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## **Surface, but Not Age Impacts Lower Limb Joint Work During Stair Ascent**

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# SURFACE, BUT NOT AGE IMPACTS LOWER LIMB JOINT WORK DURING STAIR ASCENT



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## INTRODUCTION

Age-related loss in lower limb strength, particularly ankle, may impair older adults (over 65 years of age) mobility, and result in biomechanical deficits compared to their younger counterparts.

Older adults tend to walk slower with shorter steps and exhibit diminished ankle joint kinetics (i.e., moment, power and work).

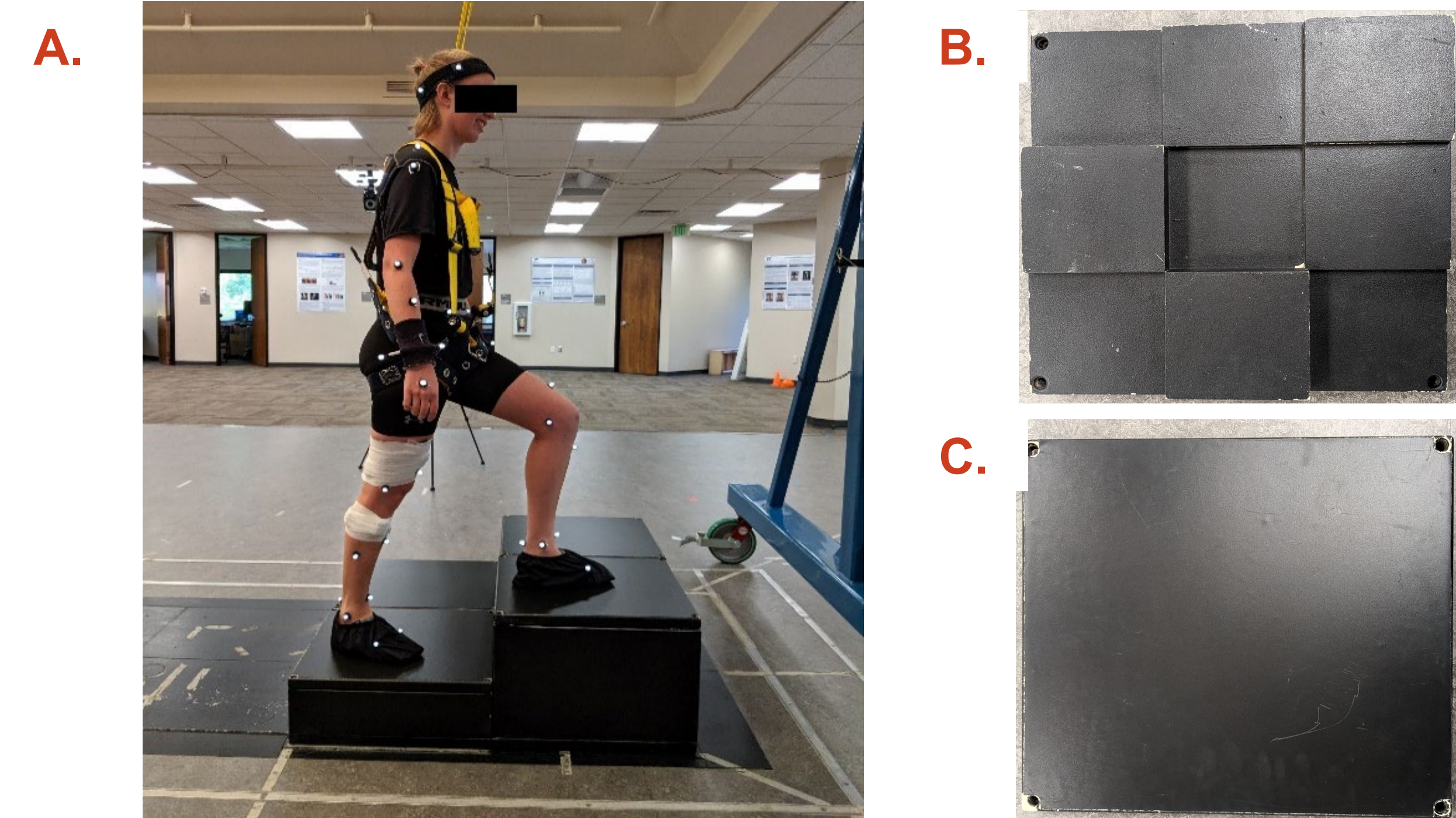
Although older adults produce smaller ankle torque and power, it is unclear if they redistribute lower limb, or increase hip or knee power to walk, particularly on challenging (e.g., uneven or slick) surfaces.

