


RESEARCH ARTICLE

A survey for characterizing details of fall events experienced by lower limb prosthesis users

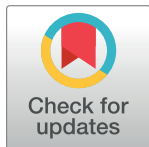
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Abstract

Despite their importance to fall prevention research, little is known about the details of real-world fall events experienced by lower limb prosthesis users. This gap can be attributed to the lack of a structured, population-specific fall survey to document these adverse health events. The objective of this project was to develop a survey capable of characterizing the circumstances and consequences of fall events in lower limb prosthesis users. Best practices in survey development, including focus groups and cognitive interviews with diverse samples of lower limb prosthesis users, were used to solicit input and feedback from target respondents, so survey content would be meaningful, clear, and applicable to lower limb prosthesis users. Focus group data were used to develop fall event definitions and construct a conceptual fall framework that guided the creation of potential survey questions and response options. Survey questions focused on the activity, surroundings, situation, mechanics, and consequences of fall events. Cognitive interviews revealed that with minor revisions, survey definitions, questions, and response options were clear, comprehensive, and applicable to the experiences of lower limb prosthesis users. Administration of the fall survey to a national sample of 235 lower limb prosthesis users in a cross-sectional preliminary validation study, found survey questions to function as intended. Revisions to the survey were made at each stage of development based on analysis of participant feedback and data. The structured, 37-question lower limb prosthesis user fall event survey developed in this study offers clinicians and researchers the means to document, monitor, and compare fall details that are meaningful and relevant to lower limb prosthesis users in a standardized and consistent manner. Data that can be collected with the developed survey are essential to establishing specific goals for fall prevention initiatives in lower limb prosthesis users.

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1.0 Introduction

Falls in lower limb prosthesis (LLP) users remain as common and consequential today as they were over 20 years ago [1–8]. Between 1996 and 2001, 50 to 58% of LLP users reported experiencing one or more falls in the previous year [1, 2, 6], while 21–29% of LLP users reported some form of injurious fall over the same time period [2, 6]. More than 20 years later, 48 to 60% of LLP users similarly report one or more falls a year [3–5, 9]. Likewise, estimates of the proportion of LLP users experiencing one or more injurious falls a year remains between 18 and 26% [7, 8]. Attempts to reduce the frequency of falls and their health-related consequences in LLP users over the past 20 years have generally focused on: i) developing and validating clinical tests to assess fall risk [4, 5, 10–12], ii) designing and testing prosthetic components to improve patient safety [13–16], iii) quantifying biomechanical balance responses to identify deficits in key balance recovery strategies [17–23], and iv) identifying modifiable and non-modifiable risk factors [1, 2, 7, 8, 24, 25]. Given that issues related to falls continue to plague LLP users, alternative approaches to reduce falls in LLP users may be needed.

A key challenge to mitigating falls in LLP users may be illustrated by the public health model [26], a systematic four-stage process that has been used to address falls in older adults [27]. The first stage of the model is a comprehensive description of the problem (i.e., characterizing the circumstances and consequences of fall events) [27]. Knowledge of how, where, and when falls occur is intended to direct research in the model's later three stages; the identification of risk factors, the design and evaluation of interventions, and the translation as well as implementation of those interventions found to be effective [28]. The public health model indicates that a thorough description of fall events is a critical first step, and without such information there is little knowledge to inform the design, testing, and implementation of effective fall prevention initiatives [3, 29].

Despite the importance of this foundational epidemiological data, little is known about the circumstances and consequences of fall events in LLP users [2, 3, 6, 8, 29]. This gap can be attributed to the lack of a structured and clinically-meaningful fall event survey with which to solicit details of LLP users' fall events [30]. While fall surveys have been developed for older adults [31–42], they may not include details of falls experienced by LLP users. Prior work has illustrated that LLP users' mobility experiences are unique [43], and their fall experiences are distinct [44]. In the absence of a structured survey to gather such information, past efforts to characterize fall events in LLP users have been limited to data collected using ad hoc questionnaires [2, 6, 8, 16] or unstructured interviews [3, 29]. Subsequently, the resulting fall circumstance and consequence data lack the detail and consistency needed to advance fall prevention research and care in this clinical population. A fall survey developed to be meaningful, clear, and applicable to LLP users would greatly improve the quality and consistency of fall data collected in both research and clinical care. An improved ability to document and therefore understand how, where, and when LLP users fall would also help to direct fall prevention interventions to the most prevalent and consequential types of falls [45–47], prioritize research needs related to fall risk assessment [48], and generate evidence to develop and revise reimbursement policies. The objective of this project was therefore to develop a structured, population-specific, fall survey capable of comprehensively characterizing the circumstances and consequences of fall events in LLP users.

2.0 Materials and methods

2.1 Overview

Best-practices in survey development and evaluation were used to design and test the lower limb prosthesis (LLP) user fall event survey [43, 49–51]. All qualitative methods, and the

reporting of their results, adhered to published guidelines and standards [52, 53]. First, focus groups were conducted to identify scenarios and terminology central to the fall experiences of LLP users [44]. These data were used to develop meaningful fall event definitions, construct and revise a conceptual fall framework, create potential fall survey questions and response options that were meaningful, clear, and applicable to LLP users [50, 54–56]. Next, cognitive interviews were conducted to evaluate the clarity, comprehension, and applicability of the proposed fall event definitions, survey questions, and response options. Finally, in a preliminary validation study, a draft of the fall event survey was administered to a national sample of LLP users to test whether the survey functioned as intended (e.g., does the survey yield falls data consistent with expectations, and that available in the literature). Revisions to the survey were made at each stage of the study based on participant feedback, data collected with the fall event survey, and consensus among study investigators.

2.2 Participant recruitment and sampling

Focus group and cognitive interview study participants were recruited from across the United States via research registries, and print, email and Internet postings. Inclusion criteria included: i) lower limb amputation at or between the ankle and hip, ii) age greater than 18 years, iii) self-reported history of one or more falls in the past year, iv) use of a prosthesis, v) reported ability to speak and read English, and vi) agreement to have the discussions recorded and transcribed for subsequent analysis. Candidates were excluded if they could not complete a preliminary intake questionnaire or participate in a group discussion. Participants were purposively sampled [57] so that a range of perspectives might be solicited, thereby deepening our understanding of LLP users' fall experiences [58, 59]. Across all focus groups and for each set of questions tested in cognitive interviews, study investigators sought participation from at least two participants who were: i) transfemoral LLP users, ii) bilateral LLP users, iii) female, iv) greater than 50 years old, v) less than 1-year post-amputation, vi) of dysvascular amputation etiology, and vii) a Veteran or Service member.

Participants in the preliminary validation study were recruited from across the United States via a research registry and study flyers posted by professional and clinical partners. Quota sampling was used so that participants with a range of mobility levels could be surveyed. Specifically, participants were screened based on their Prosthetic Limb Users—Mobility (PLUS-M) T-score, with the goal of ensuring representation across all levels of mobility. Inclusion criteria for completing the fall survey included: i) lower limb amputation at or between the ankle and hip (in one or both legs), ii) age 18 years or older, iii) current use of a prosthesis, iv) use of a prosthesis for 6 months or more, and v) reported ability to speak and read English. No additional exclusion criteria were applied.

2.3 Data collection and analysis

2.3.1 Focus group study. Focus groups were convened to understand falls from the perspective of LLP users. Details outlining procedures for these focus groups were previously reported [44]. Briefly, focus groups were conducted via video conferencing to accommodate participants from across the United States. Focus group size was limited to 8 individuals in order to encourage input and discussion among all participants [60]. Seven open-ended guiding questions [44], conceived before conducting the focus groups and modeled after published guidelines [61], were used to promote discussion of shared experiences and vocabulary pertinent to fall events among LLP users [62]. To limit strong personalities from disproportionately driving the discussion, all participants were encouraged to voice their experiences [54, 63, 64].

Focus group discussions were transcribed in real-time to facilitate data analysis [65]. Focus groups were conducted until no new themes or concepts emerged [56, 66].

Six themes, found to characterize the fall experiences of LLP users, were used to construct a conceptual framework of falls in LLP users [44]. Formulation of these themes is described in detail elsewhere [44]. Briefly, an iterative and inductive process was used to review and organize focus group themes into higher level domains and identify potential relationships between each of the resulting domains [56]. In accordance with established standards [67], the ensuing fall framework was used to define content areas that would be measured by the survey. The framework also guided a review of existing fall surveys and related literature to help develop candidate items for the LLP user fall event survey. Gaps identified in the literature were addressed through the development of new questions and/or response options, subject to additional testing and revision following the cognitive interview and validation studies. Terminology used by LLP users in the focus groups to describe fall events (i.e., falls and near-falls) was also identified and used to create relevant and meaningful definitions that would be accessible to LLP users. Initial definitions were subject to further testing and revision during cognitive interviews.

2.3.2 Cognitive interview study. Cognitive interviews were conducted via telephone to accommodate local and national participants. Consistent with the development of other LLP user-specific surveys [51], retrospective verbal probing was used to evaluate survey instructions (including event definitions), questions, and response options [50, 51, 68, 69]. In this approach, each participant first completed an electronic copy of the initial fall event survey. Immediately after, verbal probing was used to solicit information about the thought processes used by each participant to answer select survey questions [70]. Five interview guides consisting of scripted open-ended questions (i.e., probes) were used to assess candidate survey questions and their response options for clarity (i.e., was the intended purpose of the question clear), comprehension (i.e., was the question understood similarly across participants), and applicability (i.e., could the question be answered using the given response options) [70] (S1 Appendix). Each interview guide included the same probes about survey instructions, fall event definitions, and fall history. Interview guides were limited to probing 4 to 6 of the survey questions to help participants remember how they arrived at their response, limit interview time, and ensure that each question was reviewed by at least 5 participants [62]. The 4–6 survey questions differed in each of the interview guides. The order of the questions within each interview was randomized. Areas of the survey from which questions and probes were developed were mixed across interview groups (e.g., questions about fall consequences were distributed across cognitive interview groups rather than presented in just one group). Interviews were audio-recorded and combined with field notes for subsequent analysis.

Following cognitive interviews, summaries of respondents' feedback were collated. Feedback that suggested fall event definitions were unclear or non-distinct was used to inform revisions to the definitions. Feedback that suggested the interpretation of survey questions and/or their response options differed among participants, varied from what study investigators intended, or found response options to be mutually exclusive or insufficient to answer a survey question was also used to inform revisions to the survey. Finally, feedback on aspects of balance and falls that respondents considered important, but were not included in the survey, was used to make additions to the survey. Revisions to survey content that included the addition, subtraction, substitution, or re-arrangement of a word or phrase that did not change the meaning of a question, or served to simplify the meaning of the question, were considered minor. Revisions in excess of these minor edits were considered substantial, and the relevant instructions, question(s) and/or response options(s) were subject to re-

assessment via additional cognitive interviews. Questions and response options that required no or only minor revisions, as well as those that were successfully revised and confirmed to function as intended, were included in the fall event survey that was administered in a preliminary validation study.

2.3.3 Preliminary validation study. A preliminary version of the fall event survey was then administered in a cross-sectional study to a national sample of LLP users. Study investigators sought to determine if survey questions operated as intended (i.e., data collected were consistent with expected patterns and existing literature), provided adequate coverage of fall-related circumstances and consequences experienced by LLP users, and included questions and response options that LLP users could recall. LLP users found to meet inclusion and exclusion criteria were sent a personal link to a secure REDCap application, where they could complete the survey online. Reminders to complete the survey were sent to potential participants up to four times. Participants were instructed to complete the fall survey based on their “most significant fall event” in the past year. This fall event was chosen with the intent of maximizing the confidence and accuracy with which fall circumstances and consequences were recalled by study participants [71]. “The most significant fall event” was also expected to increase the probability that study participants would need to endorse response options within the consequences section of the survey, serving therefore as a better “stress test” for the instrument than ones’ “most recent fall”.

To determine if survey questions operated as intended, Chi-square and McNemar tests were run to test for expected associations between fall circumstances and consequences (e.g., forward fall and impact with hands or knees), as well as expected patterns in survey responses (e.g., “*problem with prosthesis*” and “*wearing prosthesis*” were endorsed together). For statistical tests, α was set to .05. Statistical analyses were conducted using SPSS Statistics 28 software (IBM, Chicago, IL). The frequency of endorsement and content of participants’ responses to the open-ended “*Other*” response option included with each question in the preliminary validation study survey was analyzed to assess and enhance the range of fall circumstances and consequences included in the fall event survey. When previously overlooked response options were suggested by multiple participants, and were not addressed in subsequent questions, they were added to the final survey. Finally, to determine whether the level of detail queried by the fall event survey could be recalled by LLP users, study investigators calculated: i) the frequency with which participants in the preliminary validation study endorsed the “*do not remember*” response option for each question, and ii) the percentage of participants who responded to the question “*how much confidence do you have in the details you provided*” by selecting *no confidence, low confidence, moderate confidence, high confidence, and complete confidence*.

For each study, demographic, health, and amputation characteristics were collected, along with Activities-specific Balance Confidence (ABC) scores [72] and Prosthetic Limb Users Survey—Mobility (PLUS-M) T-scores [73] to characterize participants’ balance confidence and mobility, respectively. Measures of central tendency and dispersion, or frequency and proportion, were calculated to describe the demographic, health, amputation, balance, and mobility-related characteristics of the study samples.

The readability of final survey, and its constituent parts (i.e., instructions, definitions, questions and response options), was measured with the Flesh-Kincaid reading grade level [74]. Study protocols were reviewed and approved by institutional review boards at the University of Illinois at Chicago and the University of Washington. All individuals provided consent prior to participation.

3.0 Results

3.1 Focus group study: Terminology and the lived experience of lower limb prosthesis users

3.1.1 Definition of fall and near-fall events. Review and thematic analysis of focus group discussions guided by the question “*how would you describe a fall?*” revealed that participants described two types of similar events, falls and near falls. Focus group participants (n = 25, Table 1) [44] described how these events had a common element (i.e., both required a loss of balance), but ended with different outcomes (i.e., a fall ended with them being on the floor or ground, while a near-fall ended with them remaining on their feet).

Based on these descriptions, we created a model of these fall events with three distinct elements: i) the precursor, ii) the point of departure, and iii) the outcome (Fig 1). Across focus

Table 1. Focus group (FG) study participant characteristics (n = 25).

	FG 1	FG 2	FG 3	FG 4	FG 5	Overall
	n = 6	n = 7	n = 4	n = 5	n = 3	n = 25
	n	n	n	n	n	n (%)
Gender						
Male	4	5	2	2	3	16 (64)
Female	2	2	2	3	0	9 (36)
Amputation level						
Bilateral (TT and TF)	0	2	0	1	1	4 (16)
Transfemoral	3	2	1	3	0	9 (36)
Transtibial	2	5	3	1	3	14 (56)
Amputation etiology						
Trauma	2	3	2	1	4	12 (48)
Dysvascular	2	1	0	2	1	6 (24)
Infection	1	1	1	1	0	4 (16)
Cancer	0	0	1	1	0	2 (8)
Other	0	0	1	0	0	1 (4)
Highest level of education						
Some college	1	2	2	2	2	9 (36)
College degree	2	4	1	0	1	8 (32)
Advanced degree	3	1	1	3	0	8 (32)
Other characteristics						
> 50 years old	6	6	1	4	3	20 (80)
<1 yr prosthetic experience	0	0	0	0	1	1 (4)
Military veteran	1	2	1	1	1	6 (24)
≥ 1 fall in past year	5	7	3	4	3	22 (88)
	Median (Median Absolute Deviation)					
Age (years)	63.5 (6.5)	64.0 (4.0)	44.5 (7.0)	66.0 (6.0)	59.0 (5.0)	59.0 (9.0)
Time since amputation (years)	15.0 (7.0)	18.0 (10.0)	8.5 (3.0)	44.0 (7.0)	5.0 (4.0)	17.0 (10.0)
Hours wearing prosthesis/day	15.5 (0.5)	15 (1.0)	15 (1.5)	16 (1.0)	10 (1.0)	15 (1.0)
Hours walking with prosthesis/day	2.5 (0.5)	4.0 (2.0)	9.0 (3.0)	8.0 (4.0)	8.0 (0.0)	6.0 (3.0)
PLUS-M (T-score)	50.6 (3.2)	51.2 (3.5)	49.9 (3.5)	53.6 (7.8)	49.1 (9.3)	51.2 (4.1)
ABC (0–4)	2.81 (0.47)	3.06 (0.32)	2.50 (0.28)	2.81 (0.56)	2.19 (0.50)	2.81 (0.57)
Number of falls in past year	2.0 (1.0)	2.0 (0.0)	2.0 (1.0)	3.0 (2.0)	2.0 (2.0)	2.0 (1.0)

ABC: Activities-specific Balance Confidence scale; FG: Focus Group; hrs: hours; PLUS-M: Prosthesis Limb Users Survey—Mobility; TF: Transfemoral; TT: Transtibial

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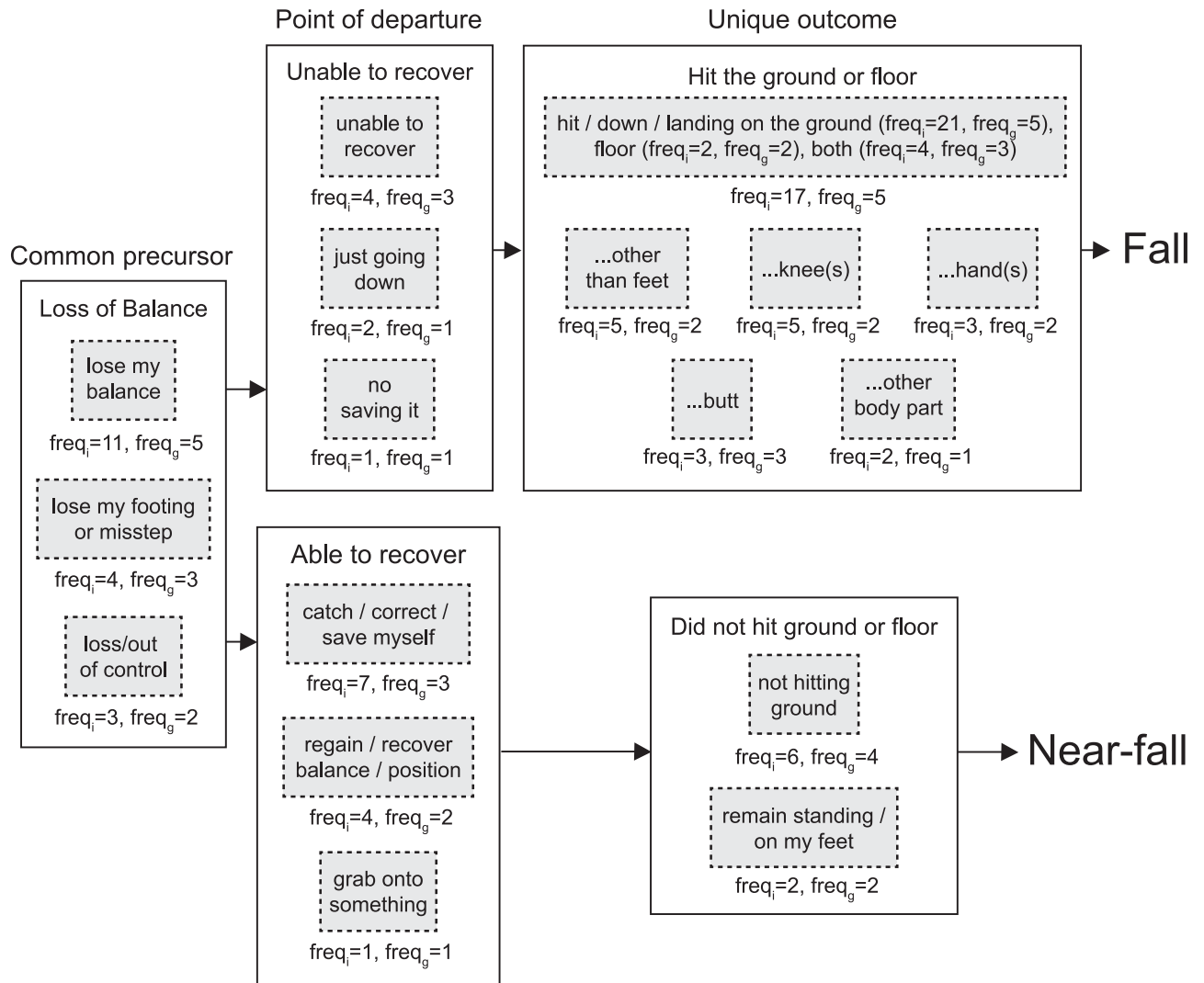


Fig 1. Formulation of the fall event definitions. Definitions for two overlapping yet unique fall events were proposed, tested, revised, and ultimately understood by lower limb prosthesis users. The focus group excerpts and the frequency with which they were used by the 25 individual lower limb prosthesis users (i.e., *freq_i*) regardless of focus group, as well as across the five focus groups (i.e., *freq_g*) are presented. Common to both falls and near-falls was a loss of balance. The ability or inability to recover marked the point of divergence between the two events, each ending in a unique outcome (i.e., hitting the ground / floor or not).

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groups, participants described how a loss of balance was a common feature of falls and near-falls (i.e., a common precursor).

“A fall is any time that I either lose my balance or lose my footing.”

(gender: Male, age: 54 years old, level of amputation: bilateral transtibial (TT), time since amputation: 5 years since amputation)

“I lose my balance and then have to grab on to something to stop me from hitting the ground.”

(Female, 59 years old, TT, 8 years since amputation)

The ability to recover one's balance appeared to be the point at which falls and near-falls diverged for focus group participants. Participants consistently described a fall as an event where they were unable to recover from the loss of balance.

"A fall is when there's no saving it."

