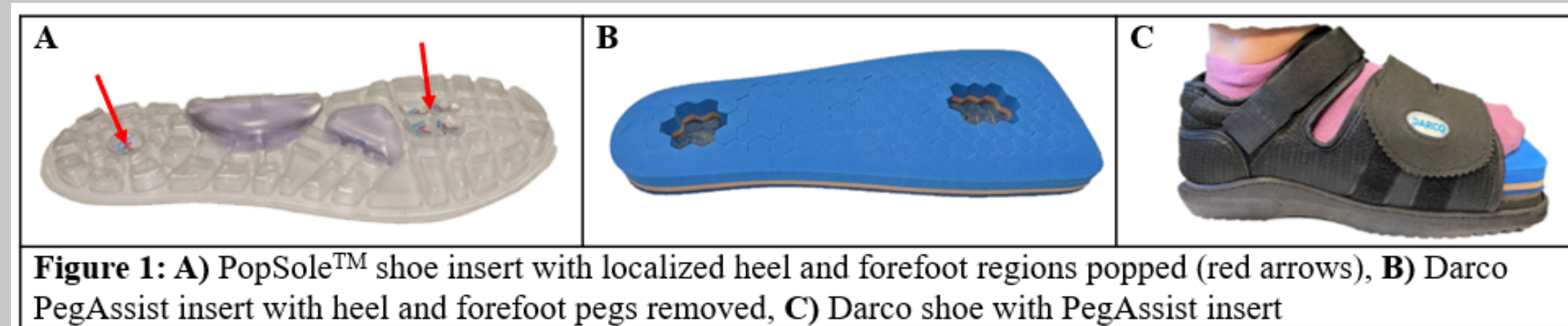


## Introduction

### Background

- Current solutions to offload sensitive areas of the foot may induce compensatory gait and can be uncomfortable, resulting in poor patient compliance.
- PopSole™ is a novel, fully customizable air-filled insole designed to decrease plantar pressure by deflating localized areas while still providing anatomic support to the foot.



**Figure 1:** A) PopSole™ shoe insert with localized heel and forefoot regions popped (red arrows), B) Darco PegAssist insert with heel and forefoot pegs removed, C) Darco shoe with PegAssist insert

### Purpose

- The purpose of this pilot study is to compare gait kinematics when walking with the PopSole device, Darco PegAssist device, and neutral running shoes (Figure 1).

### Hypothesis

- Lower extremity walking kinematics while using PopSole will not be different from running shoes, while kinematics while using Darco PegAssist will differ from running shoes.

## Methods

### Data Collection

- 10 healthy participants (5F/5M; 28 ± 6.5 years; 23.3 ± 3.0 kg/m<sup>2</sup>) with no history of foot injury, surgery, or pathology consented to this IRB-approved study.
- Participants walked overground at a self-selected pace (1.5 ± 0.2 m/s) for 2 min in three shoe conditions in a randomized order:
  - Standard neutral **running shoes**
  - **PopSole** insoles with localized forefoot and heel regions popped (worn bilaterally in running shoes)
  - **Darco PegAssist** shoes with localized forefoot and heel region pegs removed (unilateral with running shoe on left foot)
- Participants completed surveys about footwear comfort and preference.
- Kinematics were collected using 3D motion capture (12-camera Vicon) at 100 Hz (Figure 2).

### Data Analysis

- Joint angles for the hip, knee, and ankle during stance were computed in Visual3D.
- Data were averaged over a mean of 10 ± 3 steps for each shoe condition.
- A one-way repeated measures ANOVA and post-hoc paired t-tests were run using statistical parametric mapping (SPM)<sup>1</sup> in MATLAB.
- Ankle kinematics were not available for the Darco shoe and thus SPM paired t-tests were used to evaluate differences in ankle kinematics.



**Figure 2:** Marker setup used for 3D motion capture.

## References and Acknowledgements

1. Pataky TC *J Biomech*, 2010.

The authors would like to acknowledge Clarissa Lees for assistance with SPM.

