Influence of localised cooling on repeated shearing stress and friction at the heel

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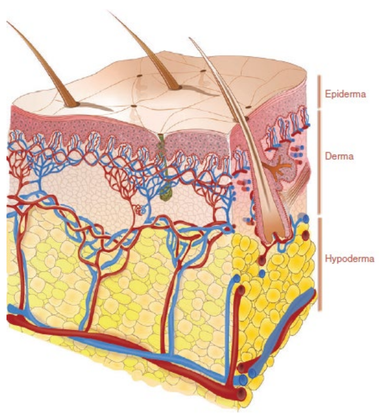
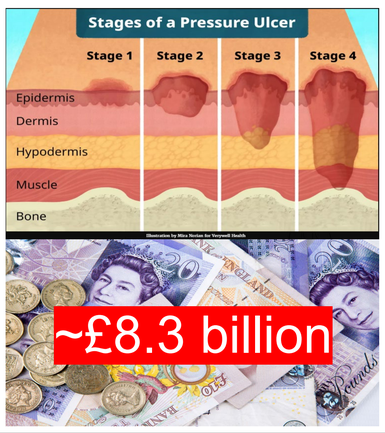
BACKGROUND

Pressure ulcers are localised injury to the skin/underlying tissues, usually over bony prominences, e.g. posterior heel.

Kottner et al., 2018

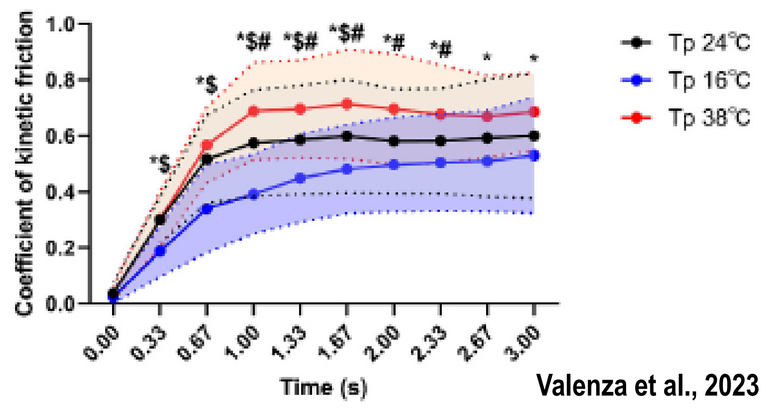




Increased temperature and humidity decrease mechanical stiffness of the skin and increase friction at the skin interface.

Kottner et al., 2018

Cooling the skin of the index finger reduces the kinetic coefficient of friction. Could the same effect be observed at the heel?



Valenza et al., 2023

KNOWLEDGE GAPS

1. We do not know **whether localised cooling would reduce kinetic friction at the heel during repeated shear stress.**
2. We do not know **whether such an effect would occur independent of stratum corneum hydration.**

METHODS

12 healthy participants (8M/4F; 24±5 y; 73±10 Kg; 175±10 cm)

