# The Relationship Between Foot Temperature Change, Shear Impulse, and Net Work During Sloped Walking

**Jenna K. Burnett**[1], Jose G. Anguiano-Hernandez[1], Song-Young Park[2], Kota Z. Takahashi[1]
[1]Department of Health and Kinesiology, University of Utah, Salt Lake City, Utah, USA
[2]Department of Health and Kinesiology, University of Nebraska, Omaha, Omaha, Nebraska, USA
Email: Jenna.Burnett@hsc.utah.edu

## Summary

Skin breakdown risk appears to be related to foot temperature. Previous literature has suggested that regional foot temperature has a dose response to regional foot mechanics. However, during sloped walking, the temperature-mechanics relationship is unclear. We tested the hypothesis that whole foot temperature change would increase with foot mechanics' magnitude. Healthy adults walked on -5°, 0°, and 5° slopes while motion capture, ground reaction force, and temperature were recorded. Total shear impulse decreased as slope increased, but whole foot mechanics were not associated with temperature change. Foot temperature appears well regulated in healthy adults despite altered mechanics in sloped walking.

## Introduction

Skin breakdown risk in individuals with diabetes is associated with foot temperature [1,2]. Regional foot temperature during activity is believed to change because of foot mechanics (i.e., shear impulse, net work) which may generate heat during ground contact [3,4]. For example, the foot's net work is generally negative, indicating energy is absorbed [4]. The absorbed energy may transform into heat, causing temperature changes during activity. However, the temperature response from mechanics may have a dose response [4]. For example, there is greater total shear impulse and temperature change on the outer foot compared to the inner foot during circle walking [4], suggesting the temperature-mechanics relationship during a task may be dose dependent. It is unclear whether other tasks (e.g., sloped walking) have a similar temperature-mechanics relationship, and understanding the temperature-mechanics dose response during activity may be important for assessing skin breakdown risk. Therefore, this study investigated the relationship between whole foot temperature change, total shear impulse, and total net work during sloped walking. We hypothesized that increased magnitudes of shear and work during sloped walking would result in increased whole foot temperature change.

## Methods

Eleven healthy adults (5M/6F, 28.7 ± 3.7 years old, 69.0 ± 8.9 kg) walked on a force treadmill (10 min, 1.2 m/s) at three slopes (-5°, 0°, 5°) while temperature, motion capture, and ground reaction force data were collected. The whole foot temperature change from pre- to post-walking was computed using the average temperature measured by thermistors at eight locations. Stance net work was computed from inverse dynamics, and stance shear impulse was computed from ground reaction forces. Stance foot mechanics were multiplied by participants' stride frequency and walk time (10 minutes) to get total net work and shear impulse. Repeated measures ANOVAs investigated the slope dependency of temperature change, total shear impulse, and total net work. A linear mixed model predicted temperature change from total shear impulse, total net work, baseline foot temperature, room temperature, and humidity.

## Results and Discussion

Decline walking produced the greatest total shear impulse (Figure 1). However, neither the total shear impulse nor total net work were associated with temperature change, contrary to our hypothesis. This null finding may be partly explained by our analyses examining the temperature-mechanics relationship of the entire foot, whereas past studies have examined these relationships in localized regions (e.g., toes, forefoot) [3,4]. Nonetheless, our results indicate that the foot temperature is not sensitive to mechanical alterations induced by walking on different slopes. This finding indicates there is effective thermoregulation of healthy feet, possibly due to various physiological functions (e.g., blood flow, sweating).

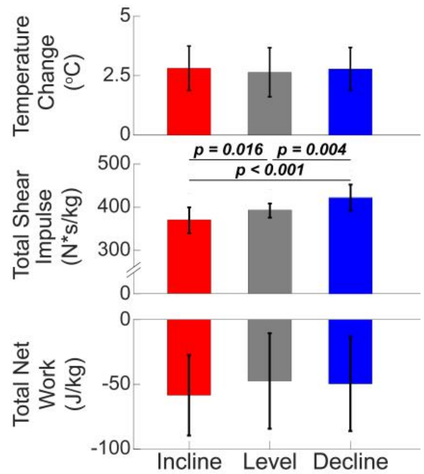


**Figure 1:** Average temperature change (top), total shear impulse (middle), and total net work (bottom) during a 10-minute walk. Total shear impulse decreased as slope increased.

## Conclusions

Foot temperature appears well regulated in healthy adults despite altered foot mechanics in sloped walking. Understanding temperature responses in other groups (e.g., individuals with diabetes) with altered thermoregulation may be key for protecting the skin health in those groups.

## Acknowledgments

This work was supported by NIH R01HD106911 awarded to KZT and SYP, and NIH 1T32DK11096601 awarded to JKB.

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