(Male, 64 years old, bilateral TT, 43 years since amputation)

"Once I start going down and I can't recover, to me that's a fall."

(Female, 57 years old, TT, 4 years since amputation)

In contrast, participants indicated that near-falls were those events where they were able to catch themselves and recover their balance.

"If I catch myself, I do not consider that a fall"

(Male, 81 years old, TF, 10 years since amputation)

"I was thinking that the sensation you are losing your balance and could fall, but were able to recover"

(Female, 57 years old, TT, 4 years since amputation)

Falls and near-falls were also described by focus group participants as having unique outcomes. A fall included contact with the floor or ground by parts of the body other than the feet. Some participants described specific examples of body parts (e.g., hands, knees) that made contact during a fall, while others were less specific.

"Going all the way down to the ground is what I consider a fall"

(Male, 59 years old, TT, 8 years since amputation)

"When I have actually gone all the way to the ground, where I actually touched the knee or both knees to the ground is what I consider a fall"

(Female, 52 years old, TF, 30 years since amputation)

Conversely, participants noted that with a near-fall, they did not contact the ground or floor.

"I have lost my balance, but didn't actually, you know, end up on or against any other surface or floor"

(Female, 43 years old, TT, 16 years since amputation)

"[A near-fall is when you] Lost your balance and perhaps, you know, caught yourself before hitting the ground"

(Male, 46 years old, TF, 50 years since amputation)

Notably, participants differentiated between the terms "floor" and "ground," which they felt related to indoor and outdoor surfaces, respectively[44]. These comments suggest that both terms should be included in any definition of a fall event.

“The [phrase] “on the ground,” indicates that it’s an outdoor activity. People can fall indoors all the time. I did. And I didn’t hit the ground. I hit my bedroom floor.”

(Male, 76 years old, TT, 8 years since amputation)

Additionally, participants used colloquial terms such as slip, trip, and/or stumble interchangeably when describing fall events. These terms were also used when referring to both fall and near-fall events. Further, the perceived mechanics associated with terms like “slip” (e.g., direction your feet move relative to your body) differed between participants (e.g., “feet would normally go back, maybe sideways”, “forward”, “Not really sure. Could it be any direction?”). Study investigators therefore made a concerted effort to avoid colloquial terms such as slip, trip, and/or stumble in the fall event definitions as they may lead to inconsistencies in data collection and/or clinical assessments.

Based on these findings, the following initial definitions for falls and near-falls were proposed for the LLP user fall event survey: a *fall* is an accidental loss of balance where your body landed on the ground or floor, and a *near-fall* is an accidental loss of balance where you caught yourself or recovered your balance before your body landed on the ground or floor.

The clarity and comprehension of these initial definitions were evaluated based on cognitive interview participant feedback (n = 25 LLP users, [Table 2](#)). Revisions to each definition were made to resolve identified misinterpretations.

Cognitive interview participants almost universally agreed that the definitions were clear.

“Yes, the definitions were clear.”

(Female, 65 years old, TF, 10 years since amputation)

“I understood each of the definitions. They were both straightforward.”

(Female, 52 years old, TF, 32 years since amputation)

Participants were also able to describe how the two definitions differed, recognizing that a fall and near-fall are two distinct events, each with a unique outcome.

“You were having me think about two different events. They end differently.”

(Male, 69 years old, TF, 52 years since amputation)

“I assume the distinction is between a temporary loss of balance that is recovered versus not being able to recover and landing on the floor.”

(Male, 81 years old, TT, 12 years since amputation)

Despite general acceptance and a stated ability to distinguish between the two definitions, cognitive interview participants recommended minor modifications. Namely, words like “accidental” were deemed as implied, self-explanatory, or intuitive, and therefore unnecessary by more than half of cognitive interview participants.

“Words like accidental are self-explanatory, maybe don’t use it. I don’t intend to fall.”

(Female, 65 years old, bilateral: TT/TF, 11 years since amputation)

“I’m not sure that accidental is necessary, seems implied.”

Table 2. Cognitive interview (CI) study participant characteristics (n = 25).

	CI 1	CI 2	CI 3	CI 4	CI 5	Overall
	n = 5	n = 5	n = 5	n = 5	n = 5	n = 25
	n	n	n	n	n	n (%)
Gender						
Male	4	5	4	3	4	20 (80)
Female	1	0	1	2	1	5 (20)
Amputation level						
Bilateral (TT and TF)	1	1	1	0	0	3 (12)
Transfemoral	2	2	3	2	3	12 (48)
Transtibial	3	3	3	3	2	14 (56)
Amputation etiology						
Trauma	2	3	2	1	4	12 (48)
Dysvascular	2	1	0	2	1	6 (24)
Infection	1	1	1	1	0	4 (16)
Cancer	0	0	1	1	0	2 (8)
Other	0	0	1	0	0	1 (4)
Highest level of education						
Some college	2	0	0	3	2	7 (28)
College degree	2	3	2	2	2	11 (44)
Advanced degree	1	2	3	0	1	7 (28)
Other characteristics						
> 50 years old	5	3	3	3	5	19 (76)
<1 yr prosthetic experience	0	1	0	1	1	3 (12)
Military veteran	0	1	3	0	2	6 (24)
≥ 1 fall in past year	3	4	5	2	4	18 (72)
	Median (Median Absolute Deviation)					
Age (years)	68 (3.0)	60 (9.0)	66 (15)	60 (5.0)	64 (6.0)	64 (5.5)
Number of co-morbidities	2.0 (1.0)	1.0 (0.0)	1.0 (0.0)	1.0 (1.0)	0.0 (0.0)	1.0 (1.0)
Time since amputation (years)	10 (3.0)	12 (3.0)	25 (9.0)	18 (0.0)	19 (13)	18 (8.5)
Hours wearing prosthesis per day	10 (2.0)	16 (1.0)	15 (1.0)	16 (1.0)	14 (3.0)	14 (2.0)
Hours walking with prosthesis/day	3.0 (1.0)	10 (5.0)	7.5 (4.5)	3.3 (1.8)	5.0 (1.0)	5.0 (3.0)
PLUS-M (T-score)	56.3 (1.0)	54.4 (5.2)	47.7 (5.2)	47.1 (4.9)	55.3 (1.7)	54.4 (3.4)
ABC (0–4)	3.38 (0.13)	3.44 (0.56)	2.88 (0.38)	2.40 (0.98)	3.38 (0.63)	3.16 (0.53)
Number of falls in past year	1.0 (1.0)	2.0 (2.0)	1.0 (0.0)	1.0 (1.0)	2.0 (1.0)	1.0 (1.0)
Number of near-falls in past year	4.0 (1.0)	4.0 (2.0)	5.0 (1.0)	2.0 (0.0)	2.0 (2.0)	3.5 (2.5)

ABC: Activities-specific Balance Confidence scale; CI: Cognitive Interview; PLUS-M: Prosthesis Limb Users Survey—Mobility; TF: Transfemoral; TT: Transtibial

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(Male, 60 years old, TT, 10 years since amputation)

Based on these recommendations, and a goal of keeping the definitions as brief and simple as possible, the word “accidental” was removed from the definitions. The fall and near-fall definitions were therefore revised to: a *fall* is a loss of balance where your body landed on the ground or floor, and a *near-fall* is loss of balance where you caught yourself or recovered your balance without landing on the ground or floor. The Flesch-Kincaid reading grade level of these final definitions was 3.9 for falls and 7.0 for near-falls. Both were reduced relative to the grade levels of the initial definitions (i.e., 6.3 and 10.9, respectively).

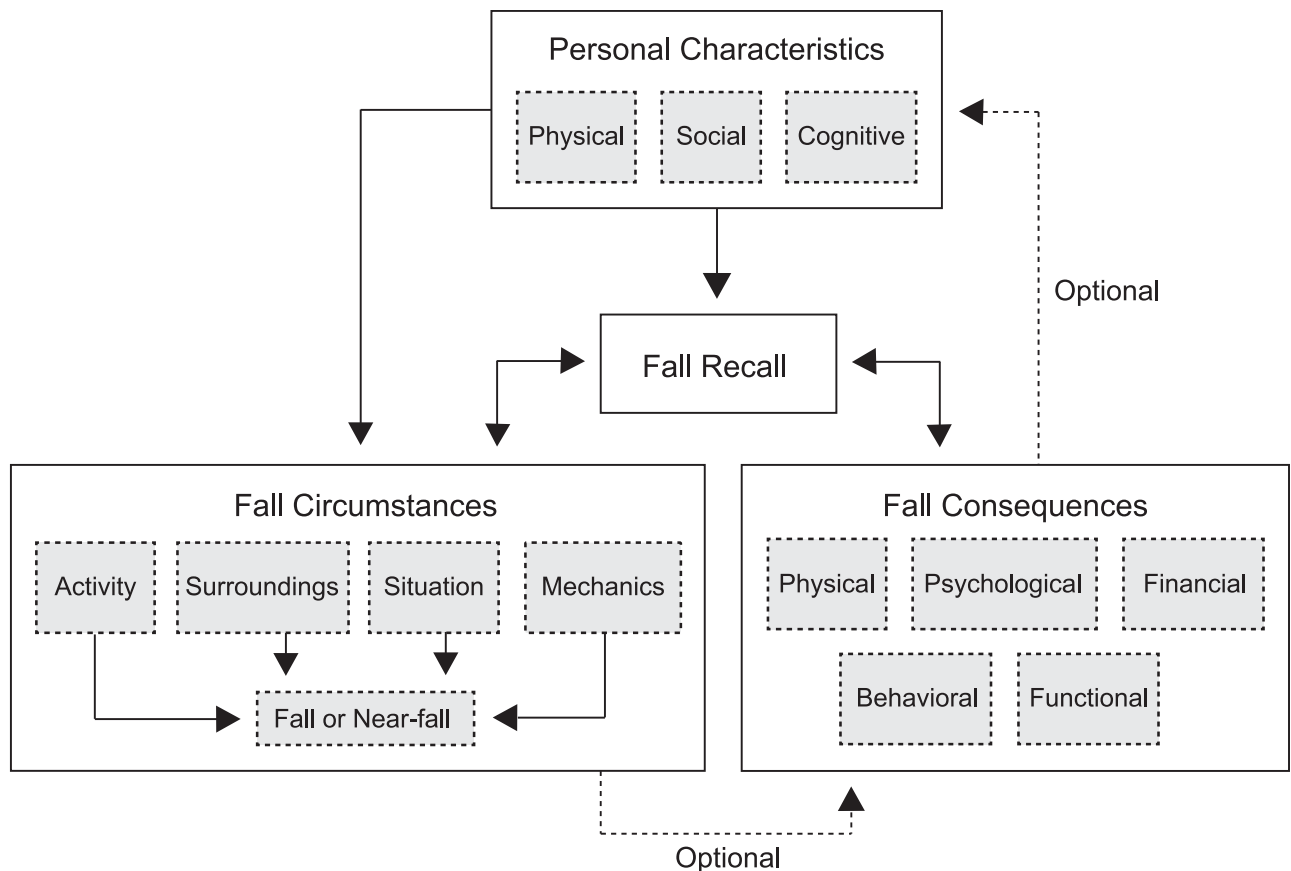


Fig 2. Conceptual framework of fall events in lower limb prosthesis users. The conceptual framework was used to identify, select, and test questions in the fall event survey that are relevant to LLP users.

<https://doi.org/10.1371/journal.pone.0272082.g002>

3.1.2 A conceptual framework of falls in LLP users. A conceptual framework of falls in LLP users was developed based on the six themes identified from a previously-published qualitative analysis of focus group discussions with LLP users (Fig 2) [44]. The proposed framework consists of four primary components: personal characteristics, fall circumstances, fall consequences, and fall recall. The first component, personal characteristics, includes features of the individual that may affect the likelihood of a fall or near-fall. These include physical characteristics such as age, strength, and/or features of the amputation and prosthesis; cognitive factors such as attention and reasoning; social factors like living situation and education level, as well as emotional characteristics such as anxiety and depression. Personal characteristics are not assessed by the fall event survey, but rather via existing health questionnaires or scored self-report outcome measures. The second component of the framework, fall circumstances, refers to settings in which the fall event occurs or actions that take place prior to and during a fall event. These include the surroundings (e.g., immediate physical environment and social setting), activity (e.g., action being performed leading up to fall event), situation (e.g., conditions that may have disrupted the users balance or contributed to the fall) and fall mechanics (e.g., motions of the body during a fall event, and impact location). The third component of the framework, consequences, describes short- and long-term outcomes of the fall event. Consequences may be physical (e.g., injury), financial (e.g., medical costs, missed work), functional (e.g., change in how activities are performed), behavioral (e.g., change in the extent to which

activities are performed), and psychological (e.g., reduced balance confidence, embarrassment). As not all fall-related events will be associated with negative health outcomes, there may not always be consequences associated with an event. Finally, fall event recall, the fourth component, captures two temporal features within the framework, what LLP users remember about the event and for how long they remember the details of the event, up to and including remembering the event at all.

The components of the framework can act on and influence each other. For example, personal characteristics may influence the circumstances and consequences of a fall. If someone has osteoporosis, they may be more likely to break a bone in a fall, or if someone is a limited ambulator, they may be more likely to fall indoors. Not all falls will necessarily result in negative health outcomes, thus there may be no consequences to a fall. When they do occur, however, consequences may modify personal characteristics if they are of sufficient severity and/or persistence.

3.1.3 Development of initial fall survey questions and response options. Guided by the fall framework, a review of existing fall circumstance and consequence literature was performed to direct the development of survey questions and response options. Previous research regarding the circumstances of fall events were found to most often characterize the immediate physical surroundings (11 studies), followed by the fall mechanics (10 studies), activities being performed during a fall (7 studies), and situation (6 studies) immediately preceding or at the time of a fall [32, 35–42, 75, 76].

Details related to fall surroundings were found to have mainly focused on the location of the fall (e.g., indoors, outdoors) [35, 37–39, 41, 76]. Characteristics of the ground or floor (e.g., smooth, dry, icy, rough, uneven) were assessed less frequently, and often probed using specific examples (e.g., grass/leaves, cement/pavement) rather than general features (e.g., hard, uneven) [38, 39, 75].

Research on the activity performed at the time of a fall has largely concentrated on activity type (e.g., walking, turning, reaching, transfers) [32, 35, 36, 38, 41, 42, 75, 76]. The details of the activity (e.g., speed and direction) [76], or whether an assistive device (e.g., cane, walker) was being used at the time of the fall [32, 33, 75, 77] were rarely examined.

Attempts to characterize situation(s) contributing to a loss of balance were found to have included physiological [32, 37–39, 41] and mechanical disruptions [32, 37–39, 41, 75, 76] (e.g., dizzy, on medication, caught foot, slipped, misplaced step), as well as specific tasks that may distract or divert one's attention (e.g., texting, talking on phone) [32, 40, 75, 76]. Noted gaps in prior work included asking respondents about prosthesis-specific situations (e.g., prosthesis not on properly, prosthesis moved unexpectedly), as well as details about which leg was involved.

Interest in fall mechanics have generally focused on fall direction (e.g., forward, to the side) [32, 39, 40, 76], and to a lesser extent, impact location (e.g., hip, knees, hand) [35, 36, 39, 75]. Far less attention has been paid to the documentation of strategies intended to prevent/stop the fall and/or minimize risk of injury (e.g., modifying step placement, body rotation) [32].

With respect to consequences, immediate physical injury (e.g., fracture, contusion, concussion) [32, 36–38, 42, 75, 76, 78–81], followed by whether treatment was sought and/or received [36–38, 40, 41, 75, 76, 80, 82, 83], have been the main focus. Fewer studies have sought to describe the functional and behavioral consequences (e.g., changes in *how* or *what* activities are performed, respectively) [37, 41, 76, 84], psychological responses to fall events (e.g., decreased balance confidence, embarrassment) [40, 84], or whether the prosthesis incurred any damage.

Questions and response options were developed to address each of the content areas defined by the fall framework. Underserved areas identified in the literature, including but not

limited to surface characteristics and terrain grade; the speed and direction of activity; whether an assistive device was being used; the fit, function, or role of the prosthesis; which leg was involved; impact location(s); strategies to recover balance and/or minimize the risk of injury; as well as functional and emotional consequences of fall events were purposively targeted during question development.

The initial LLP user fall event survey produced after focus groups with LLP users consisted of 24 closed-ended questions, assessing the activity, surroundings, situation, mechanics, and consequences of fall-related events.

3.2 Cognitive interview study: Quality, clarity, and comprehension of survey content

Instructions, questions, and response options included in the initial fall event survey were revised based on feedback from cognitive interview participants (n = 25, Table 2).

3.2.1 Instructions. All 25 cognitive interview participants reported having read the instructions prior to answering the survey questions. Participants described the instructions as “straightforward”, “clear”, and “[not] confusing.” No suggestions for additional improvements were offered.

3.2.2 Response options combined dissimilar alternatives. Some response options were described by cognitive interview participants as confusing because they combined two distinct alternatives. For example, participants reported uncertainty when selecting the response option “You were avoiding an obstacle or object” because they indicated that obstacles were generally smaller than objects, and as such, different strategies would be used to avoid them (e.g., stepping over an obstacle versus moving around an object). Participants also reported difficulty selecting “going up a ramp, hill, or incline” because a hill would be outdoors, larger, and steeper, while a ramp would be manmade, indoors, shorter, and have only a moderate incline. Study investigators chose to resolve issues such as these by splitting the response option into two (e.g., going up a hill, going up a ramp).

3.2.3 Response options were unclear. Cognitive interview participants also identified issues of clarity, where their perceptions of responses options differed from what the study investigators intended. For example, the term “sloped” was interpreted as synonymous with ramp, hill, or uneven terrain, when it was intended to refer to a surface that slanted to the side, placing a LLP user’s feet at unequal heights. To avoid confusion, study investigators removed this response option from the question “what was the ground or floor like when you fell or nearly fell?”. Participants’ view of several response options associated with the question “What part(s) of your body hit the ground, floor, or other surface when you fell or nearly fell?” also differed from what study investigators intended. For example, response options including “lower arm” and “calf” were interpreted to be any part of the arm below the shoulder, and the calf muscle rather than any portion of the leg between the knee and ankle, respectively. Study investigators clarified these response options by including explicit start and end points for each body part (e.g., Arm—between the elbow and wrist).

3.2.4 Response options were interpreted differently. Opinions of response option meanings also occasionally differed among interview participants. For example, when asked about “prosthesis moved unexpectedly,” some respondents indicated that they would endorse this response option if their prosthesis became loose or they lost suspension due to a poorly fitting socket. In contrast, other participants said this response meant that their prosthetic knee buckled and “dropped them” to the ground. Consequently, responses could be influenced both by experiences related to socket fit and unexpected behavior of a prosthetic component at the time of the fall-event. To resolve any discrepancies between respondents, the phrasing of the

response option was revised to “*your prosthesis did not respond as intended*”, and socket fit and suspension-specific response options were added (e.g., “*your socket was loose*”).

3.2.5 Response options were insufficient. Cognitive interview participants described several instances where the available response options did not provide a sufficient level of detail, either because included responses were too broad or options were missing. For example, participants reported that possible answers to the question “*What part(s) of your body hit the ground, floor, surface or object when you fell or nearly fell?*” were missing. These included, face, prosthesis, and residual limb. Similarly, feedback indicated that response options to the question, “*Because of this fall or near-fall have you done or experienced any of the following?*” were limited. Specifically, they suggested that psychological consequences, such as “frustration,” “anger,” “depression” be included among the response options. For the same question, response options denoting changes in perceptions of balance confidence or fear of falling were viewed as overly narrow, failing to consider changes in one’s confidence in their prosthesis. At the request of cognitive interview participants, and using their preferred terminology, study investigators addressed this gap by expanding the response options to include these suggestions. To accommodate the greater number of response options, study investigators created separate questions for emotional consequences (e.g., depression, frustration), behavioral consequences (change, avoid, or stop certain activities), and other fall-related consequences (e.g., decreased balance confidence, more afraid of falling). Feedback from participants also revealed that several response options for the question “*Did you seek medical treatment because of your fall or near-fall?*” were missing. Participants suggested that “physical therapy,” “massage therapy,” and “repair or replacement of their prosthesis” could be treatments sought after a fall event. These options were all added. Finally, participants noted that the question related to activity at the time of a fall should include showering or bathing, as they described feeling particularly vulnerable to falls when the bathroom surface was wet, and they needed to remove their prosthesis. Showering or bathing was therefore added as a response option to the question “*what were you doing when you fell or nearly-fell?*”.

3.2.6 Overall survey content. When asked “*What other aspects of balance and falls do you think should be included in the survey?*”, and “*What kinds of things are important for us to ask about if we want to learn more about falls?*” participants generally indicated that the fall survey was comprehensive (e.g., “*nothing else I can think of*”, “*seemed to cover all bases and be fairly extensive*”). Other participants provided specific suggestions better addressed through data collected in conjunction with, but not as part of, the LLP user fall survey (e.g., “*issues of age*”, “*footwear*”, “*type of prosthesis*”, “*time since amputation*”). Lastly, a few respondents emphasized the psychological consequences of falls (e.g., “*fear of falling*”, “*ask more about confidence or tentativeness*”, “*inquire about any emotional or psychological changes*”). These recommendations were addressed through the expansion of response options associated with questions pertaining to fall-related consequences described above. After all revisions based on cognitive interviews, the fall event survey consisted of 30 questions. This version of the survey was then administered to a national sample of LLP users in a preliminary validation study to further evaluate its content and function.

Based on cognitive interview participant feedback, instructions were deemed acceptable in their current form, twelve questions and their associated response options were unchanged, while one question was removed, and two were added based on feedback from cognitive interview participants. New response options were added to ten questions, while existing response options were deleted for three questions, revised for seven questions, and moved for one question. Finally, two questions and their response options were split up into six more focused questions.

