Smartphones Can Accurately Evaluate Postural Sway and Fall Risk Among Older Adults in Community Settings

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Summary

Older adults often seek to preserve their health and autonomy. Smartphones can empower independent living by facilitating a precision medicine approach to enhancing the health and well-being of diverse aging populations across various settings. Smartphone-derived accelerometer and gyroscope data offer accurate assessments of sway area and composite physiological-based fall risk scores. This is the first study to demonstrate that a smartphone can measure postural sway and evaluate fall risk in a large population of older adults within community settings.

Introduction

Impaired postural control is a major contributor to falls among older adults. In clinical practice, assessments of postural control typically focus on timing measures, which may not be sensitive enough to detect subtle balance deterioration. However, objective measurement of postural stability is seldom performed due to the need for sophisticated, expensive equipment that must be operated by trained professionals in a controlled laboratory setting.

The purpose of this study is to determine whether smartphones can measure postural sway and whether these data can be used to evaluate fall risk among older adults in community settings.

Methods

Adults over the age of 55 years were recruited into the study. All adults provided written informed consent. Participants completed the Physiological Profile Assessment (PPA), which measures fall risk based on contrast sensitivity, reaction time, proprioception, knee strength, and postural sway [1].

Postural sway was evaluated using the modified Clinical Test of Sensory Interaction in Balance (m-CTSIB). During all conditions, a sway meter apparatus [1] and an Android smartphone were attached to the waist. The sway meter traced the movement trajectory on a 2mm-square graph paper. The smartphone utilized the IMPROVE application [2] to collect tri-axial accelerations and angular velocities at 100Hz. All tests were performed across 12 senior and cultural centers.

A linear regression was conducted utilizing accelerometer- and gyroscope-based parameters to predict the sway area and fall risk. A two-way repeated measures ANOVA was conducted on the sway area, with the m-CTSIB condition as the within-subjects factor and self-reported falls as the between-subjects factor. All statistical analyses were performed in SPSS v28.0.

Results and Discussion

A total of 225 adults (158 Females; Aged 74.7±7.8 years; BMI 27.6±6.5 kg/m^2) completed the postural sway task (Figure 1), with 82 reporting a fall in the past year. No two-way group*condition interaction (P=0.647) or group difference (P=0.162) was found, though there was a condition difference (P<0.001) for the sway area (Table 1). A linear regression model demonstrated a strong ability to predict sway area (R^2= 0.792) and fall risk (R^2=0.925) using the smartphone-derived accelerometer and gyroscope values.

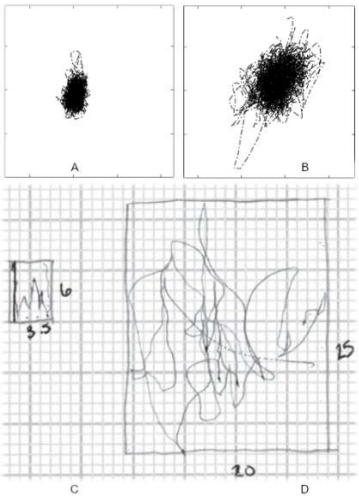

Figure 1: Representative accelerometer (A, B) and sway meter (C, D) tracing for firm and foam standing with eyes closed conditions.

Conclusions

With the ubiquity of smartphones, it is possible for older adults to self-evaluate their balance and fall risk in an easy-to-use and accurate manner.

References

[1] Lord SR et al. (2003). *Phys Ther*, **83**: 237-252.
[2] Silsupadol P et al. (2020). *IEEE J Biomed Health Inform*, **24**: 1188-1195.

Table 1: Sway area [average (SD); mm^2] across four conditions of the m-CTSIB using the sway meter for older adults.

	n	Eyes Open, Firm	Eyes Closed, Firm	Eyes Open, Foam	Eyes Closed, Foam
Non-Fallers	143	362 (383)	487 (429)	940 (1330)	2107 (3361)
Fallers	82	409 (339)	592 (615)	1041 (1597)	2766 (3615)