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PEDOMETER RESPONSE WHEN RIDING IN A VEHICLE: DOES IT COUNT?

ROBERT W. GOTSHALL, DALE E. DEVOE, TRACY L. NELSON

Department of Health and Exercise Science, Colorado State University

ABSTRACT

PEDOMETER RESPONSE WHEN RIDING IN A VEHICLE: DOES IT COUNT? **Robert W. Gotshall, Dale E. DeVoe, Tracy L. Nelson**. ***JEP*online**. 2003;6(3):9-13. Studies incorporating the use of pedometers intend to count steps, but potentially respond to all ambulatory activity. Wearing a pedometer while riding in a vehicle has the potential to add substantial counts to the daily number of "steps" that are logged by the pedometer. This potential error in data collection has not been quantified. The purpose of this study was to determine the number of steps added to a pedometer worn while riding in an automobile (small sport utility vehicle). There are many confounding variables that can contribute to such error: e.g. type of pavement, type of suspension on the vehicle, kilometers (km) driven, etc. Therefore, an attempt was made to establish a representative sample of riding conditions. Fifteen subjects wore a pedometer at the waist on a belt in line with the toes of the right foot. Subjects rode in groups in a medium-sized sport utility vehicle. A 32.2-km course, approximately 50% in-town driving and 50% country driving, was followed. Total pedometer steps recorded for the 32.2-km course were 87 ± 45 (Mean ± Std. Dev.) "steps" [range: 28 - 156 "steps"], or 2.7 ± 1.4 "steps" per km. Both values were significantly greater than zero ($p<0.05$). Considering an often-stated goal of 10,000 "steps"/day to achieve health benefits, the steps added by vehicle travel in this case were less than 1% (100 steps) of this total. It is concluded that under most normal driving conditions, the steps added by vehicle travel do not contribute substantially to daily "steps", especially when the pedometer is used in an intervention trial where a baseline is established and additional "steps" added as goals to increase physical activity.

Keywords: Physical activity; Fitness; Measurement; Steps/day; Health programs

INTRODUCTION

Pedometers may potentially be used effectively to both assess levels of physical activity in populations (4,5,7,10,13) and/or to serve as goal-setting devices in programs designed to enhance physical activity in populations (11,12). When used in either situation, the validity of the pedometer steps to reflect physical activity is important. Pedometers count “steps”, though it is obvious that other movements may be counted.

Pedometers are potentially sensitive to many ambulatory activities. For example, sport activity may increase the number of steps counted due to a variety of movements during competition. Cycling would be underestimated, as steps would not be counted. Pedometers worn on the waist require the repetitive rocking left-right of the hip to record steps, and cycling does not produce this type of motion. So pedometers would not properly measure the cycling movements of the legs. Therefore, several potential confounding activities should be evaluated independently to determine the magnitude and importance of any error in estimating daily activity or in any goal-based intervention program.

Schonhofer et al. (9) have suggested that movement during automobile travel might be registered as “steps”. Tudor-Locke and Myers (13) also indicate that the potential of vehicle travel as an error source should be identified and the magnitude determined. Any such error created by vehicle travel would depend on many factors including the type and condition of roadway, sudden stops and starts, and subject shifting position within the vehicle. With this in mind, the purpose of this study was to quantify the effect of typical driving conditions on the number of pedometer steps. It was hypothesized that the pedometer steps during vehicle travel would be significantly greater than zero, but unimportant [defined as: less than 100 steps/day] in the daily total of pedometer steps that are measured during physical activity.

METHODS

Following approval of the project by the Colorado State University Human Research Committee, fifteen subjects were recruited by posted flyers from the university community to participate. To participate, subjects had to be able to walk without assistance (e.g. cane) and be able to comfortably ride with the seat belt secured. Signed consent was obtained. Table 1 presents the subject characteristics. The women were shorter and lighter than the men. Body/Mass Index (BMI) were the same for men and women and less than 25. This is important since pedometers may be less accurate on those with a BMI > 30 (13).

Subjects wore a Yamax LS-2100 (Yamax, Tokyo Japan) on a belt at the waist over the toes of the right foot, as per manufacturer’s instructions, and as is typical when using pedometers of this type (13). The Yamax pedometer was more accurate than two other brands at low and moderate activity levels, and similar at higher levels (2). Electronic pedometers use an electronic pendulum to respond to natural hip movements while walking/running to detect steps. Six pedometers were checked for accuracy by comparing actual observer counts of steps to those counted by the pedometer. Six people wore one pedometer each and walked a standard loop inside that included one flight of stairs. Each pedometer demonstrated 100% accuracy over the approximately 600-step course. Pedometers were selected randomly from this pool of six for each ride.

Subjects rode in groups (5 different trips) in a medium-sized sport utility vehicle. The same person drove each time and wore a pedometer one time. Subjects self-selected their position in the vehicle. The pedometers were zeroed once the subject was seated and belted in the vehicle. A 32.2-km (20 mile) course was followed. This course included approximately 50% in-town driving, and 50% country driving. In-town speed averaged 40 kph (25 mph), with approximately 20 starts and stops. Country driving averaged 81 kph (50 mph), with maximal speeds of 97 kph (60 mph). The country route included hills and numerous curves and turns. Road surfaces were paved and in very good condition. At the end of the drive, pedometer steps were logged.

