Advances in Science and Technology Research Journal
Volume 7, No. 18, June 2013, pp. 36–44
DOI: 10.5604/20804075.1049601

Original Article

POSSIBILITIES OF USING THE SENSEWEAR MOBILE MONITOR IN THE ASSESSMENT OF THE PHYSICAL ACTIVITY

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Received: 2013.04.19
Accepted: 2013.05.13
Published: 2013.06.10

ABSTRACT

The aim of the presented case study analysis was to present the possibilities of using the SenseWear PRO3 Armband mobile monitor in the assessment of physical activities. During the measurement, the SenseWear PRO3 Armband recorded the following parameters: total energy expenditure [kcal], average METs (for the whole analyzed period) [-], number of steps [-], active energy expenditure [kcal], lying down duration [min], sleep duration [min], sedentary physical activity duration [min], physical activity duration [min], including moderate physical activity duration [min], vigorous physical activity duration [min] and very vigorous physical activity duration [min]. The results for chosen participant were analyzed – in various periods of time (for the 24 on-body hours session of wearing the SenseWear PRO3 Armband and the whole session), as well as for basic and broaden analysis. The graphical reports from the sessions were also presented. It was concluded that the SenseWear PRO3 Armband device is a valuable tool in everyday medical practice to specify the physical activity of individuals and to verify their declarations. For users, the SenseWear PRO3 Armband device is easy to handle, while measurement is not onerous and does not disturb typical activities.

Keywords: physical activity, device, mobile monitoring, SenseWear monitor.

INTRODUCTION

According to the Forbes portal, one of the eight most important trends that are to dominate in technology in 2013, are digital health and fitness devices improving and production for consumer use. Modern trends in technology were presented during CES 2013 (Consumer Electronic Association) Conference in Las Vegas, while other of presented important trends were inter alia: tablets, gesture and voice recognition devices or smart cars improvement and production [11].

The market of medical records, mobile apps, telehealth and fitness monitors is growing at about 40% a year. Consumer-oriented innovations are associated mainly with mobile personal systems to measure such factors as e.g. blood glucose level, heart rate and all other rates that may be recorded for treatment and prevention of diseases. The specific element of the diseases prevention, associated also with fit lifestyle promotion, is physical activity monitoring [11].

The physical activity is usually defined as: "any bodily movement associated with muscular contraction that increases energy expenditure above resting levels" [29]. Adults should do at last 150 minutes of moderate-intensity aerobic physical activity throughout the week or at last 75 minutes of vigorous-intensity aerobic physical activity throughout the week. The necessary dose

of physical activity can be accumulated in bouts of at least 10 minutes and can also consist of a combination of moderate- and vigorous-intensity periods. For additional health benefits, adult should increase the moderate-intensity aerobic activity to 300 minutes per week or vigorous-intensity aerobic activity to 150 minutes per week or an equivalent combination of moderate and vigorous intensity activity. Muscle strengthening activities should be done involving major muscle group at last 2 days a week [31].

Adults can achieve the recommended level of aerobic physical activity by regular walking. In young and middle age adults, mild walking might represent a physical effort of 3500 steps per 30 minutes, while the same effect would be achieved by older people through an effort of 2500 steps per 30 minutes. Moderate walk would thus demand 4000 steps in the case of adults and 3500 steps of older, while for a vigorous level of walking activity (walking uphill, upstairs or running), 4500 steps would be needed in adult age and 4000 in old age [29].

Regular aerobic physical activity is associated with significant health benefits. There is a direct relationship between physical activity and physical function and condition, muscle strength, flexibility and dynamic balance. Physical activity is also related to the feeling of wellbeing, physical independency and better quality of life [4, 7, 13, 17]. Moreover, physical activity has favorable effects on the functions of cardiovascular system, respiratory tract, musculoskeletal system and mental health, as well as on metabolism, resulting in influence on body mass and body composition [7, 31]. Physical activity significantly decreases the risk of coronary heart disease, hypertension, stroke, some cancers, type 2 diabetes, osteoporosis, falls and fractures [15, 23, 30, 31]. As a consequence, more active adults aged 65 and above, have lower risk of all-cause mortality than the less active ones [12, 26, 30, 31].

