# The energy return properties of the longitudinal arch in jumping

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## Introduction

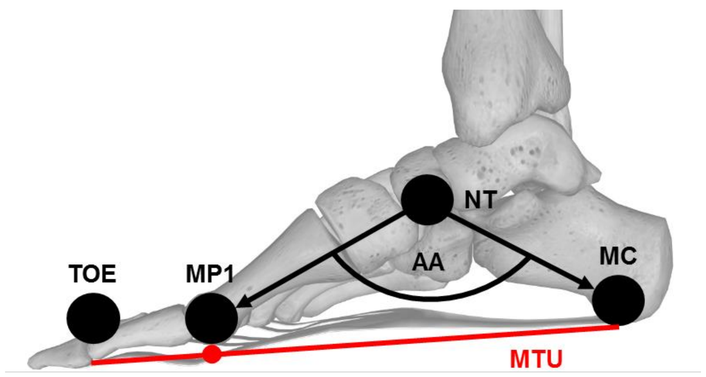
**Human foot arch:**

- Proposed to store and release elastic energy during locomotion [1]
- Experimental evidence for this assumption during jumping is missing
- Midsole bending stiffness (MBS) of footwear can affect the deformation of the arch [2] and jumping performance [3]
- Role of the arch during jumping and how it is affected by MBS is unknown

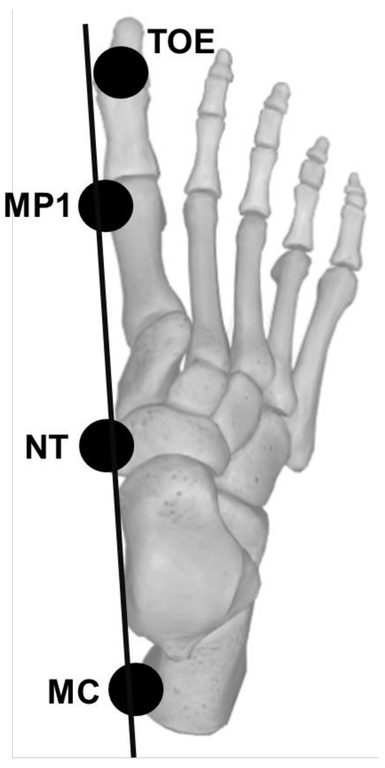
**Purpose:**

Investigate how the arch of the human foot contributes to jump height and how its mechanics are affected by increased midsole bending stiffness.

## Methods

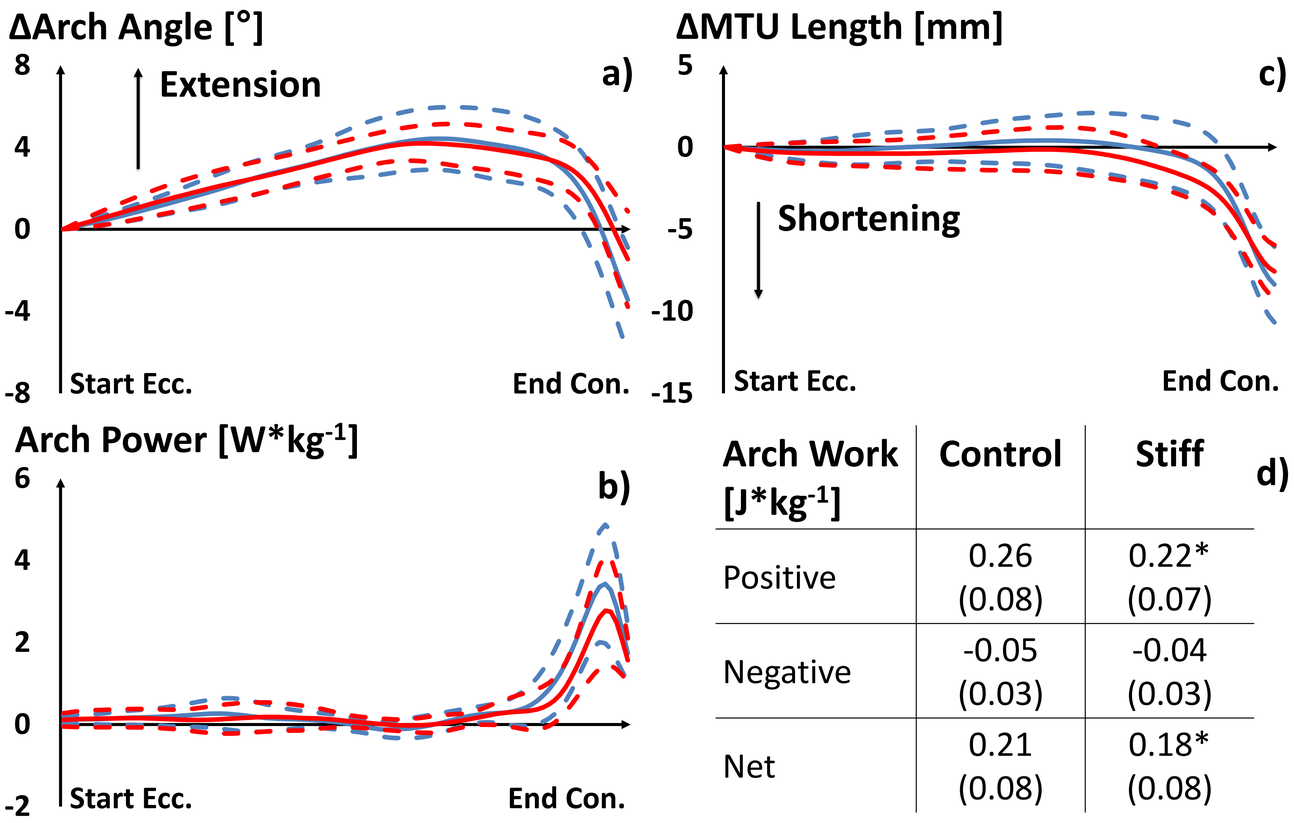



| | |
|---|---|
| AA | arch angle |
| MP1 | distal head of 1st metatarsal |
| NT | navicular tuberosity |
| MC | medial calcaneus |
| TOE | medial forefoot |
| Line | plane of best fit |
| MTU | plantar muscle-tendon unit |




- N = 10; male participants
- 5 countermovement jumps per condition
- 2 stiffness conditions: control (1.2 N/mm) & stiff (11.9 N/mm)
- Jump height determined using impulse-momentum method [4]
- GRF partitioned using weighted probabilistic approach [5]
- MTU model: $\overrightarrow{MC - MP1} + \overrightarrow{TOE - MP1}$

## Results




| Arch Work [J*kg$^{-1}$] | Control | Stiff |
|---|---|---|
| Positive | 0.26 (0.08) | 0.22* (0.07) |
| Negative | -0.05 (0.03) | -0.04 (0.03) |
| Net | 0.21 (0.08) | 0.18* (0.08) |

d)

**Fig. 1** Mean (±SD) change in arch angle (a), arch power (b), change in MTU length (c), and arch work (d) during countermovement jumps in a control (blue) and stiff (red) shoe condition for 10 participants (*p<0.05).

## Discussion & Conclusion

- Arch extended during the eccentric and flexed towards the end of the concentric phase of the jump
- Positive arch power was generated before take-off
- Arch was significantly more extended at take-off in stiff shoe
  - ↳ reduced positive work done at the arch
- Reduced positive arch work in stiff condition did not affect jump height
  - ↳ MTP joint compensated for work differences

## Acknowledgements

**Dr. Luke Kelly** for the discussion, and **Drs. Janet Ronsky** and **Gregor Kuntze** for sharing experimental equipment.

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