**PURPOSE:** to investigate age-related differences in lower limb work during a stair ascent task on challenging surfaces.

## METHODS

**Participants:** 24 (12 young: 18 to 25 years; 12 older: over 65 years, with one accidental fall in last year) adults participated.

**Task:** Each participant performed 3 trials of the stair ascent task on the normal, slick, and uneven surfaces (Fig. 1).



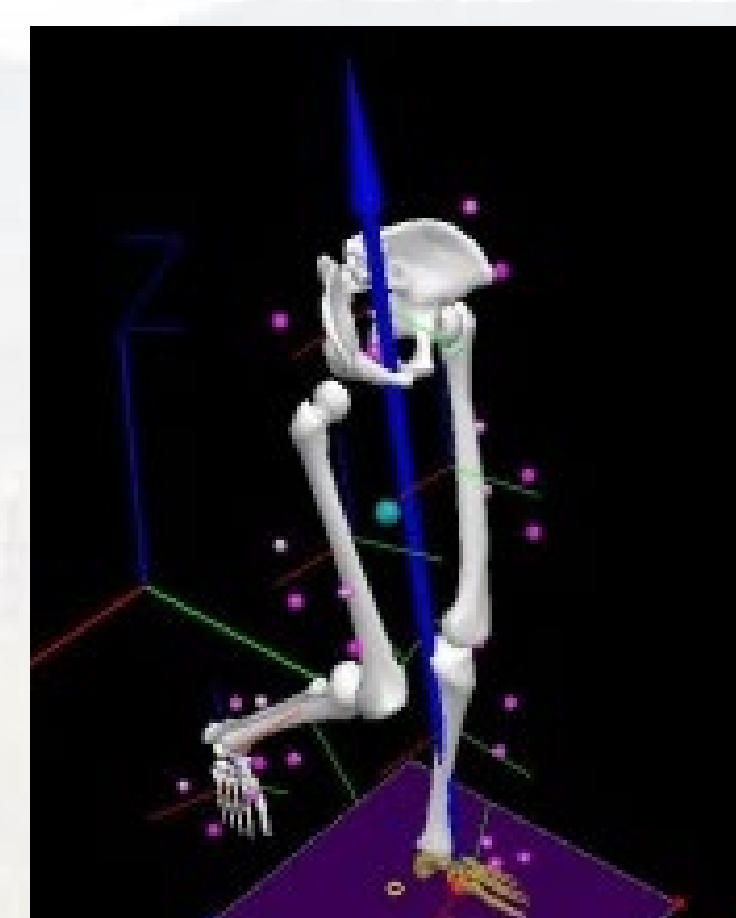
**Figure 1:** Stair ascent task required participants step up two stairs (rise: 18.5 cm) (A) outfitted with normal, uneven (B), and slick surfaces (C).

**Biomechanical Analysis:** Synchronous 3D marker trajectories and GRF data were recorded with motion capture and processed in Visual3D to obtain sagittal plane lower limb biomechanics.