16°C **24°C** **38°C**

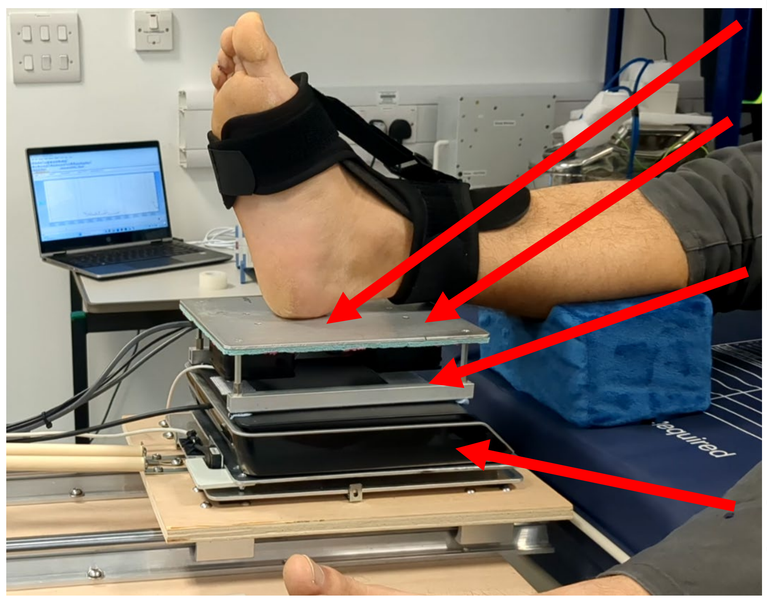


Figure. 1. Friction rig. The rig is mounted on a linear rail system and moved by a servomotor.

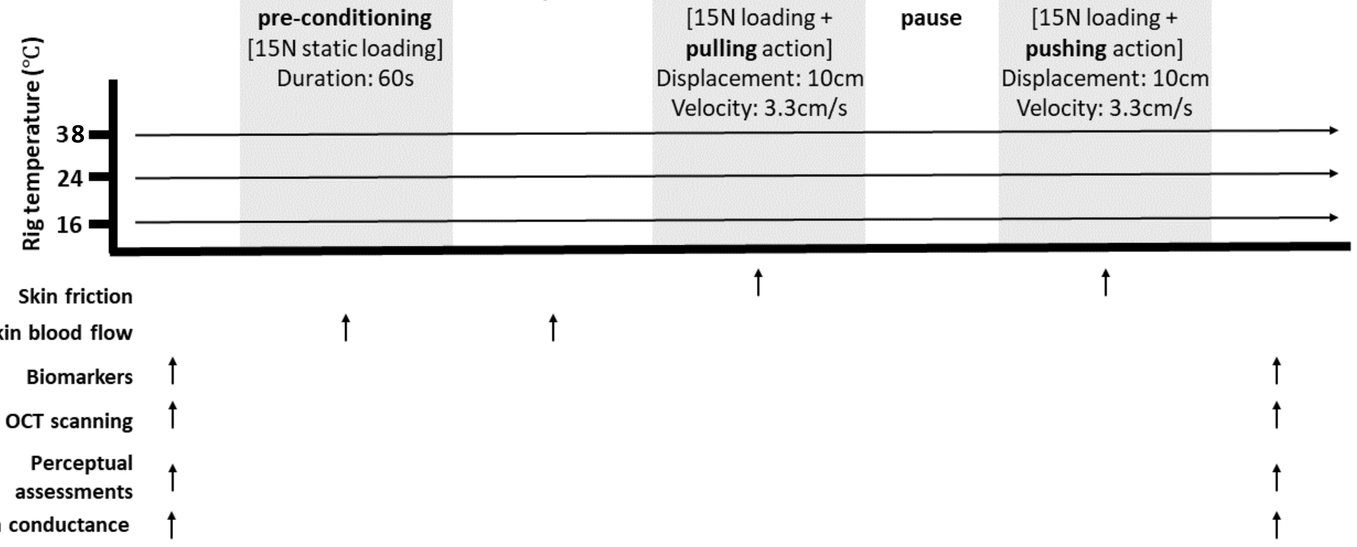
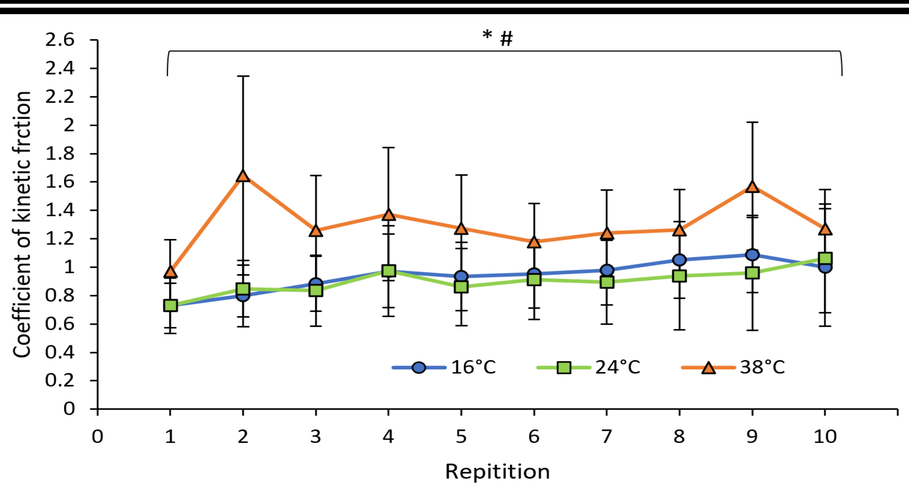


