Research Report

Balance Confidence Among People With Lower-Limb Amputations

Background and Purpose. Confidence in a person's balance has been shown to be an important predictor of social activity among people with lower-limb amputations. The purposes of this study were to describe confidence in balance among people with transtibial or transfemoral lower-limb amputations and to compare people whose amputations were due to vascular and nonvascular causes. **Subjects and Methods.** A survey of a sample of 435 community-dwelling individuals from 2 regional clinics was conducted. The sample consisted of people with unilateral transfemoral (26.7%) and transtibial (73.3%) amputations who lost their limb for vascular (53%) and nonvascular (47%) reasons. The mean age of the primarily male (71%) sample was 62.0 years (SD=15.7). **Results.** Mean scores, using the Activities-specific Balance Confidence (ABC) Scale, were 63.8 for the total sample, 54.1 for the subjects with amputations due to vascular reasons, and 74.7 for the subjects with amputations due to nonvascular reasons. Given a maximum possible ABC Scale score of 100, the results suggest that confidence was low. A difference between the subjects with amputations due to vascular reasons and those with amputations due to nonvascular reasons was observed over each item of the ABC Scale. Variables that were statistically related to balance confidence included age, sex, etiology, mobility device use, the need to concentrate while walking, limitations in activities of daily living, depression, and fear of falling. **Discussion and Conclusion.** Balance confidence scores among the study sample were low when compared with values previously reported by other researchers. Confidence was particularly low among individuals who had their amputation for vascular reasons. Balance confidence might be an important area of clinical concern. [Miller WC, Speechley M, Deathe AB. Balance confidence among people with lower-limb amputations. *Phys Ther.* 2002;82:856–865.]

Key Words: *Balance confidence, Fear of falling, Lower-limb amputation.*

William C Miller, Mark Speechley, A Barry Deathe

Assessing and improving mobility are among the primary goals of rehabilitation for people with lower-limb amputations. Often clinicians rely on performance tests such as the Two-Minute Walk Test[1] and the Timed Up & Go Test[2] or on indicators such as the use of mobility devices to determine a person's rehabilitation status. Although these measures offer some insight into physical performance or capability for mobility, we believe they do not sufficiently focus on psychological indicators such as a person's confidence with balance. A person's decreased confidence in his or her balance may impede mobility and community reintegration as much as having a physical impairment. Decreased confidence constitutes a potentially remediable barrier to mobility.[3,4]

Measures of balance confidence were developed to provide a sensitive measure of fear of falling.[3,5,6] Earlier approaches simply consisted of asking whether someone was afraid of falling.[7–9] *Balance confidence*, which is based on Bandura's theory of self-efficacy,[10] is defined as the belief that the individual has the capability to perform an activity or action. Defining fear of falling as balance confidence during activities, in our opinion, overcomes 3 limitations associated with the more general measure of fear.[6]

First, balance confidence is measured over a continuum of activities, from easy to more difficult, thereby providing better measurement qualities than if there was a simple dichotomous measure. Second, asking about the degree of confidence in performing an activity is less threatening than asking about a fear, which not only has psychiatric or phobia-related connotations but also can be perceived as a sign of weakness, especially among men.[6,11] Finally, evidence suggests that measures of self-confidence are strongly linked with independence in daily and social activities.[4,12,13]

Balance confidence has received considerable attention recently among researchers and clinicians working with elderly people.[4,14,15] However, only one published study[13] has investigated balance confidence among people with lower-limb amputations. We believe it to be plausible that balance confidence would be important among those with lower-limb amputations. The most

WC Miller, PhD, MSC(OT), is Assistant Professor, Faculty of Medicine, School of Rehabilitation Sciences, University of British Columbia, T325 Third Floor, Koerner Pavilion, 2211 Wesbrook Mall, Vancouver, British Columbia, Canada V6T 2B5 (bcmiller@telus.net). Address all correspondence to Dr Miller.

