

## PREVALENCE OF IMBALANCE AND INCO-ORDINATION IN BELOW KNEE AMPUTEES

Mr. Omkar Vivek Shinde<sup>1</sup>

Dr. Tejashree Omkar Kumbhar<sup>2</sup>

<sup>1,2</sup>Department of Physiotherapy, Krishna Institute of Medical Sciences  
(Deemed to be University), Karad, Maharashtra, India.

Article History:

Received: November 2025

Revised: December 2025

Accepted & Published : January 2026

<https://doie.org/10.65985/jbse.2026975335>

### ABSTRACT

**Background:** Below-knee amputees (BKA) often experience significant impairments in balance and coordination due to the loss of the foot and ankle complex, which are critical for proprioception and postural control. These impairments contribute to decreased mobility, increased fall risk, and reduced quality of life. Despite prosthetic interventions, functional limitations persist, necessitating a focused study on the prevalence and impact of these issues.

**Materials and method:** A cross-sectional observational survey was conducted over six months at the Orthopaedic Department of Krishna College of Physiotherapy, Karad. A total of 80 participants aged 18–60 years with unilateral below-knee amputation were selected using simple random sampling. Outcome measures included a self-made questionnaire and clinical balance and coordination assessments: Single-leg stance test, Tandem stance test, Target tapping test, and Step-touch coordination test. Data were statistically analyzed to determine prevalence rates and assess correlations with daily functioning.

**Result:** The study revealed a 95% prevalence of imbalance and a 56.25% prevalence of incoordination among BKA patients. Balance deficits were particularly evident in static and dynamic postures, while coordination issues were noted in tasks requiring bilateral limb synchronization and complex movement transitions. Many participants reported difficulties with daily activities and relied on assistive devices, with psychological factors such as fear of falling contributing to functional limitations.

**Conclusion:** This study concludes that: Imbalance is an almost universal challenge among below-knee amputees, with a prevalence rate of 95%. Incoordination affects a significant portion of the population, with 56.25% of participants showing signs of impaired motor coordination. These findings highlight that individuals with below-knee amputations are at a high risk of functional limitations that can adversely affect their mobility, independence, and quality of life. The results strongly support the incorporation of targeted balance and coordination training in the rehabilitation process for this group. Such measures not only improve postural stability and movement control but also reduce the likelihood of falls and enhance overall confidence in performing activities of daily living.

**Keywords:** Below-knee amputation, imbalance, incoordination, postural control, prosthesis, physiotherapy, functional mobility, rehabilitation.

### INTRODUCTION

The removal of body tissue through amputation results in devastating changes for patients because it damages their physical elements as well as their mental state and disrupts their social

networks [1]. BKA stands as one of the most frequent amputation types, called transtibial amputation, following peripheral vascular disease, diabetes mellitus, trauma, infections, and tumors among amputation patients [2].

The lower limb amputation patient population continues to rise globally, yet it remains most prominent within developing nations because diabetes mellitus complications and traffic accidents have increased [3]. The prosthetic device and rehabilitation program do not eliminate functional challenges faced by below-knee amputees [4].

The problems of imbalance and incoordination pose the greatest threat to amputees because they limit their ability to complete daily routines while maintaining autonomy and living comfortably [5].

When the lower limb segment and foot and ankle complex are absent, the biomechanical chain of posture and gait disrupts, which leads to ineffective or maladaptive compensatory mechanisms in patients [6].

A proper understanding of below-knee amputation's effect on imbalance and incoordination needs knowledge about how this procedure changes human anatomy and biomechanics. The lower limb amputation process requires surgeons to remove the stool portion starting from the tibial tuberosity through the ankle joint region [7].

The surgical intervention maintains the knee joint structure because it serves as an essential foundation for achieving both prosthetic mobility and functional movement [8].

The absence of the foot and ankle complex disrupts the way forces act on the ground while changing both sensory feedback and muscle movements needed for control of posture and movement. A wide base of support from the foot together with ankle strategies enables our body to achieve subtle adjustments for maintaining upright posture [9].

