JETR

JOURNAL OF
EXERCISE THERAPY
AND REHABILITATION

Journal of Exercise Therapy and Rehabilitation. 2026;13(1):25-31. DOI: 10.15437/jetr.1598812

ORIGINAL ARTICLE

Comparison of characteristic features and quality of life in faller and non-faller transtibial prosthesis users

Düşen ve düşmeyen transtibial protez kullanıcılarında karakteristik özelliklerin ve yaşam kalitesinin karşılaştırılması

Yasin YURT[1], Cansu KOLTAK[1], Özge ÇİFTÇİ[1], Tuğba PAKSOY[1], Merve PAKSOY[1]

Abstract

Purpose: Falls and fall-related injuries are common among lower limb prosthesis users. However, the reasons of falls and their impact on health-related quality of life in transtibial prosthesis users (TTPU) remain unclear. We aimed to compare the characteristic differences and quality of life between faller and non-faller TTPU.
Methods: Thirty-six TTPU participated in the study. Subjects who had fallen at least once in the past year were classified as fallers. Functional levels were assessed using the Two-Minute Walk Test, the Timed Up & Go Test, and the Functional Reach Test.
Results: Sixteen (44.44%) participants were identified as fallers. Fallers had higher age and had longer TUG test durations compared to non-fallers ($p<0.05$). Differences in working status, reason for amputation, prevalence of diabetes, and walking aid use were significant between fallers and non-fallers ($p<0.05$). Quality of life levels were similar between the groups ($p>0.05$).
Conclusion: Older age, decreased functional level, not working, having a vascular amputation, having diabetes, and using any walking aid were identified as the characteristic differences of faller transtibial prosthesis users.
Keywords: Amputation, Prosthesis, Falls, Quality of life

Öz

Amaç: *Alt ekstremite protezi kullanıcılarında düşmeler ve düşmeye bağlı yaralanmalar yaygındır. Transtibial protez kullanıcılarında (TTPK) düşme nedenleri ve bunların sağlıkla ilişkili yaşam kalitesi üzerindeki etkisi net değildir. Bu çalışmada, düşen ve düşmeyen TTPK arasındaki karakteristik farklılıkları ve yaşam kalitesini karşılaştırmayı amaçladık.*
Yöntem: *Çalışmaya 36 TTPK katıldı. Son bir yıl içinde en az bir kez düşen bireyler düşenler olarak sınıflandırıldı. Fonksiyonel seviye, İki Dakika Yürüme Testi, Süreli Kalk Yürü Testi ve Fonksiyonel Uzanma Testi ile değerlendirildi.*
Bulgular: *Katılımcıların 16'sı (%44,44) düşen olarak belirlendi. Düşenlerin yaşı daha yüksekti ve Süreli Kalk Yürü Testi süreleri daha uzundu ($p<0,05$). Çalışma durumu, amputasyon nedeni, diyabet prevalansı ve yürüme yardımcısı kullanımı açısından düşenler ile düşmeyenler arasında anlamlı farklılıklar bulundu ($p<0,05$). Gruplar arasında yaşam kalitesi seviyeleri benzerdi ($p>0,05$).*
Sonuç: *İleri yaş, azalmış fonksiyonel seviye, çalışmama durumu, vasküler nedenli amputasyon, diyabet varlığı ve yürüme yardımcısı kullanımı düşen transtibial protez kullanıcılarındaki karakteristik farklılıklardır.*
Anahtar Kelimeler: *Amputasyon, Protez, Düşmeler, Yaşam kalitesi*

1: Eastern Mediterranean University, Faculty of Health Sciences, Physiotherapy and Rehabilitation Department, North Cyprus, via Mersin 10, Türkiye
Corresponding Author: Yasin Yurt : fzt.yasinyurt@gmail.com
ORCID IDs (order of authors): 0000-0002-9561-6267; 0000-0002-7665-1040; 0009-0001-9043-9978; 0009-0009-0249-1820; 0009-0009-6003-2892
Received: December 14, 2024. Accepted: July 22, 2025.

INTRODUCTION

Reduced mobility in individuals with lower limb prostheses can lead to falls and fall-related injuries.[1,2] The annual fall rate in this population exceeds 50%.[3,4] These falls often result in negative consequences such as injury, financial loss, decreased mobility, and reduced quality of life.[5-9] Therefore, it is crucial to identify the reasons of falls among lower extremity prosthesis users and take necessary precautions to prevent secondary issues.