M Speechley, PhD, is Associate Professor, Faculty of Medicine and Dentistry, Department of Epidemiology and Biostatistics, University of Western Ontario, London, Ontario, Canada.

AB Deathe, MD (FRCPC), is Associate Professor, Department of Physical Medicine and Rehabilitation, University of Western Ontario, and Medical Director, Amputee Program, St Joseph's Health Care London, London, Ontario, Canada.

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obvious reasons are the altered gait pattern that occurs with use of prostheses, increased energy expenditure, and loss of sensory feedback associated with the loss of a lower limb, even among young people in good health whose amputation resulted from trauma. Moreover, because people with lower-limb amputations are most often elderly people with multiple comorbidities,[16] the loss of a lower limb adds an additional challenge. Finally, the prevalence for falls and fear of falling among people with lower-limb amputations appears to be very high.[17]

Our descriptive study was conducted to examine balance confidence among people with transtibial (TT) or transfemoral (TF) lower-limb amputations. Our objectives were: (1) to describe balance confidence among people with TT or TF lower-limb amputations, (2) to determine whether differences in balance confidence exist between people who have had amputations due to vascular and nonvascular causes, and (3) to determine what factors are associated with balance confidence while controlling for amputation cause and level.

Method

Design and Sample

We surveyed a sample of community-dwelling individuals with unilateral TT or TF amputations. To ensure that subjects had become accustomed to using their prostheses, only those who had been ambulating using their prostheses for a minimum of 6 months following discharge from the formal prosthetic rehabilitation program and were wearing their prostheses on a daily basis were included in the study.

A convenience sample of people who attended 1 of 2 university-affiliated clinics for people with amputations (the Southwestern Regional Amputee Clinic at St Mary's Hospital in London, Ontario, Canada, and the Chedoke Amputee Clinic in Hamilton, Ontario, Canada) between January 1 and December 31, 1998, was used. Both clinics provide 3-, 6-, and 12-month follow-up visits during the year after discharge from the rehabilitation program and annual follow-up after that. The sampling frame potentially consisted of every patient examined in these 2 clinics during that time period.

Of 563 eligible individuals, responses were received from 435 (77%). Comparisons of respondents and nonrespondents based on data from our chart review revealed no statistically significant differences at $P<.05$. Descriptive statistics for the total sample are presented in Table 1. The mean age of the primarily male (71%) subjects was 62.0 years (SD=15.7). The majority of the respondents were married (62.1%), had less than a grade 12 education (57.7%), and were not working (74.5%). The cause of amputation was related to vascular reasons for 52.9% of the sample, with 73.3% having a TT amputation compared with 26.7% having a TF amputation. Proportionally, 60% of the respondents had a TT amputation and 44% had a TF amputation for vascular reasons.

Measurement

Information from chart reviews was linked with survey data to create the database for the analyses. Chart review variables included sex, date of birth, amputation date, level of amputation (TF or TT), and cause of amputation (vascular or nonvascular). Etiology was determined based on the surgical reason for the amputation. Classification of the cause of amputation was based on the surgical report in the patient files. Table 2 presents a breakdown of how diagnoses were classified. Individuals identified as having a Symes amputation (n=23) were included in the TT amputation group, and those with a through-knee amputation (n=5) were included in the TF amputation group. Inclusion and classification of individuals with Symes and through-knee amputations was based on our clinical experience, which suggests that the functional ability of these individuals is very similar to that of people with TT and TF amputations, respectively.

The remainder of the information was collected using a mailed survey questionnaire following techniques recommended by Dillman.[18] Variables were included because of their clinical relevance or because of previously reported importance in studies of balance confidence in other populations.

Socio-demographic factors. Data for age and sex were taken from patient charts, and information regarding marital status, social support, education level, employment, and income status was ascertained from the survey questionnaire. Social support was measured using a 6-item version of the Interpersonal Support Evaluation List (ISEL).[19,20] The ISEL measures 4 dimensions of support: tangible, belonging, self-esteem, and appraisal. Scores from a 4-point Likert scale are summed, with higher scores indicating greater sources of support.

