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Association of self-reported cognitive concerns with mobility in people with lower limb loss

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Abstract

Purpose—This study tested the hypothesis that greater perceived cognitive concerns are associated with worse mobility in a cohort of prosthesis users with lower limb loss (LLL).

Method—We performed a secondary analysis of cross-sectional self-report data from a volunteer sample of people with LLL due to dysvascular and non-dysvascular causes. Perceived cognitive difficulties were assessed using the Quality of Life in Neurological Disorders Applied Cognition – General Concerns (Neuro-QoL ACGC). Mobility was measured with the Activities-Specific Balance Confidence Scale (ABC) and the Prosthetic Limb Users Survey of Mobility (PLUS-M). Simple linear regressions examined univariate relationships between cognitive concerns and mobility. Multiple linear regression analyses included demographic and amputation-related variables that could influence this relationship.

Results—Analysis of data from 1291 people with LLL demonstrated that greater cognitive concerns, measured by the Neuro-QoL ACGC, were associated with poorer perceived mobility, measured by both ABC and PLUS-M instruments. This relationship remained statistically significant after adjusting for demographic and amputation-related factors.

Conclusions—These results suggest that greater cognitive concerns are associated with worse mobility among a broad range of people with LLL. An improved understanding of this relationship is critical for optimizing rehabilitation outcomes for this population.

Keywords

Artificial limbs; amputation; cognition disorders; mobility limitation; regression analysis; self report; rehabilitation

INTRODUCTION

Rehabilitation for people with lower limb loss (LLL) has traditionally focused on the clinical management of a person's physical impairments and subsequent functional mobility

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limitations. People with LLL experience marked mobility restrictions at six months after amputation compared to before amputation [1], with deficits in functional household and community mobility persisting at one year, particularly in those >50 years of age or those with transfemoral amputation [2]. An emphasis on improving mobility through surgical, therapeutic, and/or prosthetic interventions is important because better mobility is associated with a range of desirable rehabilitation outcomes in people with LLL, including reduced frequency of falls [3], higher return to work rates [4], increased job satisfaction [5], improved social [6] and community activity [7], and greater health-related quality of life [8].

There is also a growing awareness of the need to consider cognition in the clinical management of people with LLL, as declines in cognitive function may also adversely affect important rehabilitation outcomes. For example, worse cognition has been associated with reduced ability to perform routine self-care activities [9] and limited use of a prosthesis [10] in this population. Specific links between poor cognitive functioning and mobility limitations have also been observed in people with LLL who are in the early stages of post-amputation rehabilitation [11–14]. A relationship between cognition and mobility in people with LLL may be mediated directly by the disease processes leading to amputation. For example, research suggests that type 2 diabetes is a risk factor for age-related cognitive decline and dementia [15], and it is estimated that diabetes contributes to over 55% of all major lower limb amputations [16]. Indirectly, health symptoms such as depression could adversely affect both cognitive function and walking, thus impacting the relationship between cognition and mobility in people with LLL.

While available evidence suggests a potentially important association between cognition and mobility in people with LLL, studies to date are limited in several ways. First, these studies included predominately people with LLL from dysvascular causes (i.e., 60–100% of participants) [11–14]. While it is estimated that 80% of major lower limb amputations are due to dysvascular disease [16], it is unclear if a relationship between cognition and mobility generalizes to people with non-dysvascular amputation etiologies, such as trauma, infection, or tumor. Second, participants in these studies were drawn from clinical samples of people undergoing post-amputation rehabilitation (i.e., those within a year of their amputation[s]). It is unknown whether a relationship between cognition and mobility is a transient phenomenon or persists in established prosthesis users beyond the first year after amputation. Lastly prior studies included relatively small samples (i.e., fewer than 100 people with LLL) [11–14], which could limit the ability to adjust for confounding covariates when modeling the relationship between cognition and mobility. Thus, it is unclear if associations between cognition and mobility are present in larger populations that include established prosthesis users with amputation(s) due to varied etiologies.

The aim of this study was therefore to examine the association between perceived cognitive concerns and mobility in a large, well-characterized cohort of prosthesis users with LLL from both dysvascular and non-dysvascular causes. We hypothesized that self-report of cognitive difficulties would be associated with worse mobility in people with LLL. A significant relationship between cognition and mobility in people with LLL would reinforce the importance of assessing cognition in people with LLL in order to tailor rehabilitative interventions (e.g., prosthetic care or therapy) to their cognitive abilities.