Below-knee amputated patients need their hip and knee joints as their primary tool for balance and coordination following the removal of their foot and ankle complex, so their movements become less efficient and require increased energy expenditure [10].

Balance describes the mechanism that helps the body center its mass above its standing support platform in both motionless positions and dynamic movements that involve walking [11].

Postural control functions as a complicated movement skill because it requires coordination between the vestibular system and the somato sensory system together with the visual system. Postural control serving both anticipatory and reactive functions protects people from falls and enables safe and confidence-based task completion [12].

Smooth execution of movement patterns defines the concept of coordination since it merges motor planning with timing and sequencing to reach accurate, efficient results. The right muscles activate in correct sequences of intensity to produce functional movement patterns [13].

People with BKA experience regular balance and coordination issues because their limbs lose general feedback information along with different joint angles and irregular muscle activation patterns, together with mental obstacles related to falls [14].

Such deficits both prevent rehabilitative progress and make amputees vulnerable to additional health risks, which include falls and joint-related pain and degenerative spine conditions [15]. Clinical observations along with research studies indicate balance and coordination problems are widespread among people with below-knee amputation. The impairments become noticeable while standing as well as during walking movements between stairs and when moving between different positions. [16]

Studies reveal that well-rehabilitated amputees using prosthetics over time exhibit uneven walk patterns and slower walking speeds together with enlarged postural instability compared to individuals without disability [17].

Multiple studies showed that BKA patients face balance deficiencies between 60% and 85%, yet different evaluation methods alongside study participant qualities impact these numbers [18].

Doctors note difficulty in measuring coordination problems, which commonly appear during balance tasks, including obstacle avoidance and turning and dual-task performances [19].

Those who undergo amputation as elderly patients face additional risk together with individuals who have diabetes or neuropathy or receive delayed or insufficient rehabilitation care [20].

A number of internal and external components generate imbalance and incoordination problems in below-knee amputees: -

The foot and ankle proprioceptors disappear through amputation, leaving the body without its essential position and movement detection capabilities.

The absence of body mass leads to waste reduction in the residual limb, while the remaining whole limb undergoes excessive strain, which creates functional muscle weakness.

Using a prosthesis affects walking joint movements by forcing patients to create unnecessary adjustments that could compromise their balance.

The mental state, including both anxiety and depression and fears concerning falls, creates obstacles in motor control both by worsening coordination problems.

The incorrect design or inappropriate fit of a prosthesis, along with lacking biomechanical features such as shock absorption, can reduce stability during use.

The combination of visual and vestibular impairments particularly affects older people because these dual impairments make balance control more difficult.

The functional dynamics of below-knee amputees undergo negative consequences when imbalance or incoordination occurs. People with poor balance experience reduced mobility independence and increased risk of falling since they tend to limit their community activities because of fear or worry for their safety.

The act of social withdrawal because of limb loss frequently results in depression and decreased physical movement that shortens an individual's life expectancy. The need for maximum mental awareness while moving causes daily tasks to become tiring and less natural for people with coordination impairments. Such repetitive use of artificial body parts leads patients to exhaustion alongside joint damage and abandonment of prostheses.

The resolution of these issues needs more than physical ability enhancement because it requires complete wellness alongside social recovery. The rehabilitation process for below-knee amputees uses various professionals, including physiotherapists along with prosthetists, occupational therapists, and psychologists, to help patients regain optimal function.

The following strategies form the basis to deal with both imbalance and incoordination: -

- Physiotherapy practitioners should integrate static and dynamic balance exercises, which include balance boards, stability balls, and virtual reality systems.
- Casual surgery and visual feedback procedures, along with tactile stimulation, serve to improve sensory feedback for patients.
- Core and hip muscles, along with lower extremities, need strengthening exercises as part of the treatment to support alternative body functions.
- The drills for coordination include ladder drills together with rhythmic stepping and training for specific tasks to enhance the planning and execution of movements.
- Physiotherapy efforts combining treadmill machines with real-time data monitoring provide patients proper treatment for gait irregularities.
- Assistive devices help patients walk safely through their use of canes and walkers with additional features on prosthetic components.
- Behavioral therapy focuses on treating emotional fears about falling and builds patient confidence through psychological guidance.