3.3 Preliminary validation study: Cross-sectional assessment of fall event survey function

3.3.1 Participant characteristics. 235 LLP users participated in the study. Participant demographic, health, amputation, mobility, and balance characteristics are reported in [Table 3](#). 212 participants (90.2%) recalled one or more falls and/or near-falls in the past year and completed the fall event survey. Median time to complete the fall event survey was 11 minutes, with an interquartile range of 6 minutes (Q1: 8 minutes, Q3: 14 minutes). Among them, 168 participants (71.5%) recalled one or more falls in the past year, 191 or 81.3% recalled one or more near-falls in the past year, and 23 or 9.8% recalled no falls or near-falls in the past year. Among the 212 participants who recalled a fall and/or near-fall in the past year, 158 reported that a fall was their most significant event in the past year, while 54 reported that their most significant event was a near-fall ([S1 Dataset](#)).

3.3.2 Fall survey operated as intended. Expected associations between fall circumstances and/or consequences across survey questions were observed (e.g., forward fall and impact with hands or knees). Chi-square and McNemar tests revealed that anticipated associations between fall direction and impact location, injury level and treatment sought or received, as well as fall circumstances and the use of a prosthesis or assistive device were statistically significant ($X^2 \geq 5.32$, $p \leq .021$) ([Table 4](#), [S1 Dataset](#)). Small to medium effect sizes (phi (ϕ) = .158 to .444) were observed for these statistically significant associations ([Table 4](#)).

3.3.3 Survey participants confidently recalled details of the most significant fall-related event. The “do not remember” response option was selected infrequently by study participants. On more than two thirds of survey questions, 5% or less of the participants who reported a fall as their most significant event in the past year (i.e., fall participants) endorsed “do not remember”. Across survey questions, the percentage of fall participants who endorsed “do not remember” ranged from 0 to 6%. “Do not remember” responses were endorsed more frequently for activity-related questions (range: 3% to 6%), and less frequently for consequence-related questions (0% to 2%). Among the surrounding, situation, and fall-related mechanics questions, “do not remember” was endorsed by <1% to 2%, 0% to 5%, and 4% to 5% of fall participants, respectively ([S1 Dataset](#)).

Participants who reported a near-fall as their most significant event in the past year (i.e., near-fall participants) selected “do not remember” with a slightly higher frequency than fall participants. On more than half of the survey questions, 5% or fewer of the near-fall participants endorsed “do not remember”. Endorsement of “do not remember” exceeded 10% of respondents on just two questions. Across survey questions, the percentage of near-fall participants who endorsed “do not remember” ranged from 0% to 15%. Similar to fall participants, near-fall participants endorsed “do not remember” more frequently for activity-related questions (range: 4% to 15%), and less frequently for consequence-related questions (0%). Among the surroundings, situation, and fall-related mechanics questions, “do not remember” was endorsed by between 6% to 9%, 2% to 6%, and 0% to 9% of near fall participants, respectively.

When asked at the end of the survey “how much confidence do you have in the details you provided about the fall or near-fall”, most fall (82%) and near-fall (81%) participants reported either “high confidence” or “complete confidence.” Fewer fall (16%) and near-fall (17%) participants reported having “moderate confidence” in the details they reported ([S1 Dataset](#)).

3.3.4 Survey content was expanded based on participants’ “Other” responses. Analysis of the open-ended “Other” response fields revealed that additional response options were needed to fully characterize the fall circumstances and consequences experienced by LLP users. Among questions within each of the survey sections (i.e., surroundings, activity), an average of 2 to 16% of study participants endorsed the “Other” response option. Many of the

Table 3. Preliminary validation study participant characteristics (n = 235).

	Most significant fall event in the past 12 months		
	No fall event reported (n = 23)	Fall (n = 158)	Near-fall (n = 54)
	Number of participants (% of whole sample, n = 235)		
Gender			
Male	18 (8%)	92 (39%)	30 (13%)
Female	5 (2%)	66 (28%)	24 (10%)
Amputation level			
Unilateral transtibial	15 (6%)	78 (34%)	19 (8%)
Unilateral transfemoral	4 (2%)	48 (20%)	19 (8%)
Bilateral (TT and TF)	3 (1%)	15 (6%)	9 (4%)
Other (e.g., HD)	1 (<1%)	17 (7%)	7 (3%)
Amputation etiology			
Dysvascular	10 (4%)	60 (26%)	14 (6%)
Non-dysvascular	13 (5%)	98 (42%)	40 (17%)
Highest level of education			
Some high school	0 (0%)	43 (18%)	18 (8%)
High school graduate	3 (1%)	54 (23%)	22 (9%)
Some college	7 (3%)	10 (4%)	4 (2%)
College degree	9 (4%)	1 (<1%)	0 (0%)
Advanced degree	4 (2%)	43 (18%)	8 (3%)
Employment status			
Employed	10 (4%)	3 (1%)	1 (<1%)
Retired	6 (3%)	17 (7%)	5 (2%)
Unemployed	1 (<1%)	50 (21%)	21 (9%)
Student	0 (0%)	46 (20%)	17 (7%)
On disability	6 (3%)	42 (18%)	10 (4%)
Homemaker	0 (0%)	3 (1%)	1 (<1%)
Daily use of assistive devices			
One cane	7 (3%)	21 (9%)	16 (7%)
Two cane	1 (<1%)	2 (<1%)	1 (<1%)
Two crutches	6 (2%)	1 (<1%)	5 (2%)
Walker	5 (2%)	9 (4%)	12 (5%)
Wheelchair	18 (8%)	27 (11%)	22 (9%)
Fall events in past year			
None	7 (3%)	107 (46%)	16 (7%)
≥ 1 fall	0 (0%)	158 (67%)	19 (8%)
≥ 1 near-fall	0 (0%)	141 (60%)	54 (23%)
	Median (Median Absolute Deviation)		
Age (years)	57.3 (12.0)	60.7 (7.61)	61.4 (6.01)
Number of co-morbidities	1.0 (1.0)	1.0 (1.0)	1.0 (1.0)
Number of daily medications	4.5 (5.5)	4.0 (3.0)	2.0 (2.0)
Time since amputation (years)	11.9 (3.91)	12.7 (8.44)	19.0 (9.24)
Hours wearing prosthesis wear/day	15.0 (1.50)	14.0 (2.00)	14.0 (2.00)
Hours walking with prosthesis/day	5.50 (2.00)	3.00 (2.00)	4.00 (2.00)
PLUS-M (T-score)	57.0 (6.08)	50.3 (7.50)	52.8 (8.06)
ABC (0–4)	3.60 (0.47)	3.13 (0.41)	3.63 (0.50)
Number of falls in past year	0.0 (0.0)	2.0 (1.0)	2.0 (1.0)

(Continued)

Table 3. (Continued)

	Most significant fall event in the past 12 months		
	No fall event reported (n = 23)	Fall (n = 158)	Near-fall (n = 54)
Number of near-falls in past year	0.0 (0.0)	3.0 (2.0)	4.0 (2.0)

ABC: Activities-specific Balance Confidence scale; CI: Cognitive Interview; PLUS-M: Prosthesis Limb Users Survey—Mobility; TF: Transfemoral; TT: Transtibial

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“Other” responses provided by study participants were however addressed by questions later in the survey, and were therefore deemed not to require revision, but rather repositioning within the survey. For example, for the question, “*what were you doing when you fell or nearly fell?*”, several participants reported “*using crutches*” or “*walking with a cane*”. The use of an assistive device at the time of a fall or near-fall was originally queried much later in the survey. The questions were subsequently re-ordered, moving the assistive device question to a point earlier in the survey. Similarly, the question asking whether a prosthesis was worn at the time of a fall or near-fall, was moved to the start of the survey. In total, 11 additional response options were added to six questions (Table 5, S1 Dataset). For example, in response to the question, “*Did any of the following occur to you when you fell or nearly fell?*”, participants wrote in “*stepping on an unseen object*”, and “*did not notice a small object on the floor and I stepped on it*”. Initial response options did not cover this situation, consequently, “*stepped on something*” was added as a response option to this question. With respect to fall mechanics, a host of participants described strategies to minimize the risk of injury that were not included in the original response options. These included, “*I tucked and rolled to avoid injury*”, and “*Put my hands out to avoid landing on my residual limb*”. “*Tucked and rolled*” and “*Used arms to brace yourself*” were therefore added as response options to the question, “*Did you do anything to minimize the risk of injury?*”. For the final survey, the open-ended “other” response option accompanying each question was deleted and replaced with an open-ended question at the end of each section of the survey. For example, at the end of the activity section of the survey participants are asked, “*Is there anything else you would like to tell us about what you were doing when you fell or nearly fell?*”. Similar questions were added to the end of the surroundings, situation, fall mechanics, and consequences sections.

Table 4. Expected associations between response options endorsed by study participants reporting a significant fall-related event in the past 12 months (n = 212).

Response option comparisons	X ² statistic	p-value	phi (φ)
Q19: “ <i>Problem with prosthesis</i> ”** and Q1: “ <i>Wearing prosthesis</i> ”	6.69	.015*	.444
Q3: “ <i>Walking, stepping, or running</i> ” and Q2: “ <i>Wheelchair or scooter</i> ”	9.67	.002*	-.214
Q4: “ <i>Moving quickly</i> ” and Q18: “ <i>Hurried or rushed</i> ”	11.2	.002	.229
Q19: “ <i>AD broke or moved unexpectedly</i> ” and Q2: “ <i>Using AD</i> ”	5.32	.021	.158
Q9: “ <i>Unfamiliar</i> ” and Q18: “ <i>Distracted, not paying attention</i> ”	1.23	.268	.139
Q17: “ <i>Foot got caught</i> ” and Q5: “ <i>Stepping over something</i> ”	17.4	.001	.287
Q21: “ <i>Fall forward</i> ” and Q25: “ <i>Wrist, hand, elbow, or knee impact</i> ”	9.40	.002	.211
Q21: “ <i>Fall backward</i> ” and Q25: “ <i>Buttocks, hip, or head impact</i> ”	25.4	.001	.346
Q28: “ <i>Major injury</i> ”*** and Q29: “ <i>Treatment sought</i> ”	37.5	.001	.421
Q28: “ <i>Major injury</i> ”*** and Q30: “ <i>Treatment received</i> ”	40.8	.001	.438

AD: Assistive device (i.e., cane, crutch, or walker)

* Expected cell count < 5, Fisher’s Exact test conducted.

** Problem with prosthesis includes “*prosthesis broke*”, “*prosthesis did not respond as intended*”, and “*prosthesis was not on properly*”

*** Major injury includes “*fracture or broken bone*”, “*internal injury*”, or “*concussion or head injury*”

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Table 5. Response options added to the fall survey based on open-ended “Other” field responses provided by study participants during the small-scale administration.

Question 5. Were you doing any of the following when you fell or nearly fell?	
Other open-ended response(s)	Response option(s) added/revised
<i>“Lifting a package into the car”</i>	Lifting or carrying something
<i>“Picking something up”</i>	
Question 17. Did any of the following occur to you when you fell or nearly fell?	
Other open-ended response(s)	Response option(s) added/revised
<i>“Did not notice a small object on the floor and I stepped on it with my foot”</i>	Stepped on something
<i>“Didn’t pay attention to small object on the ground”</i>	
<i>“I stepped on an unseen object on the ground”</i>	
<i>“Knee collapsed”</i>	Left / right leg gave out
<i>“My sound knee gave out”</i>	
<i>“My non-prosthetic knee just buckled”</i>	
Question 19. Did any of the following contribute to the fall or near-fall?	
Other open-ended response(s)	Response option(s) added/revised
<i>“I walked out of my socket”</i>	Prosthesis came off
<i>“My prosthesis came off”</i>	
<i>“My leg fell off”</i>	
<i>“Handrail broke away”</i>	Something you were holding moved or gave way
<i>“Walker slipped out from under me”</i>	
Question 22. Did you do anything to catch yourself or prevent the fall or near-fall?	
Other open-ended response(s)	Response option(s) added/revised
<i>“I moved and waved my arms around to try and catch my balance”</i>	Moved or waved arms around
Question 23. Did you do anything to minimize the risk of injury?	
Other open-ended response(s)	Response option(s) added/revised
<i>“I tucked and rolled to avoid damage”</i>	Tuck and roll
<i>“I rotated to the side to impact my sound rather than prosthetic leg”</i>	Rotate to the right / left
<i>“Put my hands out to avoid landing on my residual limb”</i>	Used arms to brace yourself
<i>“Used my legs to ease down slowly”</i>	Eased yourself down
<i>“Slowed my descent with my legs”</i>	
Question 30. Did you receive medical treatment because of the fall or near-fall?	
Other open-ended response(s)	Response option(s) added/revised
<i>“I am an RN, so I tended to my own wounds”</i>	Self-administered treatment
<i>“I administered my own first aid”</i>	

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Following all revisions, the final LLP user fall event survey consisted of 37 questions assessing the activity, surroundings, situation, mechanics and consequences of fall related events. The median Flesh-Kincaid reading grade level of the final LLP users fall event survey was 5.3, with a median absolute deviation of 1.6. Reading grade level of the survey instructions was 7.6. Situation and consequence-related questions had the highest median grade level (6.2), followed by fall mechanic questions (5.2), activity-related questions (3.6), and surrounding-related questions (1.0).

4.0 Discussion

The objective of this project was to develop a structured, population-specific, fall survey capable of comprehensively characterizing the circumstances and consequences of fall events in

LLP users. Using best practices in survey development, including focus groups and cognitive interviews to solicit input from target respondents, we developed a 37-question survey to characterize fall frequency, circumstances, and consequences. The proposed LLP users fall event survey (S2 Appendix) offers clinicians and researchers a means to consistently document and compare fall events among their participants and patients. The comprehensive data that can be collected with the fall survey are critical to establishing specific goals for fall prevention interventions in LLP users. Below, three questions that are central to the administration of the LLP user fall event survey are discussed: i) why should the survey be trusted? ii) what advantages does the survey have when compared to existing approaches? and iii) how might the survey be used?

4.1 Why should the LLP user fall event survey be trusted?

The methods used, stakeholders involved, results obtained, and revisions made during survey development and testing were intended to impart confidence in the ability of the LLP user fall event survey to obtain valid and meaningful data. Best-practices in survey development and evaluation were used to design and test the structured LLP user fall event survey [43, 49–51]. Focus groups conducted with a diverse sample of LLP users identified scenarios and terminology central to the fall experiences of LLP users [44]. Documentation of the lived experience guided the construction of a conceptual fall framework (Fig 2), an exercise that in combination with a thorough review of the relevant literature helped ensure survey content covered areas that are meaningful and relevant to the target population of LLP users. Previously overlooked content areas that were included in the current survey were details of the activity at the time of the fall, strategies to prevent the fall and/or minimize injury, psychological responses to a fall event, as well as LLP user-specific scenarios. The decision to distinguish between and define both falls and near-falls was also guided by focus group input from LLP users. Near-falls were described by LLP users to have the potential to be as consequential as falls. Near-falls were therefore understood to be meaningful events for LLP users that merit consideration equal to that of falls, yet rarely receive it [15, 16].

The feedback obtained from LLP users during cognitive interviews further demonstrates that survey instructions, questions, and response options were clear, applicable, and well understood by LLP users. Importantly, participants agreed that the fall event definitions were clear, and represented overlapping yet unique events. Revisions to survey content based on cognitive interview participant feedback should also increase confidence in the survey, as changes largely involved just adding additional response options to improve survey applicability or splitting existing response options to enhance survey clarity and comprehension. Improvements to the clarity and comprehension of the fall survey were achieved by splitting response options perceived by LLP users to consist of unique, non-overlapping answers. Adding to the clarity and comprehension of the fall survey was the deliberate effort by study investigators to use accessible language and phrasing throughout. Following all revisions based on participant feedback, the Flesch-Kincaid reading grade level for each section in the final survey was below the recommended level of 5.3 for written health materials [74, 85].

Results from the preliminary validation study, conducted with a large national sample of LLP users, should also impart a degree of confidence in the LLP user fall event survey. First, the relatively low frequency with which participants endorsed the “Other” response option for any given question served to confirm the breadth and depth of the fall survey (i.e., it provides sufficient coverage of relevant fall-related circumstances and consequences). Generally, when the “Other” response option was endorsed and respondents provided details of the event, these were often already included later in the survey.

Second, the low frequency with which survey respondents endorsed “do not remember” across fall survey questions (i.e., <5% on average), and the high level of confidence they expressed in their recollection of the fall event (i.e., >80% reported a high level of confidence) suggests that the questions and accompanying response options in the survey represent fall-related circumstances and consequences that LLP users can confidently recall. The confidence with which the circumstances and consequences were recalled in the current study may have been due in part to the nature of the fall event that was probed (i.e., “the most significant fall event in the past 12 months”). It is possible, if not likely, that less significant fall events are not as memorable, and LLP users would experience more difficulty in recalling the details surrounding those events.

Confidence in the survey as a tool for documenting fall events by LLP users was further bolstered when survey questions were found to yield falls data consistent with clinical expectations, and that available in the literature [2, 3, 29] (e.g., forward fall and impact with hands and/or knees). Had the preliminary validation study produced fall circumstance and/or consequence data that did not align with expectations, confidence in its administration would be questioned, and its efficacy to document fall events in LLP users in doubt. Overall, the methods used, results obtained, and revisions made indicate that survey definitions, questions, and response options are clear, well understood, comprehensive, and applicable to LLP users. These outcomes should inspire confidence among clinicians and researchers when administering the LLP user fall event survey.

4.2 What advantages does the LLP user fall event survey have when compared to existing approaches?

The structured and comprehensive design of the LLP user fall event survey offers several advantages for documenting fall events over conventional ad hoc fall questionnaires [2, 6, 8, 76] and unstructured interviews [3, 29]. Overall, the fall event survey provides a tool to collect fall event data comprehensively and consistently. Administration of the survey is therefore likely to yield comparable data, which can be aggregated and/or compared between fall studies, study sites, or clinics, as well as within or between individual LLP users for clinical decision making. The collection of quality data begins with clear and meaningful definitions of fall events. Without a clear definition, LLP users may interpret the meaning of a fall in different ways [86]. Data collected to characterize fall events and their consequences using vague definitions could subsequently be based on different events, limiting comparability and thus utility for understanding falls in LLP users. Historically, most but not all studies [1, 6, 87, 88] that have sought to document the frequency, circumstances and consequences of falls, or identify potential fall risk factors in LLP users, have included a fall definition. Variation in fall definitions across studies, the inclusion or omission of terminology the current study found problematic (e.g., “unintentional / inadvertent”, “ground or floor”, “comes to rest on”, “stumble”), as well as the absence of a near-fall definition, suggests that there may be potential challenges in comparing results between studies. The LLP user fall survey addresses these challenges and increases the consistency with which falls data can be collected by including fall event definitions that are based on input and feedback from LLP users, avoid confusing colloquial terminology, and clearly differentiate falls from near-falls.

Further enhancing the consistency with which falls data can be collected with the fall event survey, and in contrast to most [2, 3, 6, 8, 29] but not all [76] previous efforts to characterize fall circumstances and consequences in LLP users, the LLP user fall event survey uses a set of closed- rather than open-ended questions. The use of fixed-response options ensures that all respondents select from the same set of possible response options for each question. As a

result, data is easily aggregated across respondents, enabling analysis and interpretation [57]. Closed-ended questions also limit vague or incomplete responses and facilitate easier comparisons between studies. Perceived or potential drawbacks associated with closed-ended questions (i.e., too narrow in scope) are offset by the comprehensive and detailed set of response options that were developed and tested based on the lived experience of LLP users. To address the potential for details not included in the survey, each section ends with a single open-ended question, where respondents are asked: “*Is there anything else you would like to tell us about (insert module topic, e.g., what you were doing) when you fell?*”. As a result, the consistency offered by many fixed response options is balanced with the flexibility of a single “catch all” open-ended question capable of accommodating any unique or novel fall circumstances and/or consequences.

In addition to enhancing consistency and comparability, the LLP user fall event survey generates a richness of data that exceeds what has previously been reported. The breadth and depth with which fall events among LLP users can be characterized with this survey is expected to yield actionable information for a wide range of stakeholders. The quantity and quality of the fall event data may produce evidence that informs new and/or serves to modify existing reimbursement and prescription policies for prosthetic components intended to reduce falls and fall-related injuries (e.g., prescription of microprocessor knees for limited community ambulators). Administration of this survey could also aid in establishing the most pressing research needs regarding fall assessment and prevention by shifting attention from all-cause falls, towards specific and consequential types of falls. The breadth and depth of the data that can be collected with the fall event survey is also likely to yield previously unreported fall details, which may generate novel hypotheses that can be tested. For example, the preliminary validation study showed that the most-commonly endorsed response to “*did you do anything to catch yourself or prevent the fall?*”, was “*reached out to grab someone or something?*”. Compared to the more heavily researched stepping response [17, 18, 20, 89–91], the reach and grasp strategy was endorsed by nearly a five-to-one margin. A complete accounting of fall events may therefore point to the need for alternative experimental approaches to study the biomechanics of falls in LLP users. Data collected with this survey may also allow manufacturers to develop and test prosthetic components designed to respond to the most prevalent and consequential types of falls. Clear and meaningful definitions, fixed-response options, as well as the comprehensiveness of fall data that can be collected with the LLP user fall event survey has the potential to make large, timely, and important contributions to limb loss science and clinical care.

