Follow-up monitoring of physical activity after rehabilitation by means of a mobile application: Effectiveness of measurements in different age groups

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Advances in Clinical and Experimental Medicine, ISSN 1899-5276 (print), ISSN 2451-2680 (online)

Adv Clin Exp Med. 2018;27(8):1037–1044

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Funding sources

The study was financed from statutory resources of the Witold Chodźko Institute of Rural Health, Lublin, Poland.

Conflict of interest

None declared

Received on December 3, 2016

Reviewed on January 25, 2017

Accepted on February 23, 2017

Abstract

Background. Active monitoring of the level of daily physical activity seems to be a useful element for secondary prevention in public health. Low physical activity increases the incidence of cardiovascular diseases, obesity, diabetes, musculoskeletal diseases, and causes loss of the previously achieved effects of rehabilitation.

Objectives. The purpose of this study was to assess the level of physical activity in different age groups of adults with the use of the telemedical system based on a mobile application.

Material and methods. The research covered data collected remotely from 927 individuals of both genders, aged 20–80 years (group I: 20–40 years, group II: 41–60 years, group III: 61–80 years). A monitoring system (Activity Measurement Tool) developed in the Department of General Rehabilitation at the Witold Chodźko Institute of Rural Health (Lublin, Poland) was used to measure home physical activity in the examined group. The system uses a dedicated mobile application, cellular data transmission and web data-showing software. Home physical activity was assessed using the International Physical Activity Questionnaire – Short Form (IPAQ-SF) and simultaneous processing of data from a smartphone accelerometer.

Results. The mean level of physical activity in the group of active application users (≥ 2 days, $n = 494$), expressed as Metabolic Equivalent of Task (MET)-min/week (IPAQ-SF), was as follows: group I (female participants (F): 5,767.9, $n = 73$; male participants (M): 4,888.4, $n = 251$), group II (F: 3,468.7, $n = 24$; M: 4,053.5, $n = 119$) and group III (M: 5,769.3, $n = 27$; no female participants were involved). In 72.3% of users, the registered physical activity was smaller in relation to IPAQ-assessed/7 days physical activity (sign test: $n = 494$; percentage of negative differences: 72.3%; $Z = 9.9$; $p = 0.00$).

Conclusions. The research findings indicate a high level of self-reported physical activity among the users in all age and gender groups, although it is not reflected in the level of registered activity. Although the level of daily physical activity was evaluated, it was mainly among young and middle-aged men who gladly and regularly made use of the measurement possibilities offered by mobile technology.

Key words: motor activity, aging, smartphone, telerehabilitation, patient monitoring

DOI

10.17219/acem/69131

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Introduction

Contemporary medicine, making use of the rapid development of cellular telephony and mobile technologies with the use of a network of wireless broadband Internet (Long-Term Evolution – LTE), enables the opening of new opportunities in relations between the elderly or disabled people and the healthcare service.

Technologies which provide a means for continuous physiological monitoring of patients at home are especially useful in cardiac rehabilitation.^{1,2} The innovation of telemedicine enables the supplementation of conventional medical care for hemiparetic patients in the patient's home.³

The problem of an ageing society is a tremendous challenge for contemporary medicine. Regular physical activity in this group of patients is an extremely important factor in not only primary, but even more so, in secondary prevention.⁴ The findings from extensive research emphasize a strong correlation between regular physical activity and the prevention of many diseases, which is reflected in the improved quality of life in this population group.^{5,6} Physical activity, not only in the group of elderly people, constitutes an important factor affecting a person's health condition. The development of civilization largely contributes to the progress of hypokinesia in society, which affects, to a large extent, the acceleration of the aging process and the development of many civilization-related diseases.^{7–9} Research findings indicate that physical activity with a total energy expenditure higher than 4,200 kJ/week reduces the risk of developing ischemic heart disease by 30–50%, and reduces mortality even by 30%. Regular physical effort is used in the prevention of cancerous diseases, osteoporosis, type 2 diabetes and, as a result of increased energy expenditure, also overweight and obesity.^{10,11}

