EUROPEAN PSYCHOMOTRICITY JOURNAL

http://www.psychomotor.gr/epj.htm

ISSN 1791-3837
European Psychomotricity Journal 2008; 1; 1, 54-60
Special Issue: 1st Symposium of SPA-Hellas
Published by: Athlotypo Sports Publishing
http://www.athlotypo.gr/

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A study on the accuracy of three pedometers

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Abstract

A study on the accuracy of three pedometers: Omron Walking style pro HJ-720IT-E2 (OHJ), Omron walking style II (OII) and Yamax SW-200 (YSW). This study examined the effects of walking speed on the accuracy of the above pedometers**:** Thirty two subjects (271.22 ± 28,4 months) walked on a treadmill at various speeds (54, 67, 80, 94, and 107 mmin^{-1}) for five min stages. Two investigators determined steps simultaneously by a hand counter and a camera was recording all the trial. YSW and OHJ were measured on the right side and OII was measured on the left side. OHJ and OII did not differ a lot from actual steps at any speed ($p>0.05$), only YSW differed a lot at 54 m*min^{-1} ($p<0.05$). OHJ and OII appeared to be accurate at any speed and YSW provide accurate values at 64 m*min^{-1} and above.

Key Words: *physical activity, exercise, motion sensor, walking, step counter*

Introduction

There is considerable public interest in the positive relationship between physical activity and health. A wide range of studies support the belief that physical activity could lower the risk of developing chronic diseases such as diabete type II, obesity, artery disease, and hypertension (ACSM, 2000). Many studies examined the feasibility of using monitor sensors such as accelerometers and pedometers as tools of measuring physical activity levels (Freedson et al. 2000; McClain et al. 2007). The main difference between these two motion sensors is the cost and the mechanism. Pedometers are economically feasible for use in studies and cheaper than accelerometers (Crouter et al. 2003; Le Masurier et al. 2003; Schneider et al. 2003; Tudor-Locke et al. 2002). The mechanism of recording

steps depends on the brand. Most electronic pedometers consist of a horizontal spring-suspended lever arm that moves with the vertical acceleration of the hips during ambulation (Tudor-Locke et al. 2002). Some models provide a daily total of steps taken, and some other record more data like the distance and the energy expenditure and provide the opportunity to store the data for viewing or downloading to a computer. In general, pedometers are most accurate in counting steps, less accurate in calculating distance, and even less accurate in estimating the energy expenditure (Crouter et al. 2003). Pedometers provide immediate feedback to the user on the number of steps taken and they also have the potential to serve as a motivational tool to encourage adolescents to engage in increased physical activity (Basser et al. 1996; Tudor-Locke et al. 2001). Studies have shown that 30 min of brisk walking is equal to 3100-4000 steps, depending on the age of the population (Crouter et al. 2003; Welk et al. 2000; Wilke et al. 2001) and for adults 10,000 pedometer counts have been identified per day, as a daily activity goal (Tudor-Locke et al. 2001). The increasing use of pedometers in studies makes the examination of the accuracy and reliability necessary, as valid tools for measurements. Therefore, the purpose of this study was to examine the accuracy of three pedometers for measuring steps taken.

Method

Participants

Thirty two students from the Democritus University of Thrace volunteered to participate in this study. Written informed consent was obtained by all subjects before testing. The protocol, which was used, had been approved at the ethic committee. Age was recorded and anthropometric characteristics were measured (weight and height) - without shoes and with light clothing - with a stadiometer and calibrated physician's scale, respectively. Stride length was calculated by asking the subjects to take 20 strides at their normal walking

speed in an indoor hallway. This trial was performed three times and the average of the total distance was divided by the total strides (60). The result was programmed into the pedometers. Descriptive data of the subjects is presented in Table 1.

Table 1. *Physical characteristics of subjects*

	Men (N = 18)	**Women (N = 14)**	**All Subjects (N = 32)**
Age (months)	273.44 ± 1.5	268.36 ± 28.1	271.22 ± 28.4
Height (cm)	1.77 ± 8.2	1.65 ± 5.9	1.72 ± 9.3
Weight (kg)	76.58 ± 6.4	60.23 ± 5.9	69.43 ± 10.2
BMI (kgm^{-2})	24.43 ± 1.5	22.02 ± 2.2	23.38 ± 2.2

Values are Mean ± standard deviation; BMI, body mass index.

