

A Research-Based Survey on the Challenges and Perspectives of Transfemoral Amputees in Developing Nations: Prioritizing Research for Improved Prosthetic Care

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Abstract. Talking about many developing countries like India, the facts and figures don't give a clear picture about the physical well-being of an amputee and medical facilities provided to them. However, many surveys are done from time to time to provide better medical aid to individuals with the amputation. These surveys are presented with the point where prosthetics are considered to be a solution to the problem, but we are completely unaware of the problem. Real problem starts from the moment amputees start using prosthetics, we as a healthy human being just can't imagine the trauma they go through when there only hope, which is prosthetics, doesn't give them satisfactory result. Satisfactory results, which means imitating the natural gait, the pain ,burden of putting the prosthetics and maintaining it. So, it's not the end of the story for them it is a real struggle for them which they face every day, the moment they open their eyes their struggle starts. We call human beings the most advanced form of living creature and only one gifted with brains. Still, we aren't using it to draw to a solution to this problem which will help these amputees lead a healthy and secure life.

In this paper we will focus our direction towards the lower limb amputation precisely transfemoral amputees. Study will answer all such questions as to ***“Why research is focused on transfemoral amputees and not transtibial amputees?”***. How their struggle is different from transtibial amputees, for understanding this we need to study the structure of lower limb . In research we have conducted a survey while taken in consideration TAPES-R questionnaire and drawn the conclusion that lower limb amputees, specifically transfemoral amputees are facing many challenges which we can't even imagine. This study will help us in breaking down the umbrella term “lower limb amputation” to crisper and to the point research focused on transfemoral amputees. In future which will help us in evaluating the pre-existing solutions to it and we can take help of state of art ML algorithm to design an efficient algorithm that will focus on developing a prosthetic knee easing their pain by reducing the constant struggle.

Keywords: lower-limb amputation, prosthetic knee, TAPES-R questionnaire, ML algorithms

Introduction

Artificial knees, commonly referred to as prosthetic knees, are vital replacements for the individual suffering from amputation of lower limbs (transfemoral amputation or above knee amputation), amputation can be caused due to various reasons. Diabetes and peripheral vascular disease can cause problems that result in poor circulation and wounds that do not heal, accounting for a major part of transfemoral amputations. Patients with chronic metabolic illnesses are more likely to have these issues, which highlights the necessity for efficient management techniques to avoid amputations.

Research suggests that 78.9% of transfemoral amputations are caused by traumatic causes [2]. Many transfemoral amputations are the consequence of traumatic injuries. This is in contrast to other types of lower limb amputations where the percentage of traumatic causes is smaller. Treatment-resistant infections, especially those that cause gangrene, are important reasons why amputation is required. This is especially

important when blood flow is compromised by vascular illnesses, which raises the risk of serious infections [3]. Although less frequent than the other reasons, lower limb tumours might also require transfemoral amputation. In these situations, the location of the tumour and the severity of the illness frequently influence the decision to amputate [3]. Prosthetics has a very intriguing history; evidence of prosthetics includes as an Egyptian false toe on the toe of a mummy [1].

Levels of Lower Limb Amputation

Below-knee amputation (BKA), through-knee amputation (TKA), and above-knee amputation (AKA) are the three main forms of lower limb amputations. The effects on patient outcomes and rehabilitation vary depending on the type.

a. Below Knee Amputation

1. When compared to higher-level amputations, BKA is linked to greater physical quality of life and stronger functional recovery [4][5].

2. Compared to patients with TKA or AKA, individuals with BKA are more likely to achieve independent mobility and walk farther (e.g., 500 meters) [5].

b. Through-Knee Amputation

1. Compared to AKA, TKA might have some practical advantages such improved physical quality of life and the potential [4][5].

2. In contrast to patients with AKA, those with TKA typically wear their prosthesis less frequently and have more discomfort [5].

c. Above-knee amputation (AKA)

1. In some cases where BKA is not helpful, AKA is frequently adopted. Compared to BKA and TKA, it is linked to higher physiological strain and an inferior physical state of life [4][5].