METHODS

Study design

A secondary analysis of cross-sectional, self-report data collected from people with unilateral or bilateral LLL was conducted to evaluate the association between cognition and mobility. Data included in this analysis were collected between December 2011 and August 2014, as part of a study to develop the Prosthetic Limb Users Survey of Mobility (PLUS-M) [17].

Participants

Participants were recruited using magazine advertisements, listserv postings, targeted mailings, consumer organization websites, and flyers posted nationwide in private, hospital-based, and institutional clinics. Recruitment targets included a minimum of 250 people from each of the following subgroups of people with LLL: (1) unilateral below knee amputation due to trauma, (2) unilateral below knee amputation due to dysvascular complications; (3) unilateral above knee amputation due to trauma, (4) unilateral above knee amputation due to dysvascular complications, and (5) bilateral amputation resulting from trauma, dysvascular complications, tumor, congenital abnormality, or infection. Participants were required to report that they: (1) were 18 years or older; (2) had unilateral or bilateral LLL below the hip and at or above the ankle, resulting from trauma, dysvascular complications, or, in the bilateral sample only, tumor, congenital abnormality, or infection; (3) had no other amputations; (4) regularly used lower limb prostheses to walk; and (5) were able to read, write, and understand English. All study procedures were reviewed and approved in accordance with institutional review board procedures.

Data collection

Surveys were used to collect data from study participants. Surveys were made available via computer or paper according to participant preference. Computerized surveys were administered using the Assessment Center (Chicago, IL), a secure online data collection system [18]. Paper surveys were mailed directly to participants and returned using a prepaid return envelope. Paper survey responses were double-entered into a Microsoft Access (Redmond, WA) database to mitigate data-entry errors [19]. All surveys were screened to ensure that responses were complete and consistent, and participants were contacted as needed to clarify missing, inconsistent, or invalid responses. The survey comprised questions pertaining to demographic and amputation-related characteristics, cognitive concerns, and mobility.

Demographic and amputation-related characteristics

Participants were asked to provide basic demographic information such as age, sex, education, and income level. A self-reported version of the Charlson Comorbidity Index developed by Chaudhry et al. [20] was used to document presence of co-morbid health conditions. Depression was assessed as part of the Patient Reported Outcomes Measurement Information System (PROMIS)-29 v1.0 using the 4-item Depression short form (PROMIS-D) [21, 22]. We also collected information on amputation-related characteristics, such as

date of amputation(s), amputation etiology (trauma, dysvascular complications, tumor, congenital abnormality, or infection), and amputation level (below knee: ankle disarticulation [Symes] or transtibial; and above knee: knee disarticulation or transfemoral). Persons with bilateral amputations were categorized into the most proximal level of amputation in either leg.

Cognitive concerns

Perceived difficulties with cognitive abilities such as memory, attention, and decision-making were assessed using the 8-Item Quality of Life in Neurological Disorders Applied Cognition – General Concerns (Neuro-QoL ACGC) v1.0 short form [23]. This self-report measure is part of a larger set of instruments developed to assess health-related quality of life in adults and children with neurologic disorders [24]. Neuro-QoL ACGC has been used previously to study perceived cognitive abilities in a variety of clinical populations, including people with multiple sclerosis [25], stroke [26], and people with LLL [27]. The Neuro-QoL ACGC 8-item short form consists of questions that ask respondents about the frequency of cognitive concerns (e.g., problems with memory, concentration, thinking clearly) they have experienced over the previous seven days. Neuro-QoL instruments are scored on a T-metric, where the mean score and standard deviation of the development sample ($n=533$ people representative of the general U.S. population) are 50 and 10, respectively [23]. Higher scores indicate fewer cognitive concerns.

