

HABITUAL PHYSICAL ACTIVITY IN ADULTS MEASURED BY ACCELEROMETER IN COMPLIANCE WITH SELECTED HEALTH RECOMMENDATIONS

Małgorzata Dębska,^{1, A, B, C, D} Władysław Mynarski,^{1, A, B, D} Michał Rozpara,^{1, B, C}
Daniel Puciato^{2, D}

¹ Faculty of Physical Activity, Department of Tourism and Health-Oriented Physical Activity, The Jerzy Kukuczka Academy of Physical Education, Katowice, Poland

² Faculty of Physical Activity and Physiotherapy, Institute of Tourism and Leisure, University of Technology, Opole, Poland

^A Study Design; ^B Data Collection; ^C Statistical Analysis; ^D Manuscript Preparation

Address for correspondence:

Małgorzata Dębska, PhD
The Jerzy Kukuczka Academy of Physical Education,
Department of Tourism and Health-Oriented Physical Activity
Mikolowska 72A, 40-065 Katowice, Poland
E-mail: mal.debska@interia.pl

Abstract The aim of the present study was the evaluation of habitual physical activity in adult members of health promoting associations in compliance with selected health recommendations. Physical activity was monitored for 7 consecutive days using accelerometer ActiGraph GT3X+. It was observed that the percentages of individuals with sufficient physical activity differ depending on health-oriented recommendation used in the evaluation. The results indicated that despite appropriate weekly volume of physical activity expressed in energy expenditure (on the average, twice as high as the recommended minimum) and the number of steps taken daily, the prevailing majority of participants (60%) demonstrated an inadequate level of it when assessed in the context of recommendation by World Health Organization.

Key words accelerometry, health recommendations, physical activity associations, adults

Introduction

Reasonable physical activity (PA) has positive impact on the functioning of human body, with the positive changes in individual systems and organs occurring, due to both aerobic or anaerobic physical efforts. Regular aerobic physical activity causes positive adaptive changes in the cardiorespiratory system and in metabolic processes. By contrast, regular anaerobic exercise primarily stimulates adaptive functions of the locomotor system and increases muscular strength and enhances the osteoarticular system (Li, Siegrist, 2012; Molmen-Hansen, Stolen, Tjonna, Aamot, Ekeberg, Tyldum, 2012; Westcott, 2012, Van Roie, Delecluse, Coudyzer, Boonen, Bautmans, 2013)

Physical activity has a comprehensive positive impact on human body only when it meets certain quantitative and qualitative characteristics. Major quantitative PA characteristics is its volume indexed by the duration, energy expenditure, and distance covered, among other things. An important qualitative PA characteristic is its intensity, looking at: the pace of activity, the number of the Metabolic Equivalents of Task (MET), post-exertion heart rate (HR), level of fatigue and other factors.

Characteristics necessary for one's health to improve are referred to in the global body of research as health recommendations. Any health recommendation may be defined on the basis of a single PA characteristic such as the number of steps – 7,500 steps a day, energy expenditure connected to PA – 2,000 kcal/week or two or more characteristics, e.g. the duration and intensity of an activity – 5×30 minutes \times 4–6 METs (Tudor-Locke, Hatano, Pangrazi, Kang, 2008; Tudor-Locke et al., 2011; Rahl, 2010). The most frequently discussed recommendations for PA characteristics as regards health benefits have been thoroughly reviewed in Rahl's research (2010).

The varying general or specific nature of particular recommendations and differences between PA characteristics that these recommendations are based on inevitably raise the question of the agreement between assessments of individual's PA models against different recommendations. It is not by coincidence that results of individual's habitual PA in compliance with diverse health recommendations examinations have recently been presented in specialist literature (El Ansari, Khalil, Crone, Stock, 2014; Martinez-Gomez et al., 2010). No research projects such as those have been carried out in Poland yet.

The aim of the present study was the evaluation of habitual physical activity in adult members of health promoting associations in compliance with selected health recommendations. We wanted to answer the following questions in this manuscript:

1. Does the majority of members of examined associations meet the physical activity health recommendations?
2. Do various criteria of physical activity evaluation (weekly energy expenditure on PA, number of steps taken, duration of moderate-to-vigorous PA) differentiate the percentages of subjects meeting them?

Materials and methods

The study was approved by Jerzy Kukuczka Academy of Physical Education Research and Ethics Committee (2/2012). All subjects have provided written consent for the use of information collected during examination.

This study involved 50 participants: 16 women and 34 men – members of health promoting associations in Dąbrowski Basin (Poland). The selection of the study group was intentional – we assumed that members of above-mentioned associations were more physically active than general population. The majority of participants had a normal physique (BM 57.9 ± 7.5 [kg] in women and 74.2 ± 8.9 [kg] in men, BF 21.9 ± 6.6 [%] in women and 14.5 ± 6.0 [%] in men, BMI 21.9 ± 2.5 in women and 23.6 ± 2.8 in men, WHR 0.79 ± 0.05 in women and 0.89 ± 0.06 in men).

