Does the Clinical Balance and Mobility Scale improve retrospective classification of falls in community dwelling older adults?

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Abstract

Background: This research is intended to extend on previous research where the Motion and Mobility Lab[2] explored clinical and gait measures to identify a model with the highest sensitivity for retrospectively classifying fallers. From this research, a model with overall predictive accuracy of 82.9% was established. To date, clinical assessments employ assessments that are characterized by ceiling-effects and restricted range. Therefore, further research is needed on more challenging clinical measures of mobility and balance to determine whether they can be employed to improve classification of fallers.

Research Question: In the present study, the clinical assessment battery from the previous research will be augmented by including high-level balance outcome measures such as the Clinical Balance and Mobility Scale (CBMS), in addition to the previously established gait measures. The goal of this research is to determine if the CBMS, in conjunction with the measures of walking gait, can improve the retrospective classification of fallers.

Methods: Our study included 61 participants labelled as community-dwelling older adults (65 + years). Participants were classified into one of two groups (faller or non-faller) based on falls history. The experiment consisted of a test battery with 18 measures.

Results: The final statistical analysis resulted in a predictive model with 40% sensitivity, 75% specificity, and an overall predictive accuracy of 60.7%.

Significance: The CBMS does not appear to improve the retrospective classification of fallers.

Introduction

Why is fall prevention in older adults important?

- Falls are the leading cause of hospitalization due to injuries in adults aged 65 years and older.[1]
- 30% of Canadians over the age of 65 experience one or more falls each year.[1]
- Between 2003 and 2008, the injuries and deaths due to falls increased by 43% and 65% respectively.[1]

How are falls in older adults predicted?

- Traditionally, assessments include history of falls, basic muscular strength and endurance tests, postural sway, and clinical balance and mobility tests.[2]
- Recently, gait measures have been found to out-perform the traditional clinical (which regularly result in the ceiling effect) and physiological assessments.[2]
- Furthermore, the Clinical Balance and Mobility Scale (CBMS) does not show the ceiling effect found in the commonly employed clinical balance and mobility assessments.[3]
- Currently, the question raised is if traditional clinical measures for fall prediction should be replaced by more challenging, high-level balance outcome measures such as the CBMS.

What is the importance of this research?

- This research will extend on previous research[2] to determine whether the CBMS improves classification of fallers.
- This updated approach is crucial for clinicians that rely on the sensitivity of clinical assessments to determine the fall risk of their patients.

Figure 2. Participant walking on the GAITRite mat during a gait trial with a cognitive task.

Methodology

Participants

- 61 community-dwelling older adults (65 + years)
- 25 classified as fallers and 36 classified as non-fallers

Protocol[2]

- Various assessments were conducted to collect measures of gait with and without a cognitive task, as well as clinical balance and mobility measures.

Gait Measures[2]

- Spatiotemporal gait measures included length, width, timing, and velocity;
- Conducted via a GAITRite instrumented walkway; and
- Recorded during a 6.4m self-paced walk in two conditions: with and without a cognitive task (counting backwards by serial sevens aloud).

Clinical Mobility and Balance Measures (CBMS)

- Conducted nine of the 13 assessments due to safety concerns; and
- Employed the 0-5 scale for each assessment.

Data Analysis[2]

- An iterative Principal Component Analysis (PCA) was conducted with nine previously established gait measures[2] along with nine CBMS measures (Spyder 4.0.1);
- A backwards stepwise binary logistic regression of the key variables from the PCA was conducted to identify the model with highest sensitivity (SPSS); and
- A Hosmer-Lemeshow test was then employed to test the fit of the model (SPSS).

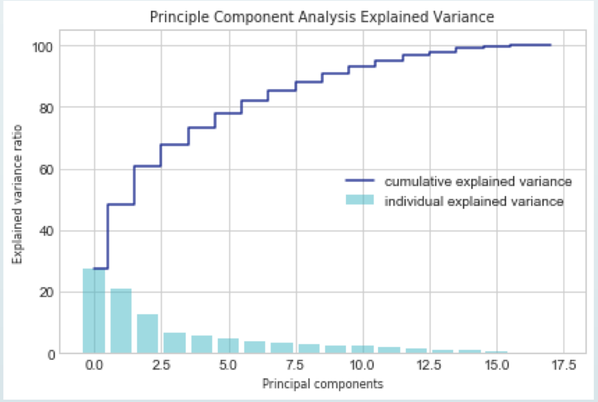

Figure 1. Cumulative and individual explained variance from the first iteration of the principle component analysis.

