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Original Research

Pain, Balance-Confidence, Functional Mobility, and Reach Are Associated With Risk of Recurrent Falls Among Adults With Lower-Limb Amputation

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KEYWORDS
Accidental falls;
Amputees;
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Abstract *Objective:* The study evaluated whether pain intensity and extent, balance-confidence, functional mobility, and balance (eg, functional reach) are potential risk factors for recurrent falls among adults with a lower-limb amputation.
Design: Cross-sectional study.
Setting: Research laboratory.
Participants: Eighty-three adults with unilateral lower-limb amputation that occurred >1 year prior (26 transfemoral- and 57 transtibial-level amputation; 44.6% women; 51.8% traumatic cause of amputation; N=83).
Intervention: Not applicable.
Main Outcome Measures: Participants reported on the number of falls in the past year, as well as pain intensity in the low back, residual, and sound limbs. Balance-confidence (per the Activities-Specific Balance-Confidence Scale [ABC]), functional mobility (per the Prosthetic Limb Users

List of abbreviations: ABC, Activities-Specific Balance-Confidence Scale; CI, confidence interval; FRT, Functional Reach Test; ICC, intraclass correlation coefficient; LBP, low back pain; LLA, lower-limb amputation; mFSST, modified Four Square Step Test; OR, odds ratio; PLUS-M, Prosthetic Limb Users Survey of Mobility; RLP, residual limb pain; TFA, transfemoral amputation; TTA, transtibial amputation.
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Survey of Mobility ([PLUS-M]), and balance (per the Functional Reach and modified Four Square Step Tests) were obtained.
Results: After considering non-modifiable covariates, greater extent of pain, less balance-confidence, worse self-reported mobility, and reduced prosthetic-side reach were factors associated with recurrent fall risk. Adults reporting pain in the low back and both lower-limbs had 6.5 times the odds of reporting recurrent falls as compared with peers without pain. A 1-point increase in ABC score or PLUS-M T score, or 1-cm increase in prosthetic-side reaching distance, was associated with a 7.3%, 9.4%, and 7.1% decrease in odds of reporting recurrent falls in the past year, respectively.
Conclusions: Of the 83 adults, 36% reported recurrent falls in the past year. Presence of pain in the low back and both lower-limbs, less balance-confidence, worse PLUS-M score, and less prosthetic-side reaching distance were identified as modifiable factors associated with an increased odd of recurrent falls.

Falls are the most common mechanism of injury in the older adult population, accounting for more than half of all injury-related deaths.[1-3] More than 40% of adults with lower-limb amputation (LLA) who fall, sustain injuries,[4] which can lead to pain, functional impairments, mobility loss, and disability. Furthermore, 49% of adults with LLA who fall report a fear of future falls, which can lead to reduced participation in daily activities and societal roles.[4]

Adults with LLA fall at nearly twice the rate of community-dwelling older adults.[5] Post-amputation sequelae, such as reduced somatosensory feedback on the amputated side[6] from the loss of sensory receptors critical for maintenance of balance,[7] increase fall risk. Identification of modifiable risk factors is critical to evaluate patient fall risk post-LLA and develop targeted interventions to mitigate falling and downstream falls-related physical and psychological consequences.

After LLA, while patient demographic (ie, age, sex) and amputation-specific (ie, time since amputation) characteristics are associated with falls,[5,8,9] and falls-related injuries,[10] these factors may not be modifiable. It is well established that pain presence and intensity are modifiable factors that are independently associated with fall risk among community-dwelling older adults.[11] For example, older adults with pain are twice as likely to experience recurrent falls (ie, ≥2 falls in the past year) when compared with those without pain.[12] Post-amputation, pain is a significant health care concern, with 95% of American adults reporting pain in 1 or more body regions,[13] yet, the effect of pain in multiple locations on fall risk post-amputation has received limited attention. What is known is that low back and joint pain are each independently associated with falling after LLA,[14,15] but it remains unknown if a greater number of painful sites elevates fall risk.

