# SUBJECTIVE AND OBJECTIVE ASSESSMENTS OF PHYSICAL ACTIVITY IN EMPLOYED WOMEN AGED 50 TO 64 YEARS

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**Abstract** **Background:** The aim of the study was to present data on subjective and objective assessments of physical activity in employed women and differences in their activity levels depending on age, education level, place of residence, financial status, and BMI. Another aim was to evaluate correlations of physical activity assessed subjectively and objectively with the aforementioned variables. **Methods:** Ninety employed women aged 50 to 64 years were divided into 3 groups. The International Physical Activity Questionnaire (IPAQ-S) was used for the subjective assessment, and the ActiGraph GT3X activity monitor was used for objective assessment. **Results:** The subjective assessment of total physical activity levels in the women was significantly higher than their objective assessment. The statistically significantly highest physical activity levels assessed by means of the questionnaire were found for women with the poorest financial status, or primary or secondary education levels and, for the assessments using accelerometers, the women with a BMI indicating overweight. A weak positive correlation (R = 0.25) was found between the total physical activity levels assessed subjectively and objectively. **Conclusions:** It seems that the use of only one tool for evaluation of physical activity level is not very conclusive. The use of both subjective and objective tools is needed to obtain reliable information about physical activity level.

**Key words** physical activity, women aged 50 to 64 years, IPAQ-S, accelerometer

## Introduction

Physical activity has been claimed to play an important role in health protection (Blair, Dunn, Marcus, Carpenter, Jaret, 2001; Haskell et al., 2007; Sallis et al., 2009; Riekert, Ockene, Pbert, 2013; Chaix et al. 2014; World Health Organization, 2014; Neufer et al., 2015) and is one of the most important lifestyle factors. At the end of the last century, C. Bouchard and R.J. Shephard (1994) demonstrated a direct effect of physical activity on human health. Many scientific centres have been involved in research on physical activity, however, few studies have used both subjective and objective assessment tools, particularly to examine active professional women aged 50 to 64 years. This period of life, which is often defined as a precursor to old age, has often been neglected in analyses of the health statuses and functioning of women, although people in this age range tend to experience symptoms of "wear" of the human body that may develop into many adverse health and mental problems. Dynamic hormonal changes are observed in women after 50 years of age, connected with the cessation of ovarian function. Frequent stress, resulting from social determinants (growing children, ageing parents, professional duties), may lead to various health problems, such as mental disorders. M. Chia and R.C. Abrams (2002) found that with the coexistence of these factors, women in their fifties and sixties show clinical symptoms of depression much more often than in other age groups. Various ailments related to menopause and the higher health risks observed after the age of 50, the quality of life of women deteriorates. Due to all the changes and problems experienced by women aged 50+ years, actions should be taken to prevent diseases and dysfunctions that may become frequent in the subsequent decades of life (Ostrowska, 2015). Female health promotion should primarily focus on three factors (diet, physical activity and stress), which are hugely important for the prevention, treatment and rehabilitation of the most serious diseases, and for building health resources (Słońska, 2015). The present study concerns one of the above factors, i.e. physical activity.

Physical activity in people aged 15 to 69 years has been assessed using the IPAQ questionnaire (Craig et al., 2003; Tomioka, Iwamoto, Saeki, Okamoto, 2011). This tool is inexpensive, thus allowing for assessment of physical activity levels in large populations. Since this tool is subjective, it is not perfect and can lead to overestimation or underestimation of physical activity levels (Ferrari, Friedenreich, Matthews, 2007; Neilson, Robson, Friedenreich, Csizmadi, 2008). Therefore, assessment of physical activity is often based on the use of a questionnaire in combination with accelerometer measurements (Kowalski, Rhodes, Naylor, Tuokko, MacDonald, 2012; Prince et al., 2008; Hagstromer, Ainsworth, Oja, Sjostrom, 2010; Harris et al., 2009).

The aim of the study was to present both subjective and objective data concerning assessment of the physical activity of active professional women aged 50 to 64 years, and differences in their activity levels depending on age, education level, place of residence, financial status and BMI. Another aim was to evaluate correlations of physical activity assessed subjectively and objectively with the above variables.

