)	2.64 (1.07–6.54)	5.40 (1.73–16.87)	0.0083

*45.72–304.4 m.

**≥304.5 m.

****P* values are from the polychotomous logistic regression model. Maximum rescaled $R^2 = 0.51$.

home or in the community. It has already been demonstrated that reliance on others for ambulation is associated with greater pain interference.¹⁸ Furthermore, reliance on others is associated with higher depression scores, although this is also mediated by pain interference.¹⁹ Lastly, those who utilize prescription pain or spasticity medication are more limited in terms of distances.²⁰ The current findings suggest that rehabilitation professionals need to help the patient closely monitor their ambulation, make appropriate choices for devices that minimize pain and pain interference, and even consider wheelchair options under more limiting circumstances (i.e. relying on others to ambulate).

Limitations

Several limitations must be kept in mind when interpreting the results of the study. First, reports of utilization of devices, reliance on people for help, and ability to both walk distances and climb stairs are all based on self-report. Although this may add some degree of reporting bias, the descriptive qualifiers for distances walked should limit bias. Self-report was necessary with such a large participant sample. Second, all data are cross-sectional. Therefore, we do not have any information on how ambulatory patterns change over time in relation to ability to walk distances. We also do not know if the ambulatory pattern is stable, may have changed in the recent past, or may be changing in the future. Third, the participant sample averaged 9.8 years post-injury at assessment. This is both a strength and a limitation. The findings are clearly generalized

to those having lived a long time with SCI, but they may not generalize as well for those with newer injuries (participants in our study were at least 1 year post-injury). Fourth, it was beyond our scope to identify the underlying mechanisms or mediating factors relating devices to distances. Factors such as pain may be important mediators that require further investigation. Lastly, our findings do not provide any evidence for or against the benefits of interventions to improve ambulation.

Future research

Additional research is needed to identify how variations in ambulation are related to health and quality of life. Previous research has identified associations between independence and ambulation and important outcomes, including pain interference and depression^{18,19} but was limited in the assessment of quality of ambulation. The current findings lay the foundation for such studies by delineating relationships between reliance on devices and people to ambulate distances. Longitudinal research is also needed in identifying change in ambulation over time.

Conclusion

The extent to which individuals with SCI ambulate distances of 1000 ft or more varies dramatically depending on the amount they rely on devices or other people for assistance. The greatest distances are traveled by those who either rely on no devices/people or those who rely on a single cane or crutch; whereas those who rely

on people or walkers are least likely to ambulate community distances.

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