Mobility

Mobility was measured with two self-report instruments, the Activities-Specific Balance Confidence Scale (ABC) and the Prosthetic Limb Users Survey of Mobility (PLUS-M). The ABC is a 16-item self-report measure that asks people to rate their confidence in performing various ambulatory activities [28]. The ABC shows excellent internal consistency (Chronbach $\alpha=0.95$) [29], excellent test-retest reliability ($ICC(1,1)=0.91$ - $ICC(3,1)=0.94$ over repeated administrations) [29, 30], good convergent construct validity relative to performance-based instruments ($r=0.72$ with the 2-Minute Walk Test and $r=-0.70$ with the Timed Up and Go) [29], and excellent known-groups construct validity (ABC scores were statistically significantly different among prosthesis users classified by their clinician-assigned Medicare functional level) [31] in people with LLL. A revised version of the ABC using a 5-point ordinal scale [32] was administered in this study. The ABC produces a mean summary score that ranges from 0 to 4. Higher ABC scores indicate better balance confidence during ambulatory activities.

Mobility was also measured using the PLUS-M v1.2 short form, a 12-item self-report instrument developed to measure perceived mobility with a prosthesis in people with LLL [17]. PLUS-M scores exhibit good reliability across a wide range of mobility (reliability <0.9 from $-3SD$ to $2SD$) [17], excellent test-retest reliability ($ICC(3,1)=0.96$ over repeated administrations) [30], good convergent construct validity when compared to performance-based mobility measures ($r_s=0.54$ with the Amputee Mobility Predictor and $r_s=-0.56$ with the Timed Up and Go) [31], and excellent known-groups construct validity (PLUS-M scores were significantly different among prosthesis users classified by Medicare functional level) [31]. PLUS-M items ask respondents to rate their perceived ability to carry out actions that

require the use of both lower limbs, ranging from household ambulation to outdoor recreational activities. PLUS-M is scored on a T-metric, where the mean score and SD of the development sample (n=1091 people with LLL) are 50 and 10, respectively [17]. Higher PLUS-M T-scores indicate better mobility.

Statistical analysis

Descriptive statistics were used to characterize the sample using frequencies, means, and standard deviations (SD). Simple linear regressions were conducted to examine the univariate relationships between cognitive concerns and each measure of mobility. Neuro-QoL ACGC T-score was included as the independent variable; ABC score and PLUS-M T-score were included as dependent variables. Multiple linear regression analyses were subsequently performed (i.e., one for each model), and included additional independent variables (i.e., select demographic and amputation-related variables from the existing dataset) that could influence the relationship between cognition and mobility. Depression was included in multiple regression models because of the well-established association between self-reported cognition and depression [25, 33, 34]. Age, PROMIS-D T-score, years since first amputation, Neuro-QoL ACGC T-score, ABC score, and PLUS-M T-score were entered as continuous variables. Education, individual income, and number of comorbidities (0, 1, 2, 3+) were entered as ordinal variables. Sex (1=male or 2=female), amputation etiology (1=non-dysvascular or 2=dysvascular), amputation level (1=above knee or 2=below knee), and number of affected limbs (1=unilateral or 2=bilateral amputation) were entered as binary variables. Demographic and amputation-related variables were entered into the model first, and cognition was entered last to examine the relationship between cognition and mobility after adjusting for these demographic and clinical characteristics. Post-hoc multiple linear regression analyses were performed based on etiology subgroups (non-dysvascular, dysvascular), with adjustment for remaining variables, to determine if the relationship between cognition and mobility differed based on amputation etiology. SAS software v9.3 (SAS Institute Inc., Cary, North Carolina) and PASW Statistics v18.0 for Windows (SPSS, Inc., Chicago, Illinois) were used for all analyses.

RESULTS

Participants

Completed surveys were obtained from a total of 1291 people with LLL (87% of surveys completed via computer, 13% completed via paper), including 1086 people with unilateral amputation and 205 people with bilateral amputation (tables 1 and 2). The total sample had a mean (SD) age of 54.3 (13.7) years at the time of the survey, with 904 (70.0%) male participants. The mean age at the time of amputation was 42.2 (18.0) years, with 64.9% having below knee amputation and 35.1% having above knee amputation. The majority of participants reported amputation(s) resulting from non-dysvascular causes (57.7%). Of those with non-dysvascular etiologies, 89.4% had amputations due to trauma, 5.9% had amputation due to infection, 2.7% had amputation due to congenital abnormalities, and 2.0% had amputation due to >1 etiology. At the time they were surveyed, participants were, on average, 12.2 (14.1) years post amputation, with 90% of the sample at least 1-year post-amputation. Participants reported using their prosthesis or prostheses for an average of 12.3

(4.1) hours per day. Sixty percent of the study sample reported a Neuro-QoL ACGC T-score 0.5 SD or more below the mean, and 20% of the sample reported a score 1.0 SD or more below the mean, reflecting meaningful impairments in cognitive concerns relative to the general population [35]. Demographic and amputation-related variables were missing for <3% of participants, resulting in a slightly smaller sample (n=1254) in the multiple regression models compared to the simple regression models.