2. Compared to patients with BKA or TKA, patients with AKA have lower rates of obtaining independent mobility and walking longer distances [5].

d. Hip Disarticulation

1. Hip disarticulations account for only 0.39-0.5% of lower limb amputations annually [6].

2. There is limited scientific literature on hip disarticulation outcomes due to the rarity of the procedure [6].

3. Patient-reported outcomes and quality of life measures are underutilized in this population [6].

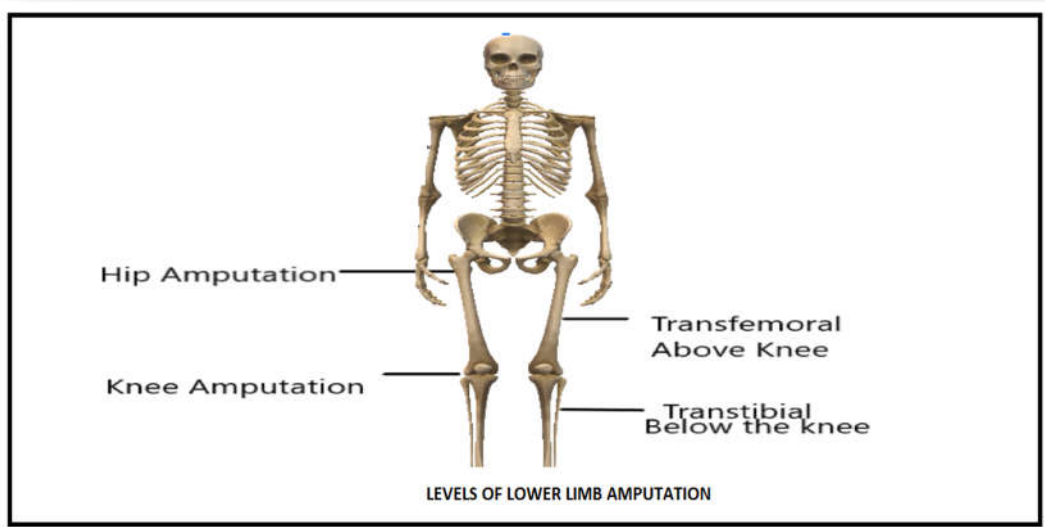


Figure 1: Levels of Lower Limb amputation

Directing attention to the transfemoral amputees is the need of an hour because they face a different kind of problem, unlike the transtibial amputees, they do not possess a knee joint. The presence of the knee helps the transtibial amputees in moving well and thus leads a better-quality life when fitted with the prosthesis. In contrast, the transfemoral amputees are seriously affected by the loss of this critical articulation. As such, our study supports the many complexities in rehabilitation and their needs to ensure that special attention is directed towards the same.

MATERIAL AND METHODS

In light of the above findings, cross-sectional study was conducted, hospital-based group of 334 patients. This research work aimed to describe the psychosocial adjustment of lower-limb amputated patients to surgical results and prosthetic rehabilitation by taking into account the TAPES-R questionnaire.

- Study design: A cross-sectional study conducted at a hospital
- Examine Time frame: eighteen months
- Study population: Every patient admitted to a hospital after having a lower limb amputated attending OPD/IPD in a tertiary care hospital, the prosthetic limb center fulfilled the requirements for inclusion.
- Population Size (N): The total number of people (1000 in this example) in the population.
- Level of Confidence (Z): The extent to which the sample is thought to accurately represent the population 95% and 1.96 Z-scores, respectively.
- The range that the true population parameter is anticipated to fall within is known as the margin of error (E). Typical margins are 5%.
- Proportion (p): The estimated percentage of the population with the relevant attribute (if this percentage is uncertain, 0.5 is often used since it yields the largest possible sample size).

To determine the percentage of amputees dealing with problems including stump pain, activity restriction, psychological adjustment, and prosthesis satisfaction, 334 individuals were sampled for the study. Finding a 95% confidence interval with a finite population adjustment (N=1000) was the aim. The sample size and margin of error for each problem were determined as follows:

- Stump Pain: 43.33 percent (Sample: 334, Margin: 4.3%)
- Activity Restriction: 76.78% (5% Margin, 215 Sample)
- psychological adjustment: 67.60% (5% margin, 252 sample)
- Prosthesis Satisfaction: 93.87% (Margin: 5%, Sample: 252)

This guarantees that the results, with a low margin of error, represent the entire population.

Exclusion

Below 18-year individuals are not included as the amputation and prosthetic application is avoided as rational answers need to be recorded.