Figure. 2. Standardised repeated shear protocol delivered at the heel. Evoked repeated shear stress under 3 thermal conditions. Non-invasive measurements were conducted [estimation of skin friction from the ratio of tangential and normal fore, skin blood flow via LDF; inflammatory biomarker sampling from skin sebum; structural and functional imaging via Optical Coherence Tomography (OCT); perceptual assessment of subjective thermal sensation, comfort, and acceptance, and measurement of skin conductance to be used as an index of local skin hydration] at different time points (identified in the diagram by ↑).

RESULTS

Figure 3. Coefficient of kinetic friction recorded during a standardised shearing protocol consisting of 10 repeated shearing movements. Data (n=12) are presented as means and ±95%CI across three temperature conditions, 16°C (circles), 24°C (squares) and 38°C (triangles). * Main effect of time ($P < 0.05$). # main effect of temperature ($P < 0.05$).



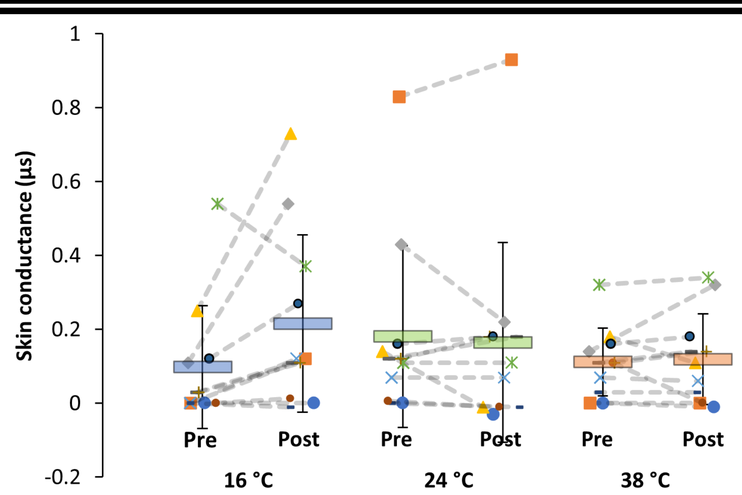


Figure 4. Measures of skin conductance taken from the heel pre- and post the shearing protocol, across three temperature conditions, 16°C, 24°C and 38°C. Data (n=11) are presented as individual responses. Group mean values are denoted by the horizontal bars and ±SD. No significant differences observed for time ($P = 0.06$), temperature ($P = 0.63$), or interaction ($P = 0.11$).

TAKE HOME MESSAGES

1. **Cooling the skin at the heel lowered the kinetic coefficient of friction during a repeated shearing stress protocol, compared to a warmer temperature.**
2. **The reduction in friction occurred in the absence of any variation in stratum corneum hydration levels from the beginning to the end of the protocol.**
3. **These findings suggest cooling may offer therapeutic benefits for pressure ulcer prevention by minimising frictional forces at the heel.**

Reference: Kottner et al. Clin Biomech (Bristol, Avon). (2018). Valenza A, et al. J Mech Behav Biomed Mater. (2023).

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