ORIGINAL ARTICLE

THE IMPACT OF AGE ON FUNCTIONALITY AND FALL RISK IN TRANSFEMORAL AMPUTEES

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Highlight: (1) Advanced age compromises functionality in transfemoral amputees. (2) Advancing age increases fall risk. (3) Rehabilitation is essential to enhance functionality and promote independence.

PRE-PROOF
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THE IMPACT OF AGE ON FUNCTIONALITY AND FALL RISK IN TRANSFEMORAL AMPUTEES

ABSTRACT

Lower-limb amputations result in significant impairments in functional capacity, balance, and motor coordination. Among these functional limitations, the elevated incidence of falls in this population is particularly prominent, with such outcomes being directly associated with age. Accordingly, the objective of this study was to investigate the influence of age on functional performance and fall risk in individuals with transfemoral amputation. This is an observational, analytical, cross-sectional study, comprising a sample of 18 male individuals with transfemoral amputation, aged between 30 and 80 years. The following instruments were employed for the assessments: *Amputee Mobility Predictor* (AMP), Functional Independence Measure (FIM) and the Timed Up and Go (TUG) test. Descriptive statistics and the Spearman correlation test were applied ($p<0.05$). A moderate, inverse, and significant correlation was observed between age and the Amputee Mobility Predictor (AMP), as well as the total and motor domains of the Functional Independence Measure (FIM) ($p=0.01$, $p=0.05$, and $p=0.01$, respectively). In addition, age demonstrated a strong and significant correlation with the Timed Up and Go (TUG) test ($p<0.000$), indicating a greater risk of falls. Age had a negative impact on both functionality and fall risk, as higher age was associated with longer completion time in the TUG test and poorer functional performance assessed by the AMP and FIM. These findings may contribute to the rehabilitation process by promoting greater independence and quality of life in individuals with lower-limb amputation.

Keywords: Amputation; Functionality; Rehabilitation.

INTRODUCTION

The number of lower-limb amputee patients is increasing worldwide[1], with vascular, traumatic, and tumoral conditions being the main etiologies[2]. In general, amputation directly impacts the reduction of functional capacity, balance, and independence in performing basic and instrumental activities of daily living[1,3], additionally resulting in social, economic, psychological, and occupational issues[3].

Considering the level of amputation, transfemoral amputations cause greater impairment of functionality, as they impose higher physiological and energetic demands, along with deficits in balance, stability, and coordination[4,5], when compared to transtibial

amputations, which, being at a lower level, facilitate locomotion with reduced energy expenditure, since the knee joint is preserved[6].

Among the variables related to the functional impairments presented by amputees, a higher incidence of falls stands out[7], which can be explained by deficits in mobility and motor control, reduced sensory feedback and proprioceptive information[8], leading to alterations in gait pattern, decreased gait speed, increased energy expenditure[9], and a greater risk of falls[7]. Furthermore, functionality is also directly associated with age, as advancing age is linked to a higher number of comorbidities that directly affect balance and mobility[10]. Therefore, it is evident that lower-limb amputation has a profound physical, functional, and emotional impact, directly affecting the quality of life of amputees[11].

Therefore, little is known about the relationship between age, functional capacity, and fall incidence in lower-limb amputees, as the performance measures commonly used in the literature are too broad and fail to account for the specific characteristics of this population. In this context, assessments using quantitative instruments specifically designed for amputees hold strong clinical relevance, as they allow the implementation of targeted interventions during the rehabilitation process, contributing to treatments tailored to the functional impairments and deficits observed. In light of the above, this study aimed to evaluate the impact of age on functionality and fall risk in transfemoral amputees.

METHODS

Observational and analytical research with a cross-sectional design, conducted in accordance with Resolution 466/12 and approved by the Research Ethics Committee of the University of Caxias do Sul (CAAE 55310721.4.0000.5341).

The sample consisted of 18 individuals, over 20 years of age, of both sexes, registered at the Clinical Center of a Community University in Rio Grande do Sul. This Clinical Center is part of the Unified Health System (SUS) and provides care to the entire 5th Regional Health Coordination of the State of Rio Grande do Sul, encompassing 49 municipalities in the region. The sample size was established by convenience, determined intentionally and non-probabilistically, according to the number of transfemoral amputee patients who enrolled in and attended the service during the 12-month data collection period (Figure 1).

The inclusion criteria comprised patients: (a) with transfemoral amputation at different stages of rehabilitation; (b) capable of fully responding to and completing the tests; (c) aged over 20 years; and (d) who signed the Informed Consent Form (ICF). The exclusion criteria were: (a) patients with amputation-related diseases that impaired functionality; (b) presence of decompensated chronic disease; (c) children and adolescents with amputation; (d) patients with amputation at other levels or bilateral amputation; and (e) presence of cognitive deficits that prevented the completion of the tests.

