Effects of common outdoor surfaces and sex on gait dynamics in healthy adults assessed with a single accelerometer

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Summary

This study investigates the effects of outdoor surfaces on gait using non-linear dynamics metrics derived from a single accelerometer. Participants walked over a series of common outdoor surfaces. Results indicate significant surface effects on all gait dynamics variables, independent of sex. Two sex × surface interaction effects highlight the importance of considering sex in gait dynamics analysis.

Introduction

Walking on diverse surfaces, such as those found in various natural and (wo)man-made terrains, may influence gait dynamics. Moreover, given a persistent underrepresentation of females in research [2], it is unclear how sex modulates the biomechanical response to walking on outdoor surfaces.

Methods

29 healthy young adults (14 females) walked on 7 outdoor surfaces: flat, banked left and right, cobblestone, grass, sloped up and down while lower back accelerations were recorded at 100 Hz using an Xsens inertial measurement unit (IMU) (Movella, Netherlands) [3]. Gait was assessed for movement predictability (Sample Entropy), smoothness (Log Dimensionless Jerk), symmetry (step and stride regularity), and stability (short- and long-term Lyapunov Exponents). Generalized Estimated Equations assessed all surfaces compared to flat, sex differences, and interaction effects.

Results and Discussion

Significant surface effects on all gait dynamics variables were obtained, independent of sex (Figure 1). Banked right and sloped down surfaces decreased Sample Entropy, indicating less predictable movement patterns. All surfaces increased Log Dimensionless Jerk, suggesting jerkier movements. Cobblestone and sloped down surfaces reduced step symmetry, while banked surfaces improved stride symmetry. Short-term Lyapunov Exponent decreased on cobblestones, indicating reduced step-to-step variability, whereas sloped up walking increased it. Long-term Lyapunov Exponent increased on all surfaces, indicating more chaotic movement patterns. No significant sex differences were found in gait dynamics. Significant sex × surface interactions were observed for Sample Entropy and stride symmetry on banked right surfaces, with females showing decreased Sample Entropy and increased stride symmetry compared to males.

Conclusions

This study highlights the importance of considering surface type and sex in gait dynamics research.

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References

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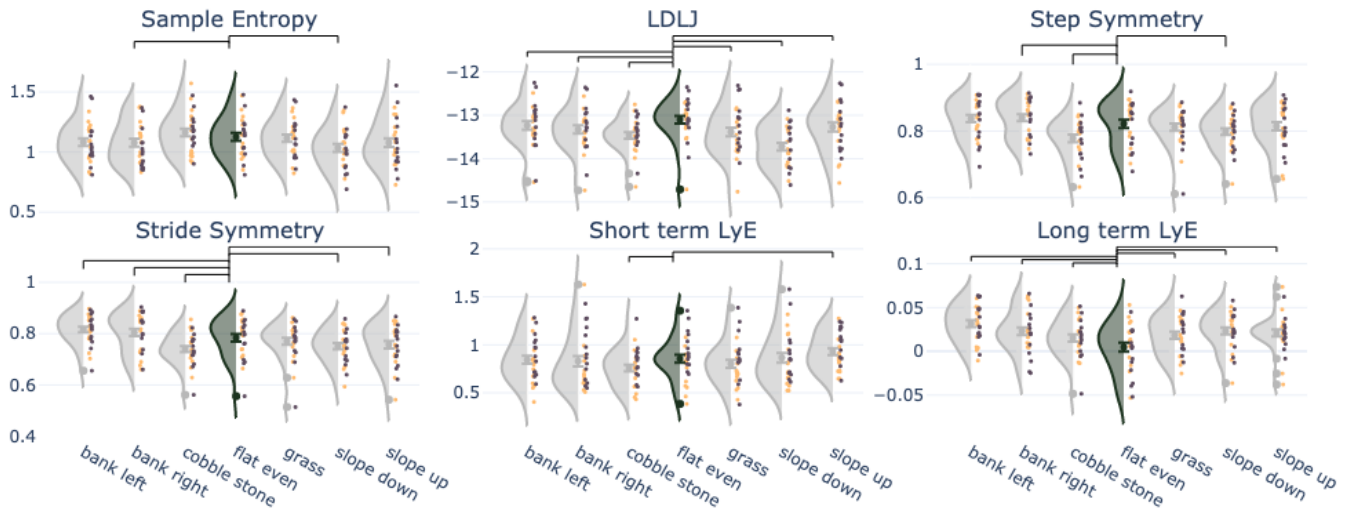

Figure 1: Surface effects on all gait dynamics variables, significant effects are shown with the whiskers. Purple dots=female, yellow dots=male.