Identifying existing and establishing additional benefits of the LLP user fall event survey is an on-going area of research. A direct comparison between data collected with the fall event survey and a conventional patient interview would serve to clarify the “value added” of using a standardized fall survey over less structured approaches. The translation and validation of the LLP user fall event survey into other languages and cultures would also add to its value in the prosthetic community by increasing access to the survey internationally and ensuring valid and meaningful comparisons of fall events across cultures and languages. Prospective administration of the fall event survey (i.e., administering the survey immediately after falls occur) would serve to better characterize the range of fall events experienced by LLP users, and expand upon knowledge about the “most significant” fall events we measured in the preliminary validation study. Finally, additional research to expand and revise survey content to reflect fall experiences of other clinical populations (e.g., stroke, multiple sclerosis) would uniquely position researchers to compare important details of fall events between clinical populations and highlight areas of overlap as well population-specific needs with a single instrument.

4.3 How might the LLP user fall event survey be used?

The fall event survey has potential applications across each of the four stages of the public health model [27]. Having resolved the need for a structured and standardized approach to comprehensively characterize fall events in LLP users in the current study, it is now possible to address gaps in stage one of the public health model as applied to falls by LLP users; “describe the problem” [27]. The fall event survey may also prove useful in stage two, interpreting factors that increase or decrease the risk of falls. Rather than regarding risk factors as generic, and related to any and all falls, risk factors may instead be associated with specific fall event outcomes (e.g., injurious versus non-injurious), and/or fall event circumstances (e.g., forward versus backward fall directions). The administration of the survey during research focused on causes and correlates of fall events in LLP users (i.e., stage 2 of the public health model) may therefore identify factors that serve to motivate the design of fall prevention initiatives, fall prediction measures, or prosthetic components that are specific to particular fall types. Finally, in stages 3 and 4, the fall event survey could help track fall event outcomes during comparative effectiveness trials. Here, the level of detail captured by the survey could be useful in helping determine whether fall prevention interventions (e.g., initiatives or devices) are broadly effective regardless of fall circumstances, or more effective at reducing a specific type of fall. Establishing the degree of specificity associated with an intervention may contribute to improved prescription guidelines and prevent an intervention that would otherwise be abandoned if found to be ineffective at reducing all-cause falls.

As wearable sensors become more prevalent, and interest in their use to detect [92, 93] as well as understand the movements of real-world falls becomes of increasing interest [86, 94–96], the LLP user fall event survey is uniquely suited to provide the context required to interpret the voluminous and noisy data wearable sensor generate. In fact, descriptions of the circumstances surrounding falls using voice recorders were critical to interpretation of otherwise noisy data collected with inertial measurement units during fall events in older adults [97]. Administering the fall event survey in concert with the deployment of wearable sensors may help explore key movements during real-world fall events in LLP users. In doing so, the same data may contribute to concurrent improvements in the sensitivity and specificity of algorithms intended to provide automated detection of fall events in LLP users from wearable sensor data [92, 93, 98].

The LLP user fall event survey can be used to collect retrospective or prospective fall event data during cross-sectional and longitudinal studies, respectively. When collecting *retrospective* fall data in a cross-sectional study, researchers should consider the length of the recall period and which fall event(s) to document, as both may influence fall recall decay. Given the level of detail within the survey, and our limited understanding of fall recall decay in LLP users [5], it may be prudent to focus on a single memorable fall event, particularly if a longer recall period is selected (e.g., one year). Concentrating on a single fall event is likely to maximize respondent recall and therefore data accuracy. Memorable fall events that may be of interest and advance our understanding of falls in LLP users include, but are not limited to, the most recent fall, the most injurious fall, or as was done in the current study, the fall event deemed most “significant” by study participants. When collecting *prospective* data, researchers often seek to minimize fall recall decay by limiting the time that elapses between when a fall occurs and when it is documented. Current recommendations suggest that prospective fall events be recorded daily (i.e., fall or no fall, details of the fall), and reported on a monthly basis [99]. Several of the survey questions that document the consequences of a fall event may however require additional time after a fall before they can be answered (i.e., questions 29–35). Depending on the nature and severity of the fall event, a three-to-seven-day delay may need to be built

into the timeline between the fall event and its documentation, a practice which may also minimize participant burden.

While designed to be administered in its entirety, individual sections of the LLP user fall event survey may also be administered independently. Researchers or clinicians may administer specific sections (e.g., fall consequences) or questions (e.g., fall direction, impact location) to reduce respondent burden, and/or focus on areas of scientific or clinical interest. Should a targeted data collection be preferred, it is recommended that all original response options per question be retained. If specific response options are deemed unnecessary to the research question or clinical application, reintroduction of the open-ended “*Other*” response option in each question is recommended to ensure that relevant details of the fall event are not overlooked.

5.0 Conclusion

To improve the documentation of fall events in LLP users, we developed a novel structured LLP user-specific fall event survey ([S2 Appendix](#)) using best practices, including input from target respondents (i.e., focus groups and cognitive interviews with LLP users) [43, 49–51]. The resulting fall event survey is a 37-question instrument created to record and report fall frequency (i.e., number of events), fall circumstances (i.e., activity, surroundings, situation, and mechanics), and fall consequences (i.e., physical, financial, functional, behavioral, and psychological) in LLP users with a standardized and consistent approach. The LLP user fall event survey will help researchers and clinicians gather, document, track, and compare fall events among their participants and patients with greater ease, detail, consistency, and confidence. In doing so, the body of evidence required to design, test, and justify fall prevention initiatives to the individual needs of LLP users can be significantly improved.

Supporting information

S1 Appendix. Cognitive interview guides.

(DOCX)

S2 Appendix. Lower limb prosthesis user fall event survey.

(DOCX)

S1 Dataset. Data from preliminary validation study.

(XLSX)

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References

1. Gauthier-Gagnon C, Grise MC and Potvin D. Enabling factors related to prosthetic use by people with transtibial and transfemoral amputation. *Arch Phys Med Rehabil* 1999; 80: 706–713. [https://doi.org/10.1016/s0003-9993\(99\)90177-6](https://doi.org/10.1016/s0003-9993(99)90177-6) PMID: 10378500
2. Miller WC, Speechley M and Deathe B. The prevalence and risk factors of falling and fear of falling among lower extremity amputees. *Arch Phys Med Rehabil* 2001; 82: 1031–1037. <https://doi.org/10.1053/apmr.2001.24295> PMID: 11494181
3. Kim J, Major MJ, Hafner B, et al. Frequency and circumstances of falls reported by ambulatory unilateral lower limb prosthesis users: A secondary analysis. *PM & R* 2019; 11: 344–353. <https://doi.org/10.1016/j.pmrj.2018.08.385> PMID: 30195705
4. Sawers A and Hafner B. Validation of the Narrowing Beam Walking Test in lower limb prosthesis users. *Arch Phys Med Rehabil* 2018; 99: 1491–1498. <https://doi.org/10.1016/j.apmr.2018.03.012> PMID: 29653108
5. Sawers A and Hafner BJ. Performance-based balance tests, combined with the number of falls recalled in the past year, predicts the incidence of future falls in established unilateral transtibial prosthesis users. *PM & R* 2022; 14(4): 434–444. <https://doi.org/10.1002/pmrj.12627> PMID: 33951296
6. Kulkarni J, Wright S, Toole C, et al. Falls in patients with lower limb amputations: prevalence and contributing factors. *Physiotherapy* 1996; 82: 130–136.
7. Wong CK, Chihuri ST and Li G. Risk of fall-related injury in people with lower limb amputations: A prospective cohort study. *J Rehabil Med* 2016; 48: 80–85. <https://doi.org/10.2340/16501977-2042> PMID: 26694526
8. Chihuri S and Wong CK. Factors associated with the likelihood of fall-related injury among people with lower limb loss. *Inj Epidemiol* 2018; 5: 42. <https://doi.org/10.1186/s40621-018-0171-x> PMID: 30417269
9. Wong CK, Chen CC, Blackwell WM, et al. Balance ability measured with the Berg Balance Scale: a determinant of fall history in community-dwelling adults with leg amputation. *J Rehabil Med* 2015; 47: 80–86. <https://doi.org/10.2340/16501977-1882> PMID: 25223891
10. Dite W, Connor HJ and Curtis HC. Clinical identification of multiple fall risk early after unilateral transtibial amputation. *Arch Phys Med Rehabil* 2007; 88: 109–114. <https://doi.org/10.1016/j.apmr.2006.10.015> PMID: 17207685
11. Major MJ, Fatone S and Roth EJ. Validity and reliability of the Berg Balance Scale for community-dwelling persons with lower-limb amputation. *Arch Phys Med Rehabil* 2013; 94: 2194–2202. <https://doi.org/10.1016/j.apmr.2013.07.002> PMID: 23856150
12. Miller WC, Deathe AB and Speechley M. Psychometric properties of the Activities-specific Balance Confidence Scale among individuals with a lower-limb amputation. *Arch Phys Med Rehabil* 2003; 84: 656–661. [https://doi.org/10.1016/s0003-9993\(02\)04807-4](https://doi.org/10.1016/s0003-9993(02)04807-4) PMID: 12736877
13. Sawers A and Hafner BJ. Outcomes associated with the use of microprocessor-controlled prosthetic knees among individuals with unilateral transfemoral limb loss: a systematic review. *J Rehabil Res Dev* 2013; 50: 273–314. <https://doi.org/10.1682/jrrd.2011.10.0187> PMID: 23881757
14. Kahle JT, Highsmith MJ and Hubbard SL. Comparison of nonmicroprocessor knee mechanism versus C-Leg on Prosthesis Evaluation Questionnaire, stumbles, falls, walking tests, stair descent, and knee preference. *J Rehabil Res Dev* 2008; 45: 1–14. <https://doi.org/10.1682/jrrd.2007.04.0054> PMID: 18566922

15. Hafner BJ and Smith DG. Differences in function and safety between Medicare Functional Classification Level-2 and -3 transfemoral amputees and influence of prosthetic knee joint control. *J Rehabil Res Dev* 2009; 46: 417–433. PMID: [19675993](#)
16. Rosenblatt NJ, Bauer A, Rotter D, et al. Active dorsiflexing prostheses may reduce trip-related fall risk in people with transtibial amputation. *J Rehabil Res Dev* 2014; 51: 1229–1242. <https://doi.org/10.1682/JRRD.2014.01.0031> PMID: [25625226](#)
17. Crenshaw JR, Kaufman KR and Grabiner MD. Trip recoveries of people with unilateral, transfemoral or knee disarticulation amputations: Initial findings. *Gait Posture* 2013; 38: 534–536. <https://doi.org/10.1016/j.gaitpost.2012.12.013> PMID: [23369663](#)
18. Curtze C, Hof AL, Otten B, et al. Balance recovery after an evoked forward fall in unilateral transtibial amputees. *Gait Posture* 2010; 32: 336–341. <https://doi.org/10.1016/j.gaitpost.2010.06.005> PMID: [20609587](#)
19. Bolger D, Ting LH and Sawers A. Individuals with transtibial limb loss use interlimb force asymmetries to maintain multi-directional reactive balance control. *Clin Biomech* 2014; 29: 1039–1047. <https://doi.org/10.1016/j.clinbiomech.2014.08.007> PMID: [25200883](#)
20. Shirota C, Simon AM and Kuiken TA. Transfemoral amputee recovery strategies following trips to their sound and prosthesis sides throughout swing phase. *J Neuroeng Rehabil* 2015; 12: 1–11. <https://doi.org/10.1186/s12984-015-0067-8> PMID: [26353775](#)
21. Yang J, Jin D, Ji L, et al. The reaction strategy of lower extremity muscles when slips occur to individuals with trans-femoral amputation. *J Electromyogr Kinesiol* 2007; 17: 228–240. <https://doi.org/10.1016/j.jelekin.2006.01.013> PMID: [16603384](#)
22. Miller SE, Segal AD, Klute GK, et al. Hip recovery strategy used by below-knee amputees following mediolateral foot perturbations. *J Biomech* 2018; 76: 61–67. <https://doi.org/10.1016/j.jbiomech.2018.05.023> PMID: [29887363](#)
23. Segal AD and Klute GK. Lower-limb amputee recovery response to an imposed error in mediolateral foot placement. *J Biomech* 2014; 47: 2911–2918. <https://doi.org/10.1016/j.jbiomech.2014.07.008> PMID: [25145315](#)
24. Vanicek N, Strike S, McNaughton L, et al. Postural responses to dynamic perturbations in amputee fallers versus nonfallers: a comparative study with able-bodied subjects. *Arch Phys Med Rehabil* 2009; 90: 1018–1025. <https://doi.org/10.1016/j.apmr.2008.12.024> PMID: [19480879](#)
25. Tobaigy M, Hafner B and Sawers A. Recalled number of falls in the past year, combined with perceived mobility, predicts the incidence of future falls in unilateral lower limb prosthesis users. *Phys Ther* 2022; 102(2): pzab267. <https://doi.org/10.1093/ptj/pzab267> PMID: [34971384](#)
26. Mercy JA, Rosenberg ML, Powell KE, et al. Public health policy for preventing violence. *Health Aff (Millwood)* 1993; 12: 7–29. <https://doi.org/10.1377/hlthaff.12.4.7> PMID: [8125450](#)
27. Stevens JA, Baldwin GT, Ballesteros MF, et al. An older adult falls research agenda from a public health perspective. *Clin Geriatr Med* 2010; 26: 767–779. <https://doi.org/10.1016/j.cger.2010.06.006> PMID: [20934621](#)
28. Grabiner MD and Kaufman KR. Developing and establishing biomechanical variables as risk biomarkers for preventable gait-related falls and assessment of intervention effectiveness. *Front Sports Act Living* 2021; 22: 3:722363. <https://doi.org/10.3389/fspor.2021.722363> PMID: [34632378](#)
29. Anderson CB, Miller MJ, Murray AM, et al. Falls after dysvascular transtibial amputation: A secondary analysis of falling characteristics and reduced physical performance. *PM & R* 2021; 13(1):19–29. <https://doi.org/10.1002/pmrj.12376> PMID: [32249517](#)
30. Steinberg N, Gottlieb A, Siev-Ner I, et al. Fall incidence and associated risk factors among people with a lower limb amputation during various stages of recovery—A systematic review. *Disabil Rehabil* 2019; 41: 1778–1787. <https://doi.org/10.1080/09638288.2018.1449258> PMID: [29540083](#)
31. Lach HW, Reed AT, Arfken CL, et al. Falls in the elderly: Reliability of a classification system. *J Am Geriatr Soc* 1991; 39: 197–202. <https://doi.org/10.1111/j.1532-5415.1991.tb01626.x> PMID: [1991951](#)
32. Crenshaw JR, Bernhardt KA, Achenbach SJ, et al. The circumstances, orientations, and impact locations of falls in community-dwelling older women. *Arch gerontol geriatr* 2017; 73: 240–247. <https://doi.org/10.1016/j.archger.2017.07.011> PMID: [28863352](#)
33. Fritz NE, Eloyan A, Baynes M, et al. Distinguishing among multiple sclerosis fallers, near-fallers and non-fallers. *Mult Scler Relat Disord* 2018; 19: 99–104. <https://doi.org/10.1016/j.msard.2017.11.019> PMID: [29182996](#)
34. Berg WP, Alessio HM, Mills EM, et al. Circumstances and consequences of falls in independent community-dwelling older adults. *Age and Ageing* 1997; 26: 261–268. <https://doi.org/10.1093/ageing/26.4.261> PMID: [9271288](#)

35. Stack E and Ashburn A. Fall events described by people with Parkinson's disease: implications for clinical interviewing and the research agenda. *Physiother Res Int* 1999; 4: 190–200. <https://doi.org/10.1002/pri.165> PMID: 10581625
36. Ashburn A, Stack E, Ballinger C, et al. The circumstances of falls among people with Parkinson's disease and the use of Falls Diaries to facilitate reporting. *Disabil Rehabil* 2008; 30: 1205–1212. <https://doi.org/10.1080/09638280701828930> PMID: 18608387
37. Piau A, Mattek N, Duncan C, et al. The five W's of falls: Weekly online health survey of community-dwelling older adults: Analysis of 4 years prospective follow-up. *J Gerontol A Biol Sci Med Sci* 2019; 303: 258–256.
38. Sotimehin AE, Yonge AV, Mihailovic A, et al. Locations, circumstances, and outcomes of falls in patients with glaucoma. *Am J Ophthalmol* 2018; 192: 131–141.
39. Palvanen M, Kannus P, Parkkari J, et al. The injury mechanisms of osteoporotic upper extremity fractures among older adults: A controlled study of 287 consecutive patients and their 108 controls. *Osteoporos Int* 2000; 11: 822–831. <https://doi.org/10.1007/s001980070040> PMID: 11199185
40. Smulders E, Enkelaar L, Weerdesteyn V, et al. Falls in older persons with intellectual disabilities: fall rate, circumstances and consequences. *J Intellect Disabil Res* 2012; 26: <https://doi.org/10.1111/j.1365-2788.2012.01643.x> PMID: 23106830
41. Pitchai P, Dedhia H, Bhandari N, et al. Prevalence, risk factors, circumstances for falls and level of functional independence among geriatric population—A descriptive study. *Indian J Public Health* 2019; 63: 21–26. https://doi.org/10.4103/ijph.IJPH_332_17 PMID: 30880733
42. Ramdharry GM, Reilly-O'Donnell L, Grant R, et al. Frequency and circumstances of falls for people with Charcot-Marie-Tooth disease: A cross sectional survey. *Physiother Res Int* 2017; 23: e1702–1706. <https://doi.org/10.1002/pri.1702> PMID: 29282812
43. Hafner BJ, Morgan SJ, Abrahamson DC, et al. Characterizing mobility from the prosthetic limb user's perspective: Use of focus groups to guide development of the Prosthetic Limb Users Survey of Mobility. *Prosthet Orthot Int* 2016; 40: 582–590. <https://doi.org/10.1177/0309364615579315> PMID: 25944625
44. Kim J, McDonald CL, Hafner BJ, et al. Fall-related events in people who are lower limb prosthesis users: the lived experience. *Disabil Rehabil* 2021; 1–12. <https://doi.org/10.1080/09638288.2021.1891467> PMID: 33689544
45. Wild D, Nayak USL and Isaacs B. Description, classification and prevention of falls in old-people at home. *Rheumatol Rehabil* 1981; 20: 153–159. <https://doi.org/10.1093/rheumatology/20.3.153> PMID: 7280490
46. Topper AK, Maki BE and Holliday PJ. Are activity-based assessments of balance and gait in the elderly predictive of risk of falling and/or type of fall? *J Am Geriatr Soc* 1993; 41: 479–487. <https://doi.org/10.1111/j.1532-5415.1993.tb01881.x> PMID: 8486878
47. Robinovitch SN, Feldman F, Yang Y, et al. Video capture of the circumstances of falls in elderly people residing in long-term care: an observational study. *Lancet* 2013; 381: 47–54. [https://doi.org/10.1016/S0140-6736\(12\)61263-X](https://doi.org/10.1016/S0140-6736(12)61263-X) PMID: 23083889
48. Hart-Hughes S, Latlief GA and Phillips S. A review of clinical outcome assessment instruments for gait, balance, and fall risk in persons with lower extremity amputation. *Top Geriatr Rehabil* 2014; 30(1): 70–76.
49. Cella D, Riley W, Stone A, et al. The Patient-Reported Outcomes Measurement Information System (PROMIS) developed and tested its first wave of adult self-reported health outcome item banks: 2005–2008. *J Clin Epidemiol* 2010; 63: 1179–1194. <https://doi.org/10.1016/j.jclinepi.2010.04.011> PMID: 20685078
50. Amtmann D, Cook KF, Johnson KL, et al. The PROMIS initiative: involvement of rehabilitation stakeholders in development and examples of applications in rehabilitation research. *Arch Phys Med Rehabil* 2011; 92: S12–19. <https://doi.org/10.1016/j.apmr.2011.04.025> PMID: 21958918
51. Morgan SJ, Amtmann D, Abrahamson DC, et al. Use of cognitive interviews in the development of the PLUS-M item bank. *Qual Life Res* 2014; 23: 1767–1775. <https://doi.org/10.1007/s11136-013-0618-z> PMID: 24442531
52. Tong A, Sainsbury P and Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *Int J Qual Health Care* 2007; 19: 349–357. <https://doi.org/10.1093/intqhc/mzm042> PMID: 17872937
53. O'Brien BC, Harris IB, Beckman TJ, et al. Standards for Reporting Qualitative Research: A synthesis of recommendations. *Acad Med* 2014; 89: 1245–1251. <https://doi.org/10.1097/ACM.0000000000000388> PMID: 24979285
54. Brédart A, Marrel A, Abetz-Webb L, et al. Interviewing to develop Patient-Reported Outcome (PRO) measures for clinical research: eliciting patients' experience. *Health Qual Life Outcomes* 2014; 12: 15. <https://doi.org/10.1186/1477-7525-12-15> PMID: 24499454