Studies confirm that early continuous Rehabilitation cuts down balance and coordination disorders while optimizing prosthesis performance together with decreasing secondary complications.

Onset of imbalance and incoordination problems in below-knee amputees requires more complete data to determine their frequency while investigating population-related elements.

Below-knee amputees in low- and middle-income countries receive restricted rehabilitation help and unreliable prosthetic devices, thus worsening their functional disabilities.

The research fills this knowledge gap by measuring below-knee amputees' imbalance and incoordination rates in a specified population while establishing relevant risk factors and stressing the necessity of specific treatment approaches.

Healthcare providers, together with policymakers and rehabilitation specialists, receive valuable information about early identification and appropriate management of these impairment types through these data

As the main objective, health professionals aim to achieve enhanced functional abilities together with diminished fall risk and superior quality of life for below-knee amputees.

**MATERIALS AND METHODOLOGY:**

The study was an observational type of study with 80 participants conducted in Karad, Maharashtra. The study duration was about 6 months. The review was conducted with the approval of the Ethical Committee of the institution where the study was conducted. By reviewing the inclusion and exclusion criteria of the participants, the sample population was selected. The participants were told about the study and consent form was taken from them regarding the study. A self-made questionnaire was distributed to participants in printed form. Additionally, participants were assessed using balance and coordination tests, including the single-leg stance test, tandem stance test, target tapping test, and step-touch coordination test. The responses and the result were then recorded and analyzed.

**RESULT:**

The study revealed a 95% prevalence of imbalance and a 56.25% prevalence of incoordination among BKA patients. Balance deficits were particularly evident in static and dynamic postures, while coordination issues were noted in tasks requiring bilateral limb synchronization and complex movement transitions. Many participants reported difficulties with daily activities and relied on assistive devices, with psychological factors such as fear of falling contributing to functional limitations.

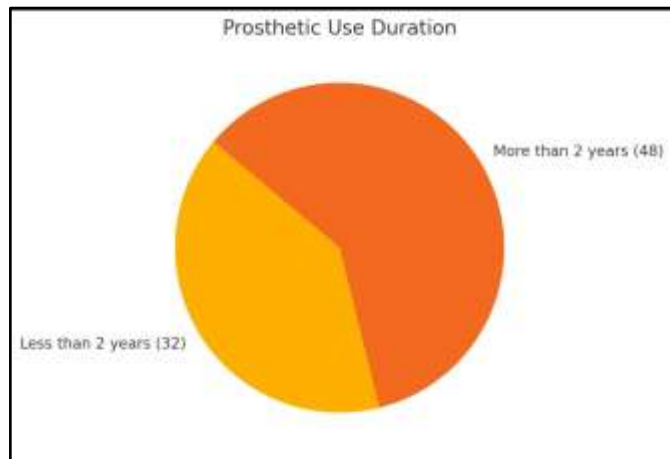
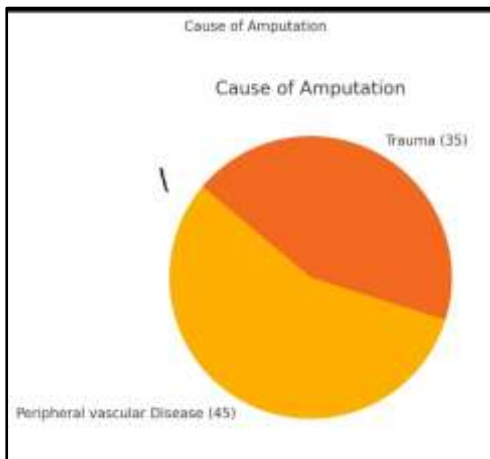
**STATISTICAL ANALYSIS AND RESULT:**

