Physical Activity Monitor Recordings are Task and Population Dependent

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Abstract

Activity monitors are commonly placed on the waist. The waist's proximity to the body's center of mass has made it a good predictor of physical activity and energy expenditure in healthy people during whole body movement. It is unclear whether a similar prediction exists for populations with extremely low levels of physical activity. For example, people with peripheral neuropathy (PN) greatly reduce their daily activity because of pain, burning sensations or numbness induced movement impairments. Therefore, placement of activity monitors on the waist may not be appropriate to estimate physical activity/ energy expenditure in this population. Purpose: To compare the activity in people with PN using accelerometry-based activity monitors (AM) to observe differences due to monitor placements. Methods: Five men (Mean±SD: 71±17 yrs, 85.6±10.3 kg, 28.6±3.2 kg/m^2 BMI) and 12 women (72±6 yrs, 71.1±12.0 kg, 27.5±4.3 kg/m^2 BMI) with PN, wear activity monitors while sitting quietly (control condition) or performing simulated daily activities: reading while sitting, floor sweeping, table dusting, laundry folding, bagging groceries, self-selected "slow" (52.6±15.1 m/min) and "brisk" (68.6±14.8 m/min) walking. Each subject was fit with 6 AMs on the left and right ankles, both wrists, and the anterior beltline. Activity data were summarized as mean activity levels (counts/min) for each monitor location and activity. Mean values across the 6 monitor locations were compared using a repeated measures ANOVA within each activity. Results: Mean values obtained by the monitors worn on the wrists were approximately 500-5000% higher than those on the waist and ankles in 5 non-walking tasks (P<0.05). For the walking trials, mean values were about 250% higher at the ankles compared to the waist and wrist values (P<0.05). No significant difference was observed between right and left ankles, wrists, or waist positions. Conclusions: Location of the monitors with the highest activity values was task dependent. Although arm movements were the most active for daily tasks in people with PN, this may not be true in other populations, where daily tasks may be more complex and require greater physical exertion. Future research should focus on considering common daily tasks of a particular population when monitoring physical activity.

Introduction

Peripheral neuropathy (PN) is a pathology associated with damage to the peripheral nerves, causing weakness, numbness, abnormal sensations and/or pain in the extremities. Often of unknown etiology, PN commonly accompanies diseases such as diabetes with a U.S. prevalence of 14.8% in those at least 40 years old. The disease has been referred to as sensory neuropathy due to its profound effect on sensations, especially at the early stages of the disease, although it also affects motor output. With damage beginning in the distal extremities involving large myelinated nerve fibers, common manifestations of PN are lower limb dysfunction. For example, people diagnosed with peripheral neuropathy (PN) have impaired balance and/or locomotion . Deficits in sensory and/or motor systems are blamed for reductions in daily activity for this population, especially activities involving movement of the whole body, thus physical activity.

Electronic activity monitors (AM) are commonly used to monitor free-living bodily movement and estimate the subsequent energy expenditure and/or the amount of physical activity. Common placement is on the waist, close to the body's center of mass, making it a good predictor of physical activity (PA) and energy expenditure in healthy people during whole body movement. Whether waist placement and the associated prediction equations for physical activity are appropriate for populations with extremely low levels of physical activity that are less likely to perform whole body movements, such as with PN, remains to be tested. Moreover, standardized protocols do not exist for determining how many monitors should be worn or the optimal placement of monitors on the body.

The **PURPOSE** of this study was to observe if differences in AM recordings exist due to monitor placement during activities commonly used by this population. Since PN patients restrict daily activities (i.e., those involving whole body movement), we **HYPOTHESIZED** that AM placement on the waist would not provide the most accurate estimate of PA in this population when performing common daily tasks.

Methods

Participants:

Five men (Mean±SD: 71±17 yrs age, 85.6±10.3 kg body mass, 28.6±3.2 kg/m^2 BMI) and 12 women (72±6 yrs, 71.1±12.0 kg, 27.5±4.3 kg/m^2 BMI), all diagnosed with peripheral neuropathy by a physician, volunteered to perform a series of structured activities that simulate activities performed in the home. Each participant was verbally informed of the intent of the experiment and the protocol, as well as providing written informed consent.