Physical activity is one of the determinants of the total energy expenditure [5, 25]. In case of lack of special measuring device, to asses physical activity, it may be estimated only by using physical activity level (PAL) indexes that allow evaluating energy expenditure associated with physical activity, as a magnification of basic energy expenditure. The total energy expenditure calculated on the basis of the above-mentioned calculation is only an approximate value. In spite of the fact that using PAL indexes may be useful for groups, in case of specific research and nutritional counseling, precise estimation of individual energy requirements, taking into account physical activity, as a factor modifying total energy expenditure [5, 25], is essential [24]. In practice, physical activity is most often assessed on the basis of the physical activity recall, while more precise methods of doubly labeled water or indirect calorimetry are used only occasionally, as they are onerous for participants or the sophisticated equipment is needed [24, 28].

One of the available less sophisticated device that allows assessing physical activity of individuals, is the SenseWear PRO3 Armband by Body Media Inc. (USA). It is a multi sensor body monitor with galvanic skin response sensor (to assess changes in the skin electrical resistance), heat-flux sensor, skin temperature and near-armband temperature sensors (to assess temperature changes), as well as two-axis accelerometer (to assess body movements and position). It constantly registers and gathers information about an individual, his/her physiological condition and behavior, throughout being worn.

In the SenseWear PRO3 Armband, the level of physical activity is calculated on the basis of metablic equivalent (MET). One MET is defined as the energy expenditure of sitting quietly, equivalent to resting oxygen intake of approximately 3,5 ml of oxygen uptake per kilogram of body weight per minute in case of average adult individual [10]. The physical activity may be defined as a sedentary life style – in the case of MET $< 3,0$, moderate physical activity – in the case of MET $\in <3,0; 6,0)$, vigorous physical activity – in the case of MET $\in <6,0; 9,0)$ and very vigorous physical activity – in the case of MET $> 9,0$.

During measurement, the SenseWear PRO3 Armband is worn on the back side of the upper dominant arm (the triceps muscle). The device is convenient because of small size, and non invasive measurement. Before the measurement, only configuration is needed– entering personal and anthropometric data of the individual. Moreover, all the results of the measurement are recorded and processed using the InnerView Professional 5.0 software by BodyMedia Inc. (USA), being the integral part of the system.

Research verifying the indicated measurements conducted using SenseWear PRO3 Armband shows that it is characterized by high accuracy of the results – it is > 90% for total energy expenditure, active energy expenditure, number

of steps, lying down, sleep and physical activity duration [19, 27]. Simultaneously, repeatability of results is also high (> 90% for total energy expenditure and active energy expenditure) [19], while mean error in comparison with method of indirect calorimerty and event detection is low (< 10% for total energy expenditure, < 5% for physical activity duration) [3].

The aim of the presented case study analysis was to present the possibilities of using the SenseWear PRO3 Armband mobile monitor in the assessment of the physical activity.

MATERIALS AND METHODS

The measurement of the physical activity was conducted using SenseWear PRO3 Armband in the group of individuals aged over 60, as the part of the KBN NN 312-113-738 Research Grant. Out of the analyzed individuals, one participant, characterized by moderate physical activity was chosen to present the parameters that may be measured using the SenseWear PRO3 Armband and possibilities of analysis.

The chosen individual was a woman, aged 71, characterized by height of 165 cm and weight of 59 kg (body mass index – 21,7 kg/m^2), right-handed and non-smoker (the presented data are required during individual programming the device for the participant). The measurement was conducted for 3 consecutive days (starting Tuesday afternoon – 6.07.2010 and ending Friday afternoon – 9.07.2010) – as the analyzed woman was retired and declared that her physical activity during week days and weekend days do not differ, measurement was conducted during week days only.