Risk factors for falling can vary between the early and late periods following lower limb amputation. Yu et al. associated falls during the early in-hospital period with vascular etiology, transtibial amputation level, and right-sided amputation.[10] In contrast, Pauley et al. identified factors such as age over 70 years, comorbidities, prolonged hospital stay, polypharmacy, cognitive impairment, and bilateral amputation as risk factors for falls in individuals undergoing rehabilitation.[11] In the late period, different studies have identified transfemoral amputation level, pain, amputation duration of less than 4 years, stump problems, decreased muscle strength, and reduced vibration sense as risk factors for falls.[1,12,13]

Although transfemoral amputees are known to be at greater risk of falling, the proportion of falls and fall-related injuries among transtibial amputees is also significant.[5,12,14] Studies on falls in transtibial prosthesis users (TTPU) typically assess gait variability and balance.[12,13,17] TTPU who have fallen exhibit greater variability in step length, step width, step time, and swing phase compared to those who have not fallen.[15,16] While some studies associate reduced dynamic balance with falls in TTPU, other studies have shown similar balance abilities between fallers and non-fallers.[12,13,17] Gait and balance can also be influenced by the type of prosthesis used. Previous researches have demonstrated the positive effects of vacuum-assisted transtibial prostheses on balance and gait, but their impact on falls remains unknown.[18,19]

Studies examining falls in lower limb prosthesis users are insufficient to provide clear information about TTPU because they often include different amputation levels. Few studies have explored the spatio-temporal characteristics of gait and balance in TTPU. Additionally, no studies have reported the health-related quality of life (HRQoL) of TTPU who have fallen. Therefore, the aim of this study is to investigate the characteristic differences and the quality of life between fallers and non-fallers.

METHODS

This descriptive cross-sectional study was conducted among TTPU at an outpatient clinic between August 2023 and December 2023. The research protocol was approved by the Eastern Mediterranean University Research and Publication Ethics Board (decision number 2023/011), and all participants signed informed consent forms. This trial was registered on ClinicalTrials.gov with the number NCT05999539 before it started.

Inclusion criteria for the study were: being over 18 years of age, using a transtibial prosthesis for at least one year, and being able to walk independently (with or without a walking aid) for at least 30 meters. Exclusion criteria included the use of multiple prostheses, discomfort with the prosthesis, or having a wound on the stump. The effect size was calculated using the G-Power program (Version 3.1.9.2, Kiel University, Germany) with an effect size of d:1.01, based on the Timed Up and Go (TUG) duration of the first 10 participants (5 fallers, 5 non-fallers). To achieve a power of β:0.80 at a significance level of α=0.05, the required sample size was determined to be 34 participants.

Procedure

Participants who had fallen at least once in the past year were classified as fallers. Data collected included age, gender, body mass index, reason for amputation, side of amputation, marital and working status, comorbidities such as diabetes, hypertension and hyperlipidemia, time since amputation, phantom sensation and pain, type of prosthesis, and use of assistive devices. Gait and balance performance were assessed using the Two-Minute Walk Test (2MWT), Timed Up and Go Test (TUG), and Functional Reach Test (FRT).

In the 2MWT, participants were asked to walk a 30-meter distance repeatedly for two minutes, and the distance walked was recorded

in meters.[20] In the TUG test, participants were asked to rise from a chair with a seat height of 46 cm, walk 3 meters, turn 180 degrees, return to the chair, and sit down.[21] The time taken was recorded in seconds using a stopwatch. In the FRT, participants stood with their dominant limb against a wall and reached forward with an arm flexed at 90 degrees and elbow extended.[22] The difference between the start and end points of the distal third finger was measured, and the best result of three attempts was recorded in centimeters.

HRQoL was assessed using the psychosocial adjustment, activity limitation, and satisfaction with the prosthesis subdomains of the Trinity Amputation and Prosthesis Experiences Scales (TAPES).[23]

Statistical analysis

Data analysis was performed using SPSS 20.0 (Statistical Package for the Social Sciences, IBM, USA). The normality of data distribution was examined using the Shapiro–Wilk test and histogram graphics. For comparisons between groups, the independent t-test was used for normally distributed data, while the Mann-Whitney U test was used when parametric conditions were not met. The significance level was set at $p < 0.05$, and results were presented as mean ± standard deviation (Mean ± SD) with minimum and maximum values. Optimal cut-off values were defined using the Index of Union method after Receiver Operating Characteristics (ROC) curve analysis for variables with significant differences.[24] The 2x2 Chi-square Test was used for comparisons of categorical variables, with results reported as n (%).

