SHORT REPORT

Validity of the inexpensive Stepping Meter in counting steps in free living conditions: a pilot study

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Br J Sports Med 2006;40:714–716. doi: 10.1136/bjsm.2005.025296

Objectives: To evaluate if inexpensive Stepping Meters are valid in counting steps in adults in free living conditions.

Methods: For six days, 35 healthy volunteers wore a criterion Yamax Digiwalker and five Stepping Meters every day until all 973 pedometers had been tested. Steps were recorded daily, and the differences between counts from the Digiwalker and the Stepping Meter were expressed as a percentage of the valid value of the Digiwalker step counts. The criterion used to determine if a Stepping Meter was valid was a maximum deviation of 10% from the Digiwalker step counts.

Results: A total of 252 (25.9%) Stepping Meters met the criterion, whereas 74.1% made an overestimation or underestimation of more than 10%. In more than one third (36.6%) of the invalid Stepping Meters, the deviation was greater than 50%. Most (64.8%) of the invalid pedometers overestimated the actual steps taken.

Conclusions: Inexpensive Stepping Meters cannot be used in community interventions as they will give participants the wrong message.

METHODS

Participants and instruments

A convenience sample of 35 healthy adults (nine men, 26 women; 20–60 years of age) volunteered to participate. The body mass index of the total sample was 19.9–26.6 kg/m². The Stepping Meter (fig 1) has a display and reset button on the front and a clip on the back. The validity of this inexpensive pedometer was tested against the Yamax Digiwalker SW-200, one of the best pedometers with regard to accuracy and reliability for counting steps.^{5–8}

Procedures and data analysis

At the start of the study, volunteers were given 30 Stepping Meters, one Yamax Digiwalker, a step count log, and information on correct pedometer use—that is, to be worn on belt or waist band and reset only in the morning. Participants were asked to wear the Yamax Digiwalker and five other Stepping Meters every day. Three pedometers were randomly worn on the right of the front of the body and three on the left. Every evening, the volunteers recorded the number of steps registered on the six pedometers for that day. This procedure was repeated for six days until all the Stepping Meters had been tested. When subjects returned the pedometers and step count log, they were asked if they had any remarks about the pedometer use.

After data collection, the researchers calculated the differences in step counts from the Yamax Digiwalker and the Stepping Meter and expressed them as deviations (%) from the counts from the Digiwalker. The criterion for validity was a maximum deviation of 10%.⁸ A positive deviation reflects an overestimation, and a negative deviation an underestimation.

RESULTS

Because of damage to the display, reset button, or clip before first use, 26 of the 1000 Stepping Meters purchased could not be tested. Figure 2 shows that 25.9% of the Stepping Meters met the criterion of a maximum deviation of 10% from the Yamax Digiwalker counts, whereas 74.1% (721) appeared to give invalid information. About 65% (467) overestimated the step count (mean (SD) overestimation 48.9 (70.5)%; maximum overestimation 1034%). The other 254 pedometers (35.2%) underestimated the step count (mean (SD) underestimation –56.1 (34.18)%; maximum underestimation –100%). In more than one third (36.6%) of the invalid Stepping Meters, the deviation was 50% or more. The magnitude of error, expressed as absolute percentage error (regardless of direction), was 51.4 (60.4)%.

Participants noticed that the Stepping Meter also registered non-stepping movements such as sitting on a chair, twisting the hip, bending over, and kneeling. Furthermore, some participants complained that the Stepping Meter could be unintentionally reset during the day by accidentally pushing the reset button.

With the continued publicity of the “10 000 steps/day” recommendation, pedometers have become very popular. They are used as a monitoring and motivational tool in the promotion of physical activity, and the “10 000 steps” concept has previously been shown to be effective in increasing lifestyle physical activity.^{1,2}

The Department of Movement and Sports Sciences of Ghent University was preparing a large community based physical activity intervention based on, and in cooperation with, “10 000 steps Rockhampton”.³ The Yamax Digiwalker, used in 10 000 steps Rockhampton, was not on the market in Belgium, and, as this type of pedometer is relatively expensive, less expensive alternatives were explored. In Belgium, pedometers gained popularity very recently, and there are some inexpensive models on the market—for example, the Stepping Meter (€1 or \$1.2 each) distributed by Blokker Belgium. It was thought that the 10 000 steps/day campaign in Ghent would be strengthened if these inexpensive pedometers were widely accessible or possibly handed out free. However, before use, their validity needed evaluation. Considering the health related purpose of the pedometer—that is, measurement of needed physical activity—validation was considered essential. Several step counters have been tested for validity and reliability, and it was found that there is considerable variation in accuracy between different brands and types.^{4–8} Therefore the purpose of this pilot study was to evaluate if the inexpensive Stepping Meter is valid in counting steps in adults in free living conditions.