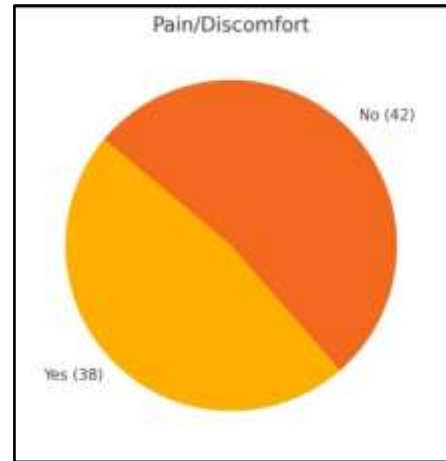
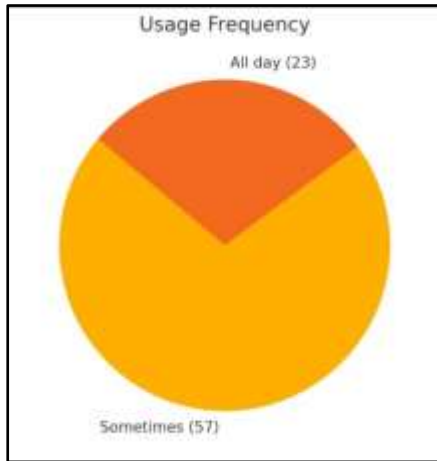
| <b>Age Group</b> | <b>Out of 80</b> |
|------------------|------------------|
| 18 – 30          | 3                |
| 31 – 40          | 19               |
| 41 – 50          | 18               |
| 51 - 60          | 40               |

| BMI         | Out of 80 |
|-------------|-----------|
| Underweight | 9         |
| Normal      | 40        |
| Overweight  | 19        |
| Obese       | 12        |

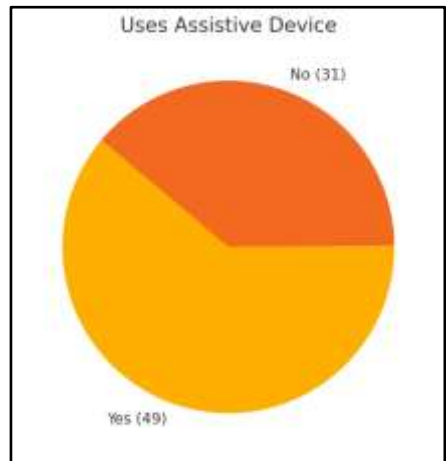
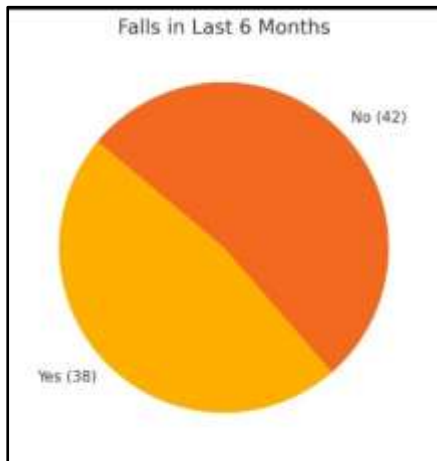
| Gender | Out of 80 |
|--------|-----------|
| Male   | 66        |
| Female | 14        |