Amputation-related factors. The number of years since amputation was based on the date of the most recent major surgery on the limb with the amputation recorded in the subject's hospital chart. For those cases where a revision of a previous amputation was performed (eg, from TT to TF), the date of the revision was considered the amputation date. Amputation cause was determined from notes in the chart. Respondents reported current mobility device use by checking whether they used canes, crutches, walkers, or no device when ambulating with the prostheses. The ability to "walk automatically" was determined from the survey by

Table 1.
Descriptive Statistics and Mean Activities-Specific Balance Confidence (ABC) Scale Scores for the Total Sample (N=435)[a]

Socio-demographic Factors	%	Mean ABC Scale Score
Age (y) ($\bar{X}\pm$SD)[b]	62.0 (15.7)	
23–55	33.1	74.93
56–70	31.7	63.94
≥71	35.2	53.29
Sex[b]		
Male	71.0	67.74
Female	29.0	54.45
Marital status[b]		
Married	62.1	59.49
Not married	37.9	66.49
Social support	15.1 (3.2)	
<16 (median)	49.7	60.53
≥16	50.3	67.09
Education[b]		
<grade 12	57.7	56.92
≥grade 12	42.3	73.27
Employment status[b]		
Working (full-time/part-time)	25.5	59.00
Not working	74.5	65.50
Income[b]		
\$0–\$19,999	38.9	57.33
\$20,000–\$39,999	33.1	63.17
≥\$40,000	27.1	73.97
Amputation-Related Factors	**%**	**Mean ABC Scale Score**
Years since amputation[b]	14.3 (16.5)	
0–3	31.0	56.08
4–13	35.2	61.29
≥14	33.8	73.59
Amputation cause[b]		
Vascular (n=230)	52.9	54.13
Nonvascular	47.1	74.72
Amputation level		
TT (n=313)	73.3	64.90
TF	26.7	60.89
Mobility device used inside[b]		
No	43.4	78.38
Yes	56.6	44.89
Automatic walking ability[b]		
No	40.9	44.21
Yes	59.1	77.42
Health-Related Factors	**%**	**Mean ABC Scale Score**
Comorbidity[b]	2.7 (2.3)	
0	20.7	73.58
1	17.0	72.29
≥2	62.3	58.28
Joint pain		
No	70.3	65.13
Yes	29.7	60.74
Intact leg problems[b]	1.0 (1.0)	
0	41.1	70.11
1–2	31.7	59.62
3–4	27.1	59.23

Table 1.
Continued

Health-Related Factors	%	Mean ABC Scale Score
Fall in past 12 mo		
No	52.4	65.02
Yes	47.6	62.76
Fall injury[b]		
No	80.2	65.22
Yes	19.8	58.19
No. of medications[b]	1.9 (2.0)	
0	35.2	71.24
1	17.7	70.26
≥2	47.1	55.89
Alcohol intake[b]		
None	63.4	61.37
Occasional	18.9	68.71
Daily	17.7	67.45
Perceived health[b]		
Excellent	9.4	85.89
Very good	21.4	72.90
Good	38.4	63.50
Fair	26.9	52.39
Poor	3.9	42.96
ADL limitation[b]		
No ADL limitation	73.6	70.51
≥1 ADL limitations	26.4	45.25
Psychological Factors	**%**	**Mean ABC Scale Score**
Depression (CES-D)[b]	10.5 (10.6)	
<16	76.7	67.98
≥16	23.3	50.95
Adaptation to amputation[b]		
No	18.4	44.34
Yes	81.6	68.22
Adaptation to prosthesis[b]		
No	21.4	42.78
Yes	78.6	69.56
Fear of falling[b]		
No	50.8	77.4
Yes	49.2	49.78

[a] TT=transtibial, TF=transfemoral, ADL=activities of daily living, CES-D=Center for Epidemiologic Studies Depression Scale. Values in parentheses are standard deviations.
[b] All subgroup means significantly different at $P<.05$.