In addition to pain, given balance-confidence and functional mobility are required for performing daily activities, deficits may contribute to falls. Prior research finds lower balance-confidence is associated with recurrent fall risk in various populations, including older adults,[16] those with Parkinson's disease,[17] and those with a history of hip fractures.[18] Among older adults, worse physical function is associated with increased risk of recurrent falls.[19] Adults with LLA demonstrate impaired balance-confidence,[6] functional mobility, and balance as compared with peers without limb loss.[20,21] To date, post-amputation research has largely focused on predicting an individual's risk of experiencing any falls vs no falls,[22,23] rather than recurrent falls, where injury risk is magnified. Thus, it is unclear whether balance-confidence, functional mobility, and balance are potential risk factors for recurrent falls after LLA. The purpose of this study was to evaluate whether pain intensity and extent, balance-confidence, functional mobility, and balance are potential risk factors for recurrent falls among adults with LLA. We hypothesized that after considering non-modifiable factors, greater pain extent and intensity, less balance-confidence, and worse functional mobility and balance would be associated with recurrent falls post-LLA.

Methods

Participants were recruited from July to August of 2017 through regional clinical practices, the University of Delaware Department of Physical Therapy, and the Amputee Coalition National Conference in Louisville, Kentucky for this cross-sectional study. Included individuals could read- and speak-English, were ≥18 years of age, had a unilateral transtibial amputation (TTA) or transfemoral amputation (TFA) >1 year prior, and were using a traditional socket prosthesis to walk ≥25 feet with or without an assistive device (to enable performance-based testing). Exclusion criteria included contralateral amputation or a medical condition that affected the participant's ability to walk (eg, limb ulcer) or safely complete performance-based tests (ie, Functional Reach, modified Four-Square Step Test). All participants signed a written informed consent approved by the University of Delaware Institutional Review Board for Human Subjects Research [project number: 1062844, initial approval: May 23, 2017].

Participant characteristics

Participants provided demographic and amputation-specific information and completed the Houghton Scale, which is a reliable (test-retest intraclass correlation coefficient $[ICC]_{2,1}$=0.96) measure of prosthesis use and stability.[24] Participants also reported their current Socket Comfort Score (test-retest $ICC_{3,1}$=0.77), which ranges from "0"= "most uncomfortable" and "10"= "most comfortable fit imaginable".[25,26]

Outcomes

Falls

Participants reported on falls in the past year, with a fall being defined as the participant's body, above the ankle, inadvertently coming to rest on ground, floor, or lower level. Recurrent falls were defined as 2 or more falls in the past year.[27]

Pain metrics

Participants reported on presence or absence of residual limb pain (ie, pain in remaining portion of limb; RLP), sound limb pain (pain in the non-amputated, contralateral limb), and low back pain (LBP). Additionally, participants verbally rated their "current" pain in all 3 regions on a 0 (no pain) to 10 (worst imaginable pain) scale. Extent of pain, that is, number of painful regions, ranging from 0 to 3, and average "current" pain intensity from the 3 regions were calculated for subsequent analyses.

Self-reported outcome measures

The Activities-Specific Balance-Confidence Scale (ABC) is a valid and reliable (test-retest $ICC_{3,1}$=0.94) measure assessing an individual's confidence in performing various activities without losing their balance.[26] The ABC consists of 16 items, each scored on a 0- to 4-point scale, where "0" indicates "no confidence" and "4" indicates "complete confidence" in performing the activity.[26] Item scores are totaled and higher scores indicate greater balance-confidence.[26]

The Prosthetic Limb Users Survey of Mobility (PLUS-M) 12-item form, a valid and reliable (test-retest $ICC_{3,1}$=0.97) population-specific measure, assesses self-reported mobility with various household and outdoor ambulatory tasks.[26,28] Items are scored on a 5-point scale where "1" indicates "unable to do" and "5" indicates "able to do without any difficulty".[26,28] Raw scores are converted to T scores, where 50 is the mean of the reference sample, and every 10 points above or below 50 represents 1 standard deviation; higher scores indicate better prosthesis-enabled functional mobility.[29]

Performance-based tests

The Functional Reach Test (FRT) is a reliable (test-retest $ICC_{3,1}$=0.92) measure for assessing functional balance.[30] Participants were instructed to "reach as far forward as possible without losing [their] balance, touching anything, or taking a step".[30,31] The distance reached was recorded in centimeters from 3 consecutive trials (averaged for analyses) on both the prosthetic and non-prosthetic side; order of testing was randomized.