The chosen individual was wearing SenseWear PRO3 Armband as it is recommended – on the dominant upper arm, over the triceps muscle and it was taken off only for short periods of time (e.g. taking a bath).

The SenseWear PRO3 Armband measured the following parameters: total energy expenditure [kcal], average METS (for the whole analyzed period) [-], number of steps [-], active energy expenditure [kcal], lying down duration [min], sleep duration [min], sedentary physical activity duration [min], physical activity duration [min], including moderate physical activity duration [min], vigorous physical activity duration [min] and very vigorous physical activity duration [min].

After conducting the measurement, the results were obtained using InnerView Professional 5.0 software being integral part of the SenseWear PRO3 Armband system. The results obtained using the basic version of the software and broaden version were compared.

RESULTS AND DISCUSSION

In the basic report, the main indicators of the physical activity are presented – total energy expenditure, average METs, number of steps, active energy expenditure, lying down, sleep and physical activity duration (Figure 1). The total energy expenditure [kcal] includes off-body estimate. In the presented example, the analyzed individual was to be wearing the SenseWear PRO3 Armband device for 3 days, 1 hour and 18 minutes, while the observed on-body time was 3 days and 6 minutes (98,4% of the planned time). On the basis of energy expenditure estimated for the on-body time, it was extrapolated also for the off-body time, as 70 kcal. In the case of the active energy expenditure [kcal] and physical activity duration [min], that are recorded for MET ≥ 3,0, at least two consecutive minutes of the physical activity are required.

In the basic report it is also possible to choose specific period of time and analyze only physical activity performed during the chosen period. It is very applicable when individuals tend to perform higher physical activity at the initial stage of wearing the SenseWear PRO3 Armband that may be called the "first day effect". It is often a result of conducting the measurement and vanishes after the first or second day of measurement, being associated with the fact that participants are highly motivated at the beginning to have better results than their general physical activity. Also when during the measurement, a lot of off-body periods of time is observed, such a day may be excluded, to make the estimates more precise.

In the presented example, the 24 on-body hours of session of wearing the SenseWear PRO3 Armband without any disturbances was also analyzed (Figure 2). As in the case of the chosen individual, no "first day effect" was observed, so the chosen period was Wednesday, being a day without off-body periods.

The possibility to analyze the chosen period is of great value, as the days when research