Protocol:

Anthropometric data (height and weight), birth date and handedness were recorded for each participant. Medications that may influence heart rate or blood pressure were also documented for each participant.

Each subject was fit with six accelerometry-based activity monitors (AM) (Actical): one on each ankle, wrist, and side of the waist . Wrist and ankle AMs were secured with wristbands, while the hip AMs were secured on beltline with clips.

Each participant performed the following structured activities: (1) sitting quietly (to estimate resting metabolic rate, RMR); (2) newspaper reading while sitting; (3) floor sweeping in a sectioned off area (7 x10) (Fig. 5); (4) table dusting (3.25 x12) (see Fig. 3); (5) laundry folding (Fig. 1); (6) bagging and unbagging groceries (Fig. 4); as well as (7) "slow" (52.6±15.1 m/min) and (8) "brisk" (680.6±14.8 m/min) overground walking (Fig. 2). Participants sat quietly for 15 minutes for the RMR measure while subsequent activities were each performed for five minutes. All activities were separated by 2 minutes of quite standing or sitting. Sitting quietly was always performed first, while activities 2 -8 were performed in a counterbalanced order.

Activity data acquired from the AMs were summarized as mean activity levels (counts/min) for each monitor location and activity for each participant. Mean values across the six monitor locations were compared using repeated measures ANOVA for each activity.

Figure 1. Clothes folding

Figure 2. Overground walking

Figure 3. Table dusting

Figure 4. Bagging and unbagging groceries

Figure 5. Floor sweeping

Results

As shown in the table below, analyses revealed that the wrist monitors had higher activity counts than the ankle and waist monitors during activities 2 -6 (P<0.05). Mean values obtained by the monitors worn on the wrists ranged from approximately 500-5000% higher than those on the waist and ankles for these performances where walking was not the primary activity.

When walking was the primary activity, the ankle monitors had higher activity counts than the wrist and waist monitors (P<0.05). Mean values for these monitors were about 250% higher at the ankles compared to the waist and wrist values for these activities.

No significant differences were identified between right and left sides. It appears that movements at the ankles, wrists, anwaist positions were fairly symmetrical.

Table. Mean Actical activity monitor output

Structured Activity	L-Ankle Actical (counts/min)	R-Ankle Actical (counts/min)	L-Hip Actical (counts/min)	R-Hip Actical (counts/min)	L-Wrist Actical (counts/min)	R-Wrist Actical (counts/min)
(1) Quiet Sitting	1 (1)	0 (0)	< 1 (< 1)	< 1 (< 1)	0 (0)	3 (3)
(2) Newspaper	3 (2)	2 (2)	2 (1)	7 (6)	* 142 (36)	*224 (52)
(3) Floor Sweeping	462 (55)	483 (64)	252 (40)	300 (48)	* 2141 (177)	* 2155 (119)
(4) Table Dusting	243 (34)	291 (57)	177 (26)	195 (31)	* 1487 (328)	* 1077 (220)
(5) Grocery Bagging	65 (13)	162 (100)	80 (13)	105 (25)	* 1841 (188)	* 1926 (160)
(6) Laundry Folding	594(50)	677 (89)	258 (26)	259 (31)	* 2674 (219)	* 2133 (236)
(7) "Slow" Walking	† 3401 (315)	† 3456 (356)	1373 (142)	1477 (142)	1224 (249)	1081 (142)
(8) " Brisk" Walking	† 4547 (304)	† 4678 (367)	2091 (208)	2050 (208)	1723 (282)	1652 (210)

Mean (SE) are shown for each activity and monitor. Output is in counts/min during the 8 structured activities for monitors worn on both left
(L-) and right (R-) ankles and wrists, as well as left and right anterior hip positions along the mid-axillary line.
* Mean Actical values at the wrist significantly higher (P<0.05) than other monitor locations but not different from each other.
? Mean Actical values at the ankle significantly higher (P<0.05) than other monitor locations but not different from each other.

Conclusion

It was found that the highest activity count values depended on the task being completed and on the location of the activity monitor in people with PN. Although count values were not the highest for the waist monitors during these tasks, future research is warranted to determine whether these monitors are better predictors of energy expenditure and physical activity i n this population.