The modified Four Square Step Test (mFSST) is a valid and reliable (test-retest $ICC_{2,1}$=0.91; $ICC_{2,2}$=0.95) measure assessing balance through multidirectional stepping.[32,33] Participants completed a prescribed sequence of steps over a "+" taped on the floor "as fast as possible without touching the tape lines."[34] After demonstration, participants completed 1 practice trial and 2 timed trials (averaged for analysis).

Statistical analyses

Statistical analyses were conducted using SPSS 28[a]. Between-group differences, that is, TFA vs TTA, in participant characteristics, pain metrics, and other outcome measures were examined using a 1-way analysis of variance, Mann-Whitney *U* tests or Chi-Square tests, as appropriate. To identify factors associated with risk of recurrent falls post-LLA, univariate logistic regression analyses were conducted with recurrent falls as the dependent variable. Pain metrics and other outcome measures significantly associated with recurrent falls were further examined in separate multivariate logistic regression models that adjusted for non-modifiable covariates: age, sex, amputation level, and time since amputation. Significance for each planned analysis was set at 0.050.

Results

Participants

Of the 94 potential participants, 3 were excluded secondary to use of an osseointegrated prosthesis, while 8 were <1-year post-amputation, resulting in 26 adults with TFA and 57 adults with TTA who met the study's criteria. Participant characteristics by amputation level are presented in table 1. Similar age, height, weight, sex, and etiology distribution were observed between amputation levels, but adults with TTA did have significantly shorter median time since amputation than those with TFA (*P*<.001). Of the 83 adults, 50 (60.2%) reported 1 or more falls, while 30 (36.1%) reported recurrent falls in the past year. While similar socket comfort

Table 1 Participant characteristics by amputation level

Measures	TFA (n=26)	TTA (n=57)	Sig.
Demographics			
Age (years)	48.9 (±14.0)	48.0 (±13.1)	0.800
Sex (women)	11 (42.3%)	26 (45.6%)	0.816
Height (cm)	171.9 (±9.7)	171.1 (±11.8)	0.759
Weight (kg)	90.2 (±20.7)	86.2 (±19.9)	0.411
Amputation-specific			
Etiology (trauma)	11 (42.3%)	32 (56.1%)	0.344
TSamp (years)*	7.3 (3.1, 12.1)	5.6 (2.4, 15.8)	<0.001
Socket Comfort Score (0-10)*	8.0 (7.0, 9.0)	8.5 (8, 9.6)	0.085
Houghton Scale (0-12)*	12 (8, 12)	12 (10, 12)	0.069
Assistive device use	8 (30.8%)	5 (8.8%)	0.020
One or more Falls	20 (76.9%)	30 (52.6%)	0.053
Recurrent Falls†	13 (50.0%)	17 (29.8%)	0.089

NOTE. Level of significance, $\alpha \leq 0.05$.
Abbreviations: Sig, significance; TSAmp, time since amputation.
* Data presented as median (25th, 75th percentile) rather than mean (±standard deviation) or N (% of sample).
† Recurrent falls was defined as 2 or more falls within the past year.