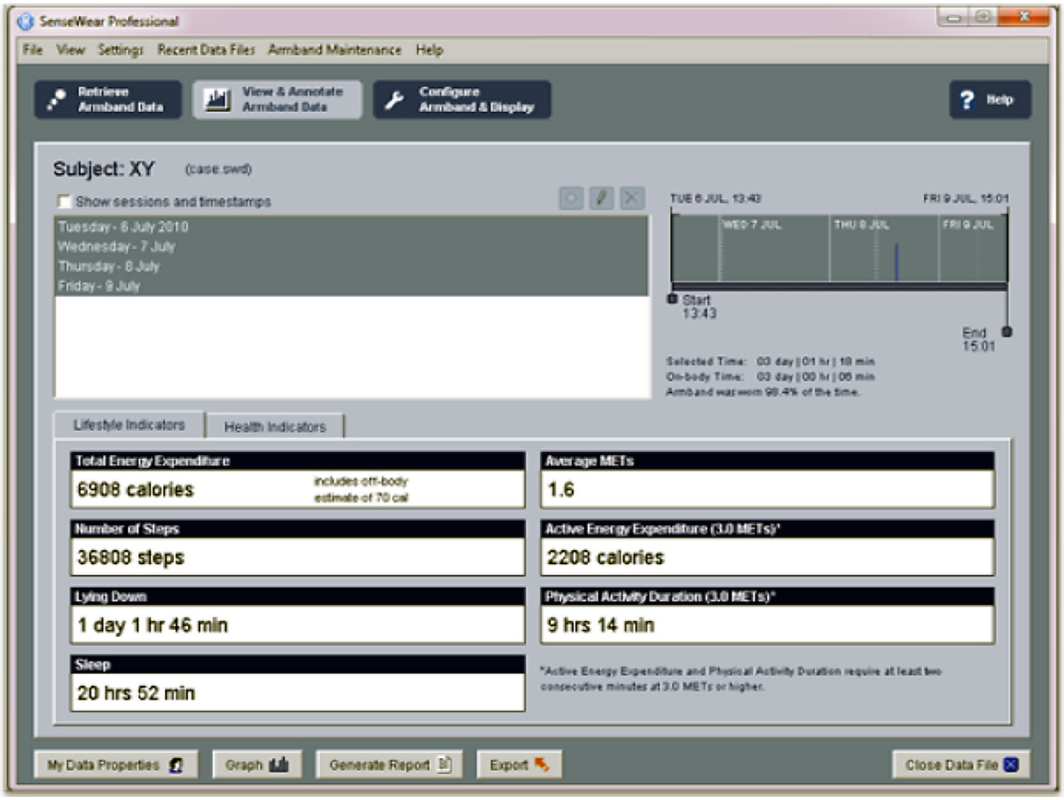

Fig. 1. The lifestyle indicators presented in the basic report from the session of wearing the SenseWear PRO3 Armband (total energy expenditure, average METs, number of steps, active energy expenditure, lying down, sleep and physical activity duration) for the chosen individual

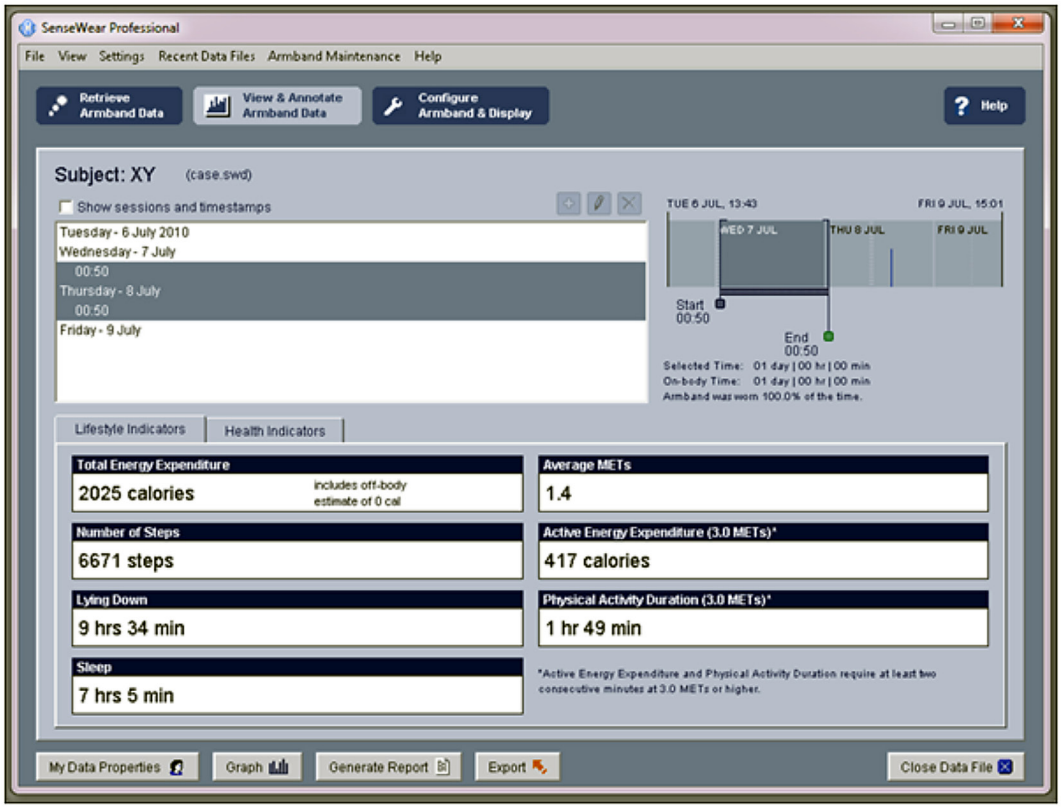

Fig. 2. The lifestyle indicators presented in the basic report from the 24 on-body hours of session of wearing the SenseWear PRO3 Armband (total energy expenditure, average METs, number of steps, active energy expenditure, lying down, sleep and physical activity duration) for the chosen individual