RESULTS

Out of the 36 TTPU included in the study, 16 (44.44%) were identified as fallers. The age and TUG test duration of the fallers were significantly higher than those of the non-fallers ($p<0.05$). ROC analysis determined cut-off values of 50.50 years for age (sensitivity: 0.938, specificity: 0.450, AUC: 0.728) and 8.14 seconds for TUG (sensitivity: 0.875, specificity: 0.500, AUC: 0.719). No significant differences were found between the two groups in terms of BMI, FRT, 2MWT, and TAPES results ($p>0.05$, Table 1). There were significant differences in working status, reason for amputation, prevalence of diabetes, and walking aid use between fallers and non-fallers ($p<0.05$, Table 2).

DISCUSSION

Authors According to the results of our study, being over 50 years old, having a TUG test time of more than 8.14 seconds, not working, having a vascular amputation, having diabetes, and using any walking aid were identified as the characteristics of faller TTPU. Interestingly, health-related quality of life (HRQoL) levels were found to be similar between fallers and non-fallers. To our knowledge, this is the first study to compare HRQoL between fallers and non-fallers among TTPU. Although no significant difference was observed in quality of life scores between the groups, this finding is noteworthy. It should be noted that, the sensitivity of the TAPES scale in detecting subtle differences related to fall experience may be limited, particularly in small or homogeneous samples. In addition, HRQoL in amputees may be influenced by various factors such as gender, age, cause of amputation, phantom pain, ability to use a prosthesis, physical function, depression, anxiety, body image, and type of prosthesis, as described in the systematic review by Maciver et al.[25] The similarity between the two groups in terms of factors such as gender, phantom pain, and type of prosthesis evaluated in our study may also help explain the absence of a significant difference in HRQoL.

Previous studies have reported that the incidence of falls in TTPU ranges from 27-61%.[12,15] Notably, the primary difference between these studies is the age of the participants. Clemens et al. found a fall rate of 27% with a mean age of 47.1 years, while Parker et al. found a fall rate of 61% in individuals with a mean age of over 60 years.[12,15] In our study, the fall rate was 44.44% among individuals with a mean age of 55.33 years. These results suggest that age may be a risk factor for falling among TTPU. This is further supported by the high rate of falls in individuals over 50 in our study. Older age is known to be an important risk factor for falls in people without prostheses. Data from studies conducted in our country

Table 1. Comparison of demographic characteristics, functional performance, and TAPES between fallers and non-fallers.

	Faller (N=16)	Non-Faller (N=20)	
	X±SD	X±SD	p
Age (years)	61.82±9.62	50.13±15.94	0.010*
Body Mass Index (kg/cm²)	27.53±4.14	24.94±3.53	0.051
Time Since Amputation (years)	6.43±8.02	12.57±14.32	0.168
The Timed Up & Go Test (sec)	9.96±2.02	8.34±2.10	0.026*
Functional Reach Test (cm)	28.43±8.84	30.35±11.50	0.589
2 Min. Walk Test (m)	127.24±22.25	143.83±28.35	0.063
TAPES	110.02±27.91	113.53±12.32	0.613
Psychosocial Adaptation	49.50±9.76	52.24±8.54	0.383
Activity Restriction	14.84±8.93	20.12±7.89	0.118
Satisfaction with the Prosthesis	39.24±8.56	43.04±7.29	0.077

*p<0.05. TAPES: Trinity Amputation and Prosthesis Experiences Scales.

Table 2: Comparison of demographic, clinical, and prosthetic characteristics between groups.

