



Effect of wrist-worn activity monitor feedback on physical activity behavior: A randomized controlled trial in Finnish young men

Anna-Maiju Jauho^{a,b,c,*}, Riitta Pyky^{a,c,d,e}, Riikka Ahola^{a,d}, Maarit Kangas^{a,d}, Paula Virtanen^f, Raija Korpelainen^{c,d,e}, Timo Jämsä^{a,b,d}

^a Medical Imaging, Physics and Technology Research Group, PO Box 5000, 90014, University of Oulu, Finland

^b Infotech Oulu, PO Box 4500, 90014, University of Oulu, Finland

^c Oulu Deaconess Institute, Department of Sports and Exercise Medicine, Albertinkatu 18 A, 90100 Oulu, Finland

^d Medical Research Center, Oulu University Hospital, University of Oulu, Oulu, Finland

^e Center for Life Course and Systems Epidemiology (CLCE), PO Box 5000, 90014, University of Oulu, Finland

^f Polar Electro, Professorintie 5, 90440 Kempele, Finland

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ABSTRACT

The purpose of this study is to evaluate whether the use of an activity monitor providing feedback has an effect on physical activity (PA) in young men. A population-based sample of 276 conscription-aged (mean = 17.9, SD = 0.7 years) men participated in a 3-month randomized controlled trial in Oulu in 2012. Participants were randomized to an intervention group (INT, N = 137) and a control group (CON, N = 139). INT received a wrist-worn monitor (Polar Active) showing daily activity, and CON received identical monitors without feedback. Main outcome was the change from baseline in objectively measured weekly time spent in moderate-to-vigorous PA (MVPA) and sedentary activity (SED), as assessed by generalized estimation equations (GEE). Other lifestyle factors were assessed by a questionnaire at baseline and at 3 months. Weekly physical activity data (≥ 4 days with ≥ 8 h each) were obtained from 72 (53%) and 90 (65%) men in the INT and CON, respectively. Based on GEE, time spent in MVPA increased ($p = 0.012$) and SED decreased ($p = 0.032$) in the INT compared with the CON. During the first 7 weeks, the INT spent on average 1 h less sedentary than the CON (t-test, $p < 0.05$). During the first week, the INT showed 12 minutes more MVPA compared to the CON (t-test, $p = 0.034$). Based on questionnaire data, the proportion of the most sedentary men decreased in the INT (Wilcoxon test, 28% vs. 10%, $p = 0.029$), with no change in the CON (20% vs. 19%, $p = 0.546$). To conclude, a wrist-worn activity monitor providing feedback had a short-term positive effect on PA and SED in young men.

Trial registration. This is a pilot study for a larger randomized controlled trial registered to the clinical trials register NCT01376986.

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Introduction

Evidence for the role of physical activity (PA) on health and well-being has increased recently. PA is positively associated with decreased risk of all-cause mortality and several diseases, and it has been estimated that physical inactivity causes 9% of premature mortality (Lee et al., 2012). Even relatively small increases in overall daily PA have been suggested to be associated with health benefits (Wen et al., 2011). In

addition, light PA, such as standing and slow walking, has been shown to have positive effects on health (Carson et al., 2013; Levine, 2007).

According to the current PA recommendations, young people under the age of 18 years should accumulate at least 60 min of moderate-to-vigorous PA (MVPA) daily (World Health Organization, 2010). A majority of young people does not meet these recommendations (Ekelund et al., 2011; Hallal et al., 2012), and after the age of 12 a marked decline in PA seems to occur, especially in Finland where 50% of all primary school children (7–12 years) reach the PA recommendations (Ministry of Social Affairs and Health, Finland, 2013; Telama and Yang, 2000). At the lower secondary level (13–16 years) the proportion was 17% and among the 16- to 19-year-olds 9% only (Ministry of Social Affairs and Health, Finland, 2013).

Sedentary behavior has been suggested to have an independent effect on health irrespective of the amount of PA (Matthews et al.,

* Corresponding author at: Medical Imaging, Physics and Technology Research Group, PO Box 5000, 90014, University of Oulu, Finland.

E-mail addresses: anna.jauho@oulu.fi (A.-M. Jauho), riitta.pyky@odl.fi (R. Pyky), riikka.ahola@oulu.fi (R. Ahola), maarit.kangas@oulu.fi (M. Kangas), paula.virtanen@polar.com (P. Virtanen), raija.korpelainen@odl.fi (R. Korpelainen), timo.jamsa@oulu.fi (T. Jämsä).

2012a; Santos et al., 2014; Sisson et al., 2009). In the United States the most sedentary age group was shown to be 16–19 years, spending approximately 60% of their waking hours sitting (Matthews et al., 2008).

It is known that self-reports overestimate the amount of PA and underestimate light activity and sitting (Shephard, 2003; Slootmaker et al., 2009). However self-reports give valuable information concerning the type and context of PA behavior which has been shown to be associated with self-perceived health, especially among active young men (Piko, 2000). A positive association has also been found between self-perceived health and self-perceived fitness (Lamb, 1992).

