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Load and Stride Increase Knee Adduction Velocity

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INTRODUCTION

Military personnel often run at a fixed cadence with heavy body borne loads (greater than 20 kg), which may increase knee adduction biomechanics and risk of musculoskeletal disease, such as knee osteoarthritis[1] (OA).

Although military personnel increase knee adduction angle, a biomechanical parameter implicated in knee OA, when walking with heavy load[2], it is unknown whether they exhibit similar increases when running with load.

Running with load may also lead to faster knee adduction, especially during the first 16% of stance[3], and elevated knee OA risk.

PURPOSE

To determine whether body-borne load and stride impact magnitude and velocity of knee adduction.

METHODS

Participants: 36 recreationally active adults (21.3 ± 2.7 yrs, 1.7 ± 0.1 m, 74.8 ± 18.5 kg).

Run Task: Required participants ran at 4 m/s (± 5%) with four body borne loads and three stride lengths.

Load: Participants completed the run with four body borne loads (20, 25, 30, and 35 kg) (**Fig. 1**).

Figure 1. For each load, participants were outfitted with a helmet, weighted vest, and mock weapon..

Stride Lengths: Participant ran with preferred stride length (PSL), and 15% shorter (SSL) and 15% longer than PSL (LSL).

Biomechanical Analysis: For each run, 3D marker trajectories and GRF data were processed using Visual3D (C-Motion, Rockville, MD) to quantify knee adduction angle. Then, custom MATLAB code (Mathworks, Natick, MA) calculated velocity of knee adduction angle (KAA) and varus thrust (VT).

METHODS CONT'D

Statistical Analysis: For analysis, each knee adduction variable was submitted to a RM ANOVA to test the main effect and interaction between body-borne load (*20, 25, 30, and 35 kg*) and stride (*SSL, PSL, and LSL*).

RESULTS

Stride length ($p<0.001$), but not load ($p=0.090$) impacted range of KAA (**Fig. 2**). Participants increased range of KAA with LSL and SSL compared to PSL ($p<0.001$, $p<0.001$), and with LSL compared to SSL ($p<0.001$).

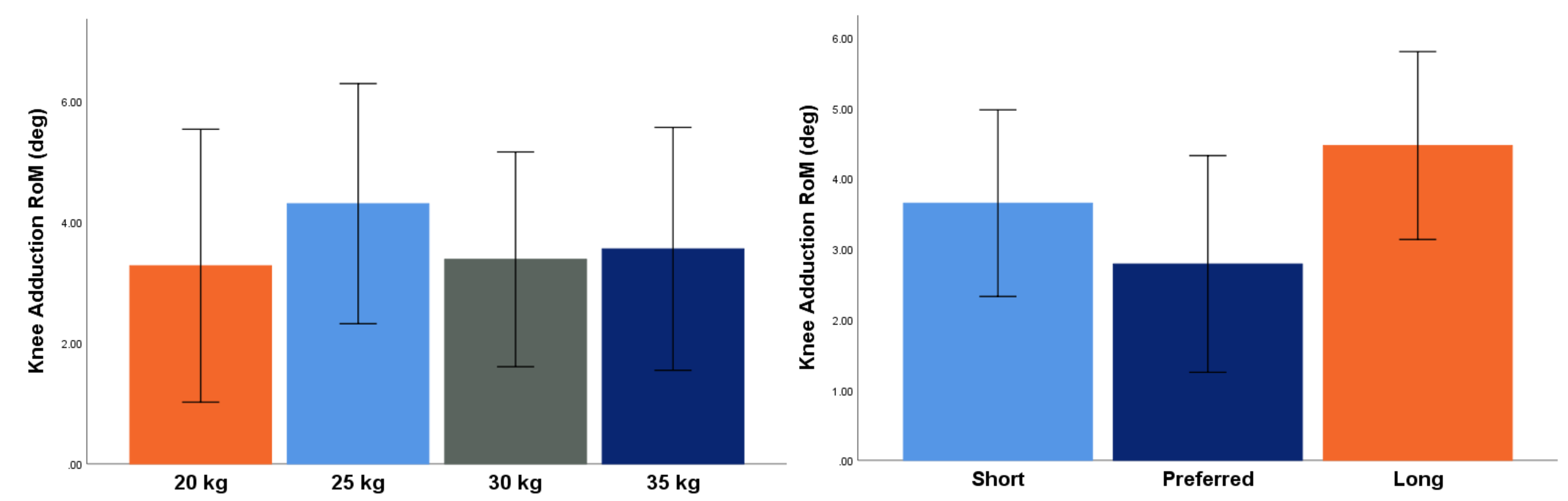

Figure 2. Mean ± SD for range of KAA with each body borne load (A) and stride length (B).