Table 2 Participant pain and functional outcomes by amputation level

Measures	TFA (n=26)	TTA (n=57)	Sig.
Pain metrics			
Site specific pain			
Residual limb pain	7 (26.9%)	13 (22.8%)	0.783
Sound limb pain	9 (34.6%)	19 (33.3%)	1.000
Low back pain	9 (34.6%)	16 (28.1%)	0.610
Extent of pain (0-3)*			
No pain	11 (42.3%)	29 (50.9%)	0.372
Pain in 1 region	9 (34.6%)	13 (22.8%)	
Pain in 2 regions	2 (7.7%)	10 (17.5%)	
Pain in 3 regions	4 (15.4%)	5 (8.8%)	
Average pain intensity†,‡	0.75 (0, 1.4)	0 (0, 1.8)	0.015
Functional metrics			
ABC (0–64)†	53 (43, 59)	57 (45, 59)	0.006
PLUS M *T-Score* (21.8–71.4)†	55.8 (50.5, 61.4)	59.6 (54.0, 67.1)	0.003
FRT prosthetic side (cm)	28.2 (±9.3)	31.0 (±8.7)	0.023
FRT non-prosthetic side (cm)	28.7 (±9.0)	31.0 (±7.4)	0.105
mFSST (s)†	9.5 (8.3, 11.0)	8.5 (7.4, 10.0)	0.088

NOTE. Level of significance, $\alpha \leq 0.05$.
Abbreviations: cm, centimeter; s, seconds.
* Number of painful regions was determined by summing participant response (0=pain absent; 1=pain present) in all 3 regions, that is, low back, residual limb, and contralateral lower-limb.
† Data presented as median (25th, 75th percentile) rather than mean (±standard deviation) or N (% of sample).
‡ Average pain intensity was calculated from "current" pain intensities from all 3 regions.

and prosthesis use were reported across amputation levels, significantly ($P<.020$) fewer participants with TTA (8.8%) used an assistive device as compared with those with TFA (30.8%). Pain and functional outcomes are presented in table 2. While no between-group differences were observed for site specific pain nor extent of pain, participants with TFA (as compared with peers with TTA) reported greater pain intensities at the time of evaluation, worse ABC and PLUS-M scores, and reached less distance with the upper extremity ipsilateral to the prosthesis during the FRT.

Factors independently associated with recurrent fall-risk

Pain, functional outcomes, and their association with recurrent falls are presented in table 3. Greater recurrent fall risk was significantly associated with greater extent of pain, greater pain intensity, less balance-confidence (per ABC), worse self-reported mobility (per PLUS-M), reduced functional reach on the prosthetic side, and worse dynamic balance (per mFSST).

Table 3 Univariate associations between potential modifiable risk factors and recurrent falls

Variable	Unstandardized β	Sig.	OR	95% CI
Pain metrics				
Extent of pain*				
Pain in 1 region	0.336	0.566	1.400	0.444–4.411
Pain in 2 regions	1.099	0.108	3.000	0.786–11.445
Pain in 3 regions	2.351	0.008	10.500	1.868–59.035
Average pain intensity	0.349	0.020	1.418	1.056–1.904
Functional metrics				
ABC	-0.064	0.004	0.938	0.898–0.980
PLUS-M *T-Score*	-0.083	0.004	0.921	0.870–0.974
FRT prosthetic side	-0.062	0.027	0.940	0.890–0.993
Total valid cases, n=*82*				
FRT non-prosthetic side	-0.049	0.109	0.953	0.898–1.011
mFSST	0.267	0.045	1.306	1.006–1.696
Total valid cases, n =*69*				

NOTE. R^2 value is Nagelkerke. Total valid cases indicates participants for which data were available. Level of significance, $\alpha \leq 0.05$.
Abbreviation: Sig, significance.
* Comparison is no pain in any of the 3 locations.

Factors associated with recurrent fall-risk after adjustment

After considering covariates, greater extent of pain, lower balance-confidence, worse self-reported mobility, and reduced prosthetic-side reach were factors that were independently associated with recurrent fall risk (table 4). Specifically, adults with LLA reporting pain in all 3 regions had 6.5 times the odds of recurrent falls as compared with peers reporting no pain (*P*=.045). A 1-point increase in ABC score was associated with a 7.3% decrease in odds of reporting recurrent falls (*P*=.017). A 1-point increase in PLUS-M T score was associated with a 9.4% decrease in odds of reporting recurrent falls (*P*=.020), and a 1-cm increase in prosthetic-side reach was associated with a 7.1% decrease in odds of reporting recurrent falls (*P*=.041).