is conducted may be characterized by various levels of physical activity. Choosing specific periods and analyzing them separately enables finding factors increasing physical activity and formulating individual recommendations for patients, being essential for a physician, as well as gives individual users very precise information. In the case of the analyzed participant, such a situation was observed – for the whole period her average METs was about 1,6, while for chosen 24 hours, it was 1,4. In both cases it may be defined as sedentary lifestyle, but also other differences were observed. The average energy expenditure per 24 hours, calculated on the basis of the whole period, was 2200–2300 kcal, while for the chosen period it was about 2000 kcal. Similarly, the number of steps per 24 hours, calculated on the basis of whole period, was about 12 000 steps, while for the chosen period it was about 6600 steps.

In the broaden report the same indicators of the physical activity are presented as in the case of basic one (total energy expenditure, average METs, number of steps, active energy expenditure, lying down, sleep and physical activity duration), accompanied by detailed indicators of the physical activity duration. It is assessed as moderate, vigorous and very vigorous physical activity duration and sedentary duration is also presented (Figure 3). As a consequence, it is possible to make more detailed analysis of factors influencing physical activity of individuals. In the case of the chosen participant, no very vigorous physical activity was detected, while most of the physical activity duration was moderate physical activity, what is quite a typical situation for individuals in this age group.

The analysis of the results for the various periods of time is the first method to determine the influence of specific activities on energy expenditure. The other is the analysis of the graphs, being available in the broaden version. The graph for the total energy expenditure may be accompanied by time periods for lying down, sleep, sedentary, physical activity duration, including moderate, vigorous and very vigorous physical activity duration (Figure 4). Such a graph is especially valuable not only to search for factors increasing physical activity and formulating individual recommendations for patients, but also to compare the following days and to analyze trends in physical activity.

Such precise graphs may be generated also for the number of steps (Figure 5) and METs. Moreover, also in the case of graphs, it is possible to choose a specific period of time and analyze only physical activity performed during the chosen period. Such a graph was also analyzed for the chosen participant and the number of steps (Figure 6). Especially if the measurement is accompanied by individual recall of activities conducted by participant, it is possible to conclude on the basis of both methods of the analysis of the physical activity, about the real physical activity of the participant and to formulate individual recommendations for him.

The SenseWear PRO3 Armband device is nowadays used to analyze the physical activity and energy expenditure in various groups – in medical practice and research. It was used to monitor physical activity of young [32] and elderly [35, 37] individuals during daily physical activity and during exercises [14, 16], as well as physical activity of children [1], obese individuals [18], individuals with cardiovascular diseases [6], with type 2 diabetes [21] and with chronic kidney disease [33]. It was also applied in the research analyzing total energy expenditure in obese individuals [8, 9], in middle-age men [34], in sportsmen [36], in elderly with chronic obstructive pulmonary disease [2, 22], as well as in individuals with Sydenham's chorea [20].

CONCLUSIONS

1. The SenseWear PRO3 Armband device is a valuable tool in everyday medical practice to specify the physical activity of individuals and to verify their declarations.
2. For users, the SenseWear PRO3 Armband device is easy to handle, while measurement is not onerous and does not disturb typical activities.

Acknowledgement

The research was supported by the KBN NN 312-113-738 Research Grant. All experimental protocols were approved by the Bioethical Commission of the Regional Medical Chamber in Warsaw (nr of medical experiment register KB/611/07, date: 07.02.2008).