Table 2.
Classification of vascular and nonvascular etiology of amputation.

Vascular	Nonvascular
Peripheral Vascular Disease	Cancer
Diabetes	Congenital Malformation
Vascularitis	Trauma
Infection Secondary to Vascular Disease	Infection Secondary to Trauma

asking whether the subject was required to concentrate on each step. This question was taken from the Prosthetic Profile of the Amputee questionnaire.[21]

Health-related factors. A physical health profile was generated based on a variety of variables. Perceived health status was assessed by having respondents rate their health on a 5-point ordinal scale ranging from "poor" to "excellent." A comorbidity count was derived using a list of 19 common health ailments, an approach used in the Ontario Health Survey.[22–24] Information about comorbidities was based on whether a physician had told the respondents that they had disorders such as heart disease, diabetes, or stroke. Data on the reliability of these measurements are not known, and we did not study their reliability. Data on medication use were collected by asking respondents if they were taking prescribed medications for any condition.[22–24] The reliability of these data also is not known. Joint pain was assessed by asking respondents whether pain was experienced in any joints. Examples included with the question included the wrists or hips in order to cue respondents to think of both upper and lower limbs. A separate question asked about the existence of general back pain. Fall injury was determined by asking the respondents whether they had "seriously" injured themselves from a fall in the 12 months prior to completing the survey questionnaire. Disability status was established by identifying any limitations in performing one or more activities of daily living using the Postal Barthel Index.[25] Kappa values for 2-week test-retest reliability of data obtained for the items among a group of individuals who had a stroke ranged from .49 to .90.[25] Although the validity of data obtained with the Barthel Index has been well established,[26] studies of validity for this self-report format have not been compared with the interview administration. We added 2 questions regarding independence with donning and doffing prostheses to the Barthel Index. Problems with the limb without the amputation were identified by use of a list of items about sensation, ulcers, pain, and swelling in the remaining limb.[21] Self-reports of alcohol consumption were scored as "daily," "occasional," or "never used."

Psychological factors. The level of depression was measured using the Center for Epidemiologic Studies Depression (CES-D) Scale.[27] Responses on 4-point Likert scales are summed across 20 items, yielding an index ranging from 0 to 60, with higher scores indicating a greater level of distress. Radloff[27] reported alpha coefficients of .85 for the general population and .90 for a group of patients with psychiatric disorders. A correlation (r) of .76 was obtained when the CES-D Scale was administered by a nurse and research clinician.[27] Test-retest reliability coefficients ranged from .4 to .7.[27,28] Low retest scores have been reported to be related to associating CES-D Scale items to recent symptoms.[27] Extensive support for validity has been reported.[26] Radloff[27] found correlations (r) of .44 to .56 with other scales of depression, and Weissman and colleagues[29] reported correlations (r) ranging from .49 to .85 with various measures of depression. A single question was used to assess adaptation to amputation and to the prosthesis.[21] A 5-point Likert scale, with anchors of "not at all adapted" and "completely adapted" at the ends of the scale, was used to indicate the degree of adaptation.

Outcome. The 16-item Activities-specific Balance Confidence (ABC) Scale[3] was used to determine balance confidence. Participants were asked to rate their level of confidence on a scale between 0% and 100% when performing a variety of activities, such as climbing stairs, reaching above the head, and walking on different surfaces. Responses are summed and then divided by 16 to provide an overall mean balance confidence score. An intraclass correlation coefficient (ICC) of .92 has been reported for 2-week test-retest reliability of measurements obtained with the ABC Scale.[3] More recently, Miller et al[30] reported a total score ICC of .91 and inter-item ICCs ranging from .53 to .87 for a sample of individuals with unilateral lower-limb amputation. Measurements obtained with the ABC Scale have been shown to correlate with those obtained with other measures of self-efficacy (r=.49) and physical ability (r=.63) and to distinguish between groups of older adults with low and high mobility.[3,5] Further strong correlations with walk tests (r=.7)[31] and self-report measures of prosthetic function (r=.67–.82)[30] also have been reported.