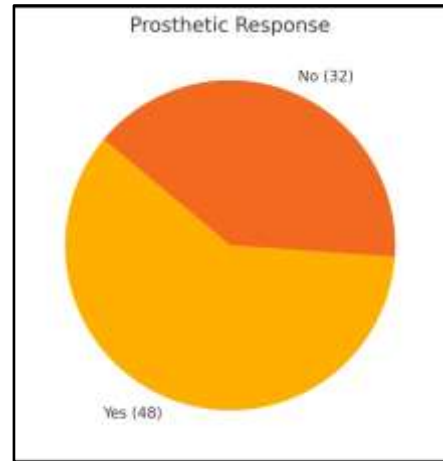
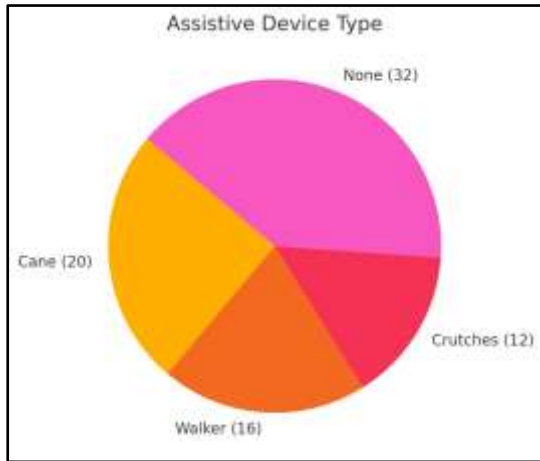
| Questions               |                  | Count Out of 80 | Frequency % |
|-------------------------|------------------|-----------------|-------------|
| Cause of Amputation     | PVD              | 45              | 56.25       |
|                         | Trauma           | 35              | 43.75       |
| Prosthetic Use Duration | Less than 2 year | 32              | 40          |
|                         | More than 2 year | 48              | 60          |
| Usage Frequency         | Sometimes        | 57              | 71.25       |
|                         | All Day          | 23              | 28.75       |
| Pain/Discomfort         | Yes              | 38              | 47.5        |
|                         | No               | 42              | 52.5        |



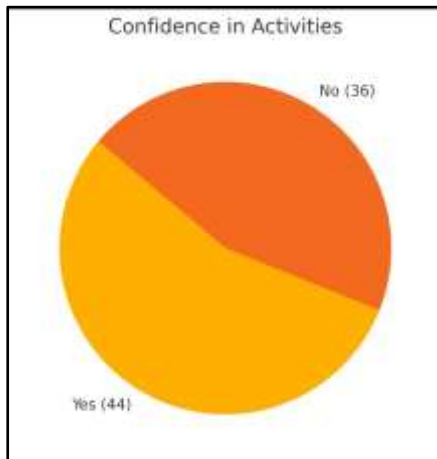


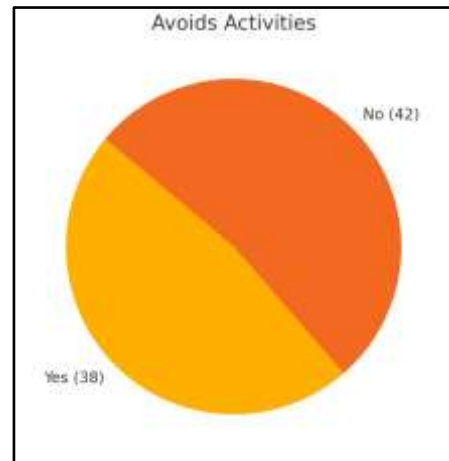
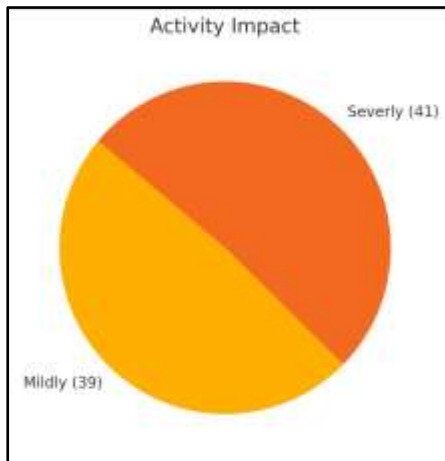
| Questions              |          | Count Out of 80 | Frequency % |
|------------------------|----------|-----------------|-------------|
| Falls in Last 6 Months | Yes      | 38              | 47.5        |
|                        | No       | 42              | 52.5        |
| Uses Assistive Device  | Yes      | 49              | 61.25       |
|                        | No       | 31              | 38.75       |
| Assistive Device Type  | Cane     | 20              | 25          |
|                        | Walker   | 16              | 20          |
|                        | Crutches | 12              | 15          |
|                        | None     | 32              | 40          |
| Prosthetic Response    | Yes      | 48              | 60          |
|                        | No       | 32              | 40          |



