What do circular leg movements tell us?

Abstract

Lower-limb motor control is closely related to health and fall risk, yet its quantitative assessment typically requires expensive and specialized equipment. Here, we present a simple method for evaluating foot dominance and postural stability using the variability of circular leg movements measured with a smartphone. Participants performed fifteen-second circular leg movements while the smartphone recorded acceleration data from which movement variability was quantified. The variability measure showed good agreement with conventional measures of postural stability obtained using dedicated equipment. Compared with the conventional approach, the proposed method is low-cost and halves measurement time. Our work contributes to the development of practical techniques for estimating motor function from everyday body movements, supporting a future in which individuals can monitor physical ability, health status, and fall risk using widely available devices.

Importance of postural stability

- Walking is essential, and age-related falls are a major issue
- To estimate the risk of falling, postural stability (ability to stand upright) must be quantified

Postural stability is not easy to measure

Conventional measure of postural stability

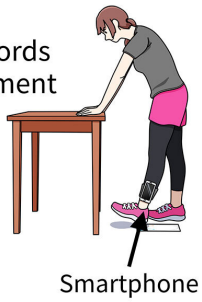
- Using a force plate, the area of the body's Center of Pressure (COP) is calculated
- Issues
  - Equipment is expensive
  - Multiple 30-60s measurements are required
  - Significant barriers to wide adoption

Circular movement variability method

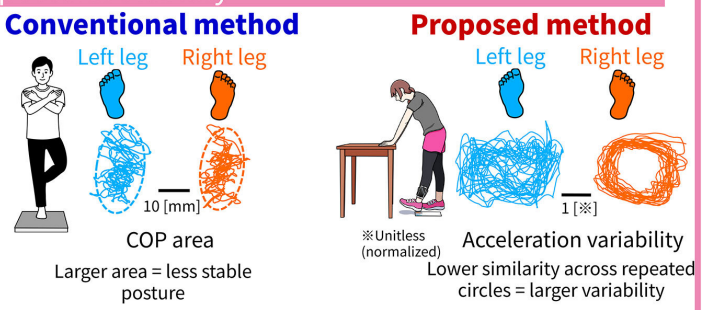
Proposed method

- Smartphone strapped to the leg records variability during 15s circular movement
- Variability of leg movement was compared to conventional measure of postural stability

※Each leg was measured three times

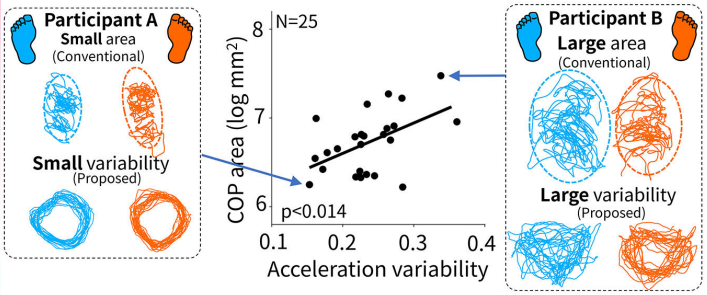


Leg movement variability can be used to assess postural stability



Larger acceleration variability indicates less stable posture

Acceleration variability and COP area were significantly related



Proposed method more reliable than conventional one

- Intra-class correlation analysis showed higher repeatability for the proposed method in both legs.

※ Mean (95% confidence interval)
※ More repeatable if closer to 1

	Intra-class correlation coefficient	
	Non-dominant	Dominant
COP area (Conventional)	0.62 (0.40-0.79)	0.48 (0.25-0.70)
Acceleration variability (Proposed)	**0.84** (0.72-0.92)	**0.80** (0.65-0.90)

Summary
Relative to conventional method, the proposed one is:

- ✓ Fast
- ✓ Affordable
- ✓ More reliable

References

[1] A. Takagi, N. Abekawa, "Variability of circular leg movements is related to footedness and postural stability," *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, Vol. 34, pp. 198–204, 2026.

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