VALIDITY ASSESSMENT OF THE IPHONE 5S AS A PEDOMETER FOR ABLE-BODIED PERSONS
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INTRODUCTION
The health benefits of physical activity, such as reducing risk of cardiovascular disease and mortality (U.S Surgeon General, 1996), are well documented. Step count is a useful proxy measure of physical activity during daily living (Tudor-Locke, 2004) and can be easily measured using low-cost pedometers. Given the popularity of the iPhone (Apple, Cupertino, CA) and its built-in accelerometer system, this device provides a convenient and universal platform to count steps during daily activity for a sizable percentage of the global population. Apple recently standardized the accelerometer hardware-software platform in the iPhone 5S to eliminate reliance on custom pedometer applications and the recurring need for validation assessment of these algorithms. The purpose of this study was to assess the concurrent validity of the iPhone 5S pedometer and the relationship between its measurement error and walking speed.

METHOD
Subjects: A convenience sample of 20 able-bodied persons (10 male, 10 female, 28±5 years, 1.71±0.14 m, 74.8±21.2 kg) participated in this study.

Apparatus: iPhone step count was compared against steps recorded by manual count and the StepWatch™ activity monitor (Orthocare Innovations, WA), which represented the criterion standard clinical measure.

Procedures: The StepWatch was programmed for each subject and attached to the right lateral malleolus as per manufacturer recommendations. The iPhone was stored in the subjects’ right hip pocket. Both devices were activated and the subjects then walked a 30m straight-line path in a level carpeted hallway at slow, normal, and fast walking speeds.

Data Analysis: Concurrent validity of the iPhone as a pedometer was assessed with Spearman’s correlation (ρ) analyses between measurement of the iPhone and both the manual count and StepWatch. Bland-Altman analyses were used to assess agreement between outcomes of each instrument and the presence of a fixed or proportional bias. Fixed bias was evaluated using a one-sample t-test to determine if the mean error between measures was different than zero. Proportional bias was evaluated using Spearman’s analyses to determine if error between measures was related to the total number of steps. A best-fit polynomial was used to model the relationship between the iPhone to manual count absolute error and walking speed. The critical α was set at 0.05.

RESULTS
The average slow, normal, and fast walking speeds were 0.95±0.13 m/s, 1.33±0.14 m/s, and 1.77±0.24 m/s, respectively. The iPhone step count was strongly correlated to the manual and StepWatch count for only the fast walking speed (ρ≥0.733, p<0.001) and no fixed or proportional bias was present for this condition. For the slow walking speed, the iPhone underestimated step count by an average of 8 steps, or 16% (p≤0.029), and a strong correlation between total number of steps and error (ρ≥-0.633, p≤.003) was observed. The relationship between iPhone to manual count error and walking speed was accurately described by a negative power function (Figure 1).

DISCUSSION
The iPhone accurately counted steps for only the fast walking speed condition. This result was supported by the observed relationship between error and walking speed where measurement error increased exponentially at slower speeds and approached zero at faster speeds. The iPhone had a consistent error for slow walking speeds and this inaccuracy reached up to 78% in this study. These mixed results suggest promise for the iPhone to serve as a valid pedometer, but reveal important limitations with real-world implications for use in individuals that walk slowly.

CONCLUSION
Despite improvements to the iPhone system through hardware-software standardization, additional work is needed to improve its accuracy across walking speeds before being considered a valid pedometer.

CLINICAL APPLICATIONS
The current iPhone 5S pedometer is accurate for monitoring daily physical activity via step count of individuals with faster walking speeds but may not be valid for patient groups that walk slowly.

REFERENCES