Gait parameters, walking Energy Expenditure and Metabolic Cost are different on Treadmills than Overground across speeds

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Introduction

- Walking energetics -> not similar between Overground (OG) & Treadmill (TM), at same speeds [1 2]
- Our past research -> for Young Adults (YA), OG & TM energetics similar at preferred speeds, but not for Older Adults (OA) [3 4]
- This research -> explored for Japanese YA for multiple speeds -> slow, comfortable & fast
- Hypothesis ->
  - at comfortable speeds, no significant differences between OG & TM
  - at non-comfortable (slow and fast) speeds, significant differences between OG & TM

Conclusion

- ✓ First hypothesis could not be accepted ✘
- ✓ Second hypothesis fully accepted ✔
- ✓ Spatiotemporal gait parameters significantly different than OG for all three walking speeds
- ✓ TM energetics significantly higher than OG for all three walking speeds
- ✓ Cautious or conservative gait on treadmill compared to overground
- ✓ Even for healthy YA, treadmill walking does not generalize well to overground

Methods

- Participants
  - 10 young females (age 21.0 ± 1.9 years | height 1.58 ± 0.04 m* | weight 49.6 ± 5.4 kg*)
  - 10 young males (age 23.3 ± 1.4 years | height 1.73 ± 0.05 m* | weight 63.2 ± 9.1 kg*)

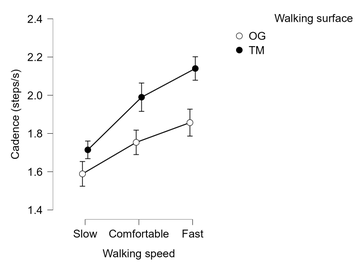
  ***significantly higher in males (p<0.001)**
- Experimental setup
  - 3-axes Xsens DOT IMUs (Movella Inc., The Netherlands) → Thighs and shanks @60Hz
  - Ambulatory Mobile Aeromonitor (Minato Medical science Co., Ltd., Japan) → Backpack
- Walking Conditions
  - Overground (OG) & Treadmill (TM)
  - 3 speeds : Slow 1.0m/s | Comfortable 1.3m/s | Fast 1.5m/s
  - Face mask (breath-by-breath measurement)
  - Shoe-type controlled
  - Randomized cross-over design
- Protocol & Calculations
  - 10 min TM familiarization. 5 min resting trial → Waling Trials : 6 min × 6 conditions
  - 4-min rest between every walking trial
  - 10 mins rest between changing of OG and TM walks
  - Resting Metabolic Rate (RMR) calculated
  - Gait parameters, Energy Expenditures and Metabolic Costs are calculated

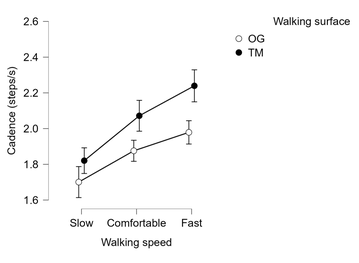


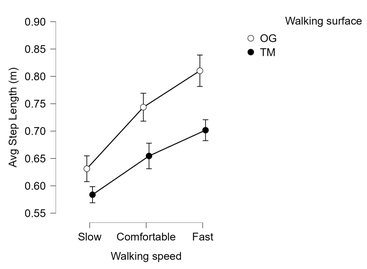

CAUTION: Treadmills do not reflect true overground gait and overestimate energetics!

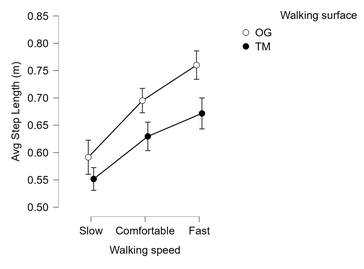
Results

Spatiotemporal gait parameters, Energy Expenditure (EE) and Metabolic costs (CoW) are significantly different (p<0.01) on TM than OG, for all 3 speeds



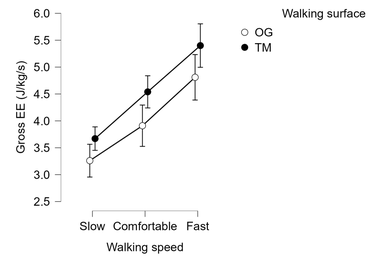


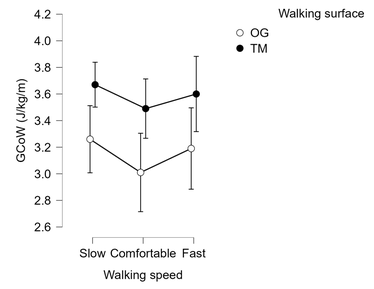




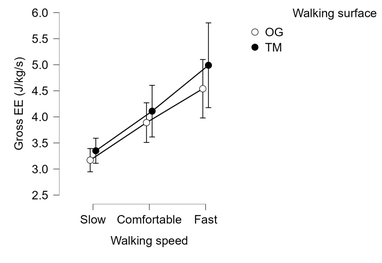
Males

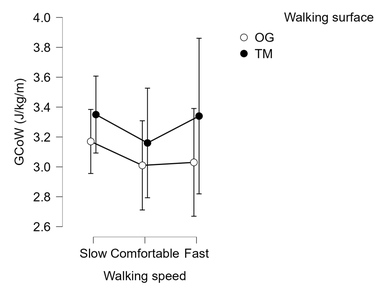
Females





Males





Females

Discussion and Future Work

- ✓ Additional energetic demand of stabilization & balance control on TM ?
- ✓ Antagonistic muscular co-contraction & walking energetics on TM ↑ ?
- ✓ Check also for healthy OA again at multiple speeds -> add kinematics, kinetics and EMG ?
- ✓ Funded grant (JSPS KAKENHI) to test & design impactful (**VR-based, GRAIL**) interventions
- ✓ Testing for lab overground -> daily-life overground generalization

References

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