## Results

### Ankle Kinematics

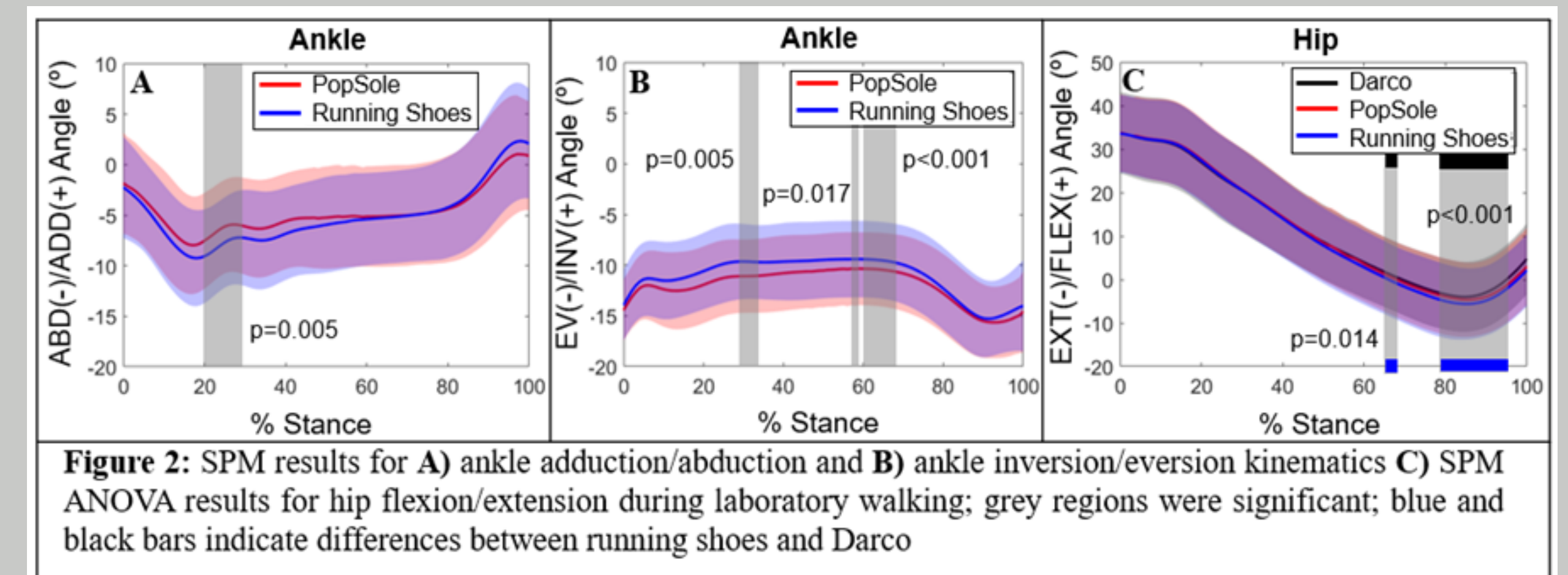
- The ankle was more adducted and everted when wearing the PopSole compared to the running shoe (Figure 2AB).

### Knee and Hip Kinematics

- Knee and hip flexion/extension and adduction/abduction kinematics waveforms were different among conditions based on the SPM ANOVA.
- However, only hip flexion/extension showed significance post-hoc, with the hip extending less when wearing the Darco compared to running shoes (Figure 2C).
- Knee and hip kinematics were not different between PopSole and running shoes.

### Survey Findings

- All participants preferred PopSole over Darco.
- 10% of participants reported PopSole affected their hip/knee and 70% felt Darco affected their hip/knee.
- 90% of participants reported feeling proper leg alignment with Popsole compared to 0% with Darco.



**Figure 2:** SPM results for A) ankle adduction/abduction and B) ankle inversion/eversion kinematics C) SPM ANOVA results for hip flexion/extension during laboratory walking; grey regions were significant; blue and black bars indicate differences between running shoes and Darco

## Discussion

### Ankle Kinematics

- Our finding that walking with the PopSole insert is associated with increased ankle frontal plane and decreased ankle transverse plane motion compared to the running shoe indicates that the foot/ankle is affected by adding the air-pocketed insole with the center heel region and forefoot regions deflated.

### Knee and Hip Kinematics

- While ankle kinematics are affected by the PopSole insert, walking gait at the knee and hip are not affected while wearing the PopSole insole compared to the running shoe.
- The hip extended less during late stance in the Darco device compared to running shoes which may result in an asymmetrical gait pattern if the contralateral leg wearing the running shoe extends more at the hip.

### Perception

- Participants were able to perceive the alteration in hip kinematics when walking in the Darco device compared to the running shoe.
- The PopSole insole was preferred to the Darco device and may therefore improve patient compliance.

### Significance

- PopSole insole was preferred to and altered hip kinematics less than the Darco PegAssist, suggesting PopSole has potential clinical benefit over the current standard of care.