Results

- The test battery consisted of 18 assessments (nine gait and nine CBMS measures) that were entered into the PCA.
- A total of five PCA iterations were required to identify the measures responsible for the highest amount of the sample variance.
- 13 measures were retrieved from the PCA: Stride Velocity Diff (SVD), Stride Length Var Diff (SLVD), Stride Time Diff (STD), Walk Look Carry (WLC), Swing % of Cycle Var (SCV), Stride Velocity Var Diff (SVVD), Lateral Dodging (LD), Stride Length Diff (SLD), Stride Width Var Diff (SWVD), Forward & Backward Walking (F&B), Stride Width Diff (SWD), Stride Time Var (STV), and Tandem Walking (TW).
- The best model identified by the backwards stepwise binary logistic regression was comprised of five measures: STD, WLC, SCV, SLD, and SWD.
- The model was found to have 75% specificity (correctly classifying non-fallers) , 40% sensitivity (correctly classifying fallers), and an overall model classification accuracy of 60.7%.
- Of the five variables identified within the model, there are positive predictive relationships between STD, WLC, and SLD with fall status, and negative predictive relationships between SCV, and SWD with fall status.
- The five variables in the model were all found to be insignificant contributors to the prediction of falls ($p > 0.05$).
- The goodness of fit tested with the Hosmer-Lemeshow test resulted with a Chi-square of 14.889, and a significance value of $p = 0.061$.
- The resulting equation from the binary logistic regression is as follows:

$$log\left(\frac{p}{1-p}\right) = -0.767 + (0.566\ x\ STD) + (0.273\ x\ WLC) - (0.737\ x\ SCV) + (0.037\ x\ SLD) - (0.493\ x\ SWD)$$

Table 1
Results of current Binary Logistic Regression at an alpha level of $p < 0.05$

Variables	B	S.E.	Wald	df	Sig	Exp(B)	95% CI	
							Lower	Upper
Stride Time Diff (STD)	0.566	0.741	0.582	1	0.445	1.761	0.566	0.741
Walk Look Carry (WLC)	0.273	0.264	1.067	1	0.302	1.314	0.273	0.264
Swing % of Cycle Var (SCV)	-0.737	0.380	3.762	1	0.052	0.479	-0.737	0.380
Stride Length Diff (SLD)	0.037	0.034	1.216	1	0.270	1.038	0.037	0.034
Stride Width Diff (SWD)	-0.493	0.257	3.696	1	0.055	0.611	-0.493	0.257
Constant	-0.767	1.099	0.487	1	0.485	0.464	-0.767	1.099

Conclusion

- Of these 13 variables, three originated from the CBMS measures: WLC, F&B, and TW
- After conducting the backwards stepwise binary logistic regression to identify the fewest variables required to retrospectively classify fallers, the only CBMS variable that was found in the most predictive model was the WLC.
- The best model identified only had 40% predictive ability for correctly classifying fallers, and 75% predictive ability of correctly classifying non-fallers, which was much lower than the original model previously established by Commandeur et al., in 2018 where the sensitivity found was 92.3%, the specificity was 66.7%, and the overall model accuracy was 82.9%.
- Therefore, our extended research findings conclude that the CBMS does not improve the retrospective classification of falls in community-dwelling older adults.
- These findings are a result of a larger sample size including the original sample from Commandeur et al., (2018) (n=61 and n=42, respectively).
- Thus, leading to the conclusion that additional analysis may be needed on the original data from Commandeur et al., (2018) with the addition of CBMS to identify if the model maintains at least 82.9% overall model accuracy.
- Lastly, we recommend that further research be conducted on larger samples of both gait measures and CBMS measures to establish an accurate and reliable test battery that produces a model with the highest sensitivity and specificity for classifying fallers and non-fallers.

Table 2
Comparison of the resulting predictive models from the current and previous research.

Model	Variables	Predictive Accuracy
Current Model	**Stride Time Diff**	40% sensitivity
	Walk Look Carry	75% specificity
	Swing % of Cycle Var	60.7% overall accuracy
	Stride Length Diff	
	Stride Width Diff	
	Constant	
Previous Model	**Stride Length Diff**	92.3% sensitivity
	Stride Width Diff	66.7% specificity
	Stride Width Var Diff	82.9% overall accuracy
	Stride Time Diff	
	Stride Velocity Var Diff	
	Constant	

Bolded variables are present in both models.

References

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