

Plantar Pressure Analysis of Indoor versus Regular Custom-Made Footwear in People with Diabetes at High Ulcer Risk

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Summary

This study compares the pressure distribution and gait stability of custom-made footwear specifically for indoor use to regular custom-made footwear in people with diabetes, neuropathy, and high ulcer risk. Thirty-six participants with recent history of plantar ulcer or partial foot amputation had custom-made indoor footwear designed using the last of their regular footwear, but lighter in weight and easier to don and doff. In-shoe plantar pressures and center-of-pressure were measured during walking in both footwear types. No significant differences were found between the indoor and regular footwear for peak pressure, pressure distribution, or center-of-pressure. These findings show that custom-made indoor footwear is a biomechanically safe alternative for regular custom-made footwear for indoor use in people with diabetes at high risk of foot ulceration.

Introduction

Custom-made footwear specifically designed to use indoors increases adherence to prescription footwear in people with diabetes, peripheral neuropathy and high ulcer risk, compared to using only regular custom-made footwear. A pilot study also showed similar maximum peak pressures with regular footwear, a quality requirement considering the indoor footwear replaces the regular footwear for indoor use. A more in-depth analysis of the pressure distribution and center-of-pressure parameters for stability of this indoor footwear in a representative sample of subjects is yet to be conducted. Such investigation can demonstrate if indoor footwear is a biomechanically safe replacement for regular custom-made footwear for indoor use. The aim was to compare indoor and regular custom-made footwear for pressure distribution and gait stability in people with diabetes at high risk of ulceration.

Methods

Custom-made indoor footwear was provided to 36 participants with diabetes, peripheral neuropathy, and a recently healed plantar foot ulcer or (partial) foot amputation. All participants were in possession of regular pressure-optimized custom-made footwear and the indoor footwear was designed based on the last of the regular footwear. The indoor footwear was lighter in weight, easier to don and doff, more comfortable because of use of softer materials for the shoe upper, and cheaper to produce. In-shoe plantar pressures were measured during walking in both shoes using Pedar-X, from which multiple peak plantar pressure and center-of-pressure parameters were calculated. Peak pressure parameters, including multidimensional parameters [1], were used to define offloading effectiveness, while center-of-

pressure parameters were used to define foot roll-over and gait stability [2,3]. Scalar peak pressure parameters between footwear types were assessed using paired t-tests. Peak pressure distributions in spatial and temporal domains and center-of-pressure parameters were assessed using paired t-tests and statistical parametric mapping.

Results

A total of 132 shoes, 66 per footwear type, of 36 participants were analyzed. Outcomes for all peak pressure parameters were non-significantly higher in the indoor compared to regular footwear ($p > 0.05$). Maximum average difference in the forefoot regions was 10.1 kPa for maximum peak pressure, 1.22 kPa.s for pressure time integral and 0.13 kPa/mm for the pressure gradient. Overall pressure distribution over time for all participants is shown in Figure 1. Center-of-pressure parameters, for both foot roll-over and stability, were not significantly different between footwear types.

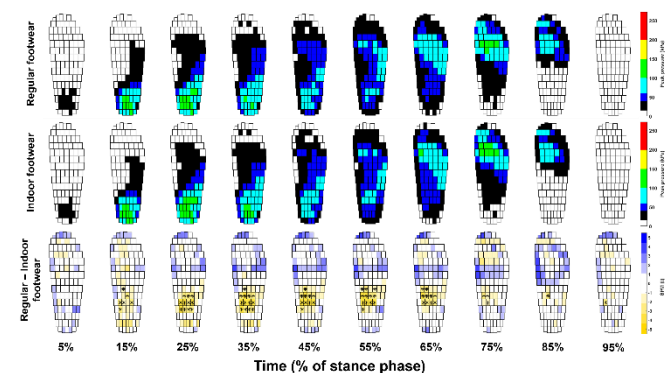


Figure 1: Peak plantar pressure distribution of regular and indoor custom-made footwear in a pressure time map. The bottom row shows the statistical comparison between both types of footwear.

Blue = pressure regular > indoor footwear, yellow = pressure indoor > regular footwear.

Discussion and Conclusion

No significant differences were found in pressure distribution, foot roll-over and gait stability between footwear types. These results show that custom-made indoor footwear is a biomechanically safe alternative for use indoors to regular custom-made footwear in people with diabetes at high risk for foot ulceration.

References

- [1] Vossen et al. (2025). *J. Biomech.*, **180**: 112502.
- [2] Menz et al. (2018). *Gait Posture.*, **63**: 91-96.
- [3] Pol et al. (2021). *Gait Posture.*, **88**: 78-83.