Discussion

Among adults >1 year post-amputation, presence of pain in the residual limb, non-amputated lower-limb, *and* low back resulted in a 6.5 times increased odds of the individual reporting recurrent falls in the past year, as compared with peers without pain in these 3 locations. Less balance-confidence, worse self-reported mobility, and reduced prosthetic-side reaching distance were also associated with an increased risk of reporting recurrent falls. Findings support

Table 4 Binary logistic regression results between potential risk factors and recurrent falls

	Unstandardized β	Sig.	OR	95% CI	R^2
Extent of pain					
Age	0.005	0.826	1.005	0.962–1.050	34.5%
Sex	-0.016	0.977	0.984	0.326–2.971	
Level	1.046	0.073	2.848	0.908–8.932	
TSAmp	-0.134	0.010	0.875	0.790–0.968	
Pain in 1 region*	-0.020	0.977	0.980	0.253–3.792	
Pain in 2 regions*	0.828	0.299	2.288	0.479–10.921	
Pain in 3 regions*	1.871	0.045	6.496	1.047–40.315	
Average pain intensity					
Age	-0.004	0.837	0.996	0.958–1.035	32.1%
Sex	-0.072	0.895	0.931	0.320–2.707	
Level	1.091	0.052	2.978	0.990–8.962	
TSAmp	-0.145	0.006	0.865	0.780–0.960	
Average pain intensity	0.303	0.062	1.353	0.985–1.860	
ABC					
Age	-0.026	0.229	0.974	0.934–1.017	35.8%
Sex	0.254	0.665	1.289	0.408–4.066	
Level	0.907	0.119	2.476	0.791–7.750	
TSAmp	-0.141	0.010	0.868	0.779–0.967	
ABC	-0.073	0.017	0.929	0.875–0.987	
PLUS-M					
Age	-0.029	0.197	0.972	0.930–1.015	35.0%
Sex	0.318	0.597	1.374	0.423–4.465	
Level	0.717	0.221	2.049	0.649–6.463	
TSAmp	-0.138	0.010	0.871	0.783–0.968	
PLUS-M *T-Score*	-0.094	0.020	0.910	0.840–0.986	
FRT (*Total valid cases*, n=*82*)					
Age	-0.023	0.274	0.977	0.937–1.019	33.6%
Sex	0.025	0.964	1.025	0.349–3.010	
Level	0.890	0.123	2.435	0.787–7.532	
TSAmp	-0.150	0.005	0.861	0.775–0.955	
FRT	-0.071	0.041	0.931	0.869–0.997	
mFSST (*Total valid cases*, n=*69*)					
Age	-0.020	0.416	0.980	0.934–1.029	32.3%
Sex	-0.097	0.875	0.907	0.270–3.046	
Level	1.333	0.045	3.793	1.032–13.944	
TSAmp	-0.130	0.016	0.878	0.790–0.976	
mFSST	0.269	0.105	1.309	0.945–1.814	

NOTE. R^2 value is Nagelkerke.
Level of significance, $\alpha \leq 0.05$.
Abbreviations: Sig, significance; TSAmp, time since amputation; Level, amputation level.
* Comparison is no pain in any of the 3 locations.

longitudinal investigation of identified modifiable factors, that is, pain extent, balance-confidence, self-reported mobility, and functional reach, to determine if these factors are prognostic for recurrent falls. Given less time since amputation was associated with reporting recurrent falls, it seems prudent to consider time since amputation as a critical covariate in future falls research.

