



Full length article

Relationship between ambulatory physical activity assessed by activity trackers and physical frailty among nursing home residents



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ABSTRACT

Backgrounds: The aim of this study was to assess the relationship between the level of ambulatory physical activity, measured by physical activity tracker, and the clinical components of physical frailty, among nursing home residents.

Methods: We proceeded in 3 steps: (1) Validation of the physical activity tracker (i.e. the Pebble): 24 volunteer adults walked on a treadmill. The number of steps recorded by the Pebble worn by the subjects was compared with the number of steps counted by the investigators, by means of the Intra-class correlation coefficients (ICC). (2) Measurement of ambulatory physical activity, using the Pebble trackers, over a 7-day period. (3) Relationship between the results obtained with the Pebble trackers (step 2) and subjects' clinical characteristics, linked to physical frailty.

Results: ICC data, showed that the reliability of the Pebble was better when it was worn at the foot level (ICC ranged from 0.60 to 0.93 depending on the tested speed). Gait speed is also an important determinant of the reliability, which is better for low gait speed. On average, the 27 nursing home residents included in the second step of this study walked 1678.4 ± 1621 (median = 1300) steps per day. Most physical components of frailty measured in this study were significantly different between subjects who walked less than 1300 steps per day and those who were more active.

Conclusion: This study showed that nursing home residents have a poor ambulatory physical activity, assessed using a physical activity tracker, which is associated with poorer physical performances and higher disability.

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1. Introduction

Aging is accompanied by a steady decline in physical activity [1]. This is an important public health concern because sedentary behavior is a strong risk for chronic diseases, disability, physical frailty and even death [2,3]. It has been recognized that physical activity can have a positive impact on these adverse health outcomes [1]. Therefore, many scientific societies recommend reaching a minimum level of physical activity per week. Physical activity consists not only of sport activities but includes also activities of daily living and movement. Although physicians

recognize the importance of physical activity for elderly people, few have incorporated physical activity counseling into routine clinic visits [4]. One barrier has been the paucity of means to objectively assess physical activity pattern [5]. Nevertheless, activity trackers are becoming increasingly more widespread, affordable [6] and used by clinicians and patients to measure physical activity. These tools have evolved over time from relatively simple mechanical pedometers to more complex accelerometers [7]. Pedometer accuracy is compromised in recording slow walking speed [8,9] and may be a serious limitation when monitoring activity in specific population, such as frail elderly. To ensure the applicability of this kind of activity tracker across age groups, it is critical to assess the validity of the device at multiple speeds and positions of wear prior to use [2]. Thus, the first objective of this study was to assess the validity and reliability of a new activity tracker, in a population of young and elderly

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adults, during a treadmill walking at multiple speeds (corresponding to slow, median and fast gait speed in elderly) and positions of wear. After the validation of the activity tracker, the second objective of the study was to measure precisely ambulatory physical activity of elderly, in nursing home settings. The third objective of this study was to assess the relationship between the measured level of ambulatory physical activity and the clinical components of physical frailty, among nursing home residents. The data presented and discussed in this article could fill a gap in the literature where few precise data exist on the extent of physical activity in nursing home.

2. Methods

2.1. Step 1: validation of the physical activity tracker (i.e. the pebble)

2.1.1. Study design

This is a cross sectional study performed among volunteer adults in order to validate the Pebble in the general population, so that this accelerometer could be used in different populations. A convenience sample of 24 volunteers was recruited, respecting equity between men and women (50% of women) and between young (12 subjects aged below 65 years) and older adults (12 subjects aged 65 years or older). Volunteers with the ability to ambulate continuously on a treadmill unaided for 30–45 min were included. Exclusion criteria consisted of any neurological disorder, cognitive disorder, recent musculoskeletal injury or surgery that would impair motor function. Informed consent was obtained from all participants. Ethics approval was obtained from the Medical Ethics Committee of the University of Liège under the number 2013/178.