The TAPES-R survey

The TAPES-R questionnaire was completed by the participants by direct interview (with translation or explanation of the questions as needed), and the results were combined. The study aimed to investigate amputees' psychological adaptations, activity limitation, prosthesis satisfaction, stump discomfort, and phantom limb pain.

TAPES-R questionnaire, which comprises four components: psychological state, activity restriction, prosthesis satisfaction, and experiences with stump and phantom limb discomfort. The TAPES-R questionnaire's domain-by-domain scores of the participants were gathered and is used to draw conclusion.

Key Parameters

- Population Size (N): 1000
- Confidence Level (Z): 1.96 (for 95% confidence)
- Margin of Error (E): 0.05 (5%)
- Proportion (p): You can use 0.5 if you want to maximize the sample size.

1. Calculate Initial Sample Size (n₀): Using the formula

$$n_0 = z^2 * p * (1 - p) / E^2 \quad (i)$$

2. Working with the values:

$$n_0 = \frac{1.96 * 0.5 * (1 - 0.5)}{(0.05)^2} = \frac{.9604}{.0025} \approx 384.16$$

3. Adjust for Finite Population: Now, adjust n₀ for the finite population:

$$n = \frac{n_0 * N}{N - 1 + n_0} \quad (ii)$$

4. Working with the values:

$$n = \frac{384 * 1 * 1000}{1000 - 1 + 384.16} = \frac{384160}{1383.16} \approx 277.2$$

While, we are getting 277, as a sample size but taking a sample size of 344 can ensure more vigorous depiction of population. It will help in reduce the margin of error and more accurate estimates.

Using the TAPES-R questionnaire, a cross-sectional study was carried out in a hospital setting with 334 patients to examine the psychological adjustment of amputees receiving prosthetic rehabilitation. Following inference is made

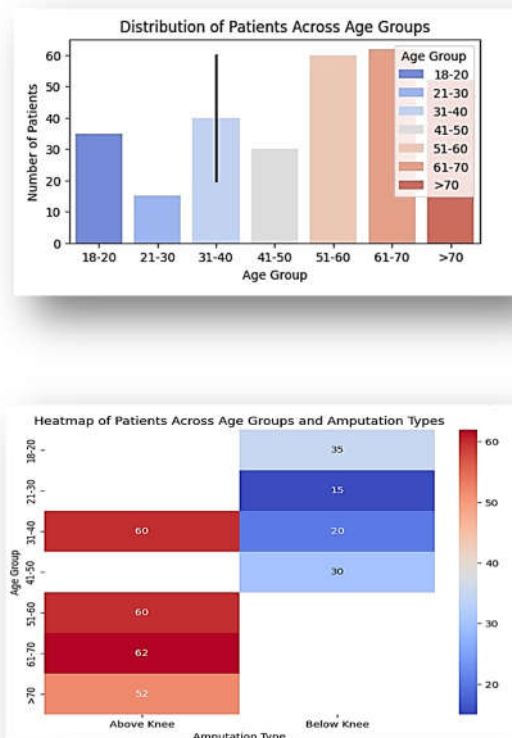


Figure 2: Distribution of Patients across Age group

I) Distribution of patients across Age Group:

a) Frequency in Particular Age Groups: This age group may be disproportionately impacted by conditions that result in amputations, given the sizeable proportion of patients in the 31–40 age range. Elderly patients are also clearly affected, as evidenced by the noteworthy occurrence of those in the 61–70 age group.

b) Possible Amputation Causes:

While chronic illnesses (like diabetes) may disproportionately impact older age groups, the higher occurrence in younger adults (31–40) may indicate factors like trauma or accidents.

Conclusion

This examination of age distribution offers important new information about the characteristics of individuals who need prosthetics. Manufacturers can improve prosthetic device functionality, comfort, and satisfaction by customizing designs to fit the unique requirements of the most impacted age groups. This will ultimately improve amputees' quality of life.