## Material and methods

### Participants

The examinations were conducted in a group of 90 women aged 50 to 64 years employed full time at a university. The women performed both intellectual and physical work as scientists, teachers, and administration employees. In order to determine the correlation between physical activity and age, the participants were divided into three age groups (50–54; 55–59; 60–64). The inclusion criteria were as follows: an age of 50 to 64 years and provision of consent for the examinations. The exclusion criterion was diseases that limited everyday physical activity purposive sampling was used: all the women who provided the consent and met the inclusion criteria were examined (i.e. 98% of women in this age category). The questionnaire data were used to obtain information concerning age, place of residence (village, city) education (higher, secondary and primary), financial status (below average, average, above average). Characterization of the women studied is presented in Table 1.

**Table 1.** Characterization of the study participants

| | | n | % |
|---|---|---|---|
| Education level | primary or secondary | 39 | 43.3 |
| | tertiary | 51 | 56.7 |
| Age | 50–54 years | 36 | 40.0 |
| | 55–59 years | 32 | 35.6 |
| | 60–64 years | 22 | 24.4 |
| Place of residence | rural area | 20 | 22.2 |
| | city | 70 | 77.8 |
| Financial status | below average | 10 | 11.1 |
| | average | 62 | 68.9 |
| | above average | 18 | 20.0 |
| BMI | normal BMI | 37 | 41.1 |
| | overweight | 26 | 28.9 |
| | obese | 27 | 30.0 |
| Age | mean | 56.4 | |
| | SD | 4.3 | |
| BMI | mean | 27.5 | |
| | SD | 5.4 | |

## Assessment of physical activity using the questionnaire

Subjective assessment of physical activity (PA) levels was performed by means of a short version of the IPAQ-S questionnaire, which can be used for estimation of the physical activity levels and monitoring of health risks. It allows for collecting information about physical activity (PA) in everyday life over the last 7 days on which participants performed various physical exercises in their professional work, at home, in the garden, to move (e.g. walking, cycling), and during leisure time as recreation, physical exercise and sport (Craig et al., 2003).

The short version of the questionnaire contains 7 questions concerning time spent on intensive, moderate and low-intensity exercise and time spent sitting over a week. Questions 1 and 2 concerned intensive exercise which make breathing hard. Questions 3 and 4 concerned moderate-intensity exercise which make breathing slightly hard. Questions 5 and 6 concerned low-intensity exercise (walking to work and at home) (Craig et al., 2003). Analyses neglected information about time spent sitting (Question 7). The participants were asked to provide data on age, education level, financial standing and place of residence. The questionnaire was filled in the presence of an examination supervisor, after 7 days wearing an accelerometer in order to compare the objective and subjective measurement of physical activity performed over the same period of time that the IPAQ concerns.

## Physical activity levels assessed using accelerometers

The objective assessment of physical exercise (PA) levels was conducted using an ActiGraph (wGT3X-BT) activity monitor, which records 24-hour physical activity information (Trost, Trost, McIver, Pate, 2005). The device is attached to an elastic band, and the women were asked to wear it around their waist for 7 consecutive days, and then to complete the IPAQ questionnaire. The participants were wearing the device all day and took it off only during washing or swimming in a swimming pool. Combined with Actilife software, the ActiGraph wGT3X-BT provides objective information about physical activity and inactivity, measures movement, energy expenditure, body positions and amount of sleep. Physical activity level was measured with divisions into intensive, moderate and low-intensity exercise.

We also measured body height, body mass and computed BMI, and compared these with WHO norms (World Health Organization, 2014).

The examinations were performed twice (from March to May and from September to October 2017) as recommended for physical activity assessment in Polish climatic conditions (Biernat, Stupnicki, Gajewski, 2007).

### Statistical analysis

Statistical analysis was conducted using STATISTICA v.10 software. We calculated arithmetic means and standard deviations for individual physical activity levels evaluated using the IPAQ questionnaire and the ActiGraph accelerometer. The significance of differences between these variables was evaluated using the paired samples Student's t-test. Differences in the physical activity level with consideration for the analyzed variables (age, place of residence, financial status, education, and BMI) were evaluated using the Student's t-test (for variables with two options) and ANOVA analysis of variance (for variables with more than two options). The strength of correlations between the results obtained from the IPAQ questionnaire and those from accelerometers were evaluated using the Spearman's rank correlation coefficient. In all analysed cases, the level of significance was set at $p = 0.05$. We also used k-means clustering analysis adopting two variables that determine the total physical activity levels of the women studied measured using the ActiGraph and the IPAQ questionnaire.