Both load ($p=0.050$) and stride length ($p<0.001$) impacted average velocity of KAA (**Fig. 3**). Greater average velocity of KAA was seen in LSL and SSL compared to PSL ($p=0.003$, $p=0.001$).

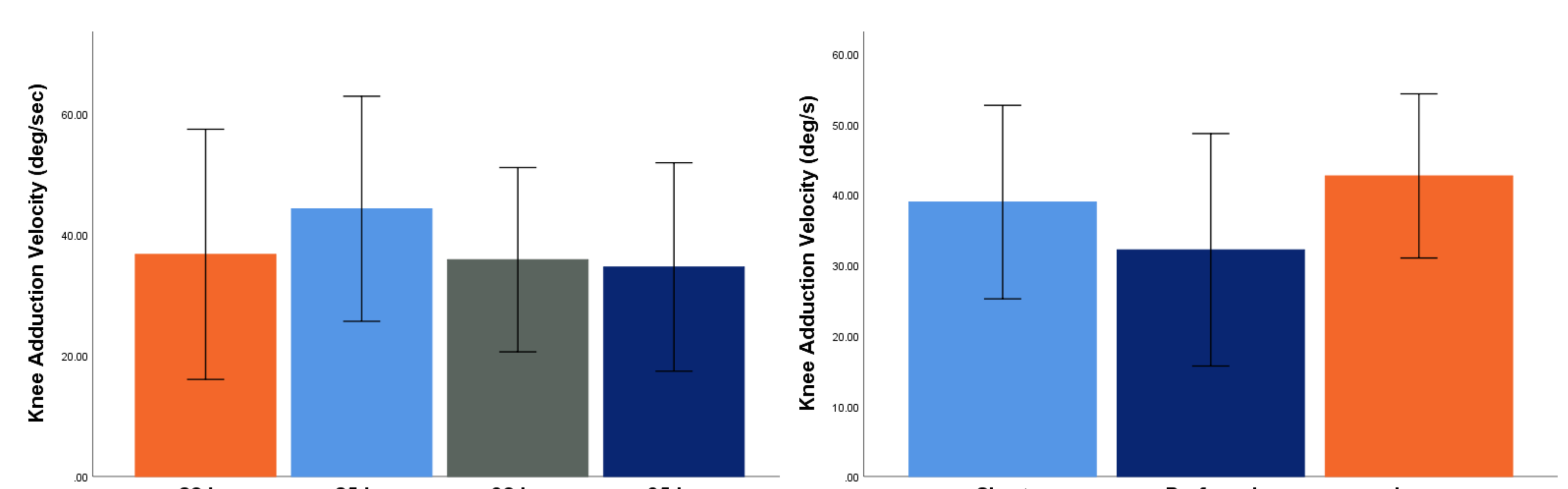

Figure 3. Mean ± SD for average velocity of KAA with each body borne load (A) and stride length (B).

Load ($p=0.010$) and stride length ($p<0.001$) impacted time to peak KAA (**Fig. 4**). Time to peak was greater with 30 and 35 kg compared to 20 kg ($p=0.024$, $p=0.03$), and with LSL and SSL compared to PSL ($p<0.001$, $p=0.001$).

REFERENCES

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2. Drew, M.D. *et al. Gait Posture* **84**, 2021.
3. Chang, A.H. *et al. Osteoarthr. Cartil.* **21**, 2013.