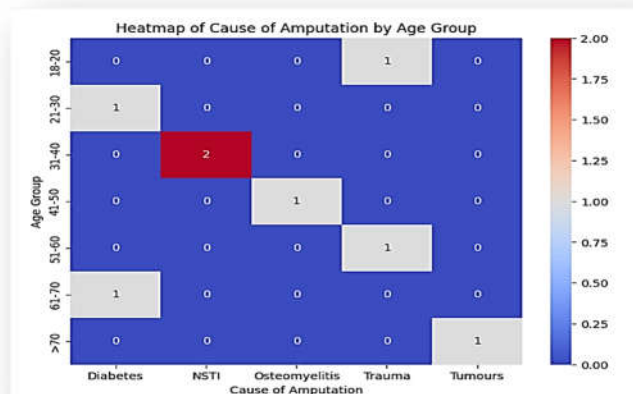


Figure 3: Amputation Type vs. Age

II) Amputation Type vs Age

a) Age Distribution: Amputations below the knee are more common in younger age groups (18–30), whereas above-knee amputations are more common in older age groups (61–70).

b) Trends: It is evident that as people age, they are more likely to have above-knee amputations. Younger people's above-knee amputations are frequently linked to trauma and accidents, especially in the case of soldiers who have lost limbs in combat.

c) Design inferences: Prosthetic solutions should be tailored to the unique requirements of each age group, with an emphasis on comfort for elderly patients and functionality for younger patients.

Targeted Approach: By comprehending these patterns, prosthetic solutions that are specifically designed to solve the particular difficulties that distinct age groups confront can be developed.

Conclusion

Comprehending these patterns can facilitate the creation of customized prosthetic systems that effectively tackle the distinct obstacles encountered by varying age groups.

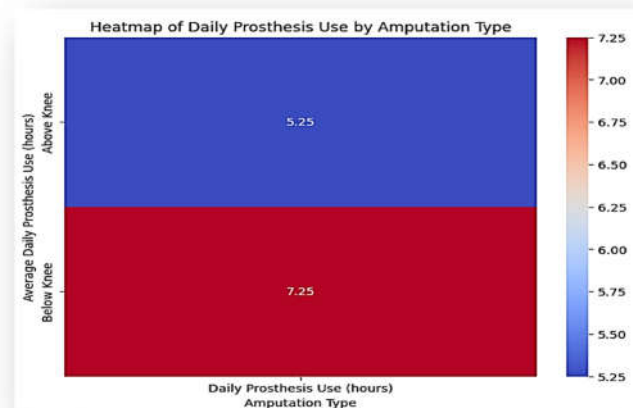


Figure 4: Daily Prosthesis Use by Amputation Type

III) Daily Prosthesis use vs. Amputation type

a) Daily Use: Compared to people with above-knee amputations, those with below-knee amputations typically use their prostheses for a greater number of hours every day.

b) Trends: amputees below the knee have far higher average daily use, suggesting a greater reliance on their prosthetic devices. On the other hand, amputees who are above the knee may encounter additional difficulties that restrict their everyday activities, possibly because of things like comfort, mobility, or the type of injury they sustained.

Conclusion

In order to promote prolonged daily usage, prosthetic devices for amputees above the knee may need to concentrate on improving comfort and use. By comprehending these patterns of use, prosthetic designs may be specifically created to match the requirements of each type of amputation, thereby enhancing the quality of life for amputees.

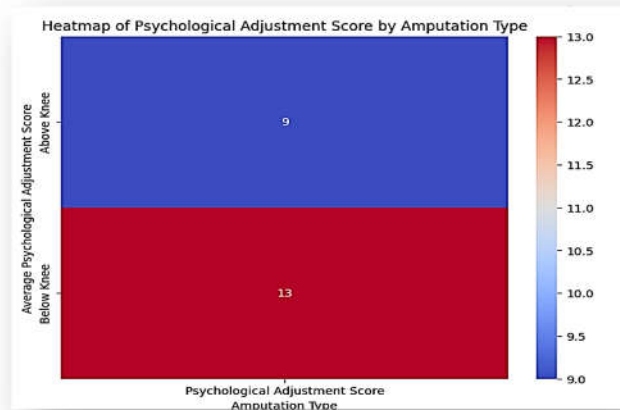


Figure 5: Psychological Adjustment Score by Amputation Type

IV) Psychological Adjustment Score vs. Amputation Type

a) **Adjustment ratings:** Compared to people who had above-knee amputations, people who had below-knee amputations typically had higher psychological adjustment ratings. This implies that amputees below the knee might adapt psychologically to their circumstances more favorably.

b) **Trends:** The lower ratings for amputees above the knee suggest that they may face difficulties adjusting psychologically, maybe as a result of the more difficult mobility and everyday tasks involved in using above-knee prosthesis.

Conclusion

By recognizing these psychological variations, above-knee amputees can receive tailored care and counselling that will enhance their overall mental health and ability to cope. All amputees can benefit from improved rehabilitation and quality of life through the creation of programs that specifically target the psychological requirements of each group.