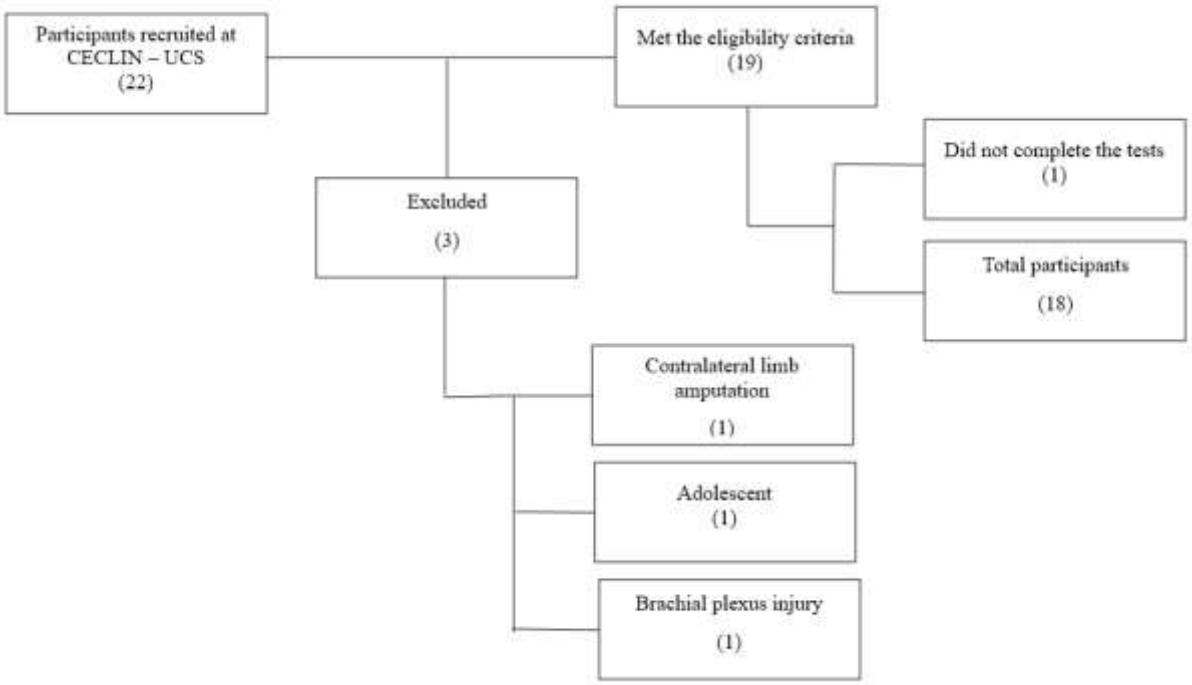

Figure 1 – Flowchart of the study sample selection

For data collection, the following instruments were used: a questionnaire for sample characterization, the Amputee Mobility Predictor (AMP), the Functional Independence Measure (FIM), and the Timed Up and Go (TUG) test.

Regarding the assessment of functionality, several tests and measures are employed to support the determination of mobility and functional capacity in amputees; however, these do not take into account the specific characteristics of this population and, therefore, lack the necessary effectiveness to ensure an accurate prognosis[12]. For this reason, Gailey et al.[13] developed the Amputee Mobility Predictor (AMP), designed to measure the potential of

amputee patients with and without a prosthesis, considering the analysis of 20 tasks specific to the amputee population. Each evaluated component tests the individual's ability to perform a given task, taking into account the different functional levels[13].

The AMP is a performance-based measure that has been validated for use in individuals with lower-limb amputation. It evaluates functional abilities and mobility without a prosthesis (AMPnoPRO) or with a prosthesis (AMPPRO), thereby assisting in the identification of limitations in functional capacity. Furthermore, the AMP demonstrates greater discrimination among amputation levels than other performance-based measures[14]. The scale assesses activities involving sitting balance, standing balance, and ambulation[15]. It consists of the evaluation of six domains: sitting balance, transfers, standing balance, gait, and ascending and descending stairs. Lower scores (with a minimum of 0) indicate poorer functional capacity, whereas higher scores indicate better functional capacity. The total possible scores are 43 points for the AMPnoPRO and 47 points for the AMPPRO, considering that individuals may use assistive devices during the test[13].

The FIM is a widely used functional assessment tool, composed of motor and cognitive subscales that indicate an individual's physical ability to move, manage activities of daily living, and communicate with the environment[16]. The scale evaluates 18 tasks, scored according to the degree of patient dependency, ranging from one (total dependence) to seven (complete independence), with a total score of 126 points. The scale is divided into six dimensions: self-care, sphincter control, transfers, locomotion, communication, and social cognition. The motor FIM encompasses self-care, sphincter control, transfers, and locomotion, with scores ranging from 1 to 91 points. The cognitive FIM comprises communication and social cognition, with scores ranging from 1 to 35 points[16].