Data Analysis

All continuous variables are presented as means and then changed into categorical-level variables to simplify univariate analysis and presentation of descriptive statistics. If the variables did not have a pre-established published cut point used to distinguish between levels of function, such as that established for the CES-D (≥16 suggests clinical depression),[27] then the variables were collapsed based on a statistical distribution. Tertiles were used for age, years since amputation, number of problems with the lower limb without the amputation, number of problems with the limb with the amputation, and prosthesis. The median value was used as a cut point to divide the social support data into those with higher and lower levels of support. Categorical variables such as marital status, education level, employment status, and mobility device used were collapsed into binary responses. Ordinal variables, such as adaptation to amputation and prosthesis, were collapsed into 2 groups to indicate whether the individual had achieved ("quite well adapted" to "completely well adapted") or had not achieved ("not at all adapted" to "moderately well adapted") a level of complete adaptation.

Table 3.
Mean Item Activities-Specific Balance Confidence (ABC) Scale Scores for Total Sample and for Respondents With Amputations Due to Vascular and Nonvascular Causes

Item	Total Sample (N=435)		Vascular Amputations (n=230)	Nonvascular Amputations[a] (n=205)
	$\overline{X}$	SD		
4. Reach at eye level	86.2	24.9	80.6	92.5
9. Get in/out of car	83.9	24.3	79.4	88.9
1. Walk around house	81.7	25.5	76.5	87.5
8. Walk outside to nearby car	81.6	26.6	75.3	88.7
3. Pick up slipper from floor	75.9	31.7	68.1	84.7
10. Walk across parking lot	74.2	32.5	65.7	83.8
7. Sweep the floor	69.9	37.3	56.6	84.9
2. Up and down stairs	69.3	32.5	62.9	76.4
12. Walk in crowded mall	63.6	36.8	52.1	76.6
11. Up and down ramp	62.0	34.1	53.4	71.6
14. Escalator holding rail	60.1	40.4	47.9	73.8
13. Walk in crowd/bumped	55.7	37.4	42.3	70.7
5. Reach on toes	50.7	40.9	37.3	65.6
6. Stand on chair to reach	39.1	40.3	22.4	57.5
15. Escalator not holding rail	38.6	39.8	24.9	54.0
16. Walk on icy sidewalks	28.9	32.4	20.6	38.3
Total ABC Scale score	63.8	26.7	54.1	74.7

[a] Difference in means between respondents with amputations due to vascular and nonvascular causes, $P<.001$.

Statistical analyses included calculation of means and percentages for descriptive purposes, t tests to assess univariable differences between 2 groups, analyses of variance (ANOVAs) to assess differences among 3 or more groups, and multiple linear regression to examine multivariable relationships with the ABC Scale scores. The forward selection regression procedure was used to assess multivariable relationships, with $P<.25$ used for entry. All factors found to be statistically different ($P<.25$) using t tests and ANOVAs were included in the maximum model. Using a liberal probability value is recommended when the goal of regression analysis is to create a "reliable" group of variables that best predicts or describes a new outcome of interest.[32] Doing so produces a regression equation that may be inclined to increase the chance of a Type I error but reduces the chance of a Type II error or loss of an important independent variable that can describe the dependent variable.[32] Therefore, all variables found to be significant at $P<.1$ that increased the adjusted multivariable coefficient of determination (R^2) by at least 0.5% were retained in the final regression model. The exceptions were amputation level and amputation cause, both of which were kept in the model regardless of their statistical significance[32] because we think they are clinically important.