55. Becker H. Measuring health among people with disabilities. *Fam Community Health* 2006; 29: 70s–77s. <https://doi.org/10.1097/00003727-200601001-00011> PMID: 16344639
56. Lasch KE, Marquis P, Vigneux M, et al. PRO development: rigorous qualitative research as the crucial foundation. *Qual Life Res* 2010; 19: 1087–1096. <https://doi.org/10.1007/s11136-010-9677-6> PMID: 20512662
57. Portney LG and Watkins MP. *Foundations of clinical research: applications to practice*. 3rd ed. Upper Saddle River, N.J. Pearson/Prentice Hall, 2009.
58. Petty NJ, Thomson OP and Stew G. Ready for a paradigm shift? Part 2: Introducing qualitative research methodologies and methods. *Man Ther* 2012; 17: 378–384. <https://doi.org/10.1016/j.math.2012.03.004> PMID: 22480949
59. Johnson R and Waterfield J. Making words count: the value of qualitative research. *Physiother Res Int* 2004; 9: 121–131. <https://doi.org/10.1002/pri.312> PMID: 15560669
60. Agan J, Koch LC and Rumrill PD Jr. The use of focus groups in rehabilitation research. *Work* 2008; 31: 259–269. PMID: 18957744
61. Krueger RA and Casey MA. *Focus groups: a practical guide for applied research*. 4th ed. Los Angeles: SAGE, 2009.
62. Breakwell GM. *Doing Social Psychology Research*. New York: John Wiley & Sons, Inc., 2004.
63. Patrick DL, Burke LB, Gwaltney CJ, et al. Content validity—establishing and reporting the evidence in newly developed patient-reported outcomes (PRO) instruments for medical product evaluation: ISPOR PRO Good Research Practices Task Force report: part 2—assessing respondent understanding. *Value Health* 2011; 14: 978–988. <https://doi.org/10.1016/j.jval.2011.06.013> PMID: 22152166
64. Vicsek L. Issues in the analysis of focus groups: generalisability, quantifiability, treatment of context and quotations. *Qual* 2010; 15: 122–141.
65. Scott SD, Sharpe H, O’Leary K, et al. Court reporters: a viable solution for the challenges of focus group data collection? *Qual Health Res* 2009; 19: 140–146. <https://doi.org/10.1177/1049732308327883> PMID: 19074635
66. Braun V and Clarke V. To saturate or not to saturate? Questioning data saturation as a useful concept for thematic analysis and sample-size rationales. *Qualitative Res Sport Exerc Health* 2021; 13: 201–216.
67. PROMIS instrument development and psychometric evaluation scientific standards. http://www.nihpromis.org/Documents/PROMISStandards_Vers2.0_Final.pdf (2012, accessed May 20 2022).
68. DeWalt DA, Rothrock N, Yount S, et al. Evaluation of item candidates: the PROMIS qualitative item review. *Med Care* 2007; 45: S12–21. <https://doi.org/10.1097/01.mlr.0000254567.79743.e2> PMID: 17443114
69. Gershon RC, Lai JS, Bode R, et al. Neuro-QOL: quality of life item banks for adults with neurological disorders: item development and calibrations based upon clinical and general population testing. *Qual Life Res* 2012; 21: 475–486. <https://doi.org/10.1007/s11136-011-9958-8> PMID: 21874314
70. Willis GB. *Cognitive interviewing: a tool for improving questionnaire design*. Thousand Oaks, Calif.: Sage Publications, 2005.
71. Strange D and Takarangi MK. Memory distortion for traumatic events: the role of mental imagery. *Front Psychiatry* 2015; 6: 27 <https://doi.org/10.3389/fpsy.2015.00027> PMID: 25755646
72. Sakakibara BM, Miller WC and Backman CL. Rasch analyses of the Activities-specific Balance Confidence Scale with individuals 50 years and older with lower-limb amputations. *Arch Phys Med Rehabil* 2011; 92: 1257–1263. <https://doi.org/10.1016/j.apmr.2011.03.013> PMID: 21704978
73. Hafner BJ, Gaunaud IA, Morgan SJ, et al. Construct validity of the Prosthetic Limb Users Survey of Mobility (PLUS-M) in adults with lower limb amputation. *Arch Phys Med Rehabil* 2017; 98: 277–285. <https://doi.org/10.1016/j.apmr.2016.07.026> PMID: 27590443
74. Flesch R. *The art of readable writing: With the Flesch readability formula*. New York: Harper & Row, 1974.
75. Heijnen MJH and Rietdyk S. Falls in young adults: Perceived causes and environmental factors assessed with a daily online survey. *Hum Movement Sci* 2016; 46: 86–95. <https://doi.org/10.1016/j.humov.2015.12.007> PMID: 26741254
76. Rosenblatt NJ, Bauer A and Grabiner MD. Relating minimum toe clearance to prospective, self-reported, trip-related stumbles in the community. *Prosthet Orthot Int* 2017; 41: 387–392. <https://doi.org/10.1177/0309364616650085> PMID: 27280640
77. Sattar S, Spoelstra SL, Alibhai SMH, et al. Circumstances of falls and fear of falling in community-dwelling older adults with cancer: Results from a mixed-methods study. *J Geriatr Oncol* 2019; 10: 105–111. <https://doi.org/10.1016/j.jgo.2018.08.005> PMID: 30170991

78. Stevens JA, Mack KA, Paulozzi LJ, et al. Self-Reported Falls and Fall-Related Injuries Among Persons Aged ≥ 65 Years—United States, 2006. *J Safety Res* 2008; 39: 345–349. <https://doi.org/10.1016/j.jsr.2008.05.002> PMID: 18571577
79. Peeters G, Jones M, Byles J, et al. Long-term consequences of noninjurious and injurious falls on well-being in older women. *J Gerontol A Biol Sci Med Sci* 2015; 70: 1519–1525. <https://doi.org/10.1093/gerona/glv102> PMID: 26273020
80. Wielinski CL, Erickson-Davis C, Wichmann R, et al. Falls and injuries resulting from falls among patients with Parkinson's disease and other parkinsonian syndromes. *Mov* 2005; 20: 410–415. <https://doi.org/10.1002/mds.20347> PMID: 15580552
81. Sattar S, Alibhai SMH, Spoelstra SL, et al. The assessment, management, and reporting of falls, and the impact of falls on cancer treatment in community-dwelling older patients receiving cancer treatment: Results from a mixed-methods study. *J Geriatr Oncol* 2018.
82. Peterson EW, Cho CC, von Koch L, et al. Injurious falls among middle aged and older adults with multiple sclerosis. *Arch Phys Med Rehabil* 2008; 89: 1031–1037. <https://doi.org/10.1016/j.apmr.2007.10.043> PMID: 18503796
83. Xu D and Drew JAR. What doesn't kill you doesn't make you stronger: The long-term consequences of nonfatal injury for older adults. *Gerontologist* 2017; 58: 759–767.
84. Sung J, Trace Y, Peterson EW, et al. Falls among full-time wheelchair users with spinal cord injury and multiple sclerosis: a comparison of characteristics of fallers and circumstances of falls. *Disabil Rehabil* 2019; 41: 389–395. <https://doi.org/10.1080/09638288.2017.1393111> PMID: 29069956
85. Doak LG and Doak CC. Patient comprehension profiles: recent findings and strategies. *Patient Couns Health Educ* 1980; 2: 101–106. [https://doi.org/10.1016/s0738-3991\(80\)80049-8](https://doi.org/10.1016/s0738-3991(80)80049-8) PMID: 10249185
86. Zecevic AA, Salmoni AW, Speechley M, et al. Defining a fall and reasons for falling: comparisons among the views of seniors, health care providers, and the research literature. *Gerontologist* 2006; 46: 367–376. <https://doi.org/10.1093/geront/46.3.367> PMID: 16731875
87. Gooday HMK and Hunter J. Preventing falls and stump injuries in lower limb amputees during inpatient rehabilitation: completion of the audit cycle. *Clin Rehabil* 2004; 18: 379–390. <https://doi.org/10.1191/0269215504cr738oa> PMID: 15180121
88. Pauley T, Devlin M and Heslin K. Falls sustained during inpatient rehabilitation after lower limb amputation: prevalence and predictors. *Am J Phys Med Rehabil* 2006; 85: 521–532. <https://doi.org/10.1097/01.phm.0000219119.58965.8c> PMID: 16715022
89. Crenshaw JR, Kaufman KR and Grabiner MD. Compensatory-step training of healthy, mobile people with unilateral, transfemoral or knee disarticulation amputations: A potential intervention for trip-related falls. *Gait Posture* 2013; 38: 500–506. <https://doi.org/10.1016/j.gaitpost.2013.01.023> PMID: 23433547
90. Kaufman KR, Wyatt MP, Sessoms PH, et al. Task-specific fall prevention training is effective for warfighters with transtibial amputations. *Clin Ortho Relat Res* 2014; 472: 3076–3084. <https://doi.org/10.1007/s11999-014-3664-0> PMID: 24811543
91. Olenšek A, Zadavec M, Burger H, et al. Dynamic balancing responses in unilateral transtibial amputees following outward-directed perturbations during slow treadmill walking differ considerably for amputated and non-amputated side. *J Neuroeng Rehabil* 2021; 18: 123. <https://doi.org/10.1186/s12984-021-00914-3> PMID: 34332595
92. Shawen N, Lonini L, Mummidisetty CK, et al. Fall Detection in individuals with lower limb amputations using mobile phones: Machine learning enhances robustness for real-world applications. *JMIR Mhealth Uhealth* 2017; 5: e151. <https://doi.org/10.2196/mhealth.8201> PMID: 29021127
93. Harari Y, Shawen N, Mummidisetty CK, et al. A smartphone-based online system for fall detection with alert notifications and contextual information of real-life falls. *J Neuroeng Rehabil* 2021; 18: 124. <https://doi.org/10.1186/s12984-021-00918-z> PMID: 34376199
94. Schwickert L, Becker C, Lindemann U, et al. Fall detection with body-worn sensors: a systematic review. *Z Gerontol Geriatr* 2013; 46: 706–719. <https://doi.org/10.1007/s00391-013-0559-8> PMID: 24271251
95. Broadley RW, Klenk J, Thies SB, et al. Methods for the real-world evaluation of fall detection technology: A scoping review. *Sensors (Basel)* 2018; 18(7): 2060. <https://doi.org/10.3390/s18072060> PMID: 29954155
96. Handelzalts S, Alexander NB, Mastruserio N, et al. Detection of real-world trips in at-fall risk community dwelling older adults using wearable sensors. *Front Med (Lausanne)* 2020; 7: 514. <https://doi.org/10.3389/fmed.2020.00514> PMID: 32984385
97. Ojeda LV, Adamczyk PG, Rebula JR, et al. Reconstruction of body motion during self-reported losses of balance in community-dwelling older adults. *Med Eng Phys* 2019; 64: 86–92. <https://doi.org/10.1016/j.medengphy.2018.12.008> PMID: 30581048

98. Aziz O, Klenk J, Schwickert L, et al. Validation of accuracy of SVM-based fall detection system using real-world fall and non-fall datasets. *PLoS One* 2017; 12: e0180318. <https://doi.org/10.1371/journal.pone.0180318> PMID: 28678808
99. Lamb SE, Jørstad-Stein EC, Hauer K, et al. Development of a common outcome data set for fall injury prevention trials: the Prevention of Falls Network Europe consensus. *J Am Geriatr Soc* 2005; 53: 1618–1622. <https://doi.org/10.1111/j.1532-5415.2005.53455.x> PMID: 16137297

Fall Survey for People with Lower Limb Amputation Cognitive Interview Guide

Questions for All Cognitive Interviews

Instructions

Did you read the instructions?

Yes No

If NO: *That's ok. I will have you look at them in just a moment. Before you do, can you tell me what you thought about when you read the words "fall" and "near-fall" in the survey? What is a fall? A near-fall?*

Fall:

Near-fall:

How would you differentiate between a fall and near-fall?

Ok, great, thank you. Now, would you please read the instructions for me?

[proceed to "If YES"]

If YES: *Were any of the survey instructions confusing? If so, which part(s)?*

Would you recommend any changes to the instructions to make them easier to understand?

When you read our definition of a "fall" and a "near-fall," was it clear what we wanted you to think about? What did you think we were asking about?

Were there any parts of our definitions that were confusing? Would you recommend using words like "accidental"?

Based on the definitions we provide, can you tell how a "fall" and "near-fall" are different?

Number of fall or near-fall experiences

In the section on fall or near-fall experiences, was it clear that we wanted you to think about falls and near-falls that occurred within the past 12 months? Did you have any trouble answering the survey based on this timeframe? If so, can you describe what was difficult?

What did you check where we asked “In the past 12 months, have you experienced a fall where your body accidentally landed on the ground or floor”?

Yes No Neither

What did you enter above the “number of falls”?

What did you check where we asked “In the past 12 months, have you experienced a near-fall where you caught yourself or recovered your balance before your body landed on the ground or floor”?

Yes No Neither

What did you enter above the “number of near-falls”?

If the participant answered only the fall OR near-fall question, or answered “yes,” but did not include a number:

How could we change the survey, if we wanted someone to be sure to answer the question both about “falls” and “near-falls”? Was there a reason that you didn’t answer both questions?

How could we change the survey, if we wanted someone to be sure to answer the question about falls/near-falls AND enter the number of falls/near-falls?

Stopping the survey

Under what situations would someone stop answering questions on the survey?

*How could we change the survey to make it clearer when we want people to stop?
[provide detail about stopping, as needed]*

Most recent fall or near-fall

How did you answer question #3 “Was your most recent event a fall or near-fall”?

Fall Near-fall Neither

How would someone answer this question if they had experienced their latest fall 1 month ago, and their latest near-fall last week?

Fall Near-fall Unknown

How would someone answer this question if they had not experienced a fall in the past 12 months, and had a near-fall 1 month ago?

Fall Near-fall Unknown

How did you answer question #4 "What was the date of your most recent fall or near-fall?"

Month: _____ Year: _____

Is it hard to remember the date of a fall or near-fall event? If so, can you think of a better way for us to ask someone about when his or her last fall or near-fall occurred?

Significance of most recent fall or near-fall

What does the term "significant" mean to you?

What makes a fall "significant" to you?

Are there other words or terms we could use to ask someone if a loss of balance or fall was personally "significant"?

Final summary question

What other aspects of balance and falls do you think should be included in the survey? What kinds of things are important for us to ask about if we want to learn more about falls?

Do you have any other suggestions for things we should include in this survey?

Questions for Cognitive Interview Group 1

Assistive Device

How did you respond to question #6, “Were you using any of the following assistive devices at the time of your fall or near fall?”

Cane Crutch Walker Wheelchair None Do not remember

Are there any other types of assistive devices that you use that were not listed?

Is it possible to be using more than one form of assistive device at the time of a fall?

Have you ever fallen while using that device?

Yes No

Time of Day

How did you respond to question #12, “What time of day was it?”

Morning (6am-12pm) Afternoon (12pm-6pm)
 Evening (6pm-12am) Night (12am-6am)
 Do not remember

How did you decide which answer to choose?

Did you use the description (eg, “morning” or “evening”) and/or the time (eg, “6am-12pm”) to select your answer?

Would you change how the time of day was divided up? If so, how?

Situations

How did you respond to question #18 “Did any of the following occur when you fell or nearly fell?”

<input type="checkbox"/> You misplaced a step	<input type="checkbox"/> Your feet slipped from underneath you
<input type="checkbox"/> You were avoiding an obstacle or object	<input type="checkbox"/> You caught your leg or foot on something
<input type="checkbox"/> You were bumped, pushed, or pulled	<input type="checkbox"/> You were moving in a crowded space
<input type="checkbox"/> Your feet were too close together	<input type="checkbox"/> You were walking on a narrow surface
<input type="checkbox"/> You were carrying an object	<input type="checkbox"/> Your vision was obstructed
<input type="checkbox"/> The floor or ground moved unexpectedly	<input type="checkbox"/> The floor or ground changed levels
<input type="checkbox"/> Your prosthesis broke	<input type="checkbox"/> Your prosthesis moved unexpectedly
<input type="checkbox"/> Your socket was loose	<input type="checkbox"/> Your prosthesis was not on properly
<input type="checkbox"/> Your assistive device broke	<input type="checkbox"/> Your assistive device moved unexpectedly
<input type="checkbox"/> Do not remember	<input type="checkbox"/> None of these apply

Can you think of a better way we could ask this question?

Do the answers represent realistic scenarios that might cause someone to lose their balance? If not, which of the scenarios were unrealistic?

Did any of the answers seem repetitive? If so, which ones?

Did you have any difficulty in selecting your answer(s)? If so, why?

Was it clear that you could choose multiple answers? Can you imagine a situation where multiple answers might apply?

Possible answers

Now I would like to ask you questions about each of the possible answers. Even though you may not have checked a box for the last fall or near-fall you have experienced, I'd like you to try to think about situations where the scenarios might cause someone to lose their balance.

Misplaced step

What would be an example of misplacing a step?

Are you more or less likely to misplace a step with your prosthetic leg? Why?

Are there certain situations where you are more likely to misplace a step?

Can you describe how someone may lose his or her balance by misplacing a step?

Feet slipping

Can you describe a situation where your feet may slip from underneath you and cause you to lose your balance?

What direction do your feet usually go relative to your body when you slip?

Obstacles or objects

What obstacles or objects do you avoid because they might cause you to lose your balance?

Is there a difference between an obstacle and an object? If so, what is the difference?

How would you move your body in order to avoid an obstacle or object?

Can you describe a situation where avoiding an obstacle or object may cause you to lose your balance or fall?

Catching a foot

When you think about catching your leg or foot on something what comes to mind?

What specific things might you catch your leg or foot on that would cause you to lose your balance or fall?

Bumped, pushed, pulled

Do you think being bumped, pushed, or pulled could cause you to lose your balance? Would getting bumped, pushed, or pulled affect balance in different ways? How?

Do you think that one causes people with lower limb amputation to lose their balance more than the others?

What do you do to maintain your balance when you are bumped, pushed, or pulled?

Crowded space

How would you describe a crowded space?

Do you avoid crowded spaces, or do you tend to find yourself dealing with them frequently?

Can you describe a specific situation where you had to move in a crowded space?

Have you ever felt as though moving in a crowded space might cause you to lose your balance and/or fall?

Do you move differently when you are in a crowded space?

Feet close together

Do you think the placement or positioning of your feet affects your balance or likelihood of falling?

Can you describe a situation where you had to place your feet closer together?

Are there situations or environment where you find yourself having to place your feet closer together than you normally would? Does this make it more difficult to maintain your balance?

Do you do anything different in order to maintain your balance when you have to put your feet close together?

Narrow surfaces

Can you give me some examples of narrow surfaces that people have to walk or step on?

Can you describe situations where walking on a narrow surface could cause someone to lose their balance?

How "narrow" does a surface have to be to make someone lose their balance?

Would you change how you walk or stand on a narrow surface to avoid a loss of balance or fall?

Carrying an object

Are you more likely to lose your balance or fall while carrying an object? Why or why not?

What kind of objects might increase the chance you would lose your balance?

How might you change how you carry an object so that your balance is not affected?

Obstructed vision

When you think of your vision being obstructed what comes to mind?

What are some reasons you think someone's vision may be obstructed?

Would having your vision obstructed affect your balance? Why?

Floor or ground moving

What are some examples of the floor or ground moving unexpectedly?

What types of unexpected floor or ground movement would make it difficult to maintain your balance?

How would you respond to unexpected movements of the floor or ground in order to maintain your balance and avoid a fall?

Do the words "ground" and "floor" mean the same thing to you? If not, how are they different?

Floor or ground changing levels

Can you describe any examples where you felt that the floor or ground changed levels on you?

What kinds of changes in the level of the floor or ground might cause you to lose your balance and/or fall?

What do you do when the floor or ground change levels to maintain your balance?

Prosthesis break

Have you ever had your prosthesis break while using it? Please describe what happened.

Can you imagine a situation where a prosthesis breaking might lead to a fall?

Prosthesis move unexpectedly

Have you ever had your prosthesis move unexpectedly? What happened?

What types of prosthesis movements would you describe as "unexpected"?

Are there specific types of unexpected prosthesis movements that may lead to a loss of balance or fall?

Loose socket

What does the phrase "a loose socket" mean to you?

Can you describe what things might cause your socket to feel loose?

Do you move differently when your socket is loose? How so?

Does a loose socket affect your balance? If so, how?

Prosthesis not on properly

Have you ever used your prosthesis when it wasn't on properly?

What does it feel like when your prosthesis is not on properly?

What things affect whether your prosthesis is on properly or not?

Can you describe a situation when your prosthesis not being on properly may cause you to lose your balance and/or fall?

Assistive device move unexpectedly

What types of things would you include under "assistive devices"?

Do you ever experience your assistive device moving unexpectedly? How?

How could an assistive device move unexpectedly and cause a fall?

Missing work

Now, I'd like to ask you about question #27 related to missing work. How did you answer the question "How much time did you miss from work because of your fall or near-fall?"

- | | |
|--|---|
| <input type="checkbox"/> Less than 1 day | <input type="checkbox"/> 1 day |
| <input type="checkbox"/> 2-3 days | <input type="checkbox"/> More than 3 days |
| <input type="checkbox"/> None of these apply | <input type="checkbox"/> Do not remember |

What does the term "work" mean to you?

Are the answers we present realistic for someone who might miss work due to a fall-related injury? If not, how would you suggest we change them?

Would you expect a fall or near-fall to lead to someone missing work? If so, for how long?

Significance of most recent fall or near-fall

What does the term "significant" mean to you?

What makes a fall "significant" to you?

Are there other words or terms we could use to ask someone if a loss of balance or fall was personally "significant"?

Questions for Cognitive Interview Group 2

Physical assistance prior to event

How did you respond to question #8, "Was someone physically assisting you just before you lost your balance?" (Choose the best answer)

Yes No Do not remember

What does it mean to give or receive "physical assistance"?

Was it clear that you were being asked about physical assistance you might have been receiving just before the fall or near-fall? If not, how could we revise this question to make that clear?

Physical assistance to avoid a fall

How did you respond to question #9, "Did someone physically assist you once you started to lose your balance?"

Yes No Do not remember

Can you describe how someone nearby might help you when you start to fall?

Imagine that you lost your balance while out walking with a friend and, to keep from falling you reached out and grabbed him or her. Which response would you choose if this situation had occurred?

Yes No Do not remember

If YES: *How could we modify the question so that it is clear we are only asking about situations where someone else reaches out to help you (and not the other way around)?*

Lighting

How did you respond to question #13, "What was the lighting like?" (Choose the best answer)

Well lit Poorly lit Do not remember

What kinds of locations are typically well lit?

What kinds of locations typically are poorly lit?

How important is good lighting to maintaining your balance?

Activities

Now, I'd like to ask you about the question related to activities you may have been engaged in at the time of the fall or near-fall.

How did you respond to question #17, "Were you doing any of the following?"