RESULTS CONT'D

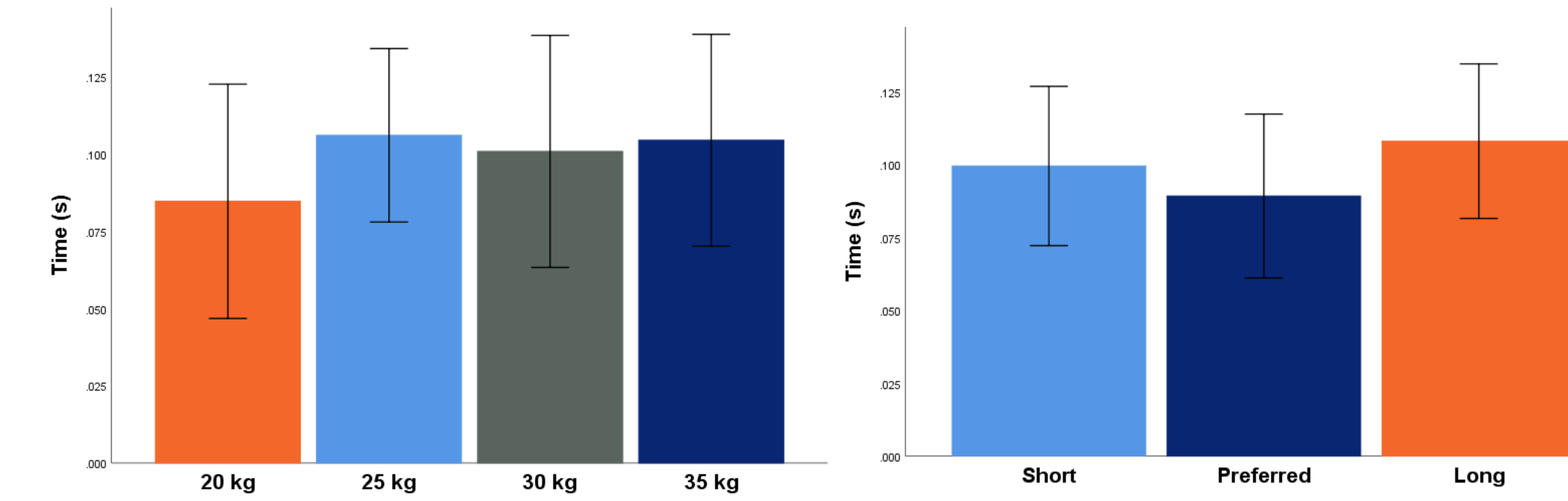

Figure 4. Mean ± SD for time to peak KAA with each body borne load (A) and stride length (B).

Both load ($p=0.014$) and stride ($p<0.001$) impacted VT (**Fig. 5**). VT increased with each addition of body borne load, and with the LSL and SSL compared to PSL ($p<0.001$, $p=0.001$).