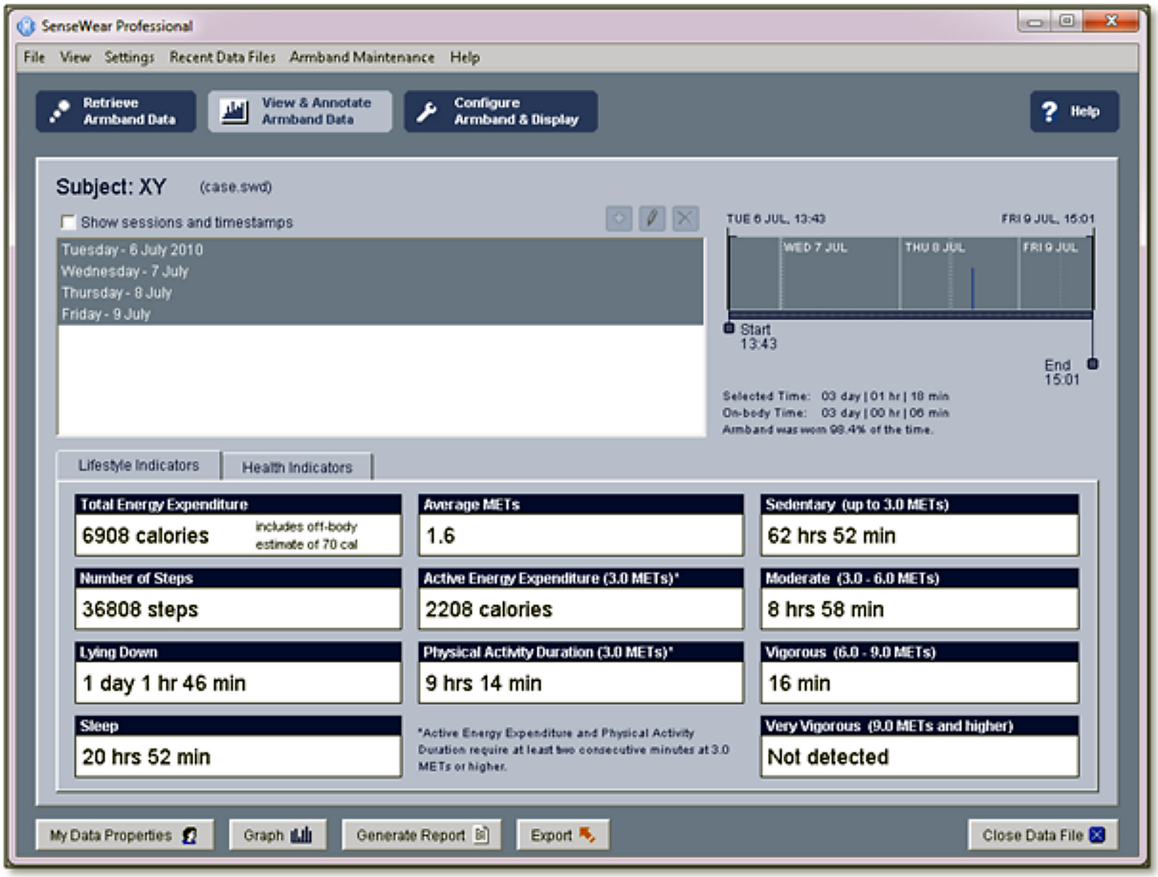

Fig. 3. The lifestyle indicators presented in the broaden report from the session of wearing the SenseWear PRO3 Armband (total energy expenditure, average METs, number of steps, active energy expenditure, lying down, sleep, sedentary, physical activity duration, including moderate, vigorous and very vigorous physical activity duration) for the chosen individual