The present study was conducted according to the Declaration of Helsinki guidelines (Act No. 1/2015 of 12 May 2015). The examinations are part of the project "Effect of lifestyles and quality of life on selected aspects of physical status of active professional women aged 50 to 64 years".

## Results

### Physical activity levels evaluated using the IPAQ questionnaire

Assessment of physical activity (PA) using the IPAQ questionnaire showed that among the analysed variables, significant differences in PA levels occurred for education level (Table 2). Women with tertiary education level and above-average financial situation had lower physical activity levels. Statistically significant differences concerned total PA levels and intensive exercise in the case of education level, and total and low PA levels in the case of financial situation (Table 2).

Weak and average negative correlations of total physical activity levels and low-intensity PA with education level and financial standing was found in the women studied (Table 3).

**Table 2.** Level of physical activity evaluated by the IPAQ questionnaire (MET-min/wk)

| | | Type of activity | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | total | | intensive | | moderate | | low | |
| | | mean | SD | mean | SD | mean | SD | mean | SD |
| Education level | primary/secondary[1] | **6,874.9[2]** | 7,304.0 | **2,467.7[2]** | 4,381.0 | 1,267.7 | 2,069.5 | 3,139.4 | 3,428.5 |
| | tertiary[2] | 3,453.1[1] | 4,811.4 | **895.5[1]** | 1,431.2 | 735.5 | 1,455.8 | 1,822.1 | 3,077.6 |
| | Student's t-test | **t = 2.61; p = 0.0106*** | | **t = 2.36; p = 0.0209*** | | t = 1.40; p = 0.1652 | | t = 1.87; p = 0.0648 | |
| Age | 50–54 years[1] | 4,429.9 | 5,388.2 | 1,429.4 | 3,488.4 | 903.5 | 2,032.5 | 2,097.0 | 2,480.6 |
| | 55–59 years[2] | 6,836.5 | 7,780.9 | 2,362.2 | 3,442.2 | 1,183.4 | 1,767.3 | 3,290.9 | 4,401.5 |
| | 60–64 years[3] | 2,906.0 | 3,853.9 | 636.2 | 1,514.8 | 740.0 | 1,208.2 | 1,529.8 | 2,079.7 |
| | ANOVA | F = 2.80; p = 0.0666 | | F = 1.99; p = 0.1436 | | F = 0.43; p = 0.6535 | | F = 2.08; p = 0.1315 | |
| Place of residence | rural areas[1] | 5,752.1 | 8,372.5 | 2,475.1 | 4,906.6 | 745.6 | 726.2 | 2,531.4 | 3,978.3 |
| | cities[2] | 4,690.8 | 5,505.0 | 1,315.8 | 2,425.1 | 1,026.6 | 1,951.0 | 2,348.4 | 3,087.2 |
| | Student's t-test | t = 0.66; p = 0.5141 | | t = 1.43; p = 0.1575 | | t = 0.61; p = 0.5412 | | t = 0.21; p = 0.8315 | |
| Financial status | below-average[1] | **6,498.2[3]** | 8,018.6 | 3,194.7 | 4,626.2 | 1,082.7 | 1,647.9 | 2,220.9 | 2 945.5 |
| | average[2] | 5,653.3 | 6,439.9 | 1,549.8 | 3,190.5 | 1,118.6 | 1,981.6 | **2 984.8[3]** | 3 576.9 |
| | above-average[3] | **1,473.4[1]** | 1,498.9 | 694.1 | 1,086.6 | 360.0 | 348.5 | **419.3[2]** | 664.2 |
| | ANOVA | F = 3.55; p = 0.0331* | | F = 2.04; p = 0.1362 | | F = 1.27; p = 0.2873 | | **F = 4.37; p = 0.0156*** | |
| BMI | normal BMI[1] | 3,797.0 | 4,729.4 | 1,003.0 | 2,057.1 | 722.5 | 1,077.1 | 2,071.5 | 2,763.5 |
| | overweight[2] | 5,039.8 | 6,860.2 | 2,164.8 | 4,297.8 | 773.6 | 1,165.5 | 2,101.4 | 3,116.5 |
| | obesity[3] | 6,334.0 | 7,189.2 | 1,767.7 | 3,053.4 | 1,473.8 | 2,684.3 | 3,092.4 | 4,015.8 |
| | ANOVA | F = 1.26; p = 0.2895 | | F = 1.07; p = 0.3484 | | F = 1.60; p = 0.2086 | | F = 0.86; p = 0.4289 | |
| Total | | 4,925.3 | 6,210.6 | 1,571.9 | 3,146.2 | 964.5 | 1,755.3 | 2,388.8 | 3,279.9 |

* Significant differences at $p < 0.05$; t – value of Student's t-test for independent samples; F – value of ANOVA analysis of variance.