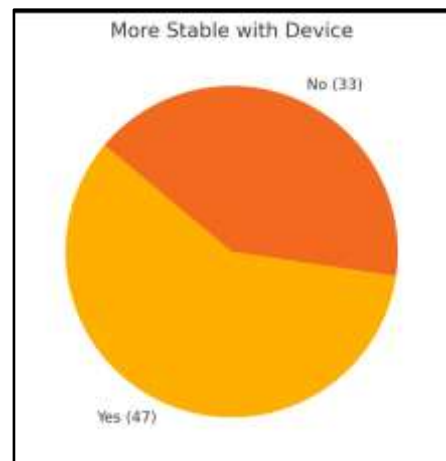
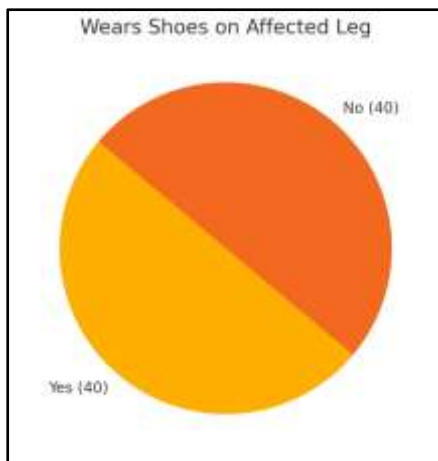


| Questions                     |         | Count Out of 80 | Frequency % |
|-------------------------------|---------|-----------------|-------------|
| Confidence in Activities      | Yes     | 44              | 55          |
|                               | No      | 36              | 45          |
| Balance/Coordination Training | Yes     | 39              | 48.75       |
|                               | No      | 41              | 51.25       |
| Activity Impact               | Mildly  | 39              | 48.75       |
|                               | Severly | 41              | 51.25       |
| Avoids Activities             | Yes     | 38              | 47.5        |
|                               | No      | 42              | 52.5        |





| Questions                   |     | Count Out of 80 | Frequency % |
|-----------------------------|-----|-----------------|-------------|
| Wears Shoes on Affected Leg | Yes | 40              | 50          |
|                             | No  | 40              | 50          |
| More Stable with Device     | Yes | 47              | 58.75       |
|                             | No  | 33              | 41.25       |



|                              |          |    |
|------------------------------|----------|----|
| Single Leg Stance Test       | Grade 1  | 45 |
|                              | Grade 2  | 35 |
| Tandem Stance Test           | Grade 1  | 45 |
|                              | Grade 2  | 35 |
| Target Tapping Test          | Positive | 35 |
|                              | Negative | 45 |
| Step Touch Coordination Test | Positive | 35 |
|                              | Negative | 45 |

## DISCUSSION:

The present study was conducted to explore the prevalence of imbalance and incoordination among individuals with below-knee amputations (BKA). With a sample size of 80 participants, the findings revealed a strikingly high prevalence of imbalance (95%) and a notable prevalence of incoordination (56.25%). These figures are indicative of the significant neuromuscular and biomechanical challenges faced by individuals after undergoing transtibial amputation.

Imbalance among BKA individuals is primarily attributed to the absence of the foot and ankle complex, which plays a central role in maintaining postural control by providing proprioceptive feedback, enabling ankle strategies, and supporting body weight distribution. The amputation disrupts the sensory-motor loop and alters the biomechanics of the lower limb, forcing the individual to depend more heavily on the hip and knee for maintaining balance. Moreover, compensatory mechanisms adopted due to prosthetic limitations often lead to inefficient movement patterns and increased energy expenditure.

Incoordination, although less prevalent than imbalance, was observed in over half of the participants. Coordination requires synchronized activation of muscles and appropriate timing of joint movements. In the absence of the natural limb components and due to maladaptive neuromuscular adaptations, individuals face difficulty in executing smooth and purposeful movements. Additionally, psychological factors such as fear of falling, anxiety, and lack of confidence in prosthetic limb use may contribute to motor control deficits and further reduce coordination.

The high prevalence rates identified in this study suggest that standard prosthetic interventions and rehabilitation may not fully compensate for the deficits induced by amputation. Many participants reported difficulty performing daily activities, use of assistive devices, and avoidance of certain movements or environments.