Statistical Analyses

Subject number was determined by power analysis to determine a small effect of treatment (Cohen’s d = 0.25 (3)) with a power of 0.90. All statistics were performed using the NCSS 2000 software (NCSS Statistical Software, Kaysville, UT). An evaluation across trials indicated no effect of trials so all data were combined. The coefficient of variation for “steps” across the 5 rides was 9%. Likewise, position within the vehicle had no effect on steps, so all were combined. Student’s *t*-test was used to evaluate subject characteristics. One-sample *t*-tests were used to test whether pedometer steps were different from zero. Data are presented as mean?standard deviation. Pedometer steps were compared to the stated goal of 10,000 steps/day for health benefits (6,8), by comparing the results to one percent of 10,000 steps to provide the reader with some measure of relative magnitude.

RESULTS

Table 1 presents the subject characteristics. Table 2 shows the total pedometer steps, range, and steps/km over the 32.2 km course. The mean step of 87 was significantly greater than zero ($p<0.05$), and was less than the 1% (100 steps) relative comparison level. The maximal reading of 156 was greater than the 1 % level. Fifty-three percent of subjects fell within ?1 standard deviation of the mean. When evaluating the pedometer steps as "steps-per-km" traveled (Table 2), the mean of 4.4 was greater than zero ($p<0.05$). The maximum was 4.8 steps per km.

Table 1. Subject characteristics.

	Women	Men
n	5	10
Age, yr	32?0.6	34?6
Height, cm	163?3*	175?2
Weight, kg	65?2*	75?2
Body/Mass Index (kg/m^2)	23?2	24?2

Note: Values are mean?standard deviation.
*p<0.05, women vs. men.

Table 2. Total pedometer steps, range of steps, and average steps per kilometer over 32.2 km (20 miles).

	Mean?SD
Total Steps	87?45
Range of Steps	28 - 156
Average Steps per Kilometer	2.7?1.4

Note: Values are mean?standard deviation.

DISCUSSION

This study demonstrated that pedometers registered steps, or "non-steps", during vehicle travel. However, the magnitude of these additional counts is small by comparison to the total number of steps taken per day that represent walking, or similar physical activity. In general, the "error" represented by the automobile travel in this study was less than 1% of the 10,000 steps-per-day targeted in many studies using pedometers to increase physical activity or to measure physical activity so far. This target, 10,000 steps per day, for health benefits has not been empirically evaluated at this time.

However, it is obvious from these data that prolonged automobile travel could add substantial steps, especially if there is significant movement of the vehicle due to type of pavement and/or terrain driven. One author (RWG) wore the pedometer during an off-road excursion in a 4-wheel drive vehicle that lasted about 6 hours. Total pedometer steps under these conditions representing very significant vehicle movement was in excess of 4,000 "steps". The lower limit of physical activity of typical healthy younger adults is typically represented by 7,000 steps/day (13). Thus, the average of 87 "steps" in this study, and the extreme of 4,000 "steps" (personal observation), during automobile travel represent ~1.2 to ~57%, respectively, of the 7,000 steps/day baseline number.

The 32.2-km course used in this study was short of the average number of vehicle kilometers of travel (VKT) by the typical American Driver. According to the US Nationwide Personal Transportation Survey (1) the average daily VKT is 51.5 km. Thus, the number of "steps" recorded by the average person based on this VKT data would be 2.7 "steps" per km times 51.5 km, or 139 "steps". This number is still very low compared to the totals discussed in the previous paragraph.

Typically, vehicle travel will add insignificant numbers to the steps/day total. However, there is a potential for a significant error. Study design and study goals play a major role in how this can be addressed in both research and in intervention programs. Particularly, a question with regard to unusual types of vehicle travel, such as excessive mileage, rough terrain etc., could be added for participant response. Certainly, individual logs of all activities (vehicle travel, sport activities, amusement park rides etc.) that potentially contribute to pedometer steps can be used. Perhaps more useful is to design studies and interventions with baseline collection periods that will include potential confounders, such as vehicle travel, sport participation etc. With the baseline activity established, adding steps/day as a goal to these baseline activity steps becomes a more controllable intervention. This type of research design should be effective in reducing the effect of confounding influences on measured steps/day and providing effective feedback in terms of steps/day as a target with regard to increasing physical activity levels.

In conclusion, as shown in the current study pedometers will sense movement while riding in a vehicle, but in most cases this will not contribute significantly to the total number of steps/day. One potential limitation of the current study is the use of a single type of vehicle, a small sport utility vehicle. This vehicle should represent the middle ground among vehicle types (with a car on the low end and a stiff-suspension vehicle such as a truck on the other end of the spectrum) with potential for inducing passenger movement. Specific driving conditions, such as travel over rough terrain, may increase pedometer step significantly and should be noted. Intervention studies that establish baseline activity and pedometer steps, followed by goal setting by adding step goals, should be more effective in evaluating physical activity assessed with pedometers, with minimal impact from confounding influences such as vehicle travel.

Address for Correspondence: Robert Gotshall, Ph.D., Department of Health and Exercise Science, Colorado State University, Fort Collins, CO 80523-1582; Phone: (970) 491-6374; FAX: (970) 491-0445; E-mail gotshall@cahs.colostate.edu

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