		Faller (n=16)	Non-Faller (n=20)	
		n (%)	n (%)	p
Gender	Female	5 (31.25)	6 (30)	0.936
	Male	11 (68.75)	14 (70)	
Age (years)	≤50	1 (6.25)	11 (55)	0.002*
	>50	15 (93.75)	9 (45)	
Timed Up & Go Test (sec)	≤8.14	2 (12.50)	10 (50)	0.018*
	>8.14	14 (87.50)	10 (50)	
Marital status	Married	11 (68.75)	17 (85)	0.422
	Single	5 (31.25)	3 (15)	
Working Status	Working	1 (6.25)	13 (65)	<0.001
	Not working	15 (93.75)	7 (35)	
Amputation Side	Left	7 (43.75)	13 (65)	0.202
	Right	9 (56.25)	7 (35)	
Reason for Amputation	Non-vascular	4 (75.00)	12 (60)	0.036*
	Vascular	12 (25.00)	8 (40)	
Diabetes	Yes	14 (87.50)	5 (25)	<0.001
	No	2 (12.50)	15 (75)	
Hypertension	Yes	6 (37.50)	3 (15)	0.146
	No	10 (62.50)	17 (85)	
Hyperlipidemia	Yes	2 (12.50)	0 (0)	0.190
	No	14 (87.50)	20 (100)	
Walking aid use	Yes	8 (50)	1 (5)	0.005*
	No	8 (50)	19 (95)	
Suspension System	Pin lock	11 (68.75)	9 (45)	0.154
	Vacuum assisted	5 (31.25)	11 (55)	
Prosthetic Foot Type	Energy storing (Carbon)	3 (18.75)	10 (50)	0.052
	Others	13 (81.25)	10 (50)	
Phantom Sense	Yes	9 (56.25)	13 (65)	0.400
	No	7 (43.75)	7 (35)	
Phantom Pain	Yes	5 (31.25)	9 (45)	0.593
	No	11 (68.75)	11 (55)	

* p<0.05.

show that the fall rate in the geriatric population is 33-36% and 80% in geriatric amputee population.[26,27] These results indicate that the faller rate increases at an earlier age in lower limb prosthesis users.

Interestingly, some previous studies found no age difference between faller and non-faller lower limb prosthesis users. This may be explained by the different reasons and levels of amputation or age groups of participants in those studies. Clemens et al. did not find an age difference between faller and non-faller TTPU, only in non-vascular amputees with a relatively lower mean age.[12] The high rate of vascular amputation and diabetes comorbidity in the faller group in our study may explain the increase in the rate of falls with increasing age. On the other hand, Miller et al. found neither age nor reason for amputation to be a risk factor for falls in lower limb amputees.[3] The difference in their study is that they worked with a large sample including transfemoral amputations. The inclusion of transfemoral amputees may have eliminated the influence of other factors. This is supported by the finding that transfemoral amputation is an important fall risk factor in the same study.

Conversely, Wong et al. did not find the level of transfemoral amputation to be a risk factor in their study of the American population, but they showed that the risk of falls increased with age in the transfemoral group.[14] Additionally, they found that the risk of falls was lower in amputees with vascular causes. These differences between populations may be related to the activity and participation levels of individuals, which have not been assessed in studies. The authors also discussed that transtibial or traumatic amputees may engage in more risky activities, increasing the risk of falls. In the same study, the authors showed that vascular comorbidity, rather than vascular etiology, was an important risk factor. Dite et al. also identified having four or more comorbidities as a factor increasing the frequency of falls in TTPU.[17] Diabetes mellitus, which had not previously been analyzed as a separate risk factor in transtibial amputees, was found to be more prevalent in the faller group in our study. Diabetes-related neuropathy is known to adversely affect balance and increase the risk of falling in the non-amputee population.[28] It is therefore not surprising that the presence of diabetes mellitus is more common in transtibial fallers. The fact that the rates of hyperlipidaemia and hypertension were similar between fallers and non-fallers in our study suggests that the presence of diabetes may be the most important comorbidity causing falls.

In our study, a TUG test time of more than 8.14 seconds was also identified as a discriminator for falls. Similarly, Sawers et al. found ≥8.17 seconds as the cut-off for the TUG test in lower limb prosthesis users.[4] These results indicate that the TUG test is a valuable assessment tool for determining fall risk in lower extremity prosthesis users. In addition, when interpreting the cut-off values obtained for TUG time and age in our study, the sensitivity and specificity values should also be taken into consideration. Although a TUG time of ≥8.17 seconds or an age of >50 years can predict fall risk with high sensitivity, the low specificity indicates that some individuals without fall risk may be misclassified as at risk. Therefore, these criteria alone may not be sufficient to accurately determine fall risk. On the other hand, we found that the 2MWT distance was similar between fallers and non-fallers. Similarly, a previous study found no difference in gait speed between fallers and non-fallers among TTPU. However, they observed that gait step regularity was lower in fallers.[15] Also, in non-amputee geriatric individuals, gait irregularity rather than walking speed is associated with falls.[29] These results may explain the similar walking speeds between fallers and non-fallers. In addition, our study only assessed fall history; however, as previously reported by Miller et al., fear of falling may also be present in non-fallers.[3] The similarity in walking speed between groups may, in part, be attributed to the presence of fear of falling in the non-faller group. Future studies would benefit from including assessments of fear of falling to provide a more comprehensive understanding of walking speed and fall risk.