Figure 1 The Stepping Meter.

DISCUSSION

The results of this pilot study illustrate that the inexpensive Stepping Meters provide incorrect information on step counts, which makes them inappropriate for physical activity promotion targets. Only a quarter of the Stepping Meters tested met the criterion of 10% maximum deviation, whereas the other 75% over-counted or under-counted the steps and made a mean absolute error of at least 51.4%. The large range of deviation without any consistency is problematic, as pedometers are used as a device to monitor physical activity. For example, an error of 20% in a 10 000 step day is 2000 steps, so either 8000 or 12 000 steps/day are recorded, which significantly changes the activity level of the user. If the results showed a consistent direction of error—that is, overestimation or underestimation—an adjustment of the recommendation would be sufficient to solve the validity problem. However, the findings show random underestimation.

The choice of a criterion of 10% may be one reason why only 25% of the pedometers tested were valid. However, this criterion was proposed in earlier studies in which different models of pedometers were compared in free living conditions.^{5,8} The positioning of the Stepping Meter can also be questioned. In this study, six pedometers had to be worn at

Figure 2 Percentage deviation of step counts of the Stepping Meters from the Yamax Digiwalker SW-200 step counts.

What is already known on this topic

- Pedometers have become very popular as a monitoring and motivational tool in the promotion of physical activity in adults
- Several pedometers have been tested for validity and reliability and there is considerable variation in accuracy between different types and brands of step counters

What this study adds

- The validity of a large number of inexpensive pedometers in counting steps in adults was evaluated in free living conditions
- The use of inexpensive pedometers should not be recommended because of considerable validity problems, which may damage any investment in good quality pedometers for physical activity health promotion

one time, so only two could be worn right above the knee. However, there is no variation in accuracy for different placements of the Yamax Digiwalker.^{5,7} Finally, any concerns about pedometer inaccuracy in obese people are not relevant because none of the volunteers in this study were obese. Consequently, there must be other explanations for the large differences in step counts.

Most of the Stepping Meters over-counted the steps. As in previous studies,^{5,7,8} assumptions can be made that the sensitivity of the internal mechanism is the main cause of inaccuracy. The threshold needed to trigger a step may be too sensitive and also receptive to non-stepping movements. This overestimation of steps is not consistent, however, as about one third of the Stepping Meters under-counted the steps. An explanation of the underestimations may be inadvertent use of the unprotected reset button of the Stepping Meter. In contrast, the Yamax Digiwalker has a cover to prevent accidental resetting.

Because of the validity problem, the Stepping Meters will not be used for the 10 000 steps/day campaign in Ghent. A pedometer that overestimates the actual steps would incorrectly indicate a healthy lifestyle when 10 000 steps/day are achieved. Using a pedometer that is inaccurate may lead to frustration and potentially low compliance. One may argue that the low validity is not a problem when only the baseline activity level is used. An increase of 2000 steps/day is also protective against chronic diseases.⁹ However, it is not known whether the Stepping Meters are reliable or not. Another type of inexpensive pedometer, McDonald's Stepometer, was previously found to be inaccurate and also inconsistent in step counting.¹⁰ Furthermore, accurate judgment of the baseline steps and a correct comparison with international classifications¹¹ would be impossible.

The wide accessibility of pedometers needs encouragement, but, because of validity problems, the use of an untested inexpensive pedometer is not recommended. The introduction of a quality label given to all valid, accurate, and reliable pedometer types and brands would be useful for researchers and individual users.

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Competing interests: none declared

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Accepted 16 May 2006

Published Online First 21 June 2006

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