The beneficial impact of physical activity is commonly known and is reflected in everyday life. Another problem is the development of reliable measurement tools. A particularly recommended research tool in the assessment of the level of physical activity in research environments, such as the European Physical Activity Surveillance System (EU-PASS) or the European Health Interview Survey (EURO-HIS), is the International Physical Activity Questionnaire (IPAQ), which enables the compilation of a comprehensive image of the physical activity of a given individual.¹²

The purpose of this paper was to assess the level of physical activity in different age groups of adults with the use of the telemedical system, using the IPAQ-short form and smartphone accelerometer data.

Material and methods

Study group

The research covered the analysis of data from 927 individuals of both genders (female participants (F): 24%;

male participants (M): 76%); age range: 20–80 years. All individuals used the mobile application when performing different types of daily physical activity for 1–7 days (days with a short night break 10.00 pm–7.00 am), as well as 8 days and more. People using the application for 1 day, 8 h or shorter ($n = 433$) were excluded from the physical activity analysis (incorrect interpretation).

The examined group was divided by age into 3 subgroups: group I: 20–40 years (F: 29.9 $\pm$ 5.4 years; M: 32.2 $\pm$ 4.8 years) (69%); group II: 41–60 years (F: 48.8 $\pm$ 6.1 years; M: 48.2 $\pm$ 5.9 years) (27%), group III: 61–80 years (M: 65.9 $\pm$ 4.2 years) (4%) (Fig. 1).

Diseases in the analyzed group of users were studied on the basis of a remote anonymous interview via a mobile application. In a great majority of subjects, no coexistence of diseases which could potentially have an impact on the degree of physical activity was confirmed. In group I, pulmonary and heart diseases were present only in 4% of the surveyed and bone diseases in 8%; in addition, the prevailing part of the group showed professional activity (76%) (Fig. 2). The situation was slightly different in group II, where heart diseases were present in 20% of the examined participants, pulmonary diseases only in 5% and bone diseases in 18%. As many as 75% of the examined people in this age group (41–60 years) were professionally active (Fig. 3). The frequency of the diseases increased with age, which is depicted in the distribution in group III. Cardiovascular system diseases were present in 37% of cases, pulmonary diseases were similar for groups I and II – present in 5% of cases, and skeletal system diseases were detected in as many as 39% of cases. Compared to other age groups, only 51% of the examined indicated professional activity (Fig. 4).

Fig. 1. Characteristics of the examined groups

Fig. 2. Characteristics of the examined group in terms of coexisting diseases (20–40 years)

F – female participants.

Fig. 3. Characteristics of the examined group in terms of coexisting diseases (41–60 years)

F – female participants.

Body mass index (BMI) was within normal limits only in the 20–40 age group – among females ($24.4 \pm 4.7 \text{ kg/m}^2$) and in male participants ($26.8 \pm 4.5 \text{ kg/m}^2$), and increased with age, indicating overweight. In the following groups BMI was higher than healthy range: II F – $27 \pm 3.9 \text{ kg/m}^2$; M – $28.3 \pm 4.6 \text{ kg/m}^2$, III M – $27.5 \pm 3.3 \text{ kg/m}^2$.

Fig. 4. Characteristics of the examined group in terms of coexisting diseases (61–80 years)

F – female participants.

Procedures

An innovative telemedical system developed in the Department of General Rehabilitation at the Witold Chodźko Institute of Rural Health (Activity Measurement Tool) was applied to assess the measurement of physical activity in the examined groups.¹³ The system makes use of cellular data transmission and the potential of smartphones.