These findings reinforce the importance of designing individualized physiotherapy protocols that address the specific needs of balance and coordination improvement. Rehabilitation programs focusing on dynamic balance training, proprioceptive re-education, coordination drills, and strength training of the core and proximal joints are critical for improving functional independence and quality of life.

Furthermore, these findings emphasize the necessity for early rehabilitation and continuous follow-up to monitor and manage balance and coordination issues, thus minimizing the risk of secondary complications such as falls, musculoskeletal strain, and psychological distress.

## CONCLUSION:

This study concludes that:

Imbalance is an almost universal challenge among below-knee amputees, with a prevalence rate of 95%.

Incoordination affects a significant portion of the population, with 56.25% of participants showing signs of impaired motor coordination.

These findings highlight that individuals with below-knee amputations are at a high risk of functional limitations that can adversely affect their mobility, independence, and quality of life. The results strongly support the incorporation of targeted balance and coordination training in the rehabilitation process for this group. Such measures not only improve postural stability and movement control but also reduce the likelihood of falls and enhance overall confidence in performing activities of daily living.

## REFERENCES

- [1] Pezzin LE, Dillingham TR, MacKenzie EJ, et al. (2000). "Rehabilitation and the long-term outcomes of persons with trauma-related amputations." *Arch Phys Med Rehabil*.
- [2] Ziegler-Graham K, et al. (2008). "Estimating the prevalence of limb loss in the United States." *Arch Phys Med Rehabil*.
- [3] Suckow BD, et al. (2015). "Trends in lower extremity amputation in the United States." *J Vasc Surg*.
- [4] Highsmith MJ, et al. (2010). "Differences in gait training interventions for transtibial amputees." *Gait Posture*.
- [5] Miller WC, Deathe AB, Speechley M. (2001). "The prevalence and risk factors of falling and fear of falling among lower extremity amputees." *Arch Phys Med Rehabil*.
- [6] Gauthier-Gagnon C, Grisé MC. (1994). "Postural control in transtibial amputees." *Am J Phys Med Rehabil*.
- [7] Isakov E. (2007). "Gait rehabilitation: a new biofeedback device for monitoring and enhancing weight-bearing over the affected lower limb." *Eura Medicophys*.
- [8] Pinzur MS. (2002). "Surgical and rehabilitative principles in the management of the dysvascular amputee." *Foot Ankle Clin*.
- [9] Vrieling AH, et al. (2008). "Gait initiation in lower limb amputees." *Gait Posture*.
- [10] Gailey R, et al. (2008). "Energy expenditure of trans-tibial amputees during ambulation at self-selected pace." *ProsthetOrthot Int*.
- [11] Horak FB. (2006). "Postural orientation and equilibrium: what do we need to know about neural control of balance to prevent falls?" *Age Ageing*.
- [12] Peterka RJ. (2002). "Sensorimotor integration in human postural control." *J Neurophysiol*.
- [13] Sainburg RL. (2002). "Evidence for a dynamic-dominance hypothesis of handedness." *Exp Brain Res*.
- [14] Hak L, et al. (2014). "Limitations in activities and participation in transtibial amputees: a systematic review." *Clin Rehabil*.
- [15] Kulkarni J, et al. (1996). "Falls in patients with lower limb amputations: prevalence and contributing factors." *Physiotherapy*.
- [16] Pruziner AL, et al. (2014). "Balance and gait performance in persons with lower-limb amputation." *J Rehabil Res Dev*.
- [17] Hafner BJ, Smith DG. (2009). "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*.
- [18] Wong CK. (2016). "Balance control in transtibial amputees during quiet standing: A systematic review." *Gait Posture*.
- [19] Pruziner AL, et al. (2016). "Dual-task effects on gait and turning in lower-limb amputees." *Gait Posture*.

- [21] Czerniecki JM, Turner AP, Williams RM. (2012). "The effect of age, diabetes, and chronic disease on functional outcomes." Arch Phys Med Rehabil.