FORCE PLATFORM CENTER OF PRESSURE MEASURES USED TO PREDICT NINTENDO Wii FIT BALANCE SCORES DURING YOGA POSES

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INTRODUCTION

The Nintendo Wii FIT system has become increasingly popular, especially among older adults who wish to improve fitness and balance levels through the balance training components of the software. Little is known about the balance score that the Wii FIT system uses when assessing balance during quiet standing and yoga.

Recent work focusing on the validity of the Wii FIT balance modules found no relation between Wii system balance scores for one-legged and two-legged quiet standing and the mean velocities of the center-of-pressure (COP) in the AP and ML directions [1]. Because yoga poses are popular among Wii system users and because the system presents challenges to users in the form of a game (i.e., earn points for greater stability), the validity of the system was the focus of this investigation.

Prieto et al. [4] suggested multiple stability measures are necessary to characterize differences between groups of subjects based on age and vision and visual input. In other words, to accurately assess balance a single measure is not appropriate. Therefore, the purpose of this study was to use a stepwise regression approach to determine which COP-based stability measures best predict Wii FIT balance scores.

METHODS

Twenty-nine participants volunteered for this study (age = 21 ± 3 yr; mass = 71 ± 15 kg; ht = 172 ± 9 cm). Each person completed two Wii FIT yoga modules for the half-moon (HM) and tree (TR) poses, both of which required single-leg stance. The tree position required the participants to balance on one leg on a flat foot, pressing the other foot against their inner thigh, as visually demonstrated by the game software. Arms were raised above the head in a tear drop formation, with hands clasped, pointing upwards. The upper body was expected to remain poised in an upright position, perpendicular to the ground. The half-moon position was similar to the tree position in that the support leg maintained a flat-footed stance, and the other foot was pressed against the inner thigh. Instead of attempting to stand with an upper body orthogonal to the ground, as in the tree position, participants were instructed by the Wii FIT system to maintain an extended support leg while laterally flexing towards the raised leg. Arms once again resembled those of the tree position, and abducted at the shoulder with hands clasped above the head. The tree and half-moon poses were attempted by participants on both right and left support legs.

The Wii FIT platform was placed on top of an AMTI force platform, and during the 30-s long scoring attempts of the participants' efforts to balance in each static yoga pose, ground reaction force data were collected at 100 Hz. COP coordinates were used to calculate the following stability measures in accordance with Prieto et al. [4]: RMS resultant distance; resultant mean velocity; 95% confidence ellipse area; mean frequency; total power; and 95% power frequency. Four stepwise regression models were computed for each condition (HM-right leg; HM-left leg; TR-right leg; TR-left leg). Wii FIT balance scores were the dependent variable and COP-based measures were independent variables. The probability of a Type I error was set at 0.05. As a follow-up to the stepwise regression analysis, a standard intraclass correlation analysis was conducted between Wii FIT balance scores and individual stability measures (critical $r = 0.35$, $p < .05$). Based on the work of Maffiuletti et al. [3], correlations above 0.75 were considered strong.

RESULTS AND DISCUSSION

Each condition resulted in a statistically significant regression model (see Table 1). RMS, a time domain distance measure [4] was the primary predictor in all models, whereas secondary predictors included another time domain distance measure (mean velocity), a variable from the frequency domain (total power) and an area measure (95% confidence ellipse area). Although all regression models were significant, considerable variability remained unexplained.

From the perspective of instrument validity (i.e., concurrent validity), no individual, COP-based measure demonstrated a Pearson Product moment correlation coefficient greater than 0.78 with the Wii FIT balance scores. Among the six independent variables across the four conditions considered in the regression models, only three correlations exceeded the 0.75, which is indicative of strong concurrent validity [3]. If this criterion correlation is is applied to the present study, the Wii Fit system balance platform should not be considered a valid instrument when assessing balance. These findings are consistent with those of Field-Eaton et al. [1], who identified low correlation coefficients (less than 0.35) between Wii system balance scores and COP velocity measures.

The stepwise regression approach used in the present study provides more information than a simple correlation analysis. RMS of the COP resultant distance was the first predictor to enter stepwise regression models of Wii system balance scores across all conditions. In subsequent steps, however, there were different predictors that entered the regression model. It appears that the spatial measure of RMS is one of the best predictors of Wii system balance score, particularly when considered in combination with a secondary measure that may be from the frequency domain (e.g., total power).

Limitations associated with this study include a data collection duration that exceeds typical durations in postural stability studies. The Wii system's standard yoga attempt lasted 30 s, whereas postural stability experiments contain durations of 20 s or less [4]. Hertel et al. [2] evaluated single-leg stance for only 10 s. The 30 s trials in the present study may have introduced fatigue. Standard postural assessments have subjects stand quietly, whereas subjects in the present study were asked to hold yoga poses for the entire duration of the assessment.

CONCLUSION

COP stability measures obtained from a force platform predicted Wii FIT system balance scores during yoga poses, with RMS resultant distance being a common predictor across conditions. However, these regression results, coupled with individual correlation coefficients, do not indicate a valid instrument for assessing balance, when evaluated with respect to traditional stability measures.

REFERENCES

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Table 1: Summary of Regression Models (Wii System Balance Score is dependent variable)

Condition	Predictors	R^2	F-ratio	p-value
HM-right	RMS, Total Power	.73	35.5	< .001
HM-left	RMS, Mean Velocity	.79	47.8	< .001
TR-right	RMS, 95%Confidence Ellip.	.60	19.4	< .001
TR-left	RMS, Total Power	.65	23.6	< .001

Note: HM = half-moon pose; TR = tree pose