Motion Capture

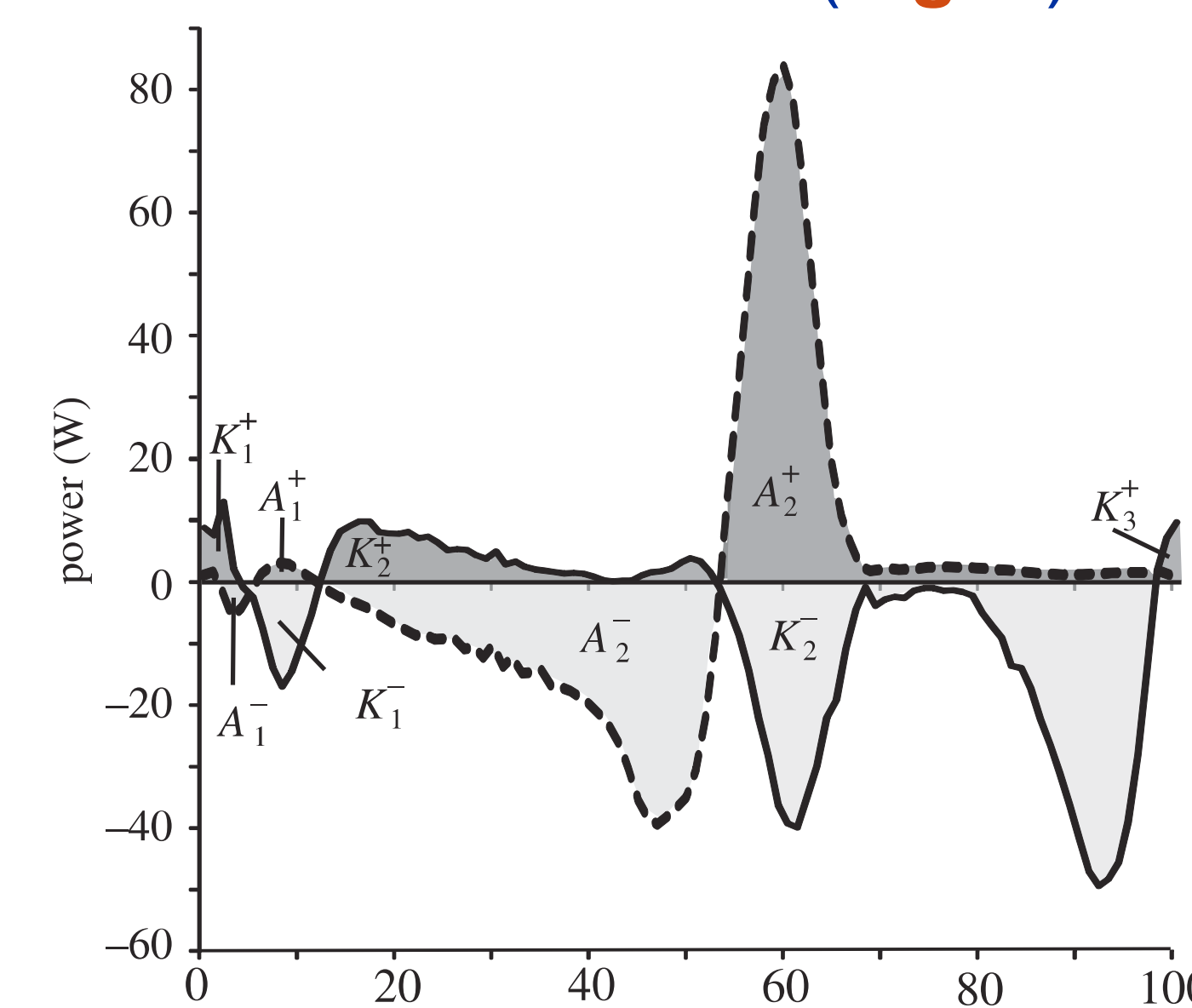


Sagittal Plane Biomechanics



## METHODS

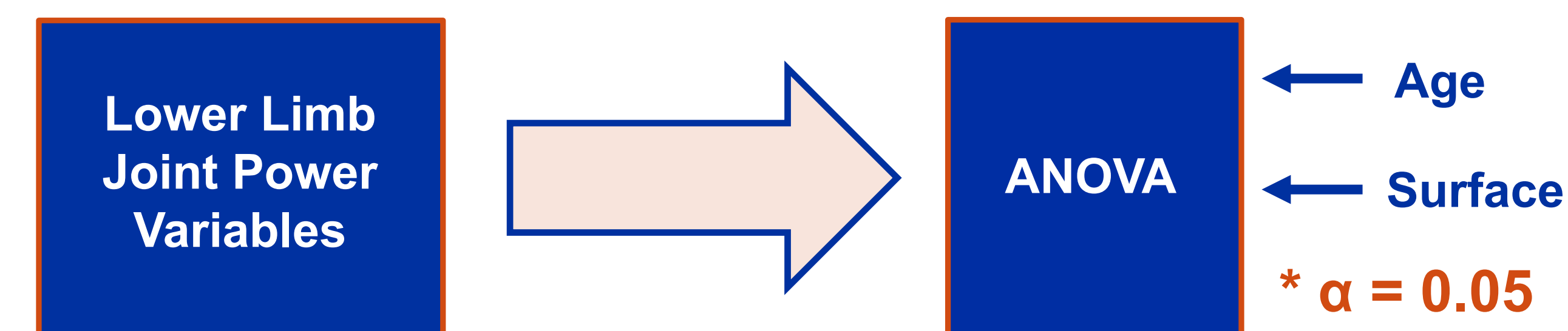
**Joint Power:** stance phase (0% - 100%) at each lower