Association between cognitive concerns and mobility

In the simple regression model, greater cognitive concerns were statistically significantly associated with poorer mobility as measured by the ABC ($\beta=0.35$, $P<0.0001$; adjusted $R^2=0.12$; table 3). After adjusting for covariates in the multiple regression model, greater cognitive concerns remained significantly associated with lower ABC scores ($\beta=0.14$, $P<0.0001$; full model adjusted $R^2=0.47$; table 3). Lower ABC scores were also significantly associated with all other variables entered in the model except education level. The relationship between lower ABC scores and more depression was the strongest ($\beta=-0.38$, $P<0.0001$), followed by the relationships between lower ABC scores and older age ($\beta=-0.22$, $P<0.0001$), above knee level of amputation ($\beta=0.16$, $P<0.0001$), and greater cognitive concerns. In post-hoc analyses separated by etiology, greater cognitive concerns were significantly associated with lower ABC scores in both the non-dysvascular (n=722; $\beta=0.16$, $P<0.0001$; full model adjusted $R^2=0.44$) and dysvascular (n=532; $\beta=0.13$, $P=0.001$; full model adjusted $R^2=0.36$) subgroups.

Greater cognitive concerns were also statistically significantly associated with worse mobility as measured by PLUS-M in both the simple ($\beta=0.32$, $P<0.0001$; adjusted $R^2=0.10$) and multiple regression models ($\beta=0.14$, $P<0.0002$; full model adjusted $R^2=0.47$; table 4). Lower PLUS-M scores were significantly associated with all other variables except education level. The relationship between PLUS-M scores and depression was the strongest ($\beta=-0.30$, $P<0.0001$), followed by the relationships between lower PLUS-M scores and older age ($\beta=-0.27$, $P<0.0001$), above knee level of amputation ($\beta=0.24$, $P<0.0001$), shorter time since amputation ($\beta=0.15$, $P<0.0001$), and greater cognitive concerns. In post-hoc analyses separated by etiology, greater cognitive concerns were significantly associated with lower PLUS-M scores in both the non-dysvascular (n=722; $\beta=0.17$, $P<0.0001$; full model adjusted $R^2=0.43$) and dysvascular (n=532; $\beta=0.13$, $P=0.0009$; full model adjusted $R^2=0.36$) subgroups.

DISCUSSION

The aim of this study was to examine the association of cognition and mobility in a large, well-characterized cohort of people with LLL due to both dysvascular and non-dysvascular causes to test the hypothesis that greater cognitive concerns would be associated with worse mobility in this population. Results of this secondary analysis indicate that greater perceived cognitive concerns, as measured by the Neuro-QoL ACGC, are associated with poorer perceived mobility, as measured by both the ABC and PLUS-M instruments. The relationship between cognition and mobility remained statistically significant even when adjusting for both demographic factors (e.g., age, sex, education, income, number of

comorbidities, depression) and amputation-related factors (e.g., etiology, level, time since amputation, number of affected limbs).

Cognitive deficits, ranging from minor impairment to dementia, are common in people with LLL [36]. A recent review examined cognitive functioning in people with LLL due primarily to dysvascular disease and noted that greater than 10% of people were diagnosed with dementia in LLL studies, compared to the 5–10% expected in the general population [36]. However, Neuro-QoL ACGC data from a large subset (n=1086) of the current sample demonstrated that the report of cognitive concerns was not differentially affected by amputation etiology [27]. In the current study, 60% of participants reported cognitive concerns, as measured by the Neuro-QoL ACGC, that were greater than the U.S. general population (i.e., 0.5 SD or more below the mean T-score). It is important to understand the presence and prevalence of cognitive deficits among people with LLL because poorer cognitive functioning may negatively impact important rehabilitation outcomes, such as prosthetic fitting, prosthetic use, and independent functioning [10, 37–39]. The results of the current study also suggest that the presence of cognitive concerns may adversely affect home and community mobility.

