# Impact of Running Speed on Kinematics and Kinetics in Recreational Amputee Runners: A Preliminary Study

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## Summary

Lower-limb amputation has an impact on physical abilities and psychological well-being, making physical activity like running important for improving quality of life. However, running requires specific prostheses, as daily-use prostheses cannot withstand highly dynamic efforts. However, research on this subject is limited. The aim of this study was to analyze the impact of running speed on kinematic and kinetic parameters in recreational lower-limb amputees. The results show significant asymmetries between the prosthetic and sound sides, particularly in terms of joint amplitude and vertical ground reaction forces. Moreover, increasing speed accentuates these differences, suggesting that the sound limb is put under greater strain, potentially increasing the risk of injury. This highlights the need to optimize running prostheses to better distribute loads and reduce risks, while improving amputee performance and comfort.

## Introduction

Regular physical activity, such as running, is recommended to improve the overall quality of life in lower-limb amputees [1]. However, this activity requires a running specific prosthesis. Daily-use prostheses are not designed for highly dynamic activities such as running. Their prolonged use can increase the risk of hip osteoarthritis [2], a risk already higher in amputees than in able-bodied people [3]. However, little research has been carried out on this topic. The aim of this study is to fill this gap by analyzing the impact of running speed on the kinematic and kinetic parameters of recreational running in lower-limb amputees.

## Methods

Six participants (1F, 5M) were involved in the study, three with transtibial (TT) and three with transfemoral (TF) amputations. Each participant used his own prosthesis. After warm-up, progressive-speed treadmill trials (6 to 12 km/h) were performed. Kinematic data were collected using an optoelectronic system (100 Hz, Vicon®) comprising infrared cameras and a set of reflective markers attached to the subjects' bodies. Running kinetics were measured using instrumented treadmill (1000 Hz, Treadmetrix®).

## Results and Discussion

Figure 1 illustrates the kinematic analysis of knee and hip sagittal motion, revealing patterns similar to those observed in able-bodied runners [4], particularly on the sound side. However, a marked asymmetry of flexion-extension peaks was observed between the unaffected and affected sides. In addition, TF runners showed increased hip solicitation and a total absence of knee flexion on the affected side during the stance phase. Increased running speed accentuates these asymmetries, particularly at the suspension phase.

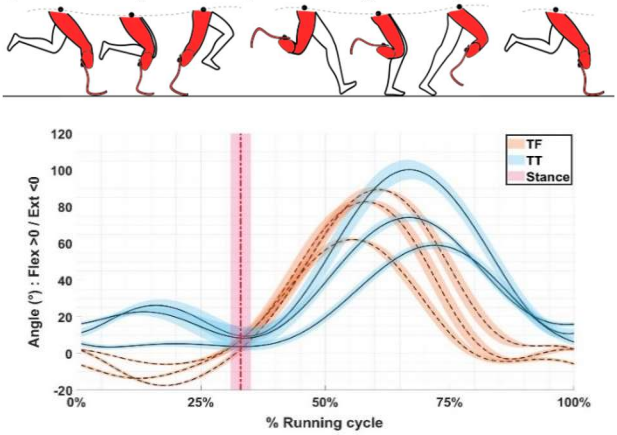


**Figure 1**: Knee flexion angle on the prosthetic side at 6 km/h.

Figure 2 presents the analysis of vertical ground reaction forces, revealing an asymmetry in peak values between the prosthetic and sound limbs. As speed increases, ground reaction forces rise on both sides but to different extents, with a greater increase on the sound side (21.9%) than the prosthetic side (2.1%). This asymmetry may elevate the injury risk for the sound limb.

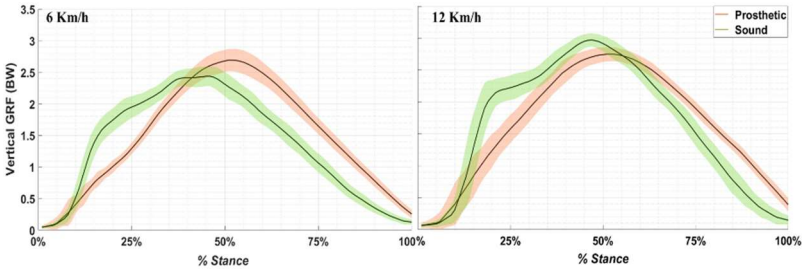


**Figure 2**: Vertical ground reaction forces at different speeds.

## Conclusions

The results reveal a marked asymmetry between the sound and prosthetic sides, with increased demands on the sound side and different strategies adopted depending on amputation level. Higher speeds exacerbate imbalances, highlighting the need for larger samples to understand differences between amateur, elite amputee, and valid runners.

## References

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