

Accuracy of Pedometer Steps and Time for Youth with Disabilities

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Abstract:

Purpose: To determine pedometer accuracy of steps and time for children with disabilities. **Methods:** Eleven girls and seven boys with multiple developmental disabilities participated in six, 80 meter self-paced walking trials. Pedometers were placed in five locations around the waist: front right [FR], front left [FL], back right [BR], back left [BL], and middle back [MB]. Each trial was video taped and actual steps and time were verified using video recordings. Accuracy was determined by percent difference between registered steps and time on the pedometers to actual steps and a time measured by video recordings. **Results:** A high level of accuracy was found for the FR and BL locations for time, while only the FR location demonstrated adequate accuracy for steps. When one outlier with excessive weight status and slow walking speed was excluded, a high level of accuracy was observed across all locations for steps and time. Differences between pedometer locations were insignificant, with the exception of FL steps which demonstrated greater percent error scores and the pedometers measured time more accurately than steps. **Conclusions:** Time showed higher precision when compared to steps in both the full and outlier excluded samples. Location had minimal influence on accuracy, suggesting placements of the pedometer out of view (BR, BL, MB) can be used to minimize wearer interference. Concern needs to be exercised when using this pedometer with youth that exhibit a combination of excessive weight status and slow walking speed.

Introduction:

Physical activity (PA) is a growing concern in children with multiple disabilities since they are more prone to develop diabetes mellitus, coronary heart disease, and childhood obesity due to a sedentary lifestyle in early adulthood. The use of pedometers in assessing PA was proven to be an accurate way of measuring children's PA [1]. Children with disabilities may have mobility limitations which could alter the precision of the steps registered. This study was conducted to examine the accuracy of pedometer measured steps and time in a population of youth (4-13 years of age) diagnosed with developmental disabilities in a controlled setting.

METHODS:

Participants: Eighteen elementary and middle school youth (girls n= 11, 9.4+/- 3.1years; boys n=7, 10.0+/- 3.4 years) with multiple disabilities participated in the

project. Inclusion criteria included the ability to maintain a steady state gait pattern with or without an assistive device for at least a distance of 100 feet. Standing height (cm) and weight (kg) were obtained without shoes using a portable standiometer and physician's scale respectively. These measurements were used to calculate body mass index (BMI, wt(kg)/ht(m)).

Pedometer: The Walk4Life Duo (WL, Plainfield, IL), selected for its high degree of accuracy [2], was used to assess both steps and time (minutes, seconds). All units were calibrated using the "Shake-test" [3] at pre-, mid-, and post-testing. This procedure was preformed three times at each shake-test and no unit exhibited more than +/- 5% error.

Self-paced walking: Each child completed 6 self-paced walking trials while wearing the WL pedometer placed at five positions around the waist using an adjustable belt. The pedometer positions were: front right hip (FR), back right hip, (BR), front left hip (FL), back left hip (BL), and middle back (MB). These positions were selected to determine appropriate placement of the pedometers for accurate register of steps and time and to determine whether placements out of direct view of the child would minimize child interference.

Prior to each walking trial pedometers were reset to zero, closed, and were positioned around the waist line at the five locations. The participants walked a 10 meter distance marked with cones and colored tape in a gymnasium or hallway a total of eight times at the child's self determined walking speed. A research staff member assisted (holding hands) as the participant walked a straight line and instructed/led him/her to turn around at the marked line. One 80 meter distance comprised one walking trial. Six trials were completed over several days secondary to participant compliance and fatigue. At the end of each trial the number of

registered steps and time (minutes and seconds) were recorded from each pedometer.

Step/time Criterion Measure: Video tapes of the walking trials were used as the criterion measure to determine pedometer step and time accuracy. The videos were observed at one-half speed by two individuals independently on computers to ensure an accurate count of the number of steps taken during each trial. A step was defined as the elevation of the foot from the ground. Actual steps were recorded using handheld tally counters. Time to complete each trial was determined by the digital elapsed time readout (hours:minutes:seconds) appearing in the media information window.

Statistical Analysis: Single measure intercorrelation coefficients (ICC) and 95% confidence intervals (95CI) were calculated to assess level of agreement between video and pedometer steps and time. The level of agreement was compared to established guidelines (ref 5): a) $\leq .79$, low agreement; b) $.80$ to $.89$, moderate agreement; and c) $\geq .90$, high agreement.

Results:

Step/Time Level of Agreement: The full sample showed a moderate level of agreement for steps on the FR pedometer; all other locations expressed low levels of agreement. The level of agreement for time resulted in a low level for the MB, a moderate level for BR and FL, and a high level of agreement for FR and BL. In the outlier excluded sample there were high levels of agreement for all locations for steps except for FL and a high level of agreement for all locations for time.

Discussion and Significance:

Youth with disabilities engage in less recreational activity [4] and are at a greater risk of becoming overweight [5] than their peers without disabilities. Thus, the ability to accurately assess the PA levels of youth with disabilities has become a priority issue [6]. While previous studies have found pedometers to be accurate with able-bodied children and adults with mental retardation, no studies to date have determined their accuracy with youth with disabilities. [2,7,8] It is unknown how the children's mobility limitations will affect the pedometer accuracy.

The results from the current study indicated that pedometer steps and time exhibit a high degree of accuracy under self-paced walking in all but one of the participants (outlier-girl, 8.6 yrs old, BMI 34.9, walking speed $33.9\text{m}^*\text{min}^{-1}$). A video review was conducted; and the outlier appears to have been stepping with minimal foot elevation from the ground which would serve to dampen the amount of vertical force generated to trigger the pedometer lever arm. Time was shown to be more accurate than steps in both sets of analyses suggesting time may be less sensitive to characteristics (BMI, walking speed) known to influence pedometer

accuracy [2,9]. Time, therefore, may be the more appropriate measure when using pedometer with individuals exhibiting similar characteristics to the outlier. Prior accuracy studies in both children showed slow walking speed influenced step count accuracy ($<54\text{m}^*\text{min}^{-1}$). The average speed of the entire sample in the current study was $49.0+12.9\text{m}^*\text{min}^{-1}$. This suggests slow walking speed may not be as influential to pedometer accuracy as previously concluded. [2, 9]

The results examining the differences among the five locations suggests that while significant differences existed, this may have been attributed to variations in manufacturer quality rather than the influence of placement itself. If tampering is a concern when using pedometers with youth with disabilities, placement of the pedometer out of direct sight will, therefore, not substantially influence its accuracy.

Conclusion:

Both steps and time using the WL pedometer was found to be accurate with youth with disabilities. The results suggest pedometer time may be a more accurate measure of ambulatory activity when pedometer step accuracy may be compromised due to excessive weight or slow walking speeds. Pedometers can be placed out of reach of the child to prevent tampering, due to minimal changes in accuracy. Further research needs to determine the accuracy of steps and time during unstructured activities and the feasibility of collecting pedometer steps and time in this population on multiple days.

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