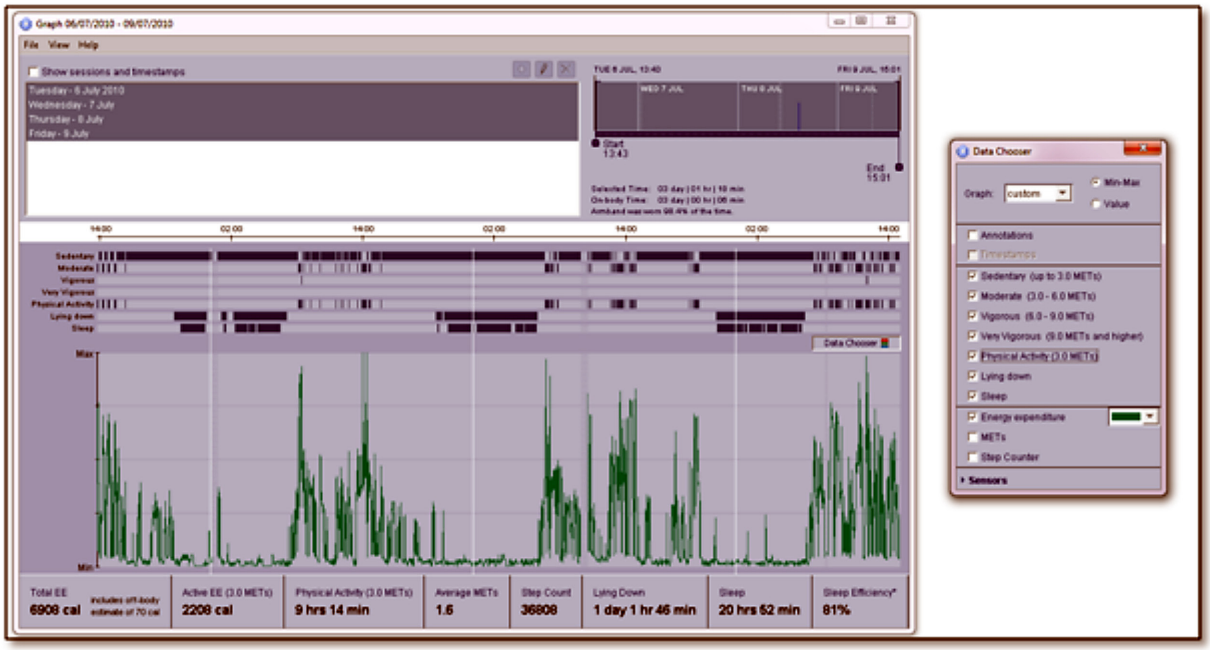

Fig. 4. Broaden graphical report from the session of wearing the SenseWear PRO3 Armband – graph for the total energy expenditure accompanied by time periods for lying down, sleep, sedentary, physical activity duration, including moderate, vigorous and very vigorous physical activity duration for the chosen individual