Another important finding of our study was the high rate of walking aid users among fallers. Walking aids are used to ensure mobility and prevent falls in prosthesis users with poor balance. However, the effect of walking aid use on fall prevention among lower limb prosthesis users is unknown. The use of a walking aid may even be a factor that increases the risk of falls. In the fall prevention guidelines for the non-

amputee older population, the use of walking aids is among the risk factors for falls with a high level of evidence.[30] Therefore, it is crucial that walking aids are selected and used appropriately. Future studies should investigate falls caused by walking aids in lower limb prosthesis users.

Previous studies have shown that vacuum-assisted transtibial prostheses improve balance and gait and may be effective in preventing falls.[18,19] In our study, there was no difference in the fall percentages between participants using vacuum-assisted and pin-lock systems. It is important to remember that our study did not inquire about the number of falls. Even if the type of prosthesis does not completely prevent falls, it may reduce the number of falls and fall-related injuries. It should also be noted that only two different types of suspension were included in our study.

Working status also differed between fallers and non-fallers in our study. This was only questioned in Miller et al.'s study, which did not find it to be a fall risk factor.[3] The difference found in our sample may be due to the fact that we included only transtibial users with a relatively lower mean age than their sample. Being an active worker can play a role in preventing falls by maintaining functional level and preventing comorbidities. They also found that having joint and back pain were risk factors for falls. In our study, phantom sensation and pain were questioned but no difference was found. Mechanical pain, which was not assessed in our study, may be associated with falls due to its relationship with activity on prosthesis. In future studies, it would be beneficial to determine factors that increase the risk of falls among TTPU by conducting regression analysis on a larger sample, taking into consideration the characteristic differences we have identified.

Limitations

The limitations of our study include the retrospective questioning of fall status over the past year, which may have led to recall bias. In addition, the lack of detailed inquiry regarding the frequency of falls and fall-related injuries limits the interpretation of our findings. Moreover, due to our inadequate sample size for conducting regression analysis, we were not able to identify which factors constitute a definite risk for falls. As only TTPU were included in our study, it has unique results in terms of showing the differences in this population.

Conclusion

Older age, decreased functional level, not working, having a vascular amputation, having diabetes, and using any walking aid were identified as the characteristics in faller TTPU. Falls had no effect on HRQoL in this group.

Acknowledgement: We would like to thank subjects who participated in the research.

Authors' Contributions: **YY:** Concept/idea development, study design, project management, data analysis/interpretation, literature search, provision of facts, provision of facilities/equipment, writing, critical review; **CK:** Study design, data collection/processing, literature search, provision of facilities/equipment, writing, critical review; **ÖÇ:** Study design, data collection/processing, literature search, provision of facilities/equipment, writing, critical review; **TP:** Data collection/processing, literature search, writing, critical review; **MP:** Data collection/processing, literature search, writing, critical review.

Funding: *None*

Conflicts of Interest: *None*

Ethical Approval: The research protocol was approved by the Eastern Mediterranean University Research and Publication Ethics Board (issue: 2023/011, date: 23.06.2023)

REFERENCES

1. Vanicek N, Strike S, McNaughton L, et al. Gait patterns in transtibial amputee fallers vs. non-fallers: biomechanical differences during level walking. Gait Posture. 2009;29:415-420.
2. Hunter SW, Batchelor F, Hill KD, et al. Risk factors for falls in people with a lower limb amputation: a systematic review. PM&R. 2017;9:170-180.
3. Miller WC, Speechley M, 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.
4. Sawers A, Hafner BJ. Using clinical balance tests to assess fall risk among established unilateral lower limb prosthesis users: cutoff scores and associated validity indices. PM&R. 2020;12:16-25.