joint (hip, knee and ankle) was calculated in Visual3D, and then positive work calculated across stance (Fig. 2).



Individual periods of positive work (dark grey) and negative work were calculated separately by integration using the trapezium rule at each lower limb joint.

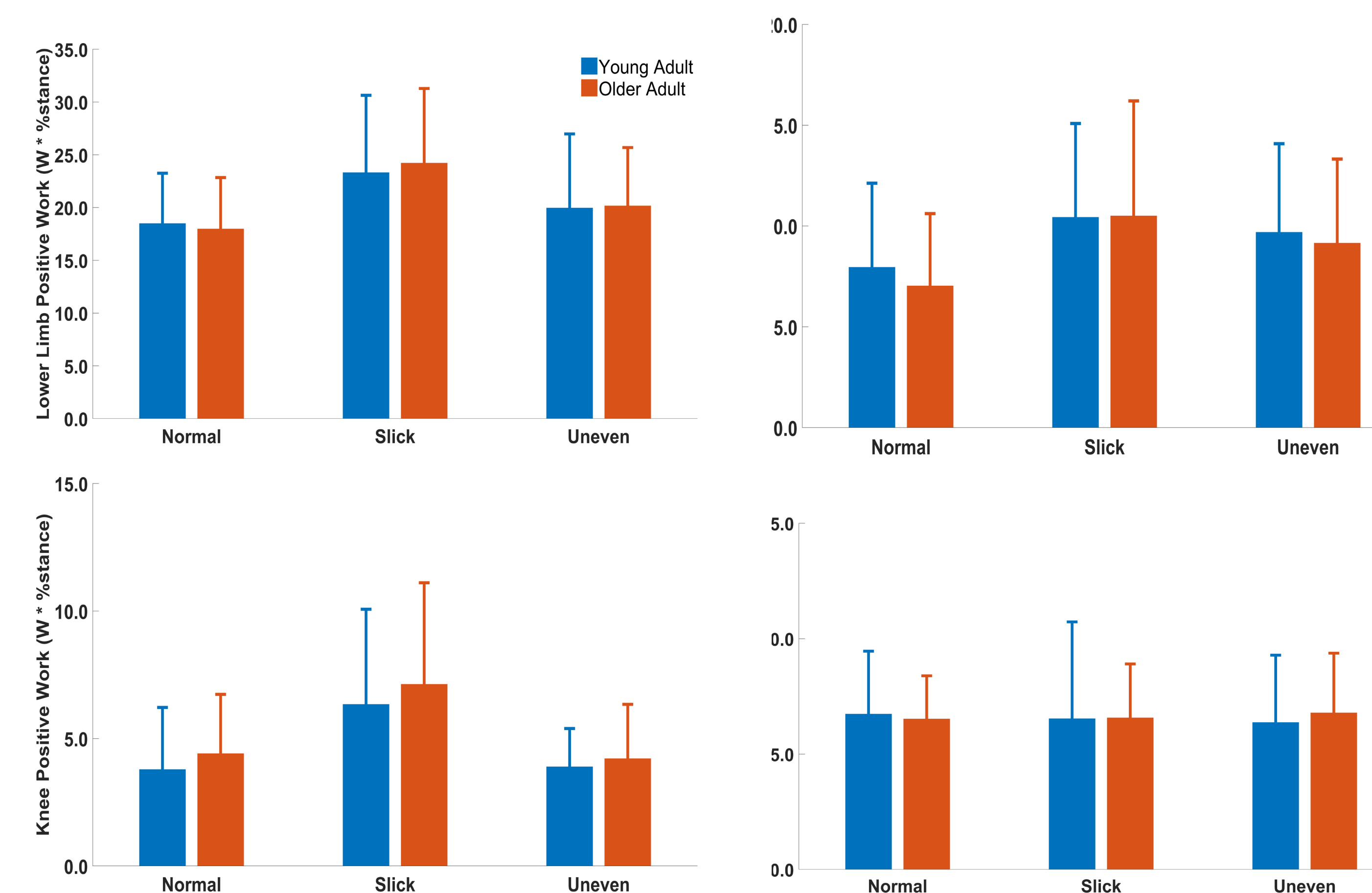
**Figure 2:** Depicts stance phase (0% - 100%) knee and ankle joint power.