- | | |
|---|--|
| <input type="checkbox"/> Standing up from a seated position | <input type="checkbox"/> Sitting down from a standing position |
| <input type="checkbox"/> Turning towards your left side | <input type="checkbox"/> Turning towards your right side |
| <input type="checkbox"/> Starting to move | <input type="checkbox"/> Coming to a stop |
| <input type="checkbox"/> Speeding up | <input type="checkbox"/> Slowing down |
| <input type="checkbox"/> Do not remember | <input type="checkbox"/> None of these apply |

Was it clear that you could choose multiple answers?

Was the layout of the answers (i.e., vertical vs. side-by-side) clear and easy to follow? Would you prefer a different layout? What suggestions do you have for presenting survey answers?

Do the answers represent realistic activities that might cause someone to lose their balance? If not, which of the answers were unrealistic?

Are there other activities that we should list here?

Did any of the answers seem redundant? If so, which ones?

Possible answers

Now I would like to ask you questions about each of the possible answers. Even though you may not have checked a box for the last fall or near-fall you have experienced, I'd like you to try to think about situations where performing these activities might cause someone to lose their balance.

Standing up

What part of standing up from a seated position is most likely to cause someone to lose his or her balance?

How does standing up from a chair differ for people who use a lower limb prosthesis?

Sitting down

Can you describe how someone may lose his or her balance while sitting down?

How might someone who wears a prosthesis sit down so that they don't fall?

Turning toward your right or left side

Can you describe how someone may lose his or her balance when turning?

Is turning more or less challenging for people with a prosthesis? Why?

What is different about turning to your right or your left side? Does turning one direction challenge your balance more than the other?

Starting to move

What does the phrase “starting to move” mean to you?

Can you describe what you imagine when you think about starting to move?

How might starting to move cause someone to lose his or her balance?

Coming to a stop

Can you describe a situation where coming to a stop might cause someone to lose their balance?

What direction do you think someone is likely to fall when “coming to a stop”?

How does coming to a stop on your prosthetic or non-prosthetic leg affect your balance?

Speeding up

How does speeding up affect someone’s balance?

When you thought about speeding up, how quickly did you picture yourself moving?

Do you think someone with a prosthesis is more likely to lose his or her balance while speeding up or slowing down? Why?

Slowing down

Can you describe for me the last time you had to slow down quickly?

What are some examples of situations where slowing down might throw someone off balance?

Fall direction

Now, I’d like to ask you about the question related to directions of a fall or near-fall.

How did you answer question #20, “In what direction did you fall or nearly fall?”

- | | |
|--|--|
| <input type="checkbox"/> Forward | <input type="checkbox"/> Backward |
| <input type="checkbox"/> Left | <input type="checkbox"/> Right |
| <input type="checkbox"/> Straight down | <input type="checkbox"/> Do not remember |
| <input type="checkbox"/> None of these apply | |

When you think about the term “direction” what does it mean to you?

Imagine you fell diagonally (for example, not straight forward and not directly to your left), how would you answer the question?

Possible answers

Now I would like to ask you questions about each of the possible answers. Even though you may not have checked a box for the last fall or near-fall you have experienced, we still want to get your opinions on each of the possible answers.

Forward

Can you describe what a forward fall would look like?

What might cause someone to lose his or her balance and fall forwards?

Backwards

What does a backward fall look like?

Can you think of a situation where someone would lose his or her balance and fall backwards?

To the left/to the right

Can you describe a situation where someone would fall to his or her left? To their right?

What kinds of things might cause a loss of balance to the right or left, but not forward or backward?

Straight down

What does it mean to fall "straight down"? Can you describe how this might occur?

What parts of the body might you expect to hit the ground when someone falls straight down?

Injury

Now, I'd like to ask you about the question related to injuries after a fall or near-fall.

How did you respond to question #24, "Did you experience an injury because of your fall or near-fall?"

- | | |
|---|--|
| <input type="checkbox"/> Bruise | <input type="checkbox"/> Cut or scrape |
| <input type="checkbox"/> Pain or soreness | <input type="checkbox"/> Swelling |
| <input type="checkbox"/> Pulled muscle | <input type="checkbox"/> Torn tendon or ligament |
| <input type="checkbox"/> Fracture or broken bone | <input type="checkbox"/> Joint dislocation |
| <input type="checkbox"/> Internal injury | <input type="checkbox"/> Concussion or head injury |
| <input type="checkbox"/> Did not experience an injury | <input type="checkbox"/> Do not remember |
| <input type="checkbox"/> None of these apply | |

*Was there an injury listed that you would **not** expect someone who falls to experience? If so, which one(s)?*

*Is there any other type of injury that could come from a fall that **was not included in this list**? If so, please describe.*

Were there any answers (types of injuries) listed that were confusing?

Questions for Cognitive Interview Group 3

Accompanied or unaccompanied fall / near-fall

How did you respond to question #7, "Were you alone or with others?"

Alone With Others Do not remember

What does "with others" mean to you (i.e., 1 other person? A group?)

How does being around others affect your balance?

How close to you (proximity) does someone have to be to you in order for them to be considered "with you"? Same room? Arms length?

Familiarity of location

How did you respond to question #10, "Were you in a familiar or unfamiliar location?"

Familiar Unfamiliar Do not remember

What makes a location familiar or unfamiliar?

How does the familiarity of a location affect your balance or likelihood of falling?

Situations

How did you respond to question #16 "Were you doing any of the following?"

Going up stairs Going down stairs
 Going up a hill, ramp, or incline Going down a hill, ramp, or incline
 Stepping up onto a surface Stepping down from a surface
 Do not remember None of these apply

Can you think of a better way we could ask this question?

*Do the answers represent realistic scenarios where someone might lose their balance?
If not, which of the scenarios were unrealistic?*

Did any of the answers seem repetitive? If so, which ones?

Did you have any difficulty in selecting your answer(s)? If so, why?

Are there other situations in which you have fallen that we haven't included?

Was it clear that you could choose multiple answers? Can you describe a situation where multiple answers might apply?

Possible answers

Now I would like to ask you questions about each of the possible answers. Even though you may not have checked a box for the last fall or near-fall you have experienced, I'd like you to try to think about situations where the scenarios might cause someone to lose their balance.

Going up / down stairs

Does going up or down a flight of stairs affect your balance in different ways? If so, what is the difference?

Can you describe how someone may lose his or her balance going up or down a flight of stairs?

What about going up or down a flight of stairs poses the greatest challenge to your balance (e.g., stepping up or down with one leg or the other, making sure your toes don't catch on the step)?

Going up / down a hill, ramp, or incline

How would you describe the difference between a hill, a ramp, and incline? Are these the same or different?

Does going up or down a hill, ramp, or incline affect your balance in different ways? If so, what is the difference?

Can you describe how someone may lose his or her balance going up or down a hill, ramp, or incline?

What part of going up or down a hill, ramp, or incline poses the greatest challenge to your balance (e.g., moving over one leg or the other, balancing while stepping with one leg)?

Stepping up onto / down from a curb

Would stepping up onto or down from a curb affect balance in different ways? How?

Can you describe how someone may lose his or her balance stepping up onto or down from a curb?

Are you more or less likely to step up on to or down from a curb with one leg or the other? Why?

Preventing a fall or minimizing risk of injury

Now, I'd like to ask you about the question related to preventing the fall or minimizing the risk of injury. How did you answer question #21 "Did you do anything to catch yourself, prevent the fall, or minimize the risk of injury?"

- | | |
|---|---|
| <input type="checkbox"/> Reached out to grab someone/something | <input type="checkbox"/> Leaned against someone/something |
| <input type="checkbox"/> Skipped or hopped | <input type="checkbox"/> Took a big step |
| <input type="checkbox"/> Changed position to limit/avoid impact | <input type="checkbox"/> Do not remember |

Are the answers we present realistic for someone who might be trying to prevent a fall or minimize the risk of injury? If not, how would you suggest we change them?

When you lose your balance or fall, what things do you do to try and regain your balance?

Are there any other strategies you use to regain your balance that we haven't included?

Is there a "safest" way for you to fall?

Possible answers

Now I would like to ask you questions about each of the possible answers. Even though you may not have checked a box for the last fall or near-fall you have experienced, I'd like you to try to think about situations where the scenarios might cause someone to lose their balance.

Reached out to grab someone/something

What would be an example of something you might reach out to grab to stop yourself from falling or limit your chances of hurting yourself while you fell?

Is reaching out to grab someone or something a realistic way to prevent a fall? To minimize the risk of injury? Why or why not?

Can you describe a situation where reaching out to grab someone or something prevented a fall and/or minimized your risk of injury when you fell?

Leaned against someone/something

What would be an example of something you might lean against when you lose your balance?

Is leaning against someone or something an effective way to minimize the risk of injury? Why or why not?

Can you describe a situation where leaning against someone or something prevented you from falling? If not, can you imagine a situation where this might happen?

Are you more likely to lean against or reach out and grab someone or something in order to prevent a fall and/or minimize the risk of injury?

Are there any situations where reaching out to grab someone or something could cause more injury?

Skipped or hopped

What is the difference between skipping and hopping?

Have you ever tried to skip or hop to avoid a fall or minimize the risk of injury? What happened? Did it work?

Are you more or less likely to skip or hop on one leg when you lose your balance? Which one and why?

Took a big step

Can you describe a situation where taking a big step may prevent a fall and/or minimize risk of injury?

Are you more or less likely to take a big step with one leg, if you're trying to regain your balance? Why?

Are there certain situations where taking a big step is the best way to prevent a fall?

Adjusted or selected a body position to avoid impact?

How would you change position to limit or avoid impact you made when you hit the ground?

Can you describe a situation where changing position allowed you to avoid a fall? What about a situation where you still fell, but changing your position reduced the impact of the fall?

Are there specific areas on your body that better tolerate the force of a fall? Are there areas that you try really hard to avoid hitting?

Functional, behavioral, and emotional consequences

Now, I'd like to ask you about the question related to whether you have made any changes after a fall or near-fall. How did you answer question #28 "Because of this fall or near-fall have you done any of the following?"

- | | |
|--|---|
| <input type="checkbox"/> Changed how you do certain activities | <input type="checkbox"/> Required more assistance to perform activities |
| <input type="checkbox"/> Avoided certain activities | <input type="checkbox"/> Stopped doing certain activities |
| <input type="checkbox"/> Rested more than usual | <input type="checkbox"/> Become more fearful of falling |
| <input type="checkbox"/> Lost confidence in your balance | <input type="checkbox"/> Felt embarrassment |
| <input type="checkbox"/> Don't remember | <input type="checkbox"/> None of these apply |

Did any of the answers seem repetitive? If so, which ones?

Was it clear that you could choose multiple answers? If not, how could we make it clear that it is OK for respondents to check multiple boxes?

Do the answers represent realistic changes someone might make after a fall or near-fall? If not, which of the scenarios were unrealistic?

Are there any other changes someone might make or feelings someone might have after a fall that we should include here?

*Over what period of time were you thinking about as you read this question?
(Prompt if needed: day, week, month, longer... shorter?)*

Possible answers

Now I would like to ask you questions about each of the possible answers. Even though you may not have checked a box for the last fall or near-fall you have experienced, I'd like you to try to think about situations where the scenarios might cause someone to lose their balance.

Change how you do certain activities

When you think about the term "activity" what comes to mind?

How might someone perform an activity differently after a fall or near-fall? Can you think of an example or two?

Can you think of a situation where someone might change how they do many activities after a fall?

What about a situation where they might change just one activity?

For how long after a fall or near-fall would you expect someone would change how he or she does any activity? Why do you say that?

Required more assistance to perform activities

What came to mind when you read the word “assistance”?

Does “assistance” include help from a person, help from a device like a cane, or both?

Is there a difference between the phrases “required more assistance” and “required assistance”? If so, what is the difference?

Can you think of any ways that someone might need “more assistance” after a fall or near-fall?

How long after the fall or near-fall do you think someone would need more assistance to perform activities?

Avoid certain activities

When you think of the term “avoid” what comes to mind?

Can you describe a situation where a fall or near-fall might cause someone to avoid certain activities? What activities might that include?

When you think about avoiding activities after a fall or near-fall, do you imagine avoiding activities for just a short period of time, or a longer period of time?

Stop doing certain activities

Would you consider “avoiding certain activities” different from “stopping certain activities”? If so, how?

How long would it take someone to “avoid an activity” for you to decide they had “stopped doing that activity”?

Is “avoided certain activities” and “stopped doing certain activities” different? If yes, how?

Can you describe a situation where a fall or near-fall might cause someone to stop doing an activity? What activities might that include?

Rested more than usual

When someone says they “rested”, what does that mean to you? What does “resting” after a fall or near-fall involve?

What is a “usual” amount of rest, and what types or amount of rest would be considered “more than usual”?

Can you describe a situation where someone might need to rest more than usual after a fall or near-fall?

Become more afraid of falling

What does it mean to be “afraid of falling”?

Why might someone be afraid of falling?

Is it possible to be “concerned” or “worried” about falling, but not be “afraid”?

How would a fall or near-fall increase someone’s fear of falling?

Lost confidence in your balance

What does “confidence in your balance” mean to you?

Can you think of a time when you lost confidence in your balance? Can you describe it?

What changes when someone loses confidence in his or her balance?

How does a loss of confidence in your balance differ from a fear of falling?

Felt embarrassment

What does it mean to “be embarrassed”?

What aspects of losing your balance or falling might be embarrassing?

How long does any embarrassment related to a fall last?

Questions for Cognitive Interview Group 4

Activities at the time of the event

Now, I'd like to ask you about the question related to activities you may have been engaged in at the time of the fall or near-fall.

How did you respond to question #15, "What were you doing?"

- | | |
|--|--|
| <input type="checkbox"/> Sitting still | <input type="checkbox"/> Standing still |
| <input type="checkbox"/> Stepping backwards | <input type="checkbox"/> Stepping forwards |
| <input type="checkbox"/> Stepping towards your left side | <input type="checkbox"/> Stepping towards your right side |
| <input type="checkbox"/> Reaching forwards | <input type="checkbox"/> Reaching backwards |
| <input type="checkbox"/> Reaching towards your left side | <input type="checkbox"/> Reaching towards your right side |
| <input type="checkbox"/> Bending over | <input type="checkbox"/> Walking |
| <input type="checkbox"/> Running | <input type="checkbox"/> Participating in sports or exercise |
| <input type="checkbox"/> Do not remember | <input type="checkbox"/> None of these apply |

Was it clear that you could choose multiple answers?

*Do the answers represent activities during which someone may lose their balance and/or fall?
Are there any activities listed that we should remove?*

Have we missed any activities that we should add to the list?

Do any of the answers seem repetitive? If so, which ones?

Possible answers

Now I would like to ask you questions about each of the possible answers. Even though you may not have checked a box, I'd like you to try to think about situations where performing these activities might cause someone to lose their balance or fall.

Sitting still

How does the surface or object someone is sitting on affect their balance?

Can you describe how someone may lose his or her balance while sitting?

Standing still

When you thought about standing still, what were you picturing? For how long were you standing still?

What aspects of standing still do you think pose the greatest challenge to someone's balance?

How does standing still affect someone wearing a prosthesis?

Stepping backwards

Under what type of situations would you expect someone to have to step backwards?

What would you describe as the most challenging part of stepping backwards for people who are wearing a prosthesis?

Is stepping backwards more challenging to someone's balance than stepping in any another direction? If so, why?

Stepping forwards

How does stepping forward on your left or right leg challenge your balance more?

How does stepping forward differ from stepping backwards?

Stepping to your left or right side

Can you describe how someone may lose his or her balance when stepping to the side?

Does stepping to the side create more challenge to someone's balance for people with a prosthesis? Why?

Reaching forwards

What things could someone do to maintain his or her balance while reaching forward?

Under what circumstances might someone lose their balance and fall when reaching forward?

Reaching backwards

Can you describe a situation when someone would need to reach backwards and possibly lose their balance?

Is it harder or easier to keep your balance when reaching behind you, rather than in front of you? Why?

What could you do to maintain your balance if you needed to reach behind you?

When you think about reaching backwards, what does that movement look like? Can you describe the position of your body?

Reaching to your left or right side

How is your balance affected when you reach to the right? To the left?

When reaching to the side, which direction challenges your balance the most? Why?

How do you think reaching causes balance problems for people who wear prostheses?

Bending over

Can you describe a time that you fell or lost your balance when you were bent over?

How do you think bending over might cause someone to lose his or her balance?

Walking

What part of walking is most likely to cause someone to lose his or her balance?

Running

How does running affect your balance differently than walking?

Would you expect a fall to be different when someone is running versus walking? If so, how?

Participating in sports or exercise

When you thought about “participating in sports or exercise” what types of things came to mind?

In what types of sports or exercise would you expect someone to lose their balance and fall?

Are there sports or exercise where someone wearing a prosthesis might be more likely to fall? Why?

Situations

Now, I'd like to ask you about the question related to situations you may have found yourself in at the time of the fall or near-fall.

How did you respond to question #19, “Did any of the following contribute to your fall or near-fall?”

- | | |
|--|---|
| <input type="checkbox"/> You were distracted or doing two things at once | <input type="checkbox"/> You were in a hurry or in a rush |
| <input type="checkbox"/> You were tired from a lack of sleep | <input type="checkbox"/> You were fatigued from activity |
| <input type="checkbox"/> You consumed alcohol or took drugs | <input type="checkbox"/> You were on medications |
| <input type="checkbox"/> Do not remember | <input type="checkbox"/> None of these apply |

*Was the layout of the answers (i.e., vertical vs. side-by-side) clear and easy to follow? Would you prefer a different layout? What suggestions do you have for presenting survey answers? Was there a situation listed that you would **not** expect to contribute to a loss of balance? If so, which one(s)?*

Possible answers

Now I would like to ask you questions about each of the possible answers. Even though you may not have checked a box for the last fall or near-fall you have experienced, I'd like you to try to think about if and how these situations might cause someone to lose their balance.

Distracted

What does the word distracted mean to you?

How do you think being distracted might affect someone's balance?

Can you describe a time when you lost your balance because you were distracted?

Are being distracted and doing two things at once the same thing? Is there a situation where they are different?

Does being distracted and doing two things at once have a similar or different effect on someone's balance? Why?

Rush or hurry

Does being in a hurry mean the same thing as being in a rush? If not, how are they different? If they are the same, which is the easiest to understand?

What types of situations might cause someone to rush or be in a hurry, and cause someone to lose their balance?

In what ways could being in a hurry or a rush affect someone's balance?

Tired

How does being tired from a lack of sleep affect your balance?

Can you describe a time when you were tired and it affected your balance?

Fatigued

Is being fatigued from activity different than being tired from a lack of sleep? If so, how?

How does fatigue from activity affect your balance?

Can you remember a time when you experienced a fall or near-fall because you were fatigued from activity? If so, what happened?

Are you more concerned about your balance when you are fatigued from activity? If so, why?

Alcohol or Drugs

What types of things would "alcohol or drugs" include? (e.g., does it include both legal and illegal drugs, beer, wine, and liquor?)

Do you think that consuming alcohol or drugs could affect someone's balance? If so, how?

Medication

What does "medications" mean to you? (e.g., does it include over-the-counter and prescribed medications?)

Have you ever taken a medication that affected your balance? If so, what did it feel like?

Let's say you tripped last week after you had taken cough syrup. Would you have checked "alcohol and drugs," "medications," neither, or both?

Impact location

Now, I'd like to ask you about the question related to the parts of your body that may have hit the ground or floor during a fall or near-fall.

How did you respond to question #23, "What part(s) of your body hit the ground, floor, surface, or other object during your fall or near-fall?"

- | | |
|--|--|
| <input type="checkbox"/> Head or neck | <input type="checkbox"/> Trunk or torso |
| <input type="checkbox"/> Shoulder | <input type="checkbox"/> Upper arm |
| <input type="checkbox"/> Elbow | <input type="checkbox"/> Lower arm |
| <input type="checkbox"/> Wrist or hand | <input type="checkbox"/> Hip or buttocks |
| <input type="checkbox"/> Thigh | <input type="checkbox"/> Knee |
| <input type="checkbox"/> Calf | <input type="checkbox"/> Ankle or Foot |
| <input type="checkbox"/> Do not remember | <input type="checkbox"/> None of these apply |

Are there other body locations that you would expect to hit the floor or ground during a fall that are not listed above? If so, which ones?

Do trunk and torso mean the same thing to you? Why?

Did you have trouble visualizing any of the body parts listed above? If so, which ones? Why?

Can you remember a time when you fell and hit a part of your body where it would be hard to respond to this question with the answers listed? If so, what happened?

Medical treatment sought

Now, I'd like to ask you about the question related to medical treatment after a fall or near-fall.

How did you respond to question #25, "Did you seek treatment from a medical facility because of your fall or near-fall?"

- No treatment sought
- Primary care clinic
- Urgent care clinic
- Emergency room
- Do not remember
- None of these apply

Can you describe the difference between primary care and urgent care? Between urgent care and an emergency room?

What types of fall-related injuries might cause someone to go to a primary care clinic? An urgent care clinic? An emergency room?

What type of things would you consider in order to decide whether you should seek medical attention after a fall-related injury?

Are there situations where you would seek medical treatment after a fall or near-fall, but not go to a primary care clinic, urgent care clinic, or an emergency room? If so, where would you go?

Questions for Cognitive Interview Group 5

Location at the time of the event

Now, I'd like to ask you about the question related to your location at the time of the fall or near-fall.

How did you respond to question #11, "Were you inside or outside?" (Choose the best answer)

- Inside Outside None of these apply
 Do not remember

What did you think about when you read the terms inside or outside?

Can you think of any locations that might be hard to describe as inside or outside?

Can you describe a situation where you were concerned that you might fall because of the location (i.e., indoor or outdoor)?