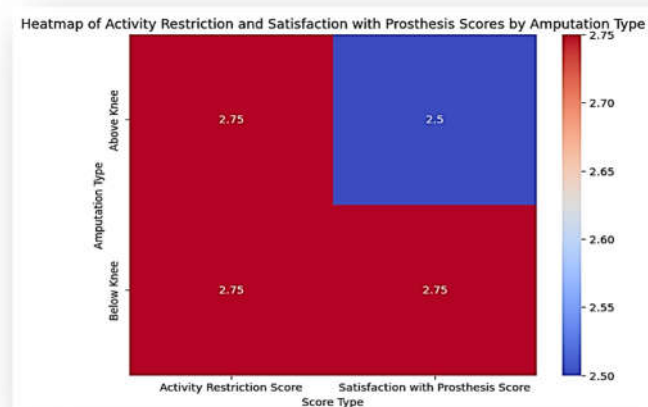


Figure 6: Activity Restriction and Satisfaction with Prosthesis Score by Amputation Type

V) Activity Restriction Score Vs. Amputation type

a) **Activity Restrictions:** Compared to amputees above the knee, those below the knee have higher activity restriction scores, indicating a higher degree of activity constraints. This implies amputees below the knee may have greater difficulties going about their everyday lives.

b) **Comparing the Groups:** Amputations above the knee resulted in much lower ratings, indicating less reported constraints. These differences may have to do with prosthetic device efficacy or mobility.

Conclusion:

Healthcare professionals can better customize rehabilitation programs to each group's needs by acknowledging the variations in activity constraints.

VI) Satisfaction with Prosthesis Score Vs. Amputation Type

Satisfaction Levels: Compared to amputees above the knee, those below the knee report being more satisfied with their prosthetics. It seems that prosthetics below the knee could be more user-friendly or efficient.

Variability in Scores: The amputees who have below the knee prosthesis exhibit a greater range of scores, indicating a fluctuating degree of satisfaction, whilst the group who are above the knee has greater consistency, but at a reduction in average satisfaction.

Conclusion

The comprehension of these satisfaction levels has the potential to improve prosthesis fitting and design procedures, hence augmenting the user experience for amputees who are above the knee. To address the unique issues raised by amputees who are above the knee and increase their general level of satisfaction with prosthetic devices, customized assistance and instruction may be required.

Conclusion

The distinctive difficulties faced by transfemoral amputees in underdeveloped nations must be addressed immediately, as this study makes clear, especially in the context of prosthetic use and rehabilitation. Although previous research recognizes the larger class of lower limb amputations, our targeted analysis shows that transfemoral amputees face unique challenges that call for customized treatments.

The TAPES-R questionnaire's results emphasize the complex relationship between prostheses adaption and satisfaction, highlighting elements like work, regular prosthesis use, and psychological well-being. Understanding amputees' experiences in general and their societal integration depends on these elements. The harsh truth is that a great number of amputees have severe psychological and physical challenges, which are frequently made worse by subpar healthcare and a lack of social support.

Varying prevalence rates are indicated by the distribution of patients among various age groups and amputation kinds. Comprehending these demographics can facilitate the customization of healthcare interventions and services. Notable correlations between the demographic variables like age and amputation type and the cause of amputation are shown by the heatmaps and boxplots. This implies that depending on the factors that are common in particular populations, customized prevention efforts can be created. There is a relationship between the type of amputation and the psychological effects on patients, according to an analysis of daily prosthesis use, psychological adjustment scores, and satisfaction levels. This emphasizes how crucial psychological assistance is to rehabilitation initiatives.

Future Work

Monitoring patients over an extended period of time via research could throw light on how results vary with continued prosthesis use and psychological assistance. Adding new variables (such socioeconomic status and geographic location) and a wider range of populations could improve our understanding of the factors impacting the outcomes of amputations. Putting particular interventions into practice and assessing their effectiveness in enhancing psychological adjustment and prosthetic satisfaction may yield insightful information about optimal procedures. By applying machine learning techniques to develop predictive models, at-risk populations may be identified and treatments may be more successfully tailored. By interacting with amputees in focus groups, more in-depth understanding of their requirements, difficulties, and experiences can be gained, which could help shape healthcare regulations and support networks.

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