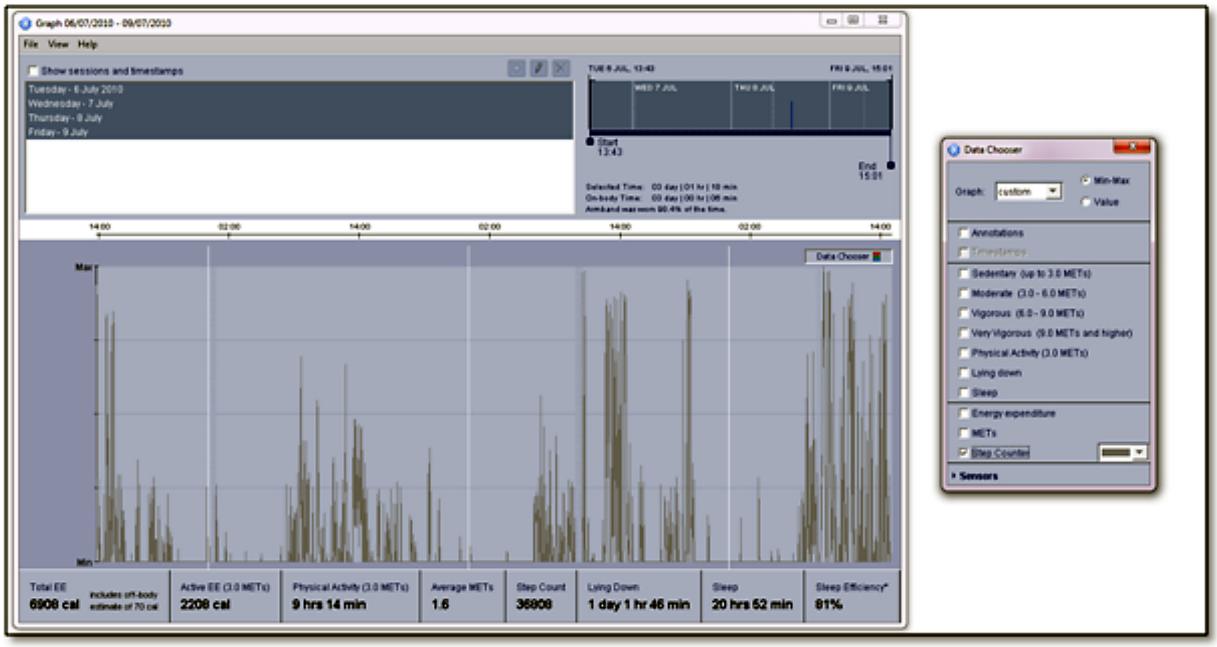

Fig. 5. Broaden graphical report from the session of wearing the SenseWear PRO3 Armband – graph for the number of steps for the chosen individual

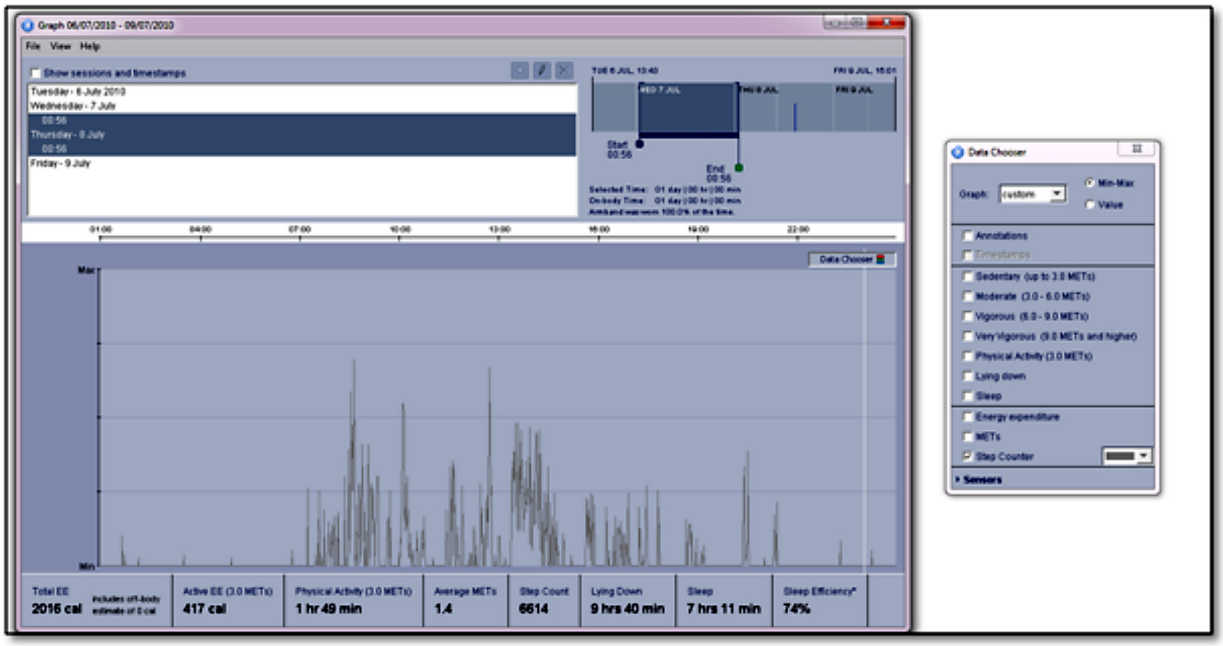

Fig. 6. Broaden graphical report from the 24 on-body hours of session of wearing the SenseWear PRO3 Armband – graph for the number of steps for the chosen individual

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