How do you think being inside or outside changes the likelihood that someone may fall?

Possible answers

Now I would like to ask you questions about each of the possible answers. Even though you may not have checked a box, I'd like you to try to think about situations where these locations might cause someone to lose their balance or fall.

Inside

Are there fall hazards that are unique to indoor locations? If so, what are they?

Outside

Are there fall hazards that are unique to outdoor locations? If so, what are they?

Ground or floor

Now, I'd like to ask you about the question related to the ground or floor at the time of the fall or near-fall. How did you respond to question #14, "What was the ground or floor like?"

- Flat Uneven
 Smooth Rough
 Wet Dry
 Slippery Sloped
 Do not remember None of these apply

Do the words ground and floor mean something different to you? If so, how do they differ?

Have we missed any descriptions of ground or floor conditions that may contribute to someone losing his or her balance?

Do any of the answers seem repetitive? If so, which ones?

*Was there a ground or floor condition that you would **not** expect to contribute to a loss of balance? If so, which one(s)?*

Possible answers

Now I would like to ask you questions about each of the possible answers. Even though you may not have checked a box, I'd like you to try to think about situations where these ground or floor conditions might cause someone to lose their balance or fall.

Flat

What are some examples of where the ground or floor may be flat, but someone could lose his or her balance and possibly fall?

Would you differentiate between a flat and a smooth surface? If so, how? Are they likely to affect someone's balance the same way?

Can you remember a time when you experienced a fall or near-fall on a flat surface? If so, what happened?

Smooth

Can you describe a few examples of what you would consider to be smooth ground or flooring?

Are there any other words you would use to describe a smooth floor? If so, what are they?

How concerned would you be about falling if you were walking on a smooth surface? How come?

Rough

Would you consider rough ground or flooring to be limited to certain locations or environments? If so, which?

How do you think rough ground or flooring might cause someone to lose his or her balance and fall?

What are some types of rough ground that you would consider likely to cause someone to lose his or her balance?

Uneven

Are uneven and rough ground different? If so, how? Are they likely to cause someone to fall in the same way?

Has there ever been a time when you had a fall or near-fall on uneven ground? If so, can you describe it?

Wet

Is a wet floor likely to result in a specific direction of fall? If so, can you describe it?

Are there certain types of wet floors that someone wearing a prosthesis might be more likely to fall? Why?

Slippery

Would you consider a slippery floor and a wet floor to be different? If so how?

Can you give me a few examples of slippery floors that might cause someone who uses a prosthesis to fall?

Dry

Do you think a dry floor might cause someone to lose his or her balance and fall? If so, how?

Can you give me a few examples of dry floors that might cause someone who uses a prosthesis to fall?

Sloped

How would you describe a sloped surface?

How does standing or walking on a sloped surface affect your balance?

Can you give me a few examples of sloped surfaces that might cause someone who uses a prosthesis to fall?

How would you have filled out this section if uneven ground were presented as a one-off disruption (e.g., curb) versus a continuous disruption (e.g., gravel pathway)?

Catching yourself

Now, I'd like to ask you about the question related to what you might have fallen on or caught yourself on at the time of the fall or near-fall.

How did you respond to question #22, "Did you fall or catch yourself on or against any of the following?"

- | | |
|--|--|
| <input type="checkbox"/> Ground or floor | <input type="checkbox"/> An object |
| <input type="checkbox"/> Another person | <input type="checkbox"/> Something else |
| <input type="checkbox"/> Do not remember | <input type="checkbox"/> None of these apply |

Is catching yourself on or against something or someone an effective way that you or other LLP users try to avoid a fall? Why or why not?

Does catching yourself on another object differ from catching yourself on another person? If so, how?

Does the ground or floor, as well as objects and people around you affect what you do when you lose your balance and/or fall? If so, how?

Possible answers

Now I would like to ask you questions about each of the possible answers. Even though you may not have checked a box, I'd like you to try to think about situations where someone might fall or catch him or herself on.

Ground or floor

What are some types of ground or floor that you might fall on?

Can you catch your self on the ground or floor without falling?

Can you describe the ground or floor the last time you fell?

An object

What types of objects have you grabbed onto in order to avoid falling? What are they?

What types of objects have you fallen onto? What are they?

Another person

Would you be more or less confident in falling or catching yourself against a person or an object? Why or why not?

If you were to lose your balance, how would you grab onto another person to avoid falling onto the ground or floor?

Something else

What other kinds of things might someone fall against or catch them self on when they lose their balance?

If you lost your balance and landed on a counter or against the wall or another person, would you consider that a fall or a near-fall? Why?

Medical treatment received

Now, I'd like to ask you about the question related to medical treatment at the time of the fall or near-fall.

How did you respond to question #26, "Did you receive medical treatment because of your fall or near-fall?"

- Treated and discharged the same day
- Admitted and hospitalized for 1 night
- Admitted and hospitalized for 2-3 nights
- Admitted and hospitalized for more than 3 nights
- Don't remember
- None of these apply

What kinds of things does "medical treatment" cover?

Have you ever received medical treatment for a fall or near-fall? If so, can you describe what it consisted of?

Are being hospitalized and being admitted the same thing? If not, how do they differ?

Lower Limb Prosthesis User Fall Event Survey

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Questions about the Lower Limb Prosthesis User Fall Event Survey

If you have questions about the LLP User Fall Event Survey or its use in clinical care or research, please contact the principal developer, Andrew Sawers, CPO, PhD (asawers@uic.edu).

Lower Limb Prosthesis User Fall Event Survey Instructions

The lower limb prosthesis user fall event survey was developed to help researchers and clinicians document the circumstances and consequences of falls and near-falls experienced by people with lower limb amputation who use a prosthesis (i.e., artificial limb).

Step 1: Administration of the fall event survey begins with an assessment of fall history (Appendix 1B). Respondents are asked to recall the number of fall and near-fall events they have experienced over a timeframe specified by the survey administrator (e.g., 12 months, 6 months). Fall history is recommended be taken at baseline and used for descriptive purposes.

Step 2: Next, the fall (Appendix 1C) and/or near-fall (Appendix 1D) probe forms should be administered to identify events of interest. For each event survey, the administrator should specify a timeframe (i.e., reporting period) over which the respondent is to reflect. If respondent indicates that they did not experience any events of interest within the specified period, the survey is complete.

Step 3: If a respondent indicates that they did experience 1 or more events of interest within the specified reporting period in the probe form, they should then be administered the fall (Appendix 1E) or near-fall (Appendix 1F) event details form for each event of interest.

Note for fall event-related consequences: Several of the survey questions that document the consequences of a fall or near-fall may require additional time after the event before they can be answered (i.e., questions 29-35). Depending on the nature and severity of the fall-related event a seven-day delay may need to be built into the timeline between the event and the administration of these seven “extended consequence” questions.

Note for longitudinal studies: If data is being collected prospectively for a longitudinal study, repeat Steps 2 and 3 as needed, using the optional language in the event probe forms (Appendix 1C and/or Appendix 1D) to inform respondents about when the next event probe will occur.

Note: Amputation-related information should be collected using ad hoc questions as part of an intake survey to assist with interpretation of fall survey results. Specifically, details regarding unilateral or bilateral amputation, the affected or amputated side if unilateral (i.e., left, or right), and the level of amputation on each side if bilateral.

Lower Limb Prosthesis User Fall Event Survey

Fall History

Instructions: This survey asks about **falls** and **near-falls** you have experienced in the **past** _____ (*fill in timeframe*). Please respond to all questions with the following definitions in mind.

- A **fall** is a loss of balance where your body landed on the ground or floor.
- A **near-fall** is a loss of balance where you caught yourself or recovered your balance without landing on the ground or floor.

History of falls:

How many **falls** have you experienced in the **past** _____ (*fill in timeframe*)?

_____ falls

History of near-falls:

How many **near-falls** have you experienced in the **past** _____ (*fill in timeframe*)?

_____ near-falls

Lower Limb Prosthesis User Fall Event Survey Fall Probe

Instructions: We would like to ask you about any **falls** you have experienced in the **past** _____ (*fill in timeframe*). Please remember, a **fall** is a loss of balance where your body landed on the ground or floor.

Have you experienced a **fall** in the past _____ (*fill in timeframe*)?

No



For cross-sectional studies:

Thank you, the survey is now complete.

For longitudinal studies:

Thank you, we will check in with you again in _____ (*fill in time to next probe*).

Yes



How many falls have you experienced in the past _____ (*fill in timeframe*)?

_____ falls

Thank you, please complete the fall event detail form for (*name events of interest – e.g., each event, most recent event*).

Give or send the respondent the fall event detail form for each event of interest

Lower Limb Prosthesis User Fall Event Survey Near-Fall Probe

Instructions: We would like to ask you about any **near-falls** you have experienced in the **past** _____ (*fill in timeframe*). Please remember, a **near-fall** is a loss of balance where you caught yourself or recovered your balance without landing on the ground or floor.

Have you experienced a **near-fall** in the past _____ (*fill in timeframe*)?

No



For cross-sectional studies:
Thank you, the survey is now complete.

For longitudinal studies:
Thank you, we will check in with you again in _____ (*fill in time to next probe*).

Yes



How many near-falls have you experienced in the past _____ (*fill in timeframe*)?

_____ near-falls

Thank you, please complete the near-fall event detail form for (*name events of interest – e.g., each event, most recent event*).

Give or send the respondent the fall event detail form for each event of interest

Lower Limb Prosthesis User Fall Event Survey

Fall Event Details

Instructions: This survey asks about **falls** you have experienced in the **past** _____ (*fill in timeframe*). Please respond to all questions with the following definition in mind.

- A **fall** is a loss of balance where your body landed on the ground or floor.

Please answer the following questions for each **fall** you reported:

1. Were you wearing your prosthesis when you fell? (Choose the **best** answer)

- Yes
- No
- Do not remember

2. Were you using any assistive devices when you fell? (Select **all** that apply)

- Cane
- Walking or trekking poles
- Crutch
- Walker
- Wheelchair or scooter
- Other _____
- Not using an assistive device
- Do not remember

ACTIVITY

3. What were you doing when you fell? (Select **all** that apply)

- Sitting still
- Standing still
- Standing up from a seated position
- Sitting down from a standing position
- Sitting up from a lying position
- Lying down from a seated position
- Bending over
- Reaching
 - Up
 - Down
 - Forwards
 - Backwards
 - To the side
- Taking a step forward
- Taking a step backwards
- Taking a step to the side
- Taking a step up
- Taking a step down
- Hopping
- Walking
- Running
- None of these apply
- Do not remember

4. Were you doing any of the following when you fell? (Select **all** that apply)

- Moving slowly
- Moving quickly
- Starting to move
- Coming to a stop
- Speeding up
- Slowing down
- Turning to the side
- Changing direction
- None of these apply
- Do not remember

Appendix 1E

5. Were you doing any of the following when you fell? (Select **all** that apply)

- Stepping over something with your right leg
- Stepping over something with your left leg
- Moving around something
- Moving in a crowded space
- Lifting or carrying something
- Participating in sports or exercise
- None of these apply
- Do not remember

6. Were you doing any of the following when you fell? (Choose the **best** answer)

- Stepping up onto a curb
- Stepping down from a curb
- Going up a ramp
- Going down a ramp
- Going up stairs
- Going down stairs
- Going up a hill
- Going down a hill
- None of these apply
- Do not remember

7. Were you doing any of the following when you fell? (Select **all** that apply)

- Showering or bathing
- Toileting
- Dressing or undressing
- Putting your prosthesis on
- Taking your prosthesis off
- None of these apply
- Do not remember

8. Is there anything else you would like to tell us about what you were doing when you fell?

SURROUNDINGS

9. How familiar to you was the location when you fell? (Choose the **best** answer)

- Familiar
- Unfamiliar
- Do not remember

10. Where were you when you fell? (Choose the **best** answer)

- Inside
- Outside
- Do not remember

11. What was the lighting like when you fell? (Choose the **best** answer)

- Well lit
- Poorly lit
- Do not remember

12. What was the ground or floor like when you fell? (Select **all** that apply)

- Flat
- Uneven
- Smooth
- Rough
- Wet
- Dry
- Slippery
- Icy
- Soft
- Hard
- Do not remember

13. Is there anything else you would like to tell us about where you were when you fell?

SITUATION

14. Were you alone or with others when you fell? (Choose the **best** answer)

- Alone
- With others
- Do not remember

15. Was someone physically helping you just before you lost your balance? (Choose the **best** answer)

- Yes
- No
- Do not remember

16. Did someone physically help you as you started to lose your balance? (Choose the **best** answer)

- Yes
- No
- Do not remember

17. Did any of the following occur to you when you fell? (Select **all** that apply)

- Right foot got caught
- Left foot got caught
- Right foot slipped
- Left foot slipped
- Right leg gave out
- Left leg gave out
- Misplaced a step
- Stepped on something
- Feet were too close together
- Floor or ground moved unexpectedly
- Floor or ground changed levels
- Got bumped or pushed
- Got tugged or pulled
- Vision was blocked
- None of these apply
- Do not remember

Appendix 1E

18. Did any of the following contribute to the fall? (Select **all** that apply)

- Distracted or not paying attention
- Hurried or rushed
- Tired from a lack of sleep
- Fatigued from activity
- Experienced dizziness or vertigo
- Medications
- Alcohol or drugs
- Footwear
- None of these apply
- Do not remember

19. Did any of the following contribute to the fall? (Select **all** that apply)

- Prosthesis broke
- Prosthesis did not respond as intended
- Prosthesis was not on properly
- Prosthesis came off
- Socket was loose
- Assistive device broke
- Assistive device moved unexpectedly
- Something you were holding moved or gave way
- None of these apply
- Do not remember

20. Is there anything else you would like to tell us about what was going on when you fell?

MECHANICS

21. In what direction did you fall? (Select **all** that apply)

- Forward
- Backward
- To the right
- To the left
- Straight down
- Do not remember

22. Did you do anything to catch yourself or prevent the fall? (Select **all** that apply)

- Reached out to grab someone or something
- Skipped or hopped
- Took a big step with right leg
- Took a big step with left leg
- Moved or waved arms around
- Did not do anything
- Do not remember

23. Did you do anything to minimize the risk of injury? (Select **all** that apply)

- Rotated to the left
- Rotated to the right
- Tucked and rolled
- Used my arms to brace myself
- Eased myself down
- Changed position to limit or avoid impact
- Did not do anything
- Do not remember

24. Did you hit anything as you fell? (Select **all** that apply)

- Another person
- An object
- A wall or door
- Something else
- Did not hit anything except the ground or floor
- Do not remember

Appendix 1E

25. What part(s) of your body hit the ground or floor when you fell? (Select **all** that apply)

- Head or neck
- Face
- Back, chest, or ribs
- Shoulder
- Arm (between shoulder and elbow)
- Elbow
- Arm (between elbow and wrist)
- Wrist, hand, or fingers
- Hip
- Buttocks
- Leg (between hip and knee)
- Knee
- Leg (between knee and ankle)
- Ankle, foot, or toes
- Residual limb
- Prosthesis
- Do not remember

26. Is there anything else you would like to tell us about how you fell?

IMMEDIATE CONSEQUENCES

27. Did the fall result in damage to an object or injury to another person? (Select **all** that apply)

- An object was damaged
- Another person was injured
- No damage to an object or injury to another person
- Do not remember

28. Did you experience an injury because of the fall? (Select **all** that apply)

- Bruise
- Cut or scrape
- Pain or soreness
- Swelling
- Pulled muscle
- Sprain
- Torn tendon or ligament
- Joint dislocation
- Fracture or broken bone
- Internal injury
- Concussion or head injury
- Damage to prosthesis
- Did not experience an injury
- Do not remember

EXTENDED CONSEQUENCES (AT LEAST 1 WEEK POST-EVENT)

29. Did you seek treatment from a medical provider because of the fall? (Select **all** that apply)

- Primary care provider
- Urgent care provider
- Emergency care provider
- Prosthetist
- Physical therapy
- Massage therapy
- Another medical professional
- Did not seek treatment
- Do not remember

30. Did you receive medical treatment because of the fall? (Choose the **best** answer)

- Self-administered treatment
- Treated but not taken to provider
- Treated and sent home the same day
- Hospitalized for 1 night
- Hospitalized for 2-3 nights
- Hospitalized for more than 3 nights
- Did not receive medical treatment
- Do not remember

31. How much time did you miss from work because of the fall? (Choose the **best** answer)

- Part of a day
- 1 day
- 2-3 days
- 4-6 days
- 1 week or more
- Did not miss any time from work
- Retired or not employed at the time
- Do not remember

32. How much time did you spend not wearing your prosthesis because of the fall? (Choose the **best** answer)

- Part of a day
- 1 day
- 2-3 days
- 4-6 days
- 1 week or more
- Wore prosthesis as usual
- Do not typically use a prosthesis
- Do not remember

Appendix 1E

33. Have you done any of the following because of the fall? (Select **all** that apply)

- Changed how you do certain activities
- Do certain activities less often
- Stopped doing certain activities altogether
- Rested more than usual
- Become more careful or cautious
- Pay more attention to your surroundings
- Began to use a cane, crutch, or walker
- Relied more on a cane, crutch, or walker
- Made safety modifications to your home
- Received physical help to perform activities
- None of these apply
- Do not remember

34. Did you experience any of the following emotions because of the fall? (Select **all** that apply)

- Embarrassment
- Depression
- Disappointment
- Sadness
- Anxiety
- Anger
- Frustration
- Fear
- None of these apply
- Do not remember

35. Did you experience any of the following changes after the fall? (Select **all** that apply)

- Less confident in your balance
- More afraid of falling
- Less confident in your prosthesis
- None of these apply
- Do not remember

36. Is there anything else you would like to tell us about what happened because of your fall?

CONFIDENCE

37. How confident are you in the details you provided about the fall? (Choose the **best** answer)

- Not at all confident
- Slightly confident
- Moderately confident
- Mostly confident
- Completely confident

Thank you for completing the survey

Lower Limb Prosthesis User Fall Event Survey Near-Fall Event Details

Instructions: This survey asks about **near-falls** you have experienced in the **past** _____ (*fill in timeframe*). Please respond to all questions with the following definition in mind.

- A **near-fall** is a loss of balance where you caught yourself or recovered your balance without landing on the ground or floor.

Please answer the following questions for each **near-fall** you reported:

1. Were you wearing your prosthesis when you nearly fell? (Choose the **best** answer)

- Yes
- No
- Do not remember

2. Were you using any assistive devices when you nearly fell? (Select **all** that apply)

- Cane
- Walking or trekking poles
- Crutch
- Walker
- Wheelchair or scooter
- Other _____
- Not using an assistive device
- Do not remember

ACTIVITY

3. What were you doing when you nearly fell? (Select **all** that apply)

- Sitting still
- Standing still
- Standing up from a seated position
- Sitting down from a standing position
- Sitting up from a lying position
- Lying down from a seated position
- Bending over
- Reaching
 - Up
 - Down
 - Forwards
 - Backwards
 - To the side
- Taking a step forward
- Taking a step backwards
- Taking a step to the side
- Taking a step up
- Taking a step down
- Hopping
- Walking
- Running
- None of these apply
- Do not remember

4. Were you doing any of the following when you nearly fell? (Select **all** that apply)

- Moving slowly
- Moving quickly
- Starting to move
- Coming to a stop
- Speeding up
- Slowing down
- Turning to the side
- Changing direction
- None of these apply
- Do not remember

5. Were you doing any of the following when you nearly fell? (Select **all** that apply)

- Stepping over something with your right leg
- Stepping over something with your left leg
- Moving around something
- Moving in a crowded space
- Lifting or carrying something
- Participating in sports or exercise
- None of these apply
- Do not remember

6. Were you doing any of the following when you nearly fell? (Choose the **best** answer)

- Stepping up onto a curb
- Stepping down from a curb
- Going up a ramp
- Going down a ramp
- Going up stairs
- Going down stairs
- Going up a hill
- Going down a hill
- None of these apply
- Do not remember

7. Were you doing any of the following when you nearly fell? (Select **all** that apply)

- Showering or bathing
- Toileting
- Dressing or undressing
- Putting your prosthesis on
- Taking your prosthesis off
- None of these apply
- Do not remember

8. Is there anything else you would like to tell us about what you were doing when you nearly fell?

SURROUNDINGS

9. How familiar to you was the location when you nearly fell? (Choose the **best** answer)

- Familiar
- Unfamiliar
- Do not remember

10. Where were you when you nearly fell? (Choose the **best** answer)

- Inside
- Outside
- Do not remember

11. What was the lighting like when you nearly fell? (Choose the **best** answer)

- Well lit
- Poorly lit
- Do not remember

12. What was the ground or floor like when you nearly fell? (Select **all** that apply)

- Flat
- Uneven
- Smooth
- Rough
- Wet
- Dry
- Slippery
- Icy
- Soft
- Hard
- Do not remember

13. Is there anything else you would like to tell us about where you were when you nearly fell?

SITUATION

14. Were you alone or with others when you nearly fell? (Choose the **best** answer)

- Alone
- With others
- Do not remember

15. Was someone physically helping you just before you nearly fell? (Choose the **best** answer)

- Yes
- No
- Do not remember

16. Did someone physically help you as you started to lose your balance? (Choose the **best** answer)

- Yes
- No
- Do not remember

17. Did any of the following occur to you when you nearly fell? (Select **all** that apply)

- Right foot got caught
- Left foot got caught
- Right foot slipped
- Left foot slipped
- Right leg gave out
- Left leg gave out
- Misplaced a step
- Stepped on something
- Feet were too close together
- Floor or ground moved unexpectedly
- Floor or ground changed levels
- Got bumped or pushed
- Got tugged or pulled
- Vision was blocked
- None of these apply
- Do not remember