Previous studies among adults and young people suggest that the self-monitoring of PA with a self-report or pedometer is associated with improved awareness and increase in PA (Bravata et al., 2007; Conroy et al., 2011; Lubans et al., 2009). In addition to feedback of activity, goal setting appears to be an important component of PA interventions (Bravata et al., 2007; Conroy et al., 2011; Lubans et al., 2009). Wearable accelerometer-based activity monitors provide the intensity, frequency, and duration of PA (Matthews et al., 2012b; Trost et al., 2005), but activity monitors can also be used as a motivation method toward a more active lifestyle. Some previous interventions among adults have used accelerometers with feedback to motivate participants and to assess their compliance with program goals (Fitzsimons et al., 2013; Godino et al., 2013). However, to our knowledge, there are no studies on the independent role of continuous feedback provided by accelerometers in PA behavior among young men.

This is a pilot study of a larger multidisciplinary MOPO study (Ahola et al., 2013). MOPO study aims to promote the health and well-being of young men by motivating them to adopt a more active lifestyle through a novel activation method that includes feedback on PA. The aim of the current study is to evaluate whether the use of a wrist-worn PA monitor providing feedback of activity has an effect on PA and sedentary time in a population-based sample of young men. Our hypothesis is that PA monitoring with feedback of activity increases PA in young men.

Material and methods

Design

The study design is a 3-month, parallel group randomized controlled trial in which young men were allocated (allocation ratio 1:1) to receive either no intervention (control group) or objectively measured, continuous feedback on their PA. The primary outcome measure was change in time spent in intensities of MVPA and sedentary activity.

Subjects

The participants were recruited at the annual military call-ups in the city of Oulu in September 2012. In Finland, the call-ups are mandatory for all men the year they reach the age of 18 years. All 1262 young men participating in the call-ups were invited to the study to go through physical performance measurements and fill in a health and lifestyle questionnaire. Finally, 778 men were measured, and 856 filled in the questionnaire, after which all volunteers ($N = 276$, mean age 17.9, SD 0.7 years) were recruited for a 3-month, randomized controlled physical activity trial.

At the call-ups, the subjects were provided written and oral information about the study, and a written consent was obtained. The study was compiled in accordance to the Declaration of Helsinki. A statement in favor of the study was received from the local Ethics Committee.

Intervention

The participants were randomized to an intervention ($n = 137$) and a control ($n = 139$) group. Randomization was performed after recruitment and it was conducted by an assistant who was involved neither in

the trial nor in the data collection and analysis. A list of computer-generated random numbers in blocks of 10 was used. Each participant received sequentially the next random assignment in the list. The subjects in the intervention group were given a wrist-worn watch-style PA monitor (Polar Active, Polar Electro, Finland) by default displaying the accumulated daily MVPA time. The time spent on different PA levels, steps, and calories for each day were also available for the user. The control group subjects continued their normal life and they were given otherwise similar but blinded devices providing only the time of day. The trial began immediately after the military call-ups without set routine.

Experimental

Objective measurement of physical activity

PA and sedentary behavior were objectively measured by Polar Active which is a waterproof uniaxial accelerometer with a 21-day memory. The participants in both groups were advised to wear the device on the non-dominating wrist at least for all waking hours and to provide data to the research database through Polar FlowLink® (Polar Electro) at least every 3 weeks. Using sex, age, weight, and height as input, Polar Active calculates the acceleration signals to metabolic equivalents (MET) with the epoch length of 30 s and provides time spent in five activity levels (1–2 MET, 2–3.5 MET, 3.5–5 MET, 5–8 MET, and >8 MET). Polar Active has been shown to correlate ($R^2 = 0.74$) with the doubly labeled water technique while assessing energy expenditure (EE) over a 7-day military training period (Kinnunen et al., 2012). A high correlation ($r = 0.987$, $p < 0.001$) has also been obtained between EE obtained with Polar Active prototype and indirect calorimetry during a 9.7-km hike (Brugniaux et al., 2010).

At least four valid days out of seven were required to be included in the analysis for each week. A valid day consisted of at least 8 h of monitoring. Weekly averages starting from the next day when the monitor was given (7-day averages) were calculated for time spent in MVPA (>3.5 MET), light PA (2–3.5 MET), and sedentary behaviors (1–2 MET) for both groups.

Physical performance measurements

At the baseline and at the end of the trial, physical performance was measured. Because of the tight call-up day schedule set by the Finnish Defence Forces and the large study population, a convenient but reliable set of measurements was chosen.

Height was measured with a ruler and waist circumference was measured midway between the lowest rib and the iliac crest with an accuracy of 0.5 cm. Body composition (body mass index, fat free mass, body fat percentage) and weight were assessed by bioelectrical impedance assessment using InBody720 (Biospace Co., Ltd., Seoul, Korea). Bilateral maximal isometric grip strength was measured with a dynamometer (SAEHAN Corporation, Korea) (Bohannon, 2012). The subject was standing legs apart and elbow at a 90° angle and was advised to grip the instrument with maximum strength. The best result of two attempts per hand was recorded. The mean value of both hands was used. Polar Fitness Test (Polar Electro, Finland) was used to evaluate aerobic fitness (Väinämö et al., 1996). The test was conducted using FT80 heart rate monitor (Polar Electro, Finland) with the subject resting for 5 min. The test predicts maximal oxygen uptake (ml/kg/min) based on resting heart rate, heart rate variability, gender, age, height, body weight, and self-estimated PA level. Polar Fitness Test has been compared with ergospirometry for measuring aerobic fitness with high correlation (0.96) and high accuracy (mean error 6.5%) (Väinämö et al., 1996). In addition, the method has been shown to associate with both self-perceived fitness and self-reported PA in a large population study (Borodulin et al., 2004, 2005).

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