The different numbers (indicated under 1, 2 and 3) in superscripts mean that differences among items are statistically significant. The same numbers in superscripts mean that differences among items are statistically insignificant.

**Table 3.** Correlations between physical activity and variables

| | Type of activity | | | |
|---|---|---|---|---|
| | total | intensive | moderate | low |
| Education level | **–0.30*** | –0.03 | –0.14 | **–0.36*** |
| Age | –0.14 | –0.14 | 0.02 | –0.03 |
| Place of residence | 0.03 | –0.05 | –0.09 | 0.10 |
| Financial status | **–0.26*** | –0.10 | –0.08 | **–0.33*** |
| BMI | 0.06 | 0.10 | 0.13 | 0.06 |

* Statistical differences at $p < 0.05$.

## Physical activity levels assessed using accelerometers

Physical activity levels assessed using accelerometers showed that among the five factors examined, differences were found only for BMI. Statistically significant differences concerned total PA, moderate PA and low-intensity PA (Table 4).

**Table 4.** Physical activity levels assessed using accelerometers (MET-min/wk)

| | | Type of activity | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | total | | intensive | | moderate | | low | |
| | | mean | SD | mean | SD | mean | SD | mean | SD |
| Education level | primary/secondary[1] | 2,881.0 | 2,541.1 | 1.6 | 7.2 | 5,09.9 | 790.7 | 2,369.5 | 1,811.8 |
| | tertiary[2] | 2,609.5 | 2,812.6 | 5.3 | 20.5 | 5,15.6 | 1,004.9 | 2,088.6 | 1,867.0 |
| | Student's t-test | t = 0.03; p = 0.9774 | | t = 1.14; p = 0.2578 | | t = 0.50; p = 0.6153 | | t = 0.22; p = 0.8274 | |
| Age | 50–54 years[1] | 2,255.8 | 1,952.9 | 3.1 | 8.5 | 369.4 | 541.4 | 1,883.4 | 1,429.2 |
| | 55–59 years[2] | 3,321.2 | 3,171.9 | 6.3 | 25.3 | 701.0 | 1,179.3 | 2,613.9 | 2,057.0 |
| | 60–64 years[3] | 2,609.8 | 2,892.0 | 0.9 | 4.0 | 468.5 | 941.9 | 2,140.3 | 2,049.6 |
| | ANOVA | F = 1.15; p = 0.3219 | | F = 0.65; p = 0.5224 | | F = 1.12; p = 0.3322 | | F = 1.08; p = 0.3453 | |
| Place of residence | rural areas[1] | 5,752.1 | 8,372.5 | 2,475.1 | 4,906.6 | 745.6 | 726.2 | 2,531.4 | 3,978.3 |
| | city[2] | 4,690.8 | 5,505.0 | 1,315.8 | 2,425.1 | 1,026.6 | 1,951.0 | 2,348.4 | 3,087.2 |
| | Student's t-test | t = 0.66; p = 0.5141 | | t = 1.43; p = 0.1575 | | t = 0.61; p = 0.5412 | | t = 0.21; p = 0.8315 | |
| Financial status | below-average[1] | 3,622.8 | 2,612.9 | 13.6 | 43.1 | 684.5 | 842.5 | 2,924.6 | 1,802.2 |
| | average[2] | 2,854.2 | 2,897.3 | 2.0 | 7.3 | 552.3 | 1,008.8 | 2,299.9 | 1,962.6 |
| | above-average[3] | 1,755.1 | 1,588.8 | 3.8 | 9.5 | 276.5 | 514.0 | 1,474.7 | 1,110.8 |
| | ANOVA | F = 1.44; p = 0.2423 | | F = 2.61; p = 0.0792 | | F = 0.45; p = 0.6388 | | F = 2.02; p = 0.1389 | |
| BMI | normal BMI[1] | **2,210.7[3]** | 1,917.5 | 6.8 | 24.3 | 380.7 | 629.4 | **1,823.2[3]** | 1,356.6 |
| | overweight[2] | **2,115.2[3]** | 1,742.8 | 3.1 | 8.1 | **296.4[3]** | 443.3 | **1,815.7[3]** | 1,324.3 |
| | obesity[3] | **4,008.0[1, 2]** | 3,765.5 | 0.1 | 0.3 | **899.8[2]** | 1,372.9 | 3,108.0[1.2] | 2,469.0 |
| | ANOVA | **F = 4.62; p = 0.0122*** | | F = 1.54; p = 0.2197 | | **F = 3.77; p = 0.0265*** | | **F = 4.82; p = 0.0102*** | |
| Total | | 2,726.3 | 2,687.1 | 3.7 | 16.2 | 513.1 | 913.8 | 2,209.4 | 1,838.0 |