Table 1. Parameters assessing the level of physical activity in the examined groups

Parameter	20–40 years		41–60 years		61–80 years	
Sex	F (n = 73)	M (n = 251)	F (n = 24)	M (n = 119)	F (n = 0)	M (n = 27)
Age [years]	29.9 ± 5.4 20–39	32.2 ± 4.8 21–40	48.8 ± 6.1 41–59	48.2 ± 5.9 41–60		65.9 ± 4.2 61–77
BMI [kg/m ²]	24.4 ± 4.7 16.9–39.3	26.8 ± 4.5 16.3–45.6	27 ± 3.9 21.3–36.8	28.3 ± 4.6 21.1–44.6		27.5 ± 3.3 21–36.2
Days of intensive physical activity	1.9 ± 1.7 0–7	1.6 ± 1.7 0–7	1.4 ± 1.3 0–5	1.5 ± 1.7 0–7		2.6 ± 1.8 0–6
Time of intensive physical activity [min]	93.3 ± 90.6 0–360	71.9 ± 96.4 0–600	76.9 ± 71.3 0–280	62 ± 84.2 0–480		92.9 ± 91.3 0–360
Days of moderate physical activity	2.8 ± 2.1 0–7	2.8 ± 2.2 0–7	2.6 ± 2.4 0–7	2.8 ± 2.1 0–7		4.3 ± 2.4 0–7
Time of moderate physical activity [min]	114 ± 105.4 0–480	104.4 ± 126.9 0–780	97.8 ± 108.8 0–420	100.3 ± 109.1 0–720		85.5 ± 71.4 0–300
Days of walking	5.5 ± 2.1 0–7	5.1 ± 2.4 0–7	4.2 ± 2.6 0–7	5.1 ± 2.3 0–7	NONE The group aged 61–80 years included 2 women – both used the application for 1 day	6.1 ± 1.5 2–7
Time of walking [min]	106.8 ± 113.9 0–600	77.2 ± 108 0–840	50.7 ± 37.5 0–120	71.2 ± 72 0–360		83.1 ± 67.7 0–240
MET-min/week ±SD (intensive efforts)	1,826 ± 2,853.3 0–16,240	1,669.4 ± 3,849.6 0–28,800	1,172 ± 1,264.5 0–4,480	1,397.3 ± 3,268.9 0–26,880		2,568.6 ± 3,928.1 0–17,280
MET-min/week ±SD (moderate efforts)	1,729.1 ± 2,281.2 0–10,080	1,710.7 ± 2,859.1 0–21,840	1,446.8 ± 2,534.3 0–11,760	1,302.5 ± 1,551.9 0–7,800		1,424.7 ± 1,304.8 0–4,800
MET-min/week ±SD (walking)	2,212.8 ± 2,637.5 0–13,860	1,508.3 ± 2,476.1 0–19,404	849.9 ± 953.3 0–2,772.2	1,353.7 ± 1,582.4 0–7,623		1,775.9 ± 1,602.7 0–5,544
Total score IPAQ-SF MET-min/week ±SD	5,767.9 ± 5,254.4 149–23,650	4,888.4 ± 6,774.0 0–53,004	3,468.7 ± 3,126.2 33–13,146	4,053.5 ± 4,890.8 0–37,392		5,769.3 ± 5,510.6 450–23,544
Registered activity (mean accelerometer data per one day) MET-min/day ±SD	639.4 ± 1,726.7 22.2–14,062.5	364.7 ± 1,609.8 5–18,124.4	364 ± 635.9 5.2–2,508.1	362.5 ± 1,008.8 6.1–10,201		516.6 ± 524.7 10.2–1,997.2

BMI – body mass index; F – female participants; M – male participants; MET – Metabolic Equivalent of Task; IPAQ-SF – International Physical Activity Questionnaire – Short Form; SD – standard deviation.

The purpose of the developed application was to maintain rehabilitation effects by motivating the users to lead an active lifestyle after the end of individual rehabilitation programs for low-back pain and other musculoskeletal disturbances.

The application uses the telemedical potential of contemporary smartphones and is available free of charge. Registered individuals may use “reverse communication” and, at the same time, remain under the supervision of a specialized team of physicians and physiotherapists. People seeing a physiotherapist have the opportunity to receive explanations and answers to questions about the telemonitoring system.

Physiotherapists have an opportunity to individually follow their patients at home by means of web software.