Consistent with previous research [11–14], the current findings support an association between cognition and mobility in people with LLL. Prior research examining this relationship has used the Timed Up and Go [12, 13], a performance-based measure of mobility, and the Locomotor Capabilities Index [11, 14], a self-reported measure of mobility. The current study incorporated two self-reported measures of mobility, the ABC and the PLUS-M. The ABC assesses respondents' confidence that they will not lose their balance while performing various ambulatory activities, such as walking around the house, sweeping the floor, or stepping onto or off an escalator [28, 32]. The PLUS-M asks respondents to rate their level of difficulty performing mobility tasks such as stepping up and down curbs, walking on an unlit street or sidewalk, or walking down a steep gravel driveway [17]. The assessment of complex walking tasks and/or environments is critical to understanding mobility in people with LLL, as they often demonstrate physical limitations when negotiating complex environments such as obstacle crossing, hills, and stairs [40–43]. A strength of the mobility measures used in the current study is that they assess a broad range of mobility tasks, from simple tasks required for household ambulation to complex tasks and environments necessary for engagement in outdoor recreational activities. Future research incorporating a range of performance-based measures in a broad sample of people with LLL would further support the association between cognition and mobility in this population.

The current study also expands on the existing body of knowledge examining the relationship between cognition and mobility in people with LLL in several important ways. First, prior work has included primarily individuals with amputation due to dysvascular etiologies, whereas over half of the sample in the current study had amputation due to non-dysvascular causes such as trauma, infection, or tumor. Evidence generalizable to people with LLL from both dysvascular and non-dysvascular etiologies is important, as more than 120,000 of the 620,000 people with major LLL in the U.S. have experienced amputation from non-dysvascular causes [16]. Results of the present study demonstrate that the relationship between cognition and mobility in people with LLL is not explained solely by

amputation etiology, as post-hoc analyses demonstrated an association between greater cognitive concerns and poorer mobility in both non-dysvascular and dysvascular subgroups. Second, previous work was focused on people who were in the early stages of rehabilitation after amputation surgery. It is possible that cognitive deficits associated with limb amputation or early rehabilitation procedures could resolve over time. The current study did not limit its sample to those actively engaged in rehabilitation, but included established prosthesis users who were, on average, 12 years post-amputation. These results demonstrate that a relationship between cognition and mobility persists in people with LLL who are beyond the first year after amputation. As the large majority (92% or more) of people with LLL receive prosthetic care beyond the first year after amputation [44, 45], knowledge of clinical characteristics, such as cognition, that may affect prosthetic outcomes like mobility seems particularly relevant. Finally, previous studies included relatively small samples that limited the ability to adjust for potential confounding factors when modeling the relationship between cognition and mobility. The large, well-characterized sample used in the current study allowed us to statistically adjust our models to account for a number of demographic and amputation-related variables that may have influenced this relationship. That a relationship between cognition and mobility persisted, even when adjusting for demographic and clinical characteristics, strengthens our confidence that declines in cognitive functioning may adversely affect mobility in people with LLL.

Several factors could contribute to a relationship between cognition and mobility in people with LLL. Amputation etiology may directly affect both cognition and mobility. For example, dysvascular disease is associated with both cognitive decline [15] and limb loss [16]. Similarly, traumatic events that can lead to LLL, such as motor vehicle accidents or falls [46] can also result in traumatic brain injury that may impact cognition. Health symptoms common in people with LLL, such as depression [47] could also impact both cognitive function and mobility. Finally, a relationship between cognition and mobility may reflect a more general role of cognitive processes in the control of walking. Associations between cognition and mobility are not unique to the population with LLL and have been demonstrated in older adult [48] and clinical populations, including people with Type II diabetes mellitus [49] and people with mild cognitive impairment [50]. The role of cognition in the control of walking may be particularly important with more complex walking tasks or environments, such as those required for functional mobility in home and community environments.