Most of the variables in this study had low missing value rates (<5%). To minimize loss of cases due to listwise deletion, missing values were replaced using multiple imputation.[33] In brief, this special form of Markov chain Monte Carlo technique is used to predict missing values for cases based on multiple simulations of available data. Essentially, multiple versions of the complete data set are generated, and the data are then allowed to converge based on the distribution of values. Multiple imputation was performed using NORM Version 2 for Windows 95/98/NT.[34] All other data management and analyses were conducted using SPSS Version 8 for Windows.*

Results

The mean ABC Scale scores for each of the variables considered in the study are presented in Table 1. The mean ABC Scale score for the entire sample was 63.8 (SD=26.7); however, 35% of the sample scored 80 or better. As shown in Table 1, the ABC scores differed across levels of all variables with the exception of social support, amputation level, joint pain, and presence of a fall in the past 12 months. Patterns of mean ABC scores across levels of the variables in Table 1 are all as we expected except for employment status. We anticipated that respondents who worked would have a higher level of balance confidence than respondents who did not work.

The differences in ABC Scale scores between respondents with TF and TT amputations (4.01 points) and between respondents who had fallen in the past year and those who had not fallen (2.26 points) were not statistically significant. Both were unexpected findings.

Table 3 presents mean values for the 16 individual items of the ABC Scale for the total group as well as the mean difference between the subjects with amputations due to vascular reasons and those with amputations due to nonvascular reasons. Items are presented in rank order from most confident to least confident based on the mean score of the total group. The subjects who had amputations for nonvascular reasons reported higher levels of balance confidence than did the subjects whose amputations were due to vascular problems for all 16 items of the ABC Scale. Based on t tests, there were differences between the 2 groups for each item, and these differences remained statistically significant after adjusting the alpha level for multiple testing using the Bonferroni correction.[32] Large between-group differences (≥29 points) were observed for items such as walking in crowded areas, sweeping the floor, and reach-

* SPSS Inc, 233 S Wacker Dr, Chicago, IL 60606.

Table 4.
Regression Model of Balance Confidence for Individuals With Transtibial and Transfemoral Lower-Limb Amputations[a]

Factor	β	b	SE	95% CI
Age	−.111	−0.188	0.056	−0.299, −0.078
Sex	.092	5.390	1.714	2.022, 8.759
Nonvascular amputation	.091	4.874	1.790	1.356, 8.392
Amputation level (TF)	−.036	−2.180	1.768	−5.656, 1.295
Perceived health	.064	1.688	0.865	−0.011, 3.388
Mobility device use	.308	16.557	1.836	12.947, 20.166
Concentrating on walking	.229	12.447	1.905	8.702, 16.192
ADL limitation	.114	3.123	0.859	1.435, 4.812
Depression (CES-D)	−.097	−0.243	0.081	−0.402, −0.085
Fear of falling	−.248	−13.249	1.723	−16.637, −9.862
R^2	.665			

[a] b=unstandardized regression coefficient, SE=standard error, CI=confidence interval, TF=transfemoral, ADL=activities of daily living, CES-D=Center for Epidemiologic Studies Depression Scale.

ing while up on their toes. Small differences between the 2 groups were observed for activities such as walking around the house, getting in and out of a car, and reaching at eye level.

Table 4 shows the results for the final regression model containing all of the variables that remained related for the study sample. As shown by the exclusion of 0 in the 95% confidence intervals, being younger, male, able to ambulate without a mobility device, and able to walk without concentrating and having fewer limitations in activities of daily living, fewer symptoms of depression, and no stated fear of falling were all independently related to balance confidence. Having a good to exceptional level of perceived health was independently related to balance confidence. Based on the standardized regression coefficients, mobility device use, fear of falling, and concentration while walking had the strongest relationship with balance confidence. The total variance accounted for by the regression equation was 67%, with fear of falling accounting for 4% of the explained variance.

Discussion

Studies of balance and postural sway consistently report variations in abilities between people with intact lower limbs and people with unilateral amputations.[35–37] Therefore, it seems plausible that decreased balance confidence may be important among people with amputations. Confidence in balance has been reported to be a better predictor of an individual's engagement in physical, daily, and social activities than actual measures of physical performance among elderly people[10] and is strongly correlated with prosthetic performance (what people do), prosthetic capability (what people can do), and social activity participation among people with amputations.[13] In our opinion, continued study of balance confidence among people with lower-limb amputations is important.