18. Did any of the following contribute to the near-fall? (Select **all** that apply)

- Distracted or not paying attention
- Hurried or rushed
- Tired from a lack of sleep
- Fatigued from activity
- Experienced dizziness or vertigo
- Medications
- Alcohol or drugs
- Footwear
- None of these apply
- Do not remember

19. Did any of the following contribute to the near-fall? (Select **all** that apply)

- Prosthesis broke
- Prosthesis did not respond as intended
- Prosthesis was not on properly
- Prosthesis came off
- Socket was loose
- Assistive device broke
- Assistive device moved unexpectedly
- Something you were holding moved or gave way
- None of these apply
- Do not remember

20. Is there anything else you would like to tell us about what was going on when you nearly fell?

MECHANICS

21. In what direction did you nearly fall? (Select **all** that apply)

- Forward
- Backward
- To the right
- To the left
- Straight down
- Do not remember

22. Did you do anything to catch yourself or prevent the near-fall? (Select **all** that apply)

- Reached out to grab someone or something
- Skipped or hopped
- Took a big step with right leg
- Took a big step with left leg
- Moved or waved arms around
- Did not do anything
- Do not remember

23. Did you do anything to minimize the risk of injury? (Select **all** that apply)

- Rotated to the left
- Rotated to the right
- Tucked and rolled
- Used my arms to brace myself
- Eased myself down
- Changed position to limit or avoid impact
- Did not do anything
- Do not remember

24. Did you catch yourself on anything to avoid falling? (Select **all** that apply)

- Another person
- An object
- A wall or door
- Something else
- Did not catch yourself on anything
- Do not remember

25. Did any of the following part(s) of your body hit anything when you nearly fell? (Select **all** that apply)

- Head or neck
- Face
- Back, chest, or ribs
- Shoulder
- Arm (between shoulder and elbow)
- Elbow
- Arm (between elbow and wrist)
- Wrist, hand, or fingers
- Hip
- Buttocks
- Leg (between hip and knee)
- Knee
- Leg (between knee and ankle)
- Ankle, foot, or toes
- Residual limb
- Prosthesis
- Did not hit anything
- Do not remember

26. Is there anything else you would like to tell us about how you nearly fell?

IMMEDIATE CONSEQUENCES

27. Did the near-fall result in damage to an object or injury to another person? (Select **all** that apply)

- An object was damaged
- Another person was injured
- No damage to an object or injury to another person
- Do not remember

28. Did you experience an injury because of the near-fall? (Select **all** that apply)

- Bruise
- Cut or scrape
- Pain or soreness
- Swelling
- Pulled muscle
- Sprain
- Torn tendon or ligament
- Joint dislocation
- Fracture or broken bone
- Internal injury
- Concussion or head injury
- Damage to prosthesis
- Did not experience an injury
- Do not remember

EXTENDED CONSEQUENCES (AT LEAST 1 WEEK POST-EVENT)

29. Did you seek treatment from a medical provider because of the near-fall? (Select **all** that apply)

- Primary care provider
- Urgent care provider
- Emergency care provider
- Prosthetist
- Physical therapy
- Massage therapy
- Another medical professional
- Did not seek treatment
- Do not remember

30. Did you receive medical treatment because of the near-fall? (Choose the **best** answer)

- Self-administered treatment
- Treated but not taken to provider
- Treated and sent home the same day
- Hospitalized for 1 night
- Hospitalized for 2-3 nights
- Hospitalized for more than 3 nights
- Did not receive medical treatment
- Do not remember

31. How much time did you miss from work because of the near-fall? (Choose the **best** answer)

- Part of a day
- 1 day
- 2-3 days
- 4-6 days
- 1 week or more
- Did not miss any time from work
- Retired or not employed at the time
- Do not remember

32. How much time did you spend not wearing your prosthesis because of the near-fall? (Choose the **best** answer)

- Part of a day
- 1 day
- 2-3 days
- 4-6 days
- 1 week or more
- Wore prosthesis as usual
- Do not typically use a prosthesis
- Do not remember

33. Have you done any of the following because of the near-fall? (Select **all** that apply)

- Changed how you do certain activities
- Do certain activities less often
- Stopped doing certain activities altogether
- Rested more than usual
- Become more careful or cautious
- Pay more attention to your surroundings
- Began to use a cane, crutch, or walker
- Relied more on a cane, crutch, or walker
- Made safety modifications to your home
- Received physical help to perform activities
- None of these apply
- Do not remember

34. Did you experience any of the following emotions because of the near-fall? (Select **all** that apply)

- Embarrassment
- Depression
- Disappointment
- Sadness
- Anxiety
- Anger
- Frustration
- Fear
- None of these apply
- Do not remember

35. Did you experience any of the following changes after the near-fall? (Select **all** that apply)

- Less confident in your balance
- More afraid of falling
- Less confident in your prosthesis
- None of these apply
- Do not remember

36. Is there anything else you would like to tell us about what happened because of your near-fall?

CONFIDENCE

37. How confident are you in the details you provided about the near-fall?

(Choose the **best** answer)

- Not at all confident
- Slightly confident
- Moderately confident
- Mostly confident
- Completely confident

Thank you for completing the survey

Question: Were you wearing your prosthesis when you fell or nearly fell? (select best answer)

	Yes	No	Don't remember
Fall (158)	129 (81.6%)	28 (17.7%)	1 (<1%)
near fall (54)	47 (87.3%)	6 (11.1%)	1 (1.9%)

Question: Were you using any assistive devices when you fell or nearly fell? (select all that apply)

	Not using an assistive device	Cane	Crutch	Walker	WC or Scooter	Other	Do not remember
Fall (158)	102 (64.6%)	16 (10.1%)	17 (10.8%)	8 (5.1%)	6 (3.8%)	8 (5.1%)	1 (<1%)
near fall (54)	40 (74.7%)	8 (14.8%)	1 (1.9%)	2 (3.7%)	2 (3.7%)	1 (1.9%)	0 (0%)

Question: What were you doing when you fell or nearly fell? (select all that apply)

	Sitting still	Got to stand	Standing still	Stand to sit	Bending over	Reaching up	Reaching down	Reaching forward	Reaching backward	Reaching to side	Taking a step forward	Taking a step backward	Taking a step to the side	Walking	Running	Sports or exercise	Shower or bathing	Other	None apply	Do not remember
Fall (158)	2 (1.3%)	7 (4.4%)	7 (4.4%)	5 (3.2%)	5 (3.2%)	1 (<1%)	4 (2.5%)	7 (4.4%)	0 (0%)	3 (1.9%)	31 (19.6%)	6 (3.8%)	8 (5.1%)	46 (29.1%)	2 (1.3%)	8 (5.1%)	11 (7.0%)	23 (14.6%)	5 (3.2%)	4 (2.5%)
near fall (54)	0 (0%)	3 (5.6%)	0 (0%)	0 (0%)	2 (3.7%)	1 (1.9%)	1 (1.9%)	3 (5.6%)	0 (0%)	0 (0%)	8 (14.8%)	2 (3.7%)	2 (3.7%)	19 (35.2%)	1 (1.9%)	5 (11.4%)	3 (5.6%)	8 (14.8%)	1 (1.9%)	3 (5.6%)

Question: Were you doing any of the following when you fell or nearly fell? (select all that apply)

	Moving slowly	Moving quickly	Starting to move	Coming to a stop	Speeding up	Slowing down	Turning to the side	Other	None apply	Do not remember
Fall (158)	25 (15.8%)	26 (16.5%)	22 (13.9%)	5 (3.2%)	10 (6.3%)	5 (3.2%)	24 (15.2%)	22 (13.9%)	22 (13.9%)	2 (0.9%)
near fall (54)	14 (25.9%)	7 (13.0%)	8 (14.8%)	2 (3.7%)	1 (1.9%)	0 (0%)	6 (11.1%)	7 (13.0%)	8 (14.8%)	8 (22.9%)

Question: Were you doing any of the following when you fell or nearly fell? (select all that apply)

	Going down a hill	Going down stairs	Stepping onto a curb	Going up a ramp	Stepping down from a curb	Going up stairs	Going down a ramp	Going up a hill	Other	None apply	Do not remember
Fall (158)	10 (6.3%)	11 (7.0%)	5 (3.2%)	5 (3.2%)	5 (3.2%)	5 (3.2%)	3 (1.9%)	0 (0%)	36 (22.8%)	70 (44.3%)	8 (5.1%)
near fall (54)	1 (1.9%)	1 (1.9%)	0 (0%)	1 (1.9%)	0 (0%)	2 (3.7%)	2 (3.7%)	0 (0%)	19 (35.2%)	22	5 (9.3%)

Question: How familiar to you was the location when you fell or nearly fell? (select best answer)

	Familiar	Unfamiliar	Other	Do not remember
Fall (158)	126 (79.6%)	29 (18.4%)	0 (0%)	3 (1.9%)
near fall (54)	45 (83.3%)	5 (9.3%)	0 (0%)	4 (7.4%)

Question: Where were you when you fell or nearly fell? (select best answer)

	Outside	Inside	Other	Do not remember
Fall (158)	87 (55.1%)	67 (42.0%)	2 (1.3%)	1 (<1%)
near fall (54)	21 (38.9%)	28 (51.9%)	0 (0%)	5 (9.3%)

Question: What was the lighting like when you fell or nearly fell? (select best answer)

	Well lit	Dim	Other	Do not remember
Fall (158)	130 (82.3%)	25 (15.8%)	0 (0%)	3 (1.9%)
near fall (54)	47 (87.0%)	2 (3.7%)	2 (3.7%)	3 (5.6%)

Question: What was the ground or floor like when you fell or nearly fell? (select all that apply)

	Flat	Uneven	Wet	Dry	Slippery	Smooth	Rough	Icy	Soft	Other	Do not remember
Fall (158)	79 (50%)	38 (24.1%)	34 (21.5%)	28 (17.7%)	27 (17.1%)	22 (13.9%)	17 (10.8%)	11 (7.0%)	8 (5.1%)	11 (7.0%)	2 (2%)
near fall (54)	25 (46.3%)	8 (14.8%)	5 (9.3%)	9 (16.7%)	7 (13.0%)	11 (20.4%)	5 (9.3%)	3 (5.6%)	2 (3.7%)	4 (7.4%)	3 (5.6%)

Question: Were you alone or with others when you fell or nearly fell?

	Alone	With others	Do not remember
Fall (158)	103 (65.5%)	50 (31.6%)	5 (3.1%)
near fall (54)	28 (51.9%)	23 (42.6%)	3 (5.6%)

Question: Was someone physically assisting you just before you lost your balance?

	Yes	No	Do not remember
Fall (158)	4 (2.5%)	154 (97.5%)	0 (0%)
near fall (54)	4 (7.4%)	49 (90.7%)	1 (1.9%)

Question: Did someone physically assist you as you started to lose your balance?

	Yes	No	Do not remember
Fall (158)	7 (4.4%)	147 (93.0%)	4 (2.5%)
near fall (54)	5 (9.3%)	48 (88.9%)	1 (1.9%)

Question: Did any of the following occur to you when you fell or nearly fell? (select all that apply)

	Caught on foot	Caught on floor	Right foot stepped	Left foot stepped	Minimalized a step	Feet too close together	Other	None apply	Do not remember
Fall (158)	33 (19.6%)	15 (9.5%)	23 (13.3%)	18 (10.1%)	12 (7.6%)	3 (1.9%)	27 (17.1%)	20 (12.7%)	8 (5.1%)
near fall (54)	10 (18.5%)	3 (5.6%)	5 (9.3%)	4 (7.4%)	12 (22.2%)	4 (7.4%)	16 (29.6%)	7 (13.0%)	3 (5.6%)

Question: Did any of the following occur to you when you fell or nearly fell? (select all that apply)

	Overexerted/pushed	Crushed something	Moving to a raised device	Floor or ground moved unexpectedly	Moved around something	Stepped over something right	Stepped over something left	Tugged or pulled	Vision blocked	Other	None apply	Do not remember
Fall (158)	3 (1.9%)	16 (10.1%)	4 (2.5%)	19 (12.0%)	2 (1.3%)	17 (10.8%)	7 (4.4%)	4 (2.5%)	4 (2.5%)	18 (11.4%)	57 (36.1%)	8 (5.1%)
near fall (54)	0 (0%)	7 (13.0%)	0 (0%)	6 (11.1%)	1 (1.9%)	1 (1.9%)	4 (7.4%)	2 (3.7%)	1 (1.9%)	15 (27.8%)	15 (27.8%)	2 (3.7%)

Question: Did any of the following contribute to your fall or near fall? (select all that apply)

	Distracted, not paying attention	Hurried or rushed	Fatigued from activity	Tired from lack of sleep	Dizziness or vertigo	Medications	Alcohol or drugs	Other	None apply	Do not remember
Fall (158)	45 (28.5%)	33 (20.9%)	15 (9.5%)	11 (7.0%)	4 (2.5%)	4 (2.5%)	0 (0%)	11 (7.0%)	58 (36.7%)	5 (3.2%)
near fall (54)	11 (20.4%)	11 (20.4%)	6 (11.1%)	2 (3.7%)	1 (1.9%)	1 (1.9%)	1 (1.9%)	1 (1.9%)	25 (46.3%)	2 (3.7%)

Question: Did any of the following occur when you fell or nearly fell? (select all that apply)

	Prosthesis did not respond as intended	Assistive device moved	Prosthesis was not on	Socket was loose	Prosthesis broke	Assistive device broke	Other	None apply	Do not remember
Fall (158)	13 (8.2%)	12 (7.6%)	12 (7.6%)	8 (5.1%)	5 (3.2%)	2 (1.3%)	4 (2.5%)	103 (65.2%)	4 (2.5%)
near fall (54)	5 (9.3%)	1 (1.9%)	2 (3.7%)	1 (1.9%)	1 (1.9%)	0 (0%)	2 (3.7%)	41 (75.9%)	1 (1.9%)

Question: In what direction did you fall or nearly fall?

	Forward	Right	Backward	Left	Down	Other	Do not remember
Fall (158)	71 (44.9%)	27 (17.1%)	36 (22.8%)	25 (15.8%)	20 (12.7%)	1 (<1%)	7 (4.4%)
near fall (54)	34 (63.0%)	3 (5.6%)	5 (9.3%)	5 (9.3%)	4 (7.4%)	2 (3.7%)	5 (9.3%)

Question: Did you do anything to catch yourself, prevent the fall, or minimize the risk of injury? (select all that apply)

	Reached out to grab someone or something	Changed position to limit or avoid impact	Took big step with right leg	Took big step with left leg	Skipped or hopped	Other	I did not do anything	Do not remember
Fall (158)	53 (33.8%)	23 (14.5%)	5 (3.2%)	4 (2.5%)	5 (3.2%)	12 (7.6%)	49 (31.0%)	8 (5.1%)
near fall (54)	22 (40.7%)	7 (13.0%)	5 (9.3%)	3 (5.6%)	9 (16.7%)	7 (13.0%)	5 (9.3%)	4 (7.4%)

Question: Did you fall or catch yourself on or against any of the following? (select all that apply)

	I did not fall or catch myself on anything or anyone	An object	Another person	Other	Do not remember
Fall (158)	83 (52.5%)	38 (24.1%)	8 (5.1%)	23 (14.6%)	6 (3.8%)
near fall (54)	26 (48.1%)	22 (40.7%)	1 (1.9%)	5 (9.3%)	0 (0%)

Question: What part(s) of you body hit the ground, floor, surface, or object when you fell or nearly fell? (select all that apply)

	Wrist, hands or fingers	Elig	Elbows	Back, chest or ribs	Knee	Shoulder	Prosthesis	Forearm	Upper arm	Thigh	Residual limb	Head or neck	Elbow	Face	Ankle or foot	Lower leg	No body contact	Other	Do not remember
Fall (158)	43 (27.2%)	48 (30.4%)	45 (28.5%)	39 (24.7%)	38 (24.1%)	15 (9.5%)	34 (21.5%)	27 (17.1%)	25 (15.8%)	22 (13.9%)	20 (12.7%)	18 (11.4%)	20 (12.7%)	9 (6.0%)	6 (3.8%)	5 (3.2%)	1 (0.6%)	1 (0.6%)	7 (4.4%)
near fall (54)	6 (11.1%)	2 (3.7%)	4 (7.4%)	5 (9.3%)	4 (7.4%)	1 (1.9%)	3 (5.6%)	4 (7.4%)	1 (1.9%)	0 (0%)	3 (5.6%)	0 (0%)	0 (0%)	1 (1.9%)	2 (3.7%)	1 (1.9%)	27 (50.0%)	2 (3.7%)	1 (1.9%)

Question: Did your fall or near-fall result in damage to an object or injury to another person? (select all that apply)

	No damage	On object	Another person	On object	Do not remember
Fall (158)	133 (84.2%)	15 (9.5%)	0 (0%)	7 (4.4%)	3 (1.9%)
near fall (54)	52 (96.3%)	2 (3.7%)	0 (0%)	0 (0%)	0 (0%)

Question: Did you experience an injury because of your fall or near-fall? (select all that apply)														
	Eye or nose/ear	Hand	Cut or scrape	Swelling	Pulled muscle	Fracture	Strain	Torn tendon or ligament	Concussion or head injury	Internal injury	Joint dislocation	Other	Did not experience injury	Do not remember
Fall (158)	83 (51.3%)	71 (44.9%)	40 (25.3%)	33 (20.9%)	12 (7.6%)	10 (6.3%)	10 (6.3%)	5 (3.2%)	7 (4.4%)	3 (1.9%)	1 (<1%)	3 (1.9%)	36 (22.8%)	1 (<1%)
near fall (54)	4 (7.4%)	4 (7.4%)	3 (5.6%)	1 (1.9%)	0 (0%)	1 (1.9%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (1.9%)	43 (79.6%)	0 (0%)

Question: Did you seek treatment from a medical facility because of your fall or near-fall? (select all that apply)						
	Emergency room	Urgent care clinic	Primary care clinic	Other	I did not seek treatment	Do not remember
Fall (158)	11 (7.0%)	11 (7.0%)	8 (5.1%)	6 (3.8%)	122 (77.2%)	0 (0%)
near fall (54)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)

Question: Did you receive medical treatment because of your fall or near-fall? (select best answer)								
	Treated and sent home same day	Treated but not taken to hospital	Hospitalized for more than 3 nights	Hospitalized for 1 night	Hospitalized for 2 to 3 nights	Other	I did not receive medical treatment	Do not remember
Fall (158)	23 (14.6%)	9 (5.7%)	2 (1.3%)	2 (1.3%)	2 (1.3%)	2 (1.3%)	118 (74.7%)	0 (0%)
near fall (54)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)

Question: Did you seek any other type of treatment because of your fall or near-fall? (select all that apply)						
	Physical Therapy	Massage Therapy	Repair / replace prosthesis	Other	I did not seek any other type of treatment	Don't remember
Fall (158)	9 (5.7%)	7 (4.4%)	6 (3.8%)	12 (7.6%)	124 (78.5%)	0 (0%)
near fall (54)	0 (0%)	0 (0%)	1 (1.9%)	1 (1.9%)	52 (96.3%)	0 (0%)

Question: How much time did you miss from work because of your fall or near-fall? (select best answer)									
	I was retired or not employed at the time	I did not miss any time from work	4 to 6 days	1 week or more	2 to 3 days	1 day	Part of a day	Other	Do not remember
Fall (158)	95 (60.1%)	50 (31.6%)	4 (2.5%)	3 (1.9%)	3 (1.9%)	1 (<1%)	1 (<1%)	1 (<1%)	0 (0%)
near fall (54)	27 (50.0%)	27 (50.0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Question: Have you done any of the following because of your fall or near-fall? (select all that apply)										
	Changed how you do certain activities	Do certain activities less often	Retired more than usual	Received physical assistance to perform activities	Stop doing certain activities all together	Relied more on a cane, crutch, or walker	Began to use a cane, crutch, or walker	Other	None apply	Do not remember
Fall (158)	44 (27.8%)	13 (8.2%)	11 (7.0%)	7 (4.4%)	12 (7.6%)	11 (7.0%)	4 (2.5%)	11 (7.0%)	76 (48.1%)	0 (0%)
near fall (54)	11 (20.4%)	3 (5.6%)	2 (3.7%)	0 (0%)	0 (0%)	4 (7.4%)	0 (0%)	10 (18.5%)	31 (57.4%)	0 (0%)

Question: Did you experience any of the following emotions because of the fall or near-fall? (select all that apply)									
	Frustration	Embarrassment	Disappointment	Anger	Anxiety	Depression	Other	None apply	Do not remember
Fall (158)	90 (57.0%)	64 (40.5%)	48 (30.4%)	33 (20.9%)	25 (15.8%)	16 (10.1%)	6 (3.8%)	22 (13.9%)	1 (<1%)
near fall (54)	24 (44.4%)	10 (18.5%)	6 (11.1%)	3 (5.6%)	9 (16.7%)	0 (0%)	3 (5.6%)	18 (33.3%)	0 (0%)

Question: Did you experience any of the following changes after the fall or near-fall? (select all that apply)						
	More afraid of falling	Less confidence in your balance	Less confident in your prosthesis	Other	None apply	Do not remember
Fall (158)	80 (50.6%)	40 (25.3%)	24 (15.2%)	7 (4.4%)	64 (40.5%)	2 (1.3%)
near fall (54)	8 (14.8%)	11 (20.4%)	5 (9.3%)	1 (1.9%)	33 (61.1%)	0 (0%)

Question: How much confidence do you have in the details you provided about the fall or near-fall (choose the best answer)					
	No confidence	Low confidence	Moderate confidence	High confidence	Complete confidence
Fall (158)	1 (<1%)	1 (<1%)	26 (16.4%)	67 (42.4%)	63 (40.0%)
near fall (54)	0 (0%)	1 (1.8%)	9 (16.7%)	27 (50.0%)	17 (31.5%)