5. Wong CK, Chihuri ST, Li G. Risk of fall-related injury in people with lower limb amputations: a prospective cohort study. J Rehabil Med. 2016;48:80-85.
6. Chihuri S, Wong CK. Factors associated with the likelihood of fall-related injury among people with lower limb loss. Inj Epidemiol. 2018;5:42.
7. Mundell B, Maradit Kremers H, Visscher S, et al. Direct medical costs of accidental falls for adults with transfemoral amputations. Prosthet Orthot Int. 2017;41:564-570.
8. van Velzen JM, van Bennekom CA, Polomski W, et al. Physical capacity and walking ability after lower limb amputation: a systematic review. Clin Rehabil. 2006;20:999-1016.
9. Pezzin LE, Dillingham TR, MacKenzie EJ. Rehabilitation and the long-term outcomes of persons with trauma-related amputations. Arch Phys Med Rehabil. 2000;81:292-300.
10. Yu JC, Lam K, Nettel-Aguirre A, et al. Incidence and risk factors of falling in the postoperative lower limb amputee while on the surgical ward. PM&R. 2010;2:926-934.
11. Pauley T, Devlin M, Heslin K. Falls sustained during inpatient rehabilitation after lower limb amputation: prevalence and predictors. Am J Phys Med Rehabil. 2006;85:521-532.
12. Clemens S, Gaunaurd I, Raya M, et al. Using theoretical frameworks to examine fall history and associated prosthetic mobility in people with nondysvascular lower limb amputation. Prosthet Orthot Int. 2022;46:484-490.
13. Quai TM, Brauer SG, Nitz JC. Somatosensation, circulation and stance balance in elderly dysvascular transtibial amputees. Clin Rehabil. 2005;19:668-676.
14. Wong CK, Chihuri ST. Impact of vascular disease, amputation level, and the mismatch between balance ability and balance confidence in a cross-sectional study of the likelihood of falls among people with limb loss. Am J Phys Med Rehabil. 2019;98:130-135.
15. Parker K, Hanada E, Adderson J. Gait variability and regularity of people with transtibial amputations. Gait Posture. 2013;37:269-273.
16. Hordacre BG, Barr C, Patritti BL, et al. Assessing gait variability in transtibial amputee fallers based on spatial-temporal gait parameters normalized for walking speed. Arch Phys Med Rehabil. 2015;96:1162-1165.
17. Dite W, Connor HJ, Curtis HC. Clinical identification of multiple fall risk early after unilateral transtibial amputation. Arch Phys Med Rehabil. 2007;88:109-114.
18. Samitier CB, Guirao L, Costea M, et al. The benefits of using a vacuum-assisted socket system to improve balance and gait in elderly transtibial amputees. Prosthet Orthot Int. 2016;40:83-88.
19. Ferraro C. Outcomes study of transtibial amputees using elevated vacuum suspension in comparison with pin suspension. J Prosthet Orthot. 2011;23:78-81.
20. Brooks D, Parsons J, Hunter JP, et al. The 2-minute walk test as a measure of functional improvement in persons with lower limb amputation. Arch Phys Med Rehabil. 2001;82:1478-1483.
21. Schoppen T, Boonstra A, Groothoff JW, et al. The Timed "up and go" test: reliability and validity in persons with unilateral lower limb amputation. Arch Phys Med Rehabil. 1999;80:825-828.
22. Gremeaux V, Damak S, Troisgros O, et al. Selecting a test for the clinical assessment of balance and walking capacity at the definitive fitting state after unilateral amputation: a comparative study. Prosthet Orthot Int. 2012;36:415-422.
23. Topuz S, Ulger O, Yakut Y, et al. Reliability and construct validity of the Turkish version of the Trinity Amputation and Prosthetic Experience Scales (TAPES) in lower limb amputees. Prosthet Orthot Int. 2011;35:201-206.
24. Perkins NJ, Schisterman EF. The inconsistency of 'optimal' cutpoints obtained using two criteria based on the receiver operating characteristic curve. Am J Epidemiol. 2006;163:670-675.
25. Maciver M, Dixon D, Powell D. Quality of life in young people with limb loss: a systematic review. Disabil Rehabil. 2023;22:1-12.
26. Guner SG, Nural N. Fall in the elderly people: determining the status within the context of dissertations conducted in Turkey. Izmir Katip Celebi Univ J Health Sci. 2017;2:9-15.
27. Ulger O, Topuz S, Bayramlar K, et al. Risk factors, frequency, and causes of falling in geriatric persons who has had a limb removed by amputation. Top Geriatr Rehabil. 2010;26:156-163.
28. Rinkel WD, van Nieuwkasteele S, Cabezas MC, et al. Balance, risk of falls, risk factors and fall-related costs in individuals with diabetes. Diabetes Res Clin Pract. 2019;158:107930.
29. Hausdorff JM, Rios DA, Edelberg HK. Gait variability and fall risk in community-living older adults: a 1-year prospective study. Arch Phys Med Rehabil. 2001;82:1050-1056.
30. Jung D, Shin S, Kim H. A fall prevention guideline for older adults living in long-term care facilities. Int Nurs Rev. 2014;61:525-533.