Protocol

Three pedometers were examined to determine the effects of walking speed on steps taken: Omron Walking style pro HJ-720IT-E2 (OHJ), Omron Walking style II (OII) and Yamax SW-200 (YSW). Before the first trial, the subjects received instructions for walking on the treadmill and were given time to adapt to walking at the various speeds. The subjects walked at speeds of 54, 67, 80, 94, and 107 $mmin^{-1}$ on a motor driven treadmill (RAM-770S). The treadmill speed and grade were calibrated before testing according to the manufacture's instructions. OHJ and YSW were worn on the right side and OII was worn on the left side, all of them were placed in the middle setting. Each trial consisted of 5 min walking at the given speed. Two investigators recorded actual steps with a hand counter (Basch SJ-504) and a camera was recording all the trial. At the end of every trial, the subject stepped off the treadmill for 2 min so that values from the electronic pedometers could be recorded.

Statistical Analysis

All analyses were performed using SPSS 11.0.1 for Windows. For all analyses, an alpha of P<0.05 was used to denote statistical significance. A two-way repeated measures ANOVA (speed*brand of pedometer) were used to determine whether there was a significant difference scores between the mean difference scores of steps taken to various speeds and pedometer brand.

Results

Table 2 shows significant differences from actual steps, and Figure 1 shows percentage of actual steps at each speed. Statistical differences were found between speed and pedometers ($F_{(speed*pedometer)} = 7{,}423$, $p=0{,}001$). YSW tended to underestimate actual steps at 54 m*min-1 ($p<0.05$). OHJ and OII did not significantly differ from actual steps at any speed ($p>0.05$). Only the OHJ provided mean values that were within ±1% of actual steps at any speed. OII provided mean values that were within ±1% of actual steps at 54, 80, 94, and 107 $mmin^{-1}$ and YSM at the last three speeds 80, 94, and 107 $mmin^{-1}$.

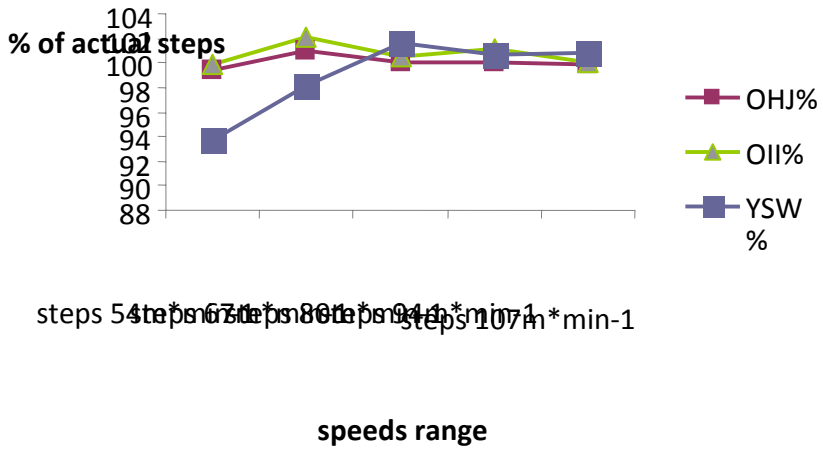
Table 2. *Pedometer accuracy for measuring steps during treadmill walking at five different speeds.*

Speed ($m*min^{-1}$)	**OHJ**	**YSM**	**OII**
54	√	-	√
67	√	√	√
80	√	√	√
94	√	√	√
107	√	√	√

- Significant underestimation of actual steps (P<0.05)

√ no significant difference

Figure 1. *Percentage of actual steps during treadmill walking*



Discussion

The results of this research confirm that all pedometers which are used, are valid tools for many researches. Pedometers provide an inexpensive tool for measuring physical activity but they seem to be unable for estimating energy expenditure (Crouter et al. 2003). Recent published researches in physical activity compared different monitor brands and catalogued pedometers as most frequently used in researches. They are manufactured by Yamax, Omron and Sportline (Le Masurier et al. 2003). OHJ and OII gave mean values that where ±1% of actual steps at any speed except 64 m*min^{-1} where OII provided ±2% of actual steps. YSW gave mean values that were ±1% at 80 m*min-1 and above, which agrees with previous study (Crouter et al. 2003). In slow speeds, pedometers are not as accurate as they are in higher speeds. Both Omron monitor sensors provide accurate values in measuring steps at any speed, indicating that these two monitors are a good choice of measuring physical activity.

Conclusion

In conclusion, the present study shows that there are differences between models in pedometer measures under control conditions. OHJ and OII appear to be accurate at any speed and YSW provide accurate values at 64 m*min^{-1} and above.

Applications

In the present study OHJ and OII appear to be more accurate in measuring steps. These two monitor sensors have the ability to record not only steps but they can also predict distance and energy expenditure. It would be useful in a future study to examine the accuracy and to compare these two pedometers with other which can estimate and record more data.

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