A 2001 cross-sectional study suggested presence of back pain (odds ratio [OR]: 1.96, 95% confidence interval [95% CI]: 1.08-3.54) or joint pain (OR: 1.67, 95% CI: 1.01-2.74), as well as having a transfemoral-level amputation (OR: 2.78, 95% CI: 1.71-4.51) were associated with reporting ≥1 fall in the past year.[15] Adults with LLA presenting with amputations >4 years prior had a reduced odds of reporting a fall (OR: 0.53, 95% CI: 0.32-0.89).[15] Our results similarly find that greater time since amputation is associated with a reduced odds of reporting recurrent falls. In fact, time since amputation may be a more important factor than age, sex, and amputation level, when appraising recurrent fall risk among adults >1 year post-amputation.

A 2019 systematic review and meta-analysis found approximately 2 × the odds of future falls in community-dwelling older adults with multisite pain as compared with peers without multisite pain.[35] Specific to recurrent fall risk, it seems presence or absence of LBP or lower-extremity pain, in isolation, may be insufficient to discriminate between individuals at risk and not at risk for recurrent falls.[36] Among older adults with chronic LBP, the odds of falling at follow-up was found to increase by 27% (OR: 1.27, 95% CI: 1.12-1.43) for every additional pain site; for each pain site that “bothered participants a lot”, then the odds of a fall increased by 36% (95% CI: 1.15-1.62).[37] These prior findings among older adults align with our findings of a 6.5 times increased odds of recurrent falls among adults with LLA with pain in multiple locations, that is, in the low back, residual *and* sound limbs, as compared with peers without pain. Post-amputation pain resulting from mechanical stresses imparted to the lumbar spine[38] and contralateral limb may be mitigated through lower-extremity strengthening for enhanced movement symmetry. Acute RLP, such as painful dermatologic conditions, may be treated with optimization of prosthetic socket fit,[39] while targeted muscle reinnervation shows promise for persistent, neuropathic RLP.

While average pain intensity at the time of evaluation was correlated with recurrent falls, after adjusting for covariates, the relation was no longer statistically significant (P=.062). Our findings may be explained by the relatively mild pain intensity (table 2) reported by our participants, as only 8.4% reported moderate (ie, ≥4/10) pain intensity. It is likely that the relation between pain intensity and recurrent falls is influenced by pain severity. For example, among community-dwelling older adults (n=40,636; mean age: 65.8±9.3 years) increased risk of falls was found for individuals with moderate (OR: 1.35, 95% CI: 1.21-1.51) or severe (OR: 1.52, 95% CI: 1.31-1.75) pain severity, and not for individuals with mild pain.[11] Similarly, older men and women reporting severe *lower-limb* pain on most days were 100% and 40% more likely to report recurrent falls in the past year, respectively, as compared with peers with mild pain; older men and women reporting severe *LBP* on most days, were 70% and 50% more likely to report recurrent falls, respectively.[40]

Altogether, findings suggest moderate-to-severe and/or frequent pain may be a risk factor for recurrent falls; therefore, future large-scale falls studies may consider evaluating not only pain intensity but also frequency and interference. Some evidence suggests pain interference contributes to falls-related psychological concerns among older, community-dwelling adults.[41] And, greater pain interference has been cited as a risk factor for recurrent falls in the past year after adjusting for covariates (slight interference: OR: 1.66, 95% CI: 1.19-2.33; moderate-to-severe interference: OR: 2.29, 95% CI: 1.67-3.13).[42]

Functional reach, a measure of trunk stability, was associated with risk of recurrent falls post-LLA. Poor postural control and reduced proprioceptive feedback post-LLA[6] may reduce the distance an individual can reach without balance loss, thereby explaining our findings. Additionally, presence of LBP, which has been reported in up to 45% of adult post-LLA,[14] may further negatively affect postural sway.[43] Although limited, prior evidence suggests significantly reduced ipsilateral reach among adults with transmetatarsal amputation (mean age: 61.8±10.3 years; mean reach: 19.1±8.6 cm) as compared with matched controls (mean age: 62.9±8.3 years; mean reach: 31.5±9.1 cm).[44] Moreover, comparison of our adults with TFA and TTA to age-matched data from adults without LLA suggests impaired functional reach.[30] Therefore, rehabilitation interventions post-LLA might focus on improving postural control to mitigate fall risk during functional activities like reaching, turning, and transferring.[45] That said, given findings in other populations (eg, older adults),[46] the FRT, as a screening tool, may be ideally used alongside other tests to estimate falls. Specifically, determination of LLA condition-specific risk for falls (and recurrent falls) is encouraged through future, prospective falls research that considers a battery of tests to enhance diagnostic accuracy.[47] Such a battery might also be used to evaluate interventions (eg, single- and dual-task gait and balance training)[48] that have resulted in balance and functional mobility improvements in adults with LLA, which might also reduce fall risk.