* Significant differences at $p < 0.05$; t – value of Student's t-test for independent samples; F – value of ANOVA analysis of variance.

The different numbers (indicated under 1, 2 and 3) in superscripts mean that differences among items are statistically significant. The same numbers in superscripts mean that differences among items are statistically insignificant.

We found weak negative correlations of total, moderate and low-intensity physical activity with the financial standing of the women examined and a weak positive correlation between low-intensity PA and BMI (Table 5).

**Table 5.** Correlations between physical activity and variables

| | Type of activity | | | |
|---|---|---|---|---|
| | total | intensive | moderate | low |
| Education level | –0.12 | 0.09 | –0.08 | –0.12 |
| Age | –0.01 | –0.06 | –0.05 | 0.01 |
| Place of residence | 0.09 | –0.01 | 0.08 | 0.09 |
| Financial status | **–0.27*** | 0.13 | **–0.27*** | **–0.27*** |
| BMI | 0.21 | –0.10 | 0.13 | **0.23*** |

* Statistical differences at $p < 0.05$.

## Comparison of physical activity levels using the questionnaire and accelerometers

The results of examinations of physical activity obtained during measurements using the questionnaire and accelerometers showed statistically significant differences for total, intensive and moderate activity, with substantially higher values obtained using the questionnaire (Table 6).

**Table 6.** Physical activity levels assessed using accelerometers and the IPAQ questionnaire (MET-min/wk)

| | | | Mean | SD |
|---|---|---|---|---|
| Type of activity | total | Accelerometer$^{1}$ | **2,730.9$^{2}$** | 2,670.3 |
| | | IPAQ$^{2}$ | 3,687.5$^{1}$ | 5,116.9 |
| | | Student's t-test | t = 2.89; p = 0.0049$^{*}$ | |
| | intensive | Accelerometer$^{1}$ | **3.3$^{2}$** | 15.0 |
| | | IPAQ$^{2}$ | **1,251.3$^{1}$** | 2,684.5 |
| | | Student's t-test | 4.60; p < 0.0001$^{*}$ | |
| | moderate | Accelerometer$^{1}$ | **529.9$^{2}$** | 918.4 |
| | | IPAQ$^{2}$ | **829.5$^{1}$** | 1,489.3 |
| | | Student's t-test | t = 2.06; p = 0.0420$^{*}$ | |
| | low | Accelerometer$^{1}$ | 2,197.6 | 1,815.6 |
| | | IPAQ$^{2}$ | 1,606.7 | 2,681.3 |
| | | Student's t-test | t = 0.1113; p = 0.9116 | |

$^{*}$ Significant differences at $p < 0.05$; t – value of the Student's t-test for dependent samples.

The different numbers (indicated under 1, 2 and 3) in superscripts mean that differences among items are statistically significant. The same numbers in superscripts mean that differences among items are statistically insignificant.

A weak positive correlation was found between the total physical activity levels assessed using the questionnaire and accelerometers (Table 7).

**Table 7.** Correlations between physical activity levels assessed using the questionnaire and accelerometers

| Type of activity | Spearman's R | t | p |
|---|---|---|---|
| Total | 0.25 | 2.37 | 0.0199$^{*}$ |
| Intensive | 0.19 | 1.80 | 0.0757 |
| Moderate | 0.14 | 1.34 | 0.1846 |
| Low | 0.17 | 1.65 | 0.1029 |

$^{*}$ Significant differences at $p < 0.05$; t – value of the Student's t-test.

Cluster analysis was also conducted with two variables: total physical activity levels for the assessment using the questionnaire and using accelerometers. Both analysed variables turned out to be statistically significant (Table 8).