**Dependent Variables:** Total limb, hip, knee and ankle positive work, and relative effort (% of total) were submitted to statistical analysis.



## RESULTS

Surface, but not age impacted lower limb work. Specifically, surface impacted total limb ( $p < 0.001$ ), hip ( $p = 0.007$ ) and knee ( $p = 0.001$ ) positive work (Fig. 3).



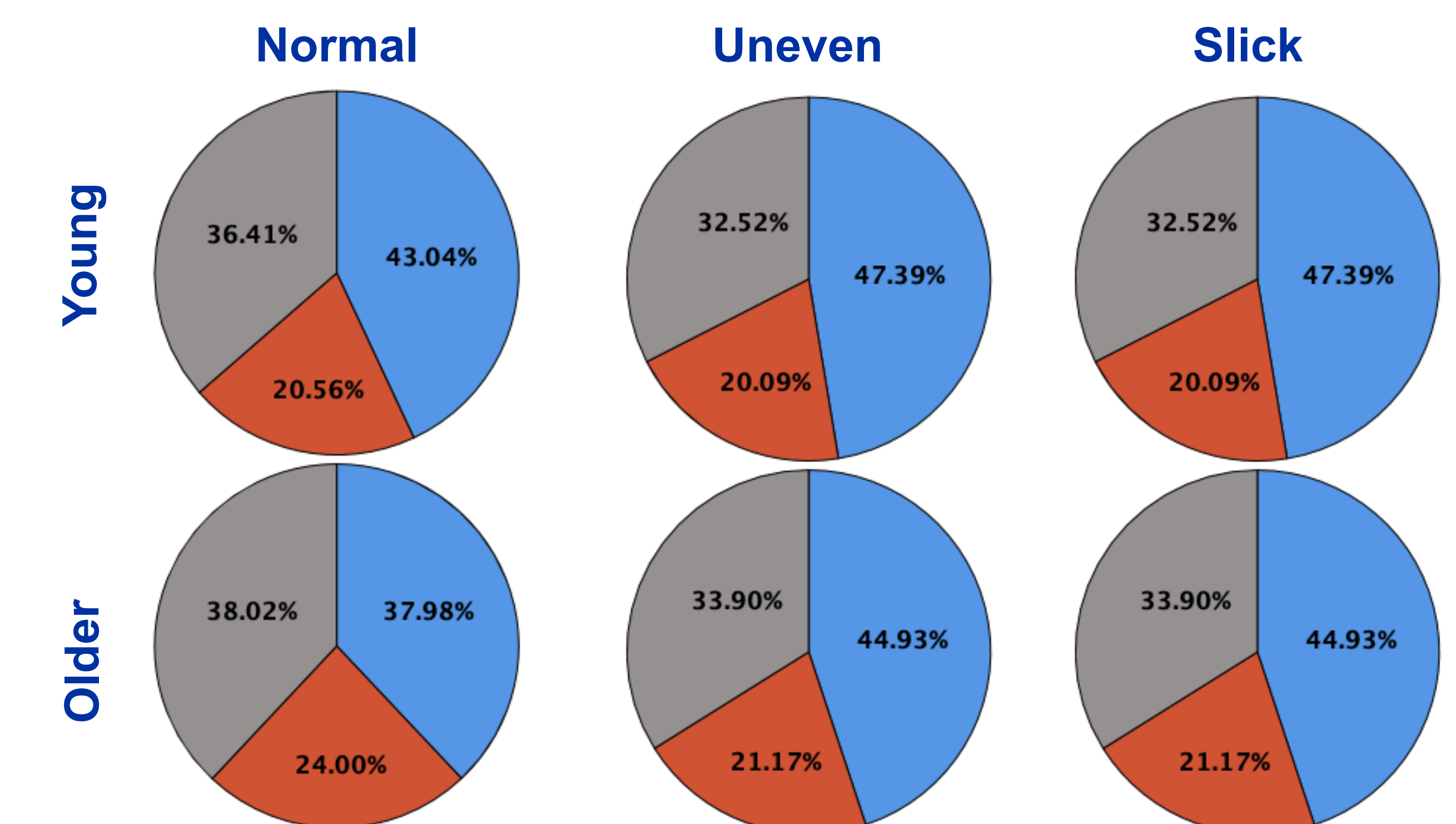
**Figure 3.** Mean  $\pm$  SD for positive work for the limb (A), hip (B), knee (C), and ankle (D) for young and older adults on each surface (normal, uneven, and slick).

## RESULTS

The limb and knee produced more positive work on the uneven compared normal ( $p < 0.001$ ;  $p = 0.002$ ) and slick ( $p = 0.005$ ;  $p < 0.001$ ) surfaces. The hip produced more positive work on uneven and slick compared to normal surface ( $p = 0.029$ ;  $p = 0.049$ ).

Surface also impacted relative knee ( $p = 0.029$ ) and ankle ( $p < 0.001$ ) work, but not hip relative work (Fig. 4).

Knee relative work was greater on the uneven compared to slick surface ( $p = 0.019$ ). Ankle relative work was greater on the normal compared to uneven ( $p < 0.001$ ) and slick ( $p = 0.028$ ) surfaces, and on the slick compared to uneven surface ( $p = 0.017$ ).



**Figure 4.** Hip (grey), knee (orange) and ankle (blue) relative effort for young and older adults on each surface (normal, uneven, and slick).

### KEY FINDINGS:

- 1) Challenging surface and not age impacted lower limb work.
- 2) On the challenging surfaces, particularly uneven, individuals produced more work from the hip and knee.
- 3) The ankle produce a larger percentage of work to ascend stairs without the challenging surface.

## CONCLUSION

Individuals produce greater work from the larger proximal musculature of the hip and knee to ascend stairs outfitted with challenging surfaces.

Lower limb work production did not differ between young and older adults, and challenging surfaces may impact all individuals similarly.

## ACKNOWLEDGEMENTS

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