The TUG assesses the basic components of mobility, including comfortable walking speed, dynamic balance, turning, and transfers. The test is also used to evaluate fall risk in older adults and has been shown to be reliable when applied to individuals with lower-limb amputations[7,17]. The test requires the participant to rise from a chair, walk a distance of 3 meters, perform a 180º turn to change direction, and return to sit down. Performance is classified according to the time taken to complete the task, measured in seconds. When the individual completes the test in a time equal to or greater than 12.47 seconds, the risk of falling is 3.2 times higher compared to a subject who performs the TUG in less time[18]. It is noteworthy that, to

perform the test, all patients used an assistive device for ambulation, namely a forearm crutch or a walker.

Regarding the procedures, initial contact was made with the clinic to present the study proposal, followed by a review of medical records to select participants according to the inclusion criteria. After selection, telephone contact was made with the chosen patients to explain the study and invite them to participate. Upon patient agreement, the date and time for data collection were scheduled.

On the scheduled evaluation day, participants were received at CECLIN by the researchers. Initially, the study procedures were explained, and subsequently, the Informed Consent Form (ICF) was signed. In the first stage, the patient identification questionnaire was completed, followed by the administration of the quantitative instruments: the Amputee Mobility Predictor (AMP), the Functional Independence Measure (FIM), and the Timed Up and Go (TUG) test.

The collected data were analyzed using the statistical software SPSS 21.0 (Statistical Package for the Social Sciences for Windows). Descriptive statistics were employed to characterize the variables, including simple and relative frequency distributions, as well as measures of central tendency (mean/median) and variability (standard deviation). For correlations, Spearman's correlation test was applied. As the decision criterion, the significance level adopted was $p \leq 0.05$. Correlations with values above 0.60 were considered strong, between 0.30 and 0.60 moderate, and below 0.30 weak.

RESULTS

A total of 18 male individuals with transfemoral amputation, aged between 30 and 80 years, all residents of the Serra Gaúcha region, were evaluated. Table 1 presents the general characteristics of the participants, showing that the most frequent cause of amputation was vascular, and the majority reported phantom limb sensation but not phantom limb pain. Most patients were still in the pre-prosthetic phase.

Table 1 – Sample characterization

Characteristics	Mean (SD)	Median (25-75)
Age (years)	63,89 (13,80)	66,50 (56,0-74,25)
Weight (kg)	73,92 (12,07)	73,50 (64,0-85,75)
Height (m)	1,72 (0,05)	1,72 (1,69-1,78)
Time since amputation (mo)	11,56 (8,52)	10,50 (4,75-17,25)
		FR (%)
Laterality of amputation		
Right		6 (33,3)
Left		12 (66,7)
Cause		
Vascular		13 (72,2)
Traumatic		2 (11,1)
Neoplastic		1 (5,6)
Infectious		2 (11,1)
Phantom limb sensation		
Yes		14 (77,8)
No		4 (22,2)
Phantom limb pain		
Yes		7 (38,9)
No		11 (61,1)
Rehabilitation phase		
Pre-prosthetic		15 (83,8)
Post-prosthetic		3 (16,7)

Legend: SD: Standard Deviation; kg: kilograms; m: meter; mo: months; FR: frequency; %: percentage.

Table 2 describes the participants' scores on the functional assessment tests: AMP, FIM, and TUG.

Table 2 – Functional assessment using the AMP, FIM, and TUG tests.

Functional Tests	Mean (SD)	Median (25-75)
AMP	29,89 (8,02)	33,0 (21,25 – 36,0)
Motor FIM	83,11 (7,50)	86,50 (81,75 – 88,0)
Cognitive FIM	34,44 (0,98)	35,0 (34,0 – 35,0)
Total FIM	117,55 (7,65)	121,5 (115,75 – 122,0)
TUG (seconds)	30,58 (19,56)	25,0 (16,0 – 38,50)

Legend: AMP: Amputee Mobility Predictor; FIM: Functional Independence Measure; TUG: Timed Up and Go; SD: Standard Deviation.

Table 3 presents the correlations between age and functional performance in the AMP, FIM, and TUG tests. A moderate, inverse, and significant correlation was observed between age and the AMP, as well as the total and motor scores of the FIM; in other words, higher test scores were associated with younger age, indicating that younger patients demonstrated greater functionality than older ones. In contrast, the TUG test showed a strong and significant

correlation, meaning that older patients required more time to complete the test than younger ones, indicating a higher risk of falls.

Table 3 – Correlation of age with functionality using the AMP, FIM, and TUG tests.