Consent for medical monitoring and scientific evaluation of anonymous data was expressed during the installation of the application.

The assessment of the intensity and frequency of physical activity was obtained by processing data from the accelerometer of the application and using International Physical Activity Questionnaire – Short Form, average week (IPAQ-SF). As a result, information was collected regarding time spent in the sitting position, time dedicated to walks, and moderate and intensive physical activity. Additional questions included in the application made it possible to gather information about comorbidities (heart, pulmonary, musculoskeletal) or calculate body mass index (BMI).

The particular types of physical activity may be expressed by the unit Metabolic Equivalent of Task (MET)-min/week, by multiplying the coefficient assigned to a given physical activity (walking – 3.3; moderate activity – 4.0; intensive activity – 8.0) by the number of days (a week) and the amount of time (min) when a given patient engages in physical activity. Summing-up the findings of every kind of physical activity, a 1-week measurement was obtained for a given individual, on the basis of which patients were assigned to particular groups, depending on the level of the intensity of physical activity:

- high – 3 or more days of intensive physical effort (min 1,500 MET-min/week); 7 or more days of any combination of efforts (walking, moderate/intensive efforts exceeding 3,000 MET-min/week);
- sufficient – 3 or more days of intensive physical efforts (min 20 MET-min/day); 5 or more days of moderate efforts or walking (min 30 min/day); 5 or more days of any combination of efforts (walking, moderate/intensive efforts exceeding 600 MET-min/week);
- insufficient (level of physical activity insufficient to fulfill the conditions of high/sufficient level, or lack of physical activity).

The criteria used to assess the level of physical activity take account of the present health recommendations, the basis of which is regular physical activity.¹⁴

In the research, the measurement of physical activity was obtained by processing data from the accelerometer

in the user's smartphone thanks to empirically prepared algorithms, eliminating the impact of the sensitivity of the accelerometer and separate factors, such as the location of the user's smartphone. Two kinds of calibration were used: static and dynamic. The value of gravitational acceleration was measured on an accelerometer (static calibration) by placing the mobile phone flat and pressing the measuring button for 3 s ($g = \sqrt{x^2 + y^2 + z^2}$), and then calculating the average of measurements for 3 s ($x, y, z \rightarrow$ temporary components of acceleration from the accelerometer). To eliminate the differences of sensitivity of accelerometers related to different types of smartphones, but also to the different places smartphones are in during the day (trousers, shirt), dynamic calibration was used. The smartphone user was asked to push the button that activates the application and walk on flat ground for 1 min until he/she received the calibration completion signal (dynamic correction = 3.3/MET-min for 1 min of walking) (Fig. 5). Calibrating parameters were obtained by multiple adjustments of calculation coefficients on the basis of tests carried out in the Activities Test Laboratory of the Institute of the Witold Chodźko Institute of Rural Health in Lublin. The measurement algorithm, application and network software were developed in cooperation with mobilesqerbox (Grzegorz Golec).

The system made it possible to adjust daily motor activity based on the interviews and anthropometric data of the user. The application monitors daily physical activity from 7 am to 11 pm and – through a diagram of a filling heart and text messages – motivates the user to intensify physical activity (Fig. 6). The most important element of the application is sending a data package to the server of the Institute once a day – the data is presented on collective charts, and in this way secure access to any measurement data is enabled. Data from the survey and measurements is collected by web software in the form of anonymous records available for researchers, however, without the

Fig. 5. Method of processing data from an accelerometer

Measurement of activity from an accelerometer MET-min = $\sum (|p - g|)$; the sum of activity for each minute estimated as the absolute value of differences in accelerations p and g .

Fig. 6. Measuring application (application interface) and a sample reading of physical activity of 1 user (web data-showing interface)

possibility of personal identification of the user without their consent.

Statistical analysis

Statistical data was prepared using STATISTICA v. 12.0 software (StatSoft Polska Sp. z o.o., Kraków, Poland) and basic descriptive statistics, sign tests and Spearman's R correlation.