Myers et al[5] reported that physically active elderly people in good health had a total mean confidence score greater than 88 on the ABC Scale. In our study, individuals with amputations due to vascular and nonvascular causes had mean scores ($\overline{X}$=54.1 and 74.7, respectively) lower than those of the sample of elderly people in good health in Myers and colleagues' study. Intervention, in the form of education, balance training, and activity, has been advocated for individuals who score below 80 on the ABC Scale.[5] This equates to about 81% of the respondents with amputations due to vascular causes and 46% of the respondents with amputations due to nonvascular causes in our study.

We expected that balance confidence would differ between people with amputations due to vascular and nonvascular causes as well as between people with TF and TT amputations. Differences between groups based on the cause of amputation were expected because individuals with vascular disease tend to be older, have more comorbidity, and use more medications. In addition, some studies[35–37] have suggested that people with amputations due to trauma perform better than people with amputations due to vascular causes in balance and postural sway. This expectation was verified in the bivariable analysis and further clarified in the multivariable analysis. The respondents with amputations due to vascular problems had lower balance confidence overall and for all activities measured. The differences were greatest for reaching while standing on a chair and using an escalator without holding the handrail. The difference was smallest for getting in and out of a car. Although fear of injury associated with falling from a chair or down a set of stairs may explain some of the difference, we believe the difference may more likely be related to the familiarity of the activity. Confidence in performing activities is likely to be higher in routine tasks that we frequently practice, such as transferring into a car or walking within a home. We believe a person's perceived capabilities are likely to determine which activities that individual will choose to perform. This may explain, in our view, why the differences in confidence between the respondents with amputations due to vascular causes and those with amputations due to nonvascular causes were twice as large for sweeping the floor than for walking outside to a nearby car. The older, more frail group of respondents with amputations due to vascular reasons did not perform some activities, especially those that they perceived were beyond their capability.

The level of amputation was not statistically related to balance confidence. This is surprising as we expected those respondents with a TF amputation to display behaviors consistent with lower confidence because of the loss of stability that is associated with the removal of both an ankle and a knee joint. Furthermore, lower balance confidence was anticipated given that prosthetic joints do not provide sensory feedback. However, in both bivariable and multivariable analyses, amputation level was not associated with balance confidence ($P>.05$).

There are several possible explanations for our findings. The ABC Scale may not be valid for measurements from people with amputations, or it may not be sufficiently sensitive to detect clinically important differences between people with TF and TT amputations. Another possible explanation is that the ABC Scale can be used to measure balance confidence overall, but the measurements cannot be used to differentiate the 2 groups because the differences in balance confidence are too small. A difference between people with TT and TF amputations also may not have been found because the vast majority of people with TF amputations are people whose leg has been removed for vascular reasons. Although all subjects in our sample had an amputation, it is possible that we did not have a representative sample and thus selected a group of highly mobile individuals with TF amputations.

We combined individuals who had a Symes amputation with individuals who had a TT amputation. It is possible that including the 23 people who had a Symes amputation, the majority of whom (n=18) had amputations due to nonvascular problems, with the people with TT amputations may have skewed our findings. However, excluding individuals with a Symes amputation increased the overall TT mean ABC Scale score by less than 0.5 and therefore had a very small overall effect on our findings. Our rationale for combining these groups was based on our belief that a Symes amputation can be considered a long TT amputation. In both cases, the ankle is the major joint that is lost; therefore, the resulting loss of sensory feedback and ankle position sense in particular occurs at the same level. Moreover, both require a patella-tendon–bearing prosthetic limb. Finally, our clinical experience suggested that mobility between these 2 groups is very similar. As logical as it is to expect differences in balance confidence between individuals with and without knee joints, it may be that adaptation to the loss of a knee joint in terms of balance confidence is equal in these populations.