Testes Funcionais	r	p ≤ 0,05
AMP	- 0,54	0,01*
Motor FIM	- 0,54	0,01*
Cognitive FIM	0,33	0,17
Total FIM	- 0,46	0,05*
TUG (seconds)	0,78	<0,000*

Legend: AMP: *Amputee Mobility Predictor*; FIM: *Functional Independence Measure*; TUG: *Timed Up and Go*; r: Correlation magnitude; *: Statistically significant difference; p≤0.05: Significance level.
Note: Spearman's correlation.

DISCUSSION

The results of the present study confirm that the higher the patient's age, the longer the time required to complete the TUG test and, consequently, the greater the risk of falls. In addition, better functionality, as assessed by the AMP and FIM, was associated with younger age. Assessing the functional capacity of individuals after lower-limb amputation is of utmost importance, as it has a significant impact on autonomy, quality of life, and the ability to perform activities of daily living[19]. The scientific literature indicates that the reduction in functional capacity may be related to increasing age, and the various impairments observed in post-amputation individuals are responsible for a higher risk of falls in this population[7,10].

Considering the assessment of mobility and fall risk through the TUG, other studies[10,20] reported similar results. Newton et al.[10], in a study with transfemoral and transtibial prosthetic users, also demonstrated that increasing age is associated with a greater number of comorbidities that negatively affect balance and mobility. When evaluating mobility using the 2-Minute Walk Test (2MWT), they found a considerable reduction in the distance walked, associated with advancing age, which may be related to the findings of the present study[10]. Karaali et al.[20], when assessing 195 lower-limb amputees, reported results indicating loss of balance and increased fall risk with advancing age. Balance assessment through the Berg Balance Scale (BBS) revealed that physical balance scores were significantly better in patients younger than 65 years[20]. In contrast, Chihuri & Wong[21], when identifying factors associated with a higher incidence of falls in individuals with lower-limb amputations through the TUG,

2MWT, and BBS, demonstrated that age was not directly related to fall incidence. However, reduced exposure to risk-related activities with increasing age could explain the lower rates of falls and injuries highlighted in their study[21].

With regard to the assessment of functionality, previous studies indicate that improved functionality is directly associated with younger age[22-25]. Corroborating the findings of the present research, the study by Dillon et al.[22] evaluated individuals with transfemoral and transtibial amputations and emphasized that age directly influenced patient functionality, as classified by the K-levels of the AMP. The authors highlighted that higher AMP scores and younger age were associated with the assignment of a higher K-level, meaning greater independence and functionality[22]. Similar results were observed in the study by Kaluf[23], which indicated that younger lower-limb amputees were more frequently classified at the highest K-level (K4). Moreover, patients at K3 were younger than those at K2, suggesting that younger patients are capable of achieving greater mobility and functionality compared to older individuals[23]. Hafner et al.[24] also assessed lower-limb amputees who were already prosthesis users and described a strong relationship between age and functionality. Patients classified in the Medicare Functional Classification Level (MFCL) as MFCL-4 were younger than those classified as MFCL-3 and MFCL-2[24]. Furthermore, a study evaluating 73 unilateral transtibial and transfemoral amputees demonstrated a correlation between higher AMP scores at both the initial and final stages of rehabilitation and patient age, indicating that older patients achieved lower AMP scores. These results are consistent with the findings of the present study[25].

In contrast to these results indicating poorer functionality with advancing age, the study by Anton, Legault, and Dudek[26] evaluated lower-limb amputees at different levels who were already prosthesis users and correlated the Locomotor Capabilities Index 5 (LCI-5), the Houghton Scale, and the Activities-specific Balance Confidence Scale (ABC) with age. The study highlighted that age did not have a significant impact on the functionality of the evaluated patients. The proposed explanation for these findings is that the sample assessed was highly functional, as all amputees included in the study were classified at K3 or K4 levels on the AMPPro, which are indicative of higher performance and functionality[26].

Considering the assessment of functionality using the FIM, the results obtained are consistent with other studies[27-29]. Marquez et al.[27] evaluated the functionality of transtibial and transfemoral amputees during a pre-prosthetic rehabilitation process and found that advanced

age resulted in lower total and motor FIM scores[27]. In addition, the studies by Karmarkar et al.[28] and Stineman et al.[29] reinforce the findings of the present research, as they also reported that older lower-limb amputees had lower FIM scores. These studies emphasize that advanced age is associated with poorer performance and greater functional impairment[28,29]. When evaluating the performance of 11 individuals with unilateral lower-limb amputation in activities of daily living (ADLs), including mobility and personal care, Santana et al.[30] demonstrated that amputees with greater dependence were of older age, which is in line with our findings.

CONCLUSIONS

This study demonstrated that advanced age is a strong predictor of falls as well as of decreased functionality. Although the results are limited to a small sample, they are particularly useful in supporting the rehabilitation process, by guiding more targeted interventions that incorporate quantitative assessments specific to these patients. Such measures may positively impact functional improvement, independence, and quality of life in individuals with lower-limb amputations.

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