2.1.2. The pebble

The Pebble+ (FitLinxx Global Headquarters, Shelton CT 06484, US) is an all-day activity monitor. It clips to an individual's shoe or waistband, blending seamlessly into daily life. The Pebble activity tracker utilizes a 3-axis accelerometer and patented technology to measure patterns of motion, producing a unique waveform signature. It uses this signature in a series of intelligent algorithms that dynamically adjust based on the type of motion detected, providing accurate, verifiable activity data for users of all ages and activity levels. The device determines total steps, activity time and individual's speed, which can be used to calculate distance and caloric burn.

2.1.3. Treadmill walking protocol

Participants were instructed in the use of the treadmill prior to the beginning of the protocol. Then, participants walked on the treadmill at predetermined speeds (set on the treadmill 2.5 km/h (0.7m/s); 4 km/h (1.1m/s) and 5.5 km/h (1.5m/s)) for 15 min at each speed. According to Mondero–Odasso, these gait speeds correspond to slow gait speed, average gait speed and fast gait speed, respectively, among the elderly [10]. These results are consistent with our previous study performed in nursing home (i.e. the SENIOR cohort) in which we showed that pre-frail subjects had a gait speed of 0.75 m/s and robust subjects had a gait speed of 1.04 m/s on average [11]. Moreover, the speeds of 4 km/h and 5.5 km/h are often used in validation studies performed in the adult population [2,12]. In the present study, persons under 30 years realized the test at the 3 speeds while people over 65 years old only realized the tests at the first 2 speeds because all these people were not able to walk at the fastest speed. Meanwhile, an observer manually counted the participants' steps. The walking test was also filmed by a camera to ensure that the number of steps counted was appropriate. A rest of approximately 1 min between two periods of walking was observed. For the test, two Pebbles

were positioned according to the manufacturer's recommendation on both right ankle and right hip. In practice, the devices were attached to the subject's shoe and waistband. After each session of 15 min, the treadmill was stopped and the Pebbles removed.

2.1.4. Statistical analysis

All descriptive data are presented as mean and standard deviation. To investigate the device validity, we assessed the level of agreement, between the number of steps estimated by the Pebble and counted by the investigator, using Intra-class Correlation coefficients (ICC). The relative reliability of the Pebble, compared to the reference (counted steps), was assessed by means of the ICC. The closer the coefficient is to 1, the higher is the reliability. We considered an ICC over 0.90 as very high, between 0.70 and 0.89 as high and between 0.50 and 0.69 as moderate [13]. All calculations were performed using SAS statistical package (version 9.3 for windows) and R statistical packages.

2.2. Step 2: measurement of ambulatory physical activity, using the pebble trackers, over a 7-day period, among nursing home residents

2.2.1. Study design

This is a cross sectional study performed in a nursing home in the area of Liège. The study population consisted of nursing home residents from "les cheveux d'Argent". Inclusion criteria were (1) to be aged 65 or over, (2) to be able to stand up and to walk (technical assistance authorized), (3) and to have given written informed consent. Disoriented patients were excluded from the study. Patient with an occasional and temporary dysfunction were also excluded. Specify that no subject included in this step had participated to the first step (validation of the pebble).

2.2.2. Data collected

Subjects were asked to wear the Pebble for 7 consecutive days. It was attached on the residents' shoe and recorded the number of steps. Demographic characteristics of the subjects were also collected: age, sex, need of care, Body mass Index (BMI), walking assistance and physiotherapy. The period of 7 days was chosen to be representative of the physical activity of the residents. Indeed, in nursing home, daily activities are similar from a week to another. Moreover, it was important to take into account the week and the week-end.

2.2.3. Statistical analysis

The data recorded by the pebble were transferred to the « Actihealth » platform using wireless. Actihealth presents the data in table form (per patient, per day, per week, per hour, . . .). The number of steps walked by each resident was expressed as mean and standard deviation. Subjects were then divided into two groups based on the median number of steps in the study population.

2.3. Step 3: relationship between results obtained with the pebble trackers (in step 2) and subjects' clinical characteristics, linked to physical frailty

2.3.1. Study design

This is a cross sectional study performed in a nursing home in the area of Liège. The study population consisted of the residents who wore the Pebble in step 2.

2.3.2. Data collected

In addition to the number of steps taken by the residents recorded by the Pebble, a large number of variables related to physical frailty were collected:

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