Ethical approval

The study was performed in compliance with the World Medical Association Declaration of Helsinki on ethical principles for medical research involving human subjects.

The authors requested the opinion of the Ethics Committee at the Institute of Rural Health and obtained consent for the study. Participants of the study were informed about the goal of the study and approach to be used. Consent was signed by all the participants prior to the study.

Results

In the assessment of the level of physical activity, the most important element was time and the number of days of physical activity above the average 7 days and according to IPAQ. Efforts at the intensive level were taken, on average (MET-min/week $\pm$ SD), in group I: $F - 1,826 \pm 2,853.3$; $M - 1,669.4 \pm 3,849.6$; in group II: $F - 1,172 \pm 1,264.5$; $M - 1,397.3 \pm 3,268.9$; and

in group III: F – n = 0; M – 2,568.6 ± 3,928.1. Efforts at the moderate level were taken, on average, in group I: F – 1,729.1 ± 2,281.2; M – 1,710.7 ± 2,859.1; in group II: F – 1,446.8 ± 2,534.3; M – 1,302.5 ± 1,551.9; and in group III: F – n = 0; M – 1,424.7 ± 1,304.8. The effort connected with walking was as follows: group I: F – 2,212.8 ± 2,637.5; M – 1,508.3 ± 2,476.1; group II: F – 849.9 ± 953.3; M – 1,353.7 ± 1,582.4; group III: F – n = 0; M – 1,775.9 ± 1,602.7. The total level of physical activity expressed as MET-min/week ± SD amounted to: in group I: F – 5,767.9 ± 5,254.4; M – 4,888.4 ± 6,774.0; in group II: F – 3,468.7 ± 3,126.2; M – 4,053.5 ± 4,890.8; and in group III: F – n = 0; M – 5,769.3 ± 5,510.6. The research results indicate that, according to a subjective assessment of the users, the whole group can be qualified into physical activity at a high level (1,500–3,000 MET-min/week). However, taking into account the average number of days of performing various physical activities, the group exceeded standards for this level of activity. Characteristic of the high level was activity on at least 3/7 days, and for the sufficient level – 3/5 days. The average value of days of intensive physical effort occurred in group I: F – 1.9 ± 1.7; M – 1.6 ± 1.7; group II: F – 1.4 ± 1.3; M – 1.5 ± 1.7; group III: F – n = 0; M – 2.6 ± 1.8. The average value of days of moderate physical effort occurred in group I: F – 2.8 ± 2.1; M – 2.8 ± 2.2; group II: F – 2.6 ± 2.4; M – 2.8 ± 2.1; group III: F – n = 0; 4.3 ± 2.4. The criterion was fulfilled by walking activity in group I: F – 5.5 ± 2.1; M – 5.1 ± 2.4; group II: F – 4.2 ± 2.6; M – 5.1 ± 2.3; group III: F – n = 0; M – 6.1 ± 1.5, which made it possible to qualify the group into the level of sufficient activity. This level is characterized by effort in various combinations of activity; therefore, objectively, the group should be qualified to the level of insufficient physical activity (Table 1).

Table 2. Assessment of the level of real physical activity in the examined group

Sign test				
variables	n	percentage of negative differences	Z	p-value
Real activity and declared activity	494	72.3%	9.9	0

Registered 1-day mean activity of the analyzed individuals: group I: F – 639.4 ± 1,726.7; M – 364.7 ± 1,609.8; group II: F – 364 ± 635.9; M – 362.5 ± 1,008.8; group III: F – n = 0; M – 516.6 ± 524.7. In 72.3% of users in the examined group, registered 1-day activity was smaller in relation to IPAQ-assessed activity per 1 day (sign test: n = 494; percentage of negative differences: 72.3%; Z = 9.9; p = 0.00) (Table 2).