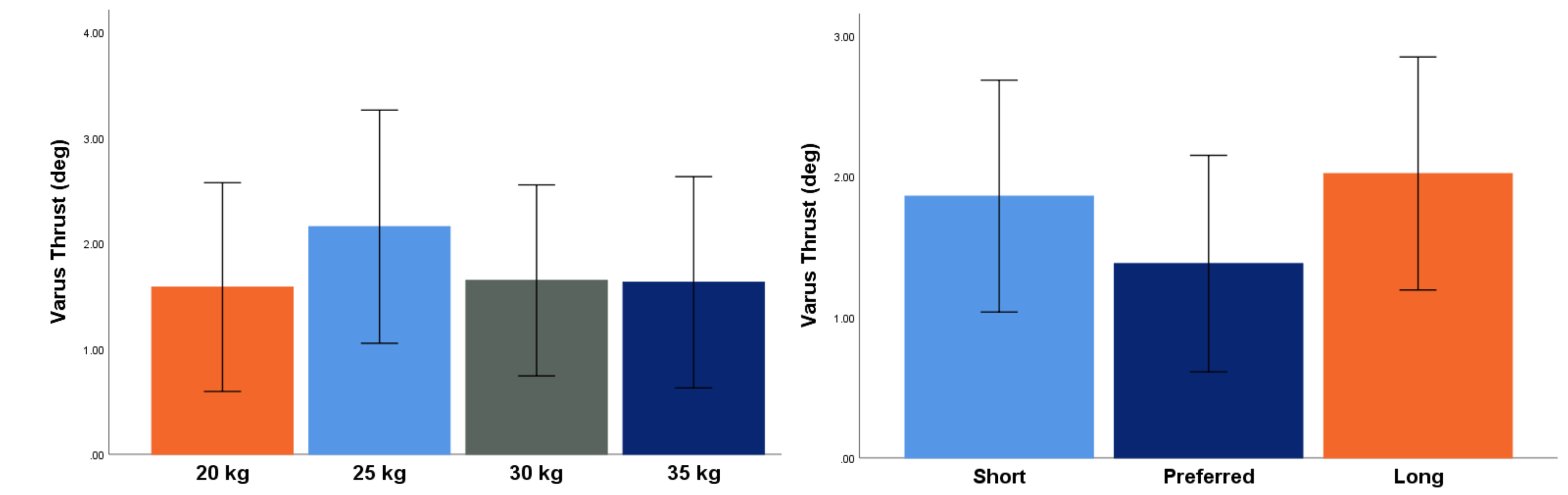

Figure 5. Mean ± SD for VT with each body borne load (A) and stride length (B).

A significant load versus stride interaction was observed for average VT velocity ($p=0.006$). When using SSL, velocity increased with 25 versus 20 kg load ($p=0.022$) and with 35 compared to 25 kg ($p=0.029$) load.

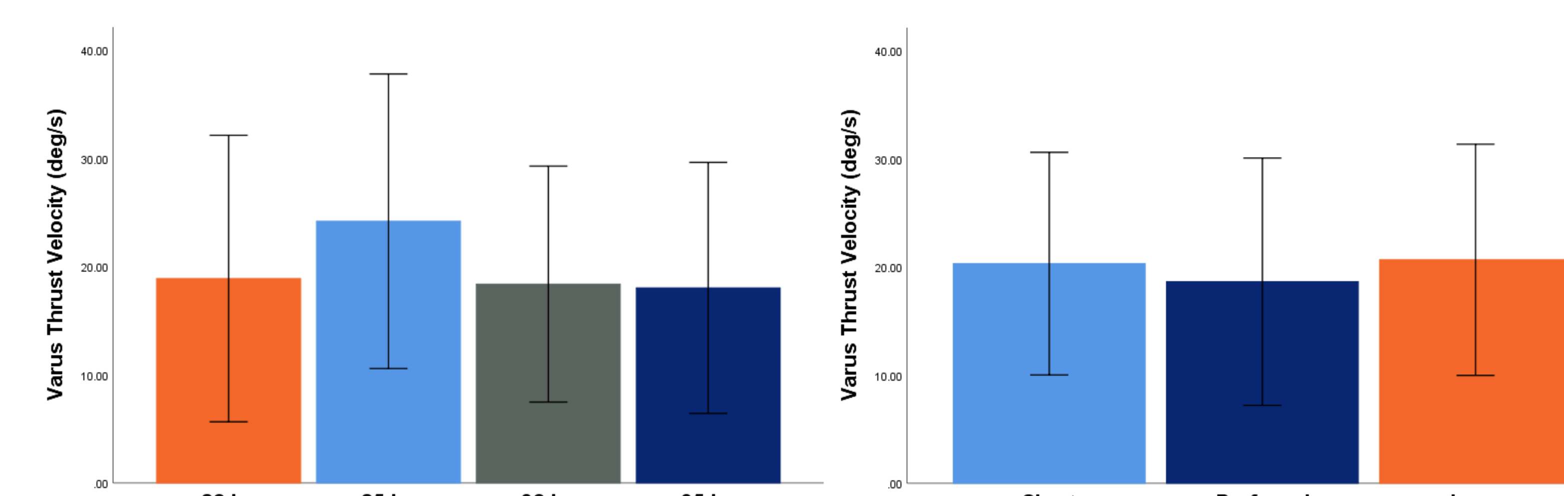

Figure 6. Mean ± SD for average VT velocity with each body borne load (A) and stride length (B).

CONCLUSION

Running with load and fixed cadence may elevate service member's risk of knee OA, as increases in load and alterations in stride led to larger, faster knee adduction. Addition of load led to faster KAA and VT and larger VT; while altering stride led to larger KAA and VT, and faster VT.