A 2021 systematic review with meta-analysis found balance and mobility were 1 of 4 domains associated with recurrent falls among older adults,[27] thus, in additional to Functional Reach, other balance and mobility measures might be considered. Given our findings, we suggest balance-confidence and prosthesis-enabled mobility warrant further exploration as key modifiable predictors of recurrent falls. Wong et al reported among adults with LLA that a 1% increase in ABC (0%-100% scale) corresponded to a 2.3% reduction in the odds of reporting a fall in the past year.[49] We expand on this research, reporting a 1-point increase in ABC score (0-64 points) is associated with a 7.3% decrease in odds of reporting recurrent falls. Preliminary evidence among adults with LLA (n=16) suggests balance-confidence can be enhanced with a biweekly supervised exercise program including stretching, trunk, and lower-extremity strengthening, as well as gait and balance activities.[50] Post-intervention, balance-confidence significantly increased to 73.6% from 63.4% (P=.001; effect size=.522),[50] although replication of the study using a patient sample with a control group and long-term follow-up is necessary before widespread adoption of this intervention in clinical practice.

After considering covariates, individuals with LLA scoring in the lowest PLUS-M tertile have been found to have 2.29 higher odds of a history of an injurious fall (95% CI: 1.96-

2.69) as compared with those with higher mobility levels.[51] In a prospective, observational study of 60 adults with LLA, number of recalled falls in the past year combined with PLUS-M T score predicted falls incidence over the subsequent 6 months.[52] Combined with our findings, use of PLUS-M in screening for fall risk seems promising, adding to the tool's clinical utility as a measure for evaluating change in functional mobility post-LLA. For example, PLUS-M scores have been shown to improve with mobility clinics that include strengthening exercises, peer support, and participation in group-based sports and recreational activities.[53]

Study limitations

While this study is among the first evaluating pain and falls post-LLA, participants rated only "current" pain; given daily pain fluctuations, rating of "average" pain intensity over 7 days may be preferred. Future use of body diagrams may enable more thorough assessment for multisite pain. Because of the sample size, the number of covariates included was limited, but larger-scale falls studies might consider other potential covariates, for example, comorbidities, number of medications, health-related quality-of-life, lower-extremity strength, prosthetic components, functional mobility level, and/or physical activity.[54,55] Further, results should only be generalized to community-dwelling adults with unilateral TFA and TTA LLA, who are acclimated to using a traditional socket prosthesis, and not minors, those with bilateral LLA, or osseointegrated prostheses, which may result in different somatosensory input. Lastly, while findings may inform future prospective cohort studies evaluating risk for recurrent falls post-LLA, given our cross-sectional study design, factors identified should be considered "potential" risk factors. Without prospective research, ideally using remote monitoring tools (eg, accelerometers, falls calendars) to mitigate falls reporting bias, it is unclear whether identified factors are predictors of falls, or the result of falls.

Conclusions

Of the 83 adults with unilateral TFA or TTA occurring >1 year prior, 36% reported recurrent falls. Presence of pain in the low back and both lower extremities, less balance-confidence, worse functional mobility, and prosthetic-side reaching were modifiable factors associated with an increased odds of recurrent falls and should be considered as potential risk factors in future prospective recurrent falls research.

Suppliers

a. SPSS v28; IBM Corp

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