**Table 8.** Analysis of variance for PA assessed using the questionnaire and accelerometers

| Variable | Analysis of variance | | | | | |
|---|---|---|---|---|---|---|
| | between SS | df | int. SS | df | F | signif. p |
| Actigraf | 4.094081E+08 | 2 | 233,994,500 | 87 | 76.1097 | 0.000000 |
| IPAQ | 2.791444E+09 | 2 | 579,848,800 | 87 | 209.4129 | 0.000000 |

Three groups were identified. The first group (15 women) included participants with low PA evaluated using accelerometers and high PA assessed using the questionnaire. Despite high results using accelerometers, the second group (17 women) showed a low PA for the questionnaire. The third group (58 women) included women whose results obtained using both measurement tools were the most similar (Figure 1).

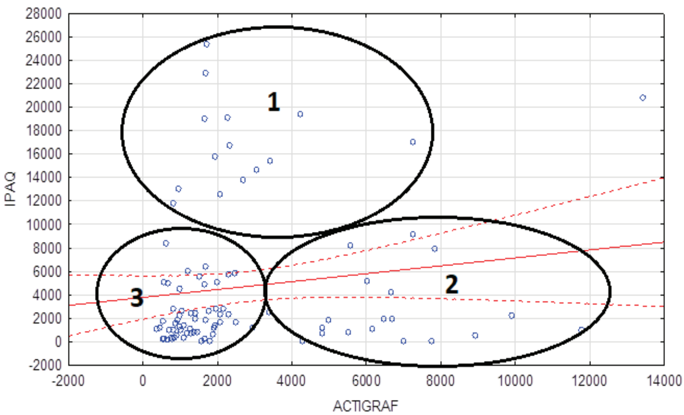


**Figure 1.** Dispersion of physical activity levels assessed using the questionnaire and accelerometers

The most numerous group (3), where subjective and objective assessment of PA were most similar, was women with higher education levels (63.6%) at the age of 50–54 (47.3%) living in cities (76.4%) with average (65.5%) or above-average (27.3%) financial situation and normal BMI (47.3%). Significant differences between the groups were found only in the case of financial status ($p = 0.0323$), with percentage of people with above-average financial standing (27.3%) significantly higher in the third group compared to the second (12.5%) and the first (0%).

## Discussion

The aim of the study was to compare subjective (IPAQ) and objective (ActiGraph) assessments of physical activity levels in a group of active professional women aged over 50 years. The assessment of physical activity levels pointed to substantial variation with respect to total, intensive and moderate activity, with higher measurements resulting from the subjective assessment. This points to overestimation of the measurements obtained using the IPAQ questionnaire. Furthermore, some help was needed to fill in the questionnaire to minimize the number of misinterpreted or missing replies. These difficulties have been also emphasized by other researchers (O'Neill et al., 2017).

The above findings encourage a more frequent use of objective tools that can be compared with each other. To meet these conditions, uniform recommendations for physical activity measurements using accelerometers should be developed, including the location of the device during the examinations, the duration of wear and the examination periods. The best solution would be to fill out the IPAQ questionnaire after the accelerometer had been worn for one week (7 consecutive days). When the respondents return the accelerometers, they would complete the IPAQ to provide information about their subjective assessments of their physical activity over the period of wearing the accelerometers. Wearing an accelerometer for one week seems to be sufficient, because this period ensures that the participants can easily recall all forms of physical activity as well as the duration and intensity. A combination of subjective and objective tools for the assessment of physical activity levels allows for a comprehensive analysis of behaviours concerning physical activity (Ainsworth, Cahalin, Buman, Ross, 2015).