A number of limitations of this research should be taken into consideration. First, the cross-sectional nature of this study design cannot be used to confirm a causal relationship between cognition and mobility. Second, the data used for this analysis were obtained from self-report measures of cognition and mobility. While self-report has the advantage of providing the patient's perspective, self-reported ability and actual performance often differ [51]. Additionally, a relationship between self-reported cognition and depression has been demonstrated in several clinical populations, including cancer survivors who received chemotherapy [33] and veterans with mild traumatic brain injury [34]. In the current study, depression demonstrated the strongest relationships with measures of mobility in multiple regression models, but it is important to note that the relationship between self-reported cognitive concerns and mobility remained statistically significant even when adjusting for

depression and other potential confounding factors. A third potential limitation is that other variables, beyond those included in this study, may impact the relationship between cognition and mobility. From the variables available as part of the parent studies, we included those that were anticipated to influence both cognition and mobility based on previous literature and/or biologic plausibility. Further research may identify additional variables that affect the relationship in people with LLL. Finally, generalizability of these results to may be limited by the recruitment of people with LLL who regularly used lower limb prostheses to walk. As previous research demonstrates that people with poorer cognitive function are less likely to be fit with and use a prosthesis [10], these results may not extend to people with LLL who only occasionally use prosthetic devices or those who primarily use wheelchairs for mobility.

Conclusions

An improved understanding of the potential interactions between cognitive functioning and mobility is critical for optimizing desired rehabilitation outcomes for people with LLL, including participation in desired social, recreational, and vocational activities. Results of this study suggest that greater cognitive concerns are associated with poorer mobility among a broad range of people with LLL, even when adjusting for demographic and amputation-related factors. The observed relationship between cognition and mobility in people with LLL reinforces the importance of assessing cognition among people with LLL in order to inform prosthetic or therapeutic interventions during rehabilitation.

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Table 1

Participant demographic characteristics. Note that percentages may not sum to 100%, due to rounding.

Characteristic	Unilateral Sample (n=1086)	Bilateral Sample (n=205)	Total Sample (n=1291)
	n (%)	n (%)	n (%)
Sex			
Male	764 (70%)	140 (68%)	904 (70.0%)
Female	319 (29%)	65 (32%)	384 (29.7%)
Not reported	3 (0.3%)	0 (0%)	3 (0.2%)
Race/Ethnicity			
Non-Hispanic white	869 (80%)	162 (79%)	1031 (79.9%)
Non-Hispanic black	98 (9%)	18 (9%)	116 (9.0%)
Hispanic	67 (6%)	10 (5%)	77 (6.0%)
Other	46 (4%)	13 (6%)	59 (4.6%)
Not reported	6 (1%)	2 (1%)	8 (0.6%)
Education			
Some high school	56 (5%)	9 (4%)	65 (5.0%)
High school graduate	263 (24%)	45 (22%)	308 (23.9%)
Some college or technical school	414 (38%)	76 (37%)	490 (38.0%)
College graduate	220 (20%)	47 (23%)	267 (20.7%)
Advanced degree	128 (12%)	28 (14%)	156 (12.1%)
Not reported	5 (0.5%)	0 (0%)	5 (0.4%)
Individual income			
<\$25,000	514 (47%)	100 (49%)	614 (47.6%)
\$25,000–\$39,999	211 (19%)	28 (14%)	239 (18.5%)
\$40,000–\$54,999	110 (10%)	28 (14%)	138 (10.7%)
\$55,000–\$69,999	76 (7%)	8 (4%)	84 (6.5%)
\$70,000–\$84,999	58 (5%)	13 (6%)	71 (5.5%)
\$85,000–\$99,999	34 (3%)	6 (3%)	40 (3.1%)
\$100,000 or more	58 (5%)	14 (7%)	72 (5.6%)
Not reported	25 (2%)	8 (4%)	33 (2.6%)
Co-morbid health conditions			
0	403 (37%)	91 (44%)	494 (38.3%)
1	370 (34%)	53 (26%)	423 (32.8%)
2	183 (17%)	25 (12%)	208 (16.1%)
3 or more	130 (12%)	36 (18%)	166 (12.9%)
	Mean (SD)	Mean (SD)	Mean (SD)
Age at time of survey (years)	54.9 (13.4)	51.2 (14.6)	54.3 (13.7)
PROMIS-D T-score	49.3 (9.3)	48.9 (8.7)	49.2 (9.2)

Table 2

Participant amputation-related characteristics. Note that percentages may not sum to 100%, due to rounding.