Fear of falling was an important factor explaining the variance in balance confidence. We contend that the relationship between fear of falling and balance confidence is not easily explained. Self-efficacy scales such as the ABC Scale were developed to provide a measure of fear of falling that is responsive, in part, by reducing perceived stigma, especially among men, often associated with admitting one has a "fear."[3,6] Given the similarity between the fear of falling and balance confidence constructs, it may be unreasonable to expect that the entire relationship would be explained by the variables measured in the study.

In a previous study,[17] we found that having a fall in the past 12 months remained a risk factor for fear of falling among people with lower-limb amputations. This finding suggests that past experience may not be necessary to alter balance confidence.[4,10] In his seminal work, Bandura[10] suggested that vicarious experience and verbal persuasion may influence self-efficacy. Translated for our study group, when people with amputations talk with other people who have had amputations who have fallen or had a near fall, this also may elicit decreased confidence. Furthermore, other people with well-meaning comments such as "you shouldn't go out right now because the sidewalks are wet and icy" may inadvertently reinforce decreased confidence. We believe that those who do not believe they can perform certain activities are more likely to avoid them and, therefore, less likely to fall. Ultimately, we contend, the individual's appraisal may change from being adaptive and avoiding hazardous activities, such as climbing on a chair to reach for something, to becoming maladaptive. People's fear may prevent them from doing activities within their capabilities, which may result in deconditioning and muscle atrophy. These results, in turn, may increase the likelihood of falls. Clinical trials assessing the effectiveness of interventions, such as education and strengthening programs, to decrease fear of falling and improve balance confidence and social activity among elderly people have shown modestly promising results[14,38] and, in our opinion, are worthy of study among people who have a lower-extremity amputation.

Our study had several limitations. Despite the fact that we used only questions and scales in our survey that had been used in previous published studies, the psychometric properties of some of these variables are unknown, and we did not determine reliability and validity for all of the measures we used. Because the data are primarily cross-sectional, claims of a temporal or causal relationship cannot be made. Variables such as falling in the 12 months prior to the study required the respondents to rely on their memory, and this can be susceptible to recall bias. We chose to assess the 12 months prior to the study because research into recall bias for identifying falls suggests this period of time is more reliable than periods of 3 or 6 months.[39] Other authors[40] have suggested that falls occurring more than 12 months in the past may still undermine balance confidence. Therefore, asking whether a person has ever fallen since receiving his or her prosthesis might have provided better information. Other variables, such as the presence of peripheral neuropathy, which is highly prevalent among diabetic- and nondiabetic-related vascular amputations,[41] were not measured due to the study design. Given the altered sensation associated with peripheral neuropathy, it is plausible that this variable contributed to a reduced sense of balance confidence and should be included in future studies of this population. Using a prospective-longitudinal design would overcome these limitations.

Although we collected information from both clinics, we assumed that all individuals had an annual follow-up visit. It is uncertain, however, what proportion of active prosthetic limb users did not attend clinic during the survey year. Despite our response rate (77%) and the fact that there were no differences between respondents and nonrespondents, we believe that replication of our study is needed to verify the magnitude of balance confidence and ensure model formation is robust with other populations of people with amputations.

Summary

Our results suggest that people with unilateral lower-limb amputations have low balance confidence and that the balance confidence is lower among individuals who had amputations due to vascular causes. Moreover, the respondents with amputations due to vascular problems consistently scored lower in balance confidence for each item of the ABC Scale. Preliminary study of balance confidence in this population demonstrated that a strong correlation existed among lower balance confidence scores, reduced prosthetic mobility and capability, and reduced participation in social activities, even after controlling for other important variables.[13] If this relationship can be found in longitudinal studies, we believe intervention trials similar to those conducted among the elderly population are warranted. Given the considerable cost of prosthetic rehabilitation[42] and the potential for further development of impairment—such as loss of muscle strength, endurance, and balance—that accompany inactivity, improving an individual's balance confidence may be one additional method of maximizing the quality of life after amputation.

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