Literature presents a lack of information about specific recommendations connected with the assessment of physical activity using accelerometers, although these modern devices are characterized by high validity and reliability (Wanner, Martin, Meier, Probst-Hensch, Kriemler, 2013; Butte, Ekelund, Westerterp, 2012). W. Osiński (2003) argued that respondents were likely to modify their behaviors during the examination period, because they attempted to obtain the best results possible. In this aspect, an interesting proposal was made by D.W. Esliger, J.L. Copeland, J.D. Barnes and M.S. Tremblay (2005). These researchers suggested that in the case where accelerometer measurements are collected for a duration of 8 days, the first day the device is worn should be neglected, because it may encourage a higher level of activity at the beginning of data collection. With the increasing popularity of the use of accelerometers in examinations of physical activity, many studies have recently explored this area of research. S. Skender et al. (2012) reviewed studies that used accelerometers and physical activity questionnaires. In most studies, the participants wore the devices for 7 days attached mainly near their hips (belt or waist). In the conclusion section, the authors argued that accelerometers were capable of ensuring more reliable and coherent results. They admitted that there were no standards concerning the use of accelerometers, including the location to which they should be attached and the minimal time of wearing. This lack leads to some inconsistencies, which indicate the need for the development of general guidelines for the use of accelerometers to improve the comparability of the measurement results in future studies. In 57 publications analysed by S. Skender et al. (2012), the correlations between the results obtained from the IPAQ and the accelerometer data were intermediate (poor to moderate). The authors found no clear correlations between physical activity assessed using the IPAQ and activity measured by accelerometers with regards to sex, age, BMI and even the time spent wearing the device. Slightly stronger correlations were found in men than in women and in younger than in older people.

In our study, the highest physical activity levels assessed using the questionnaire were obtained by women with secondary and primary education and those with the poorest financial standing. Weak and average negative correlations of the total physical activity levels and low-intensity PA with education level and financial standing was found in the women examined. It was surprising in the case of PA assessment using accelerometers that a significantly higher physical activity levels were observed in overweight women. Furthermore, we found weak negative correlations of total, moderate and low-intensity physical activity with the financial standing of the women examined, and a weak positive correlation between low-intensity PA and BMI.

We found a weak positive correlation between the total physical activity levels evaluated subjectively and objectively. As demonstrated by S. Sabia et al. (2015), who used data from an extensive study conducted in the UK (n = 3,940, including 1,016 women) in an adult population aged 60 to 83 years, the correlation of physical activity levels with obesity markers in older adults was stronger if physical activity was evaluated using accelerometers than using the questionnaire. This suggests that physical activity may be more important to obesity than it was believed before. Correlations between total physical activity and all obesity markers were greater in women compared to men.

S. Sabia et al. (2015), who cited previous researchers (Esliger et al., 2005; Skender et al., 2012), demonstrated that the correlations between subjective and objective assessment of physical activity were low or moderate and seemed to be even lower at older age (Prince et al., 2008).

Cluster analysis conducted in our study allowed for identification of a group of women where physical activity assessments using the IPAQ questionnaire was the most similar. These were women with tertiary education aged 50 to 54 years living in cities and with average or above-average financial standing and correct BMI.

Although this group was the biggest, the results of examinations of physical activity levels obtained during measurements using the questionnaire and accelerometers demonstrated statistically significant differences for total, intensive and moderate activity, with substantially higher values obtained using the questionnaire. This shows that the IPAQ is insufficient to be used as the sole tool for assessment of PA in this group.

## Conclusion

Physical activity levels in the women analysed using the subjective assessment was significantly higher than for the objective assessment with respect to total, intensive and moderate activity. Therefore, it seems that the IPAQ cannot be the only tool for PA assessment but can be successfully used as an auxiliary tool. The use of both subjective and objective tools is needed to obtain reliable information about physical activity level.

## Abbreviations

IPAQ: International Physical Activity Questionnaire; MET min./wk: Metabolic Equivalent of Work minute/week; WHO: World Health Organisation; BMI: Body Mass Index.

## Declarations. Ethics approval and consent to participate

The protocol of this study was approved by the Ethics Committee of the Academy of Physical Education (No. 1/2015 from 12 of May, 2015).

The ethical approval was obtained from the Ethics Committee of the Academy of Physical Education because at the time when we started the research, i.e. in 2015, there was no Bioethical Commission in Pope John Paul II State School of Higher Education in Biała Podlaska. Accordingly, we turned to the Jerzy Kukuczka Academy of Physical Education in Katowice, whose employees deal with similar research issues, and we obtained permission for doing the research from the Bioethics Committee for Scientific Research working in the Academy of Physical Education in Katowice. It was issued as a resolution of 12/05/2015 No. 1/2015. On the other hand, the research was conducted in John Paul II State School of Higher Education in Biała Podlaska, ul. Sidorska 95/97.

We would also like to confirm that we had written consent from all the women who participated in our research and we ensured that the results hde been collected in such a way that the women could not be personally identified in any way.

## Consent for publication

Not applicable.

## Availability of data and materials

The datasets generated and/or analyzed during the study are available from the authors upon reasonable request.

## Competing interests

The authors declare that they have no competing interests.


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