Data was collected with the use of indirect observation as a method and accelerometry as the technology. PA characteristics were assessed for 7 consecutive days using accelerometer ActiGraph GT3X+ in April and May 2014. The prevailing form of activity undertaken by members of examined associations was jogging.

The below characteristics of basic weekly physical activity were measured:

- the number of steps taken for 7 consecutive days of the monitoring,
- weekly energy expenditure on PA [kcal/week],
- weekly duration of total moderate physical activity (MPA [min]),
- weekly duration of moderate physical activity accumulated in 10 minute bouts (MPA in 10 min. bouts [min]),

- weekly duration of total vigorous physical activity (VPA [min])
- weekly duration of vigorous physical activity accumulated in 10 minute bouts (VPA in 10 min. bouts [min]).

The values of those variables were evaluated in the context of recommended weekly energy expenditure on PA (respecting global volume of PA) (Paffenbarger, Hyde, Wing, 1990) daily number of steps (respecting global volume and frequency of PA (Tudor-Locke, Hatano, Pangrazi, Kang, 2008, Tudor-Locke, Hatano, Pangrazi, Kang, 2011) and the duration of moderate-to-vigorous PA as recommended by World Health Organization (WHO, 2010).

For that purpose, the data was compared with:

1. Recommended weekly energy expenditure on PA, which should be the minimum of 2,000 kcal in any 20–59 year-old with a body mass of 70 kg (Paffenbarger, Hyde, Wing 1990). Individual values of it were derived with the following formula:

$$RWE = 2,000 \text{ [kcal/week]} \times \text{BM [kg]} / 70 \text{ kg,}$$

where: RWE – recommended weekly energy expenditure [kcal/week] on PA in people aged 20–59,

BM – body mass (kg).

2. The five-step scale of physical activity by Tudor-Locke et al. (2011), who defined the following classification of the individual's PA volume based on the number of steps taken daily: 5,000 – individuals with sedentary lifestyles, 5,000-7,499 – individuals with low PA, 7,500–9,999 – individuals with moderately active lifestyles, 10,000–12,499 – individuals with high PA (the minimum for health benefits to occur), $\geq 12,500$ – individuals with very high PA.
3. WHO's recommendation, providing that the individual should engage in at least 150 minutes of aerobic MPA per week or at least 75 minutes of aerobic VPA per week or an equivalent combination of moderate and vigorous intensity activity just to sustain or improve health (150 min MVPA). This physical activity should be accumulated in bouts of at least 10 minutes (WHO, 2010).

The principal descriptive statistics (\bar{x} , SD, max, min) of analyzed variables and percentage rates (%) of participants satisfying and not satisfying PA health recommendations were calculated in Statistica 10 Statsoft Inc.

Results

Individually estimated recommended weekly energy expenditure on PA ranged from 1377 to 2797 [kcal]. The actual value of this parameter estimated from accelerometer was between 1443 to 8522 [kcal]. On the average, the participants expended 4,257.2 [kcal] on physical activity per week, more than twice as much as the minimum recommended for the individual to sustain or improve their health (Table 1). The mean weekly duration of MPA (735.2 \pm 337.1 [min]) was more than eight times longer than VPA (83.8 \pm 81.5 [min]). Meeting the criterion of accumulating PA in at least 10 min. bouts reduced MPA volume throughout the week five times (137.8 \pm 124.0 [min]). Vigorous physical efforts with such a minimum duration (VPA in 10 min. bouts) occurred in less than half of all participants (20) (Table 1).

All men and women (100%) demonstrated proper weekly PA volume expressed in energy expenditure [kcal]. The prevailing majority of participants (98%) took recommended number of steps (10,000) each day, a criterion was not fulfilled by just 2% of all participants (1 woman) (Table 2). Less than half of all subjects (40%) satisfied WHO's recommendation for the weekly volume of PA specified as total duration time and intensity (150 minutes of MVPA [min/week]). This guideline was met merely by 41.2% of men and 37.5% of women (Table 2).

Table 1. The principal characteristics of participants' physical activity

Variable	n	$\bar{x} \pm SD$	min–max
Weekly energy expenditure on PA [kcal/week]	50	4257.2 \pm 1628.8	1443.0–8522.0
RWEE on PA [kcal/week]	50	1989.0 \pm 330.9	1377.0–2797.0
Number of steps taken daily	50	10653.0 \pm 4000	6732.4–25404.3
MPA [min/week]	50	735.2 \pm 337.1	311.0–1864.0
MPA in 10 min. bouts [min/week]	47	137.8 \pm 124.0	10.0–388.0
VPA [min/week]	48	83.8 \pm 81.5	2.0–349.0
VPA in 10 min. bouts [min/week]	20	101.6 \pm 85.5	11.0–296.0

RWEE – recommended weekly energy expenditure, MPA – moderate physical activity, VPA – vigorous physical activity.

The reason why the majority of participants failed to satisfy recommendation by WHO was that they rarely took up activities accumulated in at least 10 minutes bouts – a precondition defined in this health-oriented guideline. An evident trend was observed that the degree to which all health-oriented PA recommendations considered in this study were fulfilled in men was slightly higher than in women (Table 2).