Characteristic	Unilateral Sample (n=1086)	Bilateral Sample (n=205)	Total Sample (n=1291)
	n (%)	n (%)	n (%)
Amputation level *			
Below knee	703 (65%)	135 (66%)	838 (64.9%)
Above knee	383 (35%)	70 (34%)	453 (35.1%)
Amputation etiology			
Dysvascular	484 (45%)	62 (30%)	546 (42.3%)
Non-dysvascular	602 (55%)	143 (70%)	745 (57.7%)
Trauma ***	602 (100%)	64 (45%)	666 (89.4%)
Infection ***	N/A	44 (31%)	44 (5.9%)
Congenital ***	N/A	20 (14%)	20 (2.7%)
>1 etiology ***	N/A	15 (10%)	15 (2.0%)
	Mean (SD)	Mean (SD)	Mean (SD)
Age at amputation (years) **	43.1 (17.6)	37.1 (19.2)	42.2 (18.0)
Time since amputation (years) **	11.8 (13.9)	14.1 (14.9)	12.2 (14.1)
Prosthesis use per day (hours)	12.4 (4.1)	11.8 (4.3)	12.3 (4.1)
ABC score	2.6 (1.0)	2.5 (1.0)	2.5 (1.0)
PLUS-M T-score	50.3 (9.7)	48.8 (10.1)	50.0 (9.8)
Neuro-QoL ACGC T-score	45.9 (8.4)	46.4 (7.9)	46.0 (8.3)

* For people with bilateral LLL, this is the most proximal level of amputation in either leg.

** For people with bilateral LLL, this is age and time since first amputation in either leg.

*** Percentages reflect % of each etiology relative to the non-dysvascular sample only. In the unilateral sample, people with infection, congenital, or multiple etiologies were not eligible, and all participants in the non-dysvascular sample had LLL due to a traumatic etiology.

Table 3

Results of simple and multiple linear regression analyses examining the relationship of cognitive concerns and mobility as measured by the ABC.

	Mobility (ABC Score)		
	β	95% CI	P
Simple linear regression analysis (n=1291; adjusted R ² =0.12)			
Cognitive concerns (Neuro-QoL ACGC T-score)	0.35	0.30, 0.40	<0.0001
Multiple linear regression analysis (n=1254; adjusted R ² =0.47)			
Age	-0.22	-0.27, -0.18	<0.0001
Sex (female)	-0.10	-0.14, -0.06	<0.0001
Education	0.02	-0.02, 0.07	0.30
Individual income	0.12	0.07, 0.17	<0.0001
Co-morbid health conditions (0, 1, 2, 3+)	-0.10	-0.15, -0.04	0.0002
Depression (PROMIS-D T-score)	-0.38	-0.42, -0.33	<0.0001
Number of affected limbs (bilateral)	-0.08	-0.12, -0.04	0.0002
Level of amputation (below knee)	0.16	0.12, 0.20	<0.0001
Amputation etiology (dysvascular)	-0.12	-0.18, -0.07	<0.0001
Years since amputation	0.13	0.09, 0.18	<0.0001
Cognitive concerns (Neuro-QoL ACGC T-score)	0.14	0.09, 0.18	<0.0001

Table 4

Results of simple and multiple linear regression analyses examining the relationship of cognitive concerns and mobility, as measured by the PLUS-M.

	Mobility (PLUS-M T-Score)		
	β	95% CI	P
Simple linear regression analysis (n=1291; adjusted R ² =0.10)			
Cognitive concerns (Neuro-QoL ACGC T-score)	0.32	0.27, 0.37	<0.0001
Multiple linear regression analysis (n=1254; adjusted R ² =0.47)			
Age	-0.27	-0.31, -0.22	<0.0001
Sex (female)	-0.13	-0.18, -0.09	<0.0001
Education	0.00	-0.04, 0.05	0.84
Individual income	0.13	0.08, 0.17	<0.0001
Co-morbid health conditions (0, 1, 2, 3+)	-0.13	-0.18, -0.08	<0.0001
Depression (PROMIS-D T-score)	-0.30	-0.34, -0.25	<0.0001
Number of affected limbs (bilateral)	-0.11	-0.15, -0.07	<0.0001
Level of amputation (below knee)	0.24	0.20, 0.28	<0.0001
Amputation etiology (dysvascular)	-0.11	-0.17, -0.06	<0.0001
Years since amputation	0.15	0.10, 0.20	<0.0001
Cognitive concerns (Neuro-QoL ACGC T-score)	0.14	0.10, 0.19	<0.0002