The research findings indicate the existence of a positive correlation between age and BMI in the examined group (F = 0.246, M = 0.235; p < 0.05000) (Table 3). Body mass index was the highest in group II (41–60 years); the lowest level of physical activity was also observed in this group (MET-min/week). The group of the oldest people,

Table 3. Correlations of parameters: BMI, MET and age in the examined group

Variable	Spearman's rank-order correlation p < 0.05000			
	sex	age	BMI [kg/m ²]	MET
Age	M	1.000	0.235*	–0.019
BMI [kg/m ²]	M	0.235*	1.000	–0.048
MET-min/week	M	–0.019	–0.048	1.000
Age	F	1.000	0.246*	–0.174
BMI [kg/m ²]	F	0.246*	1.000	–0.030
MET-min/week	F	–0.174	–0.030	1.000

* significant correlation; BMI – body mass index; MET – Metabolic Equivalent of Task; F – female; M – male.

Fig. 7. Assessment of BMI in the examined age groups. Average chart, confidence interval 95%

BMI – body mass index.

Fig. 8. Assessment of MET-min/week total IPAQ-SF in the examined age groups. Average chart, confidence interval 95%

MET – Metabolic Equivalent of Task.

in spite of a high BMI (overweight), showed the highest level of self-reported physical activity in relation to other groups (Table 1; Fig. 7,8).

Discussion

Effective monitoring of the level of physical activity of the population is an essential element for primary and secondary prevention in public health.¹⁵ The implementation

of prevention programs requires the assessment of the level of physical activity in different subpopulations. Research findings indicate that as much as 31.1% of the population worldwide are inactive adults, ranging from 17% in south-eastern Asia to about 43% in America and the eastern part of the Mediterranean Sea. In addition, lack of movement increases with age, especially in highly-developed countries, with a higher trend in the population of women.¹⁶

According to the guidelines of the World Health Organization (WHO), to counteract the development of civilization-related diseases and sustain health in adults (18–64 years), it is advisable to undertake physical activity at a moderate level (≥ 150 min/week) or intensive level (≥ 75 min/week), or an equivalent combination of both physical efforts.¹⁷ The findings of the presented study indicate that only in the group of women – group I: 93.3 ± 90.6 and group II: 76.9 ± 71.3 , and in the group of men – group III: 92.9 ± 91.3 , the conditions for making intensive efforts were fulfilled. In groups I and II (M), the average time of intensive activity was too low – group I: 71.9 ± 96.4 ; group II: 62 ± 84.2 . On the other hand, no group fulfilled the criteria for moderate effort – group I: $F - 114 \pm 105.4$; $M - 104.4 \pm 126.9$; group II: $F - 97.8 \pm 108.8$; $M - 100.3 \pm 109.1$; group III: $M - 85.5 \pm 71.4$.

Regular physical activity plays an important role in the reduction of body mass.^{18,19} Recent research findings made it possible to prepare detailed criteria for the activity of people with overweight or obesity. Moderate activity (60–90 min/day) is necessary to reduce BMI and maintain weight at the appropriate level. In the current study, average values in terms of time of activity relate to the whole week, which indicates an insufficient level of physical effort. Scott et al. emphasize that the effectiveness of physical activity takes place during efforts lasting ≥ 10 min, and an increase in its level affects reduction in body mass.²⁰ In this paper, the existence of a positive correlation between age and BMI in the examined group was observed: ($F - 0.246$, $M - 0.235$; $p < 0.05000$). Body mass index was the highest in group II (41–60 years); the lowest level of physical activity (MET-min/week) was also recorded in this group. In spite of high BMI (overweight), the oldest age group showed the highest level of physical activity in relation to other groups. In addition, the findings of multi-center research emphasize that an unsuitable level of physical activity, or its lack, is strictly associated with the development of civilization-related diseases, which, in consequence, cause 1.9 million deaths worldwide.^{21,22}

Research conducted in 8 countries of the European Union assessed the level of physical activity among a large group of the population. The statistical data for particular countries were as follows: Belgium – 67 MET-h/week, Finland – 70.2 MET-h/week, France – 63.8 MET-h/week, Germany – 84.5 MET-h/week, Italy – 19.6 MET-h/week, the Netherlands – 56.4 MET-h/week, Spain – 39.3 MET-h/week, and the UK – 27.6 MET-h/week.²³ The findings of the presented study, after conversion of MET-min/week into MET-h/