Table 2. Compliance with selected health recommendations for physical activity

Recommendation	Women	Men	General
Recommended weekly energy expenditure on PA (Paffenbarger i in., 1990)	(16) 100%	(34) 100%	(50) 100%
7.500 steps each day (Tudor-Locke et al., 2011)	(15) 93.8%	(34) 100%	(49) 98%
150 min MPA or 75 min VPA or equivalent (WHO, 2010)	(6) 37.5%	(14) 41.2%	(20) 40%

Discussion

The aim of this study was to investigate habitual physical activity in members of health promoting associations in compliance with basic health recommendations. The evaluation of physical activity in the context of getting health benefits in members of such associations has not been the aim of domestic studies yet.

The prevailing number of domestic studies related to PA assessment are conducted with the use of subjective methods (Bergier, Bergier, Soroka, Kubińska, 2010; Biernat, Piątkowska, 2012; Nawrocka, Prończuk, Mynarski, Garbaciak, 2012). These methods consist in estimating PA parameters from questionnaires and their results tend to be overestimated (Biernat, 2011, Pate et al., 2015). In our research, we used the three-axial accelerometer ActiGraph GT3X+ in order to raise the quality of results of PA monitoring. Objective tools of PA assessment, which validity and reliability are high (Lipert, Jegier, 2009; Rothney, Brychta, Meade, Chen, Buchowski, 2010; Butte, Ekelund, Westertep, 2012; Thomas, Silverman, Nelson, 2015), are commonly used by foreign researchers (Colley et al., 2011, Ruiz et al., 2011, Evenson, Buchner, Morland, 2012; Sheers, Philippaerts, Lefevre, 2013; Mutikainen, Helander, Pietilä, Korhonen, Kujala, 2014). In Poland, research on PA characteristics based on impartial measurement tools is still scarce (Mynarski, Nawrocka, Rozpara, Garbaciak, 2012; Włodarek, Majkowski, Majkowska, 2012).

The results of our research indicated that the weekly energy expenditure on habitual physical activity among examined members of health promoting associations was high, because it exceeded on average twice the recommended level (RWE). Additionally during the week of monitoring, a vast majority of participants (98%) took an adequate number of steps to fulfill the recommendation by Tudor-Locke et al. (2011). The results of authors' own research are pretty optimistic in the light of those demonstrated in another researches (Chastin et al., 2009; Bassett, Wyatt, Thompson, Peters, Hill, 2010; Hirvensalo et al., 2011; Biernat, 2011; Colley et al., 2011; Pate et al., 2015). The possible reason of that is the fact that our study looked exclusively on members of health promoting associations, who seem to be more physically active than the general population.

Despite high weekly energy expenditure on PA and number of steps taken less than half of participants (40%) met the criterion of recommended weekly duration of moderate-to-vigorous PA in the context of WHO guideline. It indicates that low intensity physical activity was dominant in the members of examined associations' typical week. The percentage rate of individuals meeting WHO criterion of PA was high in comparison with the results of Canadians conducted by Colley et al. (2011) (15,5%) and similar to these indicated in Finnish employees by Multikainen et al. (42%) (2014). It should be emphasized that citizens of above mentioned countries are recognized as one of the most physically active all over the world. More optimistic results (73%) were indicated in Flemish by Scheers et al. (2013).

The main reason for the high percentage rate of men and women not satisfying health recommendations for PA as defined by WHO was that the activities undertaken by research participants were rarely accumulated in minimum 10 minutes bouts (WHO, 2010).

What points to that are authors' own observations, as only 40% of women and men participating in this study satisfied WHO PA recommendation (including duration and intensity 150 min MVPA), whilst regarding less complex criteria by Paffenbarger et al. (1990) (including only volume) or Tudor-Locke et al. (2011) (including volume and frequency) all of them or mostly all meet health-oriented recommendation. The consequences of various basic criteria of physical activity assessment, included in health-oriented recommendations, are quite significant differences in PA evaluation even in the same study group (percentages of compliance with PA guidelines are unlike). A similar trend was observed in research conducted by Chastin et al. (2009), Scheers et al. (2013) and Chaix et al. (2014) where the degree to which a PA recommendation was satisfied differed depending on the criterion used in the evaluation. There are still only few publications investigating this problem.

In relation to the results of this manuscript and the fact of existing diversified criteria of health-oriented PA assessment, it seems to be important to evaluate habitual PA of certain social group in compliance with different recommendations simultaneously in order to receive an overview of the proportion of people being sufficiently active.

Conclusions

The aim of this study was to investigate habitual physical activity in adult members of health promoting associations in compliance with selected PA characteristics recommended for health benefits to occur. The below conclusions summarize the results of this study:

1. Despite appropriate weekly volume of PA expressed as energy expenditure (on the average, twice as high as the recommended minimum) and the number of steps, the prevailing majority of participants demonstrated an inadequate level of PA when assessed according to WHO's recommendation.

2. It was observed that the percentage rate of individuals with appropriate physical activity differs depending on the criterion used in the evaluation.

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