/week, were as follows: group I: $F - 96.1$; $M - 81.4$; group II: $F - 57.9$; $M - 67.5$; group III: $F - n = 0$; $M - 96.1$. The level of physical activity in the examined groups was relatively high, which enables the qualification of the users into the level of high activity. However, taking into account the average number of days of performing various physical activities, the group exceeded the standards for this level of activity. A characteristic of the high level of activity was at least 3/7 days, and the sufficient level at 3/5 days. The average number of days of intensive physical effort in group I: $F - 1.9 \pm 1.7$; $M - 1.6 \pm 1.7$; group II: $F - 1.4 \pm 1.3$; $M - 1.5 \pm 1.7$; group III: $F - n = 0$; $M - 2.6 \pm 1.8$. The average number of days of moderate physical effort in group I: $F - 2.8 \pm 2.1$; $M - 2.8 \pm 2.2$; group II: $F - 2.6 \pm 2.4$; $M - 2.8 \pm 2.1$; group III: $F - n = 0$; $M - 4.3 \pm 2.4$. The only fulfilled criterion by activity was in walking in group I: $F - 5.5 \pm 2.1$; $M - 5.1 \pm 2.4$; group II: $F - 4.2 \pm 2.6$; $M - 5.1 \pm 2.3$; group III: $F - n = 0$; $M - 6.1 \pm 1.5$, which enables qualifying the group into the level of sufficient activity. This level is characterized by various combinations of activity; therefore, objectively, the group should be qualified to the level of insufficient physical activity. Shephard emphasizes that in subjective assessment, individuals most often significantly raise the real level of activity, which is confirmed by the present research, which shows that in as many as 72.3% of subjects, the real activity was lower than the declared activity (self-reported) (Table 2).²⁴

One of the fundamental problems in measuring the level of physical activity in everyday life of an individual is the development of a precise way of assessment. Many methods have been developed for the promotion of strategies for physical activity, including, among others, IPAQ, which is used worldwide.²⁵ Many studies indicate the high reliability of this method, not only in the measurement of time and intensity of physical effort, but, above all, the assessment of total energy expenditure within the whole week.^{26,27} The IPAQ has been developed for the age range 15–69 years, although it is increasingly more often used in the group of elderly people.²⁸ In this study, the examined group was divided into 3 age subgroups: I – 20–40 years, II – 41–60 years, III – 61–80 years, in order to check the intensity and degree of physical activity in these age groups, including elderly people. Apart from IPAQ, the telemedical potential of contemporary smartphones was used, thanks to which it was possible to assess the actual level of daily physical activity, and the results were compared with the declared values in a given application user. The research showed the level of registered physical activity as being lower, although through using the application the result can be monitored, and if it is too low, it is possible to change it by motivating and, even more so, by educating the user.

Limitations of the study

The objective of the study was achieved; nevertheless, attention should be paid to the limitations which occur

mainly in the area of measurements of physical activity, and result from the natural characteristics of telemedical measurements. The first limitation is a varied duration and continuity of independently performed measurements of physical activity after rehabilitation. Another limitation is the way of completing IPAQ-SF. In the present study, a survey was performed via a mobile application. The application contains detailed hints and guidelines to individual questions; however, IPAQ, according to its authors, was designed to be completed in a written form or on telephone. The abovementioned shortcomings result in a considerable variability of the results of measurements in individual groups, which limits the possibilities of drawing conclusions.

Conclusions

As a result of using the mobile application and the telemedical system developed at the Witold Chodźko Institute of Rural Health, it is possible to assess the level of physical activity at home, although mainly among younger people (<60), who gladly make use of the measurement possibilities of the smartphone, which indicates the usefulness of this low cost method in the active maintenance of the effects of general rehabilitation.

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