Determining the level of physical activity estimated by the Canada Fitness Survey questionnaire using criteria of the International Physical Activity Questionnaire

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Summary

Study aim: The aim of the study was to determine the weekly energy expenditure measuring MET/min/week based on data collected through the Canada Fitness Survey (CFS), according to the classification used in the International Physical Activity Questionnaire (IPAQ), and to verify the adopted method to assess the level of physical activity in students of physical education.

Material and methods: The study involved 116 female students (21.1 ± 1.6) and 276 male students (21.2 ± 1.7), studying Physical Education at Kazimierz Wielki University. Physical activity (PA) of respondents assessed using the Canada Fitness Survey was converted to energy expenditure in MET/min/week using the criteria established in the IPAQ. Body composition was assessed according to bioelectrical impedance.

Results: A significantly smaller fat fraction was observed in the group of students with high physical activity (PA) ($p < 0.01$). In women, there was a significant relation between FAT% and all analysed characteristics of physical activity: total physical activity (TPA) – 0.274, vigorous intensity (VI) – 0.216, number of days spent on physical activity (DTPA) – 0.199 and number of days spent on vigorous intensity (DVI) – 0.202 ($p < 0.05$). In men, a significant relation was found between all the analysed tissue components and the adopted variables of PA (FAT% vs. TPA – 0.145, VI – 0.203, DTPA – 0.187; FATkg vs. TPA – 0.123, VI – 0.186, DTPA – 0.178; FATkg vs. DVI – 0.131). BMI significantly correlated with VI (–0.162) and DVI (–0.140), $p < 0.05$.

Conclusions: Based on data collected using the CFS on the type and frequency of PA during a week, we can determine the level of activity in a measurable way, using the IPAQ classification. There is a significant relationship between thus determined physical activity levels and body composition in both women and men, which proves the accuracy of the adopted method of converting weekly energy expenditure to MET/min/week.

Keywords: Physical activity – International Physical Activity Questionnaire (IPAQ) – Canada Fitness Survey (CFS) – Body composition – Students

Introduction

PA and nutrition are modifiable elements of lifestyle, the improvement of which may reduce the incidence of many metabolic-civilization diseases [31]. Standardizing testing procedures and creating the conditions for conducting international comparative analysis of the collected empirical data relating to various elements of lifestyle and health of the population, with particular emphasis on aspects related to PA, can contribute to the identification of environmental

pathogens [16]. Selection of an appropriate method of PA studies is complicated, and it depends on many different conditions [1]. In population studies on lifestyle, including PA, the use of diagnostic surveys is popular. Questionnaires filled in independently by respondents, conducted by pollsters or supported by video clips, are typically used for subjective assessment of the level of PA. The questionnaires to measure physical activity are still being upgraded and modified, their accuracy and reliability are being confirmed, and new solutions are being implemented based on systematically obtained results of previous studies [28].

In recent years, one of the questionnaires most frequently used in Europe is the International Physical Activity Questionnaire (IPAQ). However, opinions on the research tool differ. On the one hand, some authors confirm the consistency of test results obtained through the use of IPAQ with the results obtained by objective methods, such as measurement with an accelerometer [11, 20]. On the other hand, there are publications containing allegations related to the disturbing influence of important factors, e.g. the level of respondents' fitness to the reliability of the results in the IPAQ [27] and related to revaluation [23], as observed in the Polish population in the case of the extended version of the IPAQ [4].

Selection of the appropriate questionnaire to study the PA of a particular population is therefore very important. Questionnaires used in children are different from those used in adults and in the elderly [15]. Based on the answers given, it is possible to collect quantitative information on participation in different types of activity and to determine its frequency [7, 12, 26], to calculate the total daily or weekly energy expenditure [5, 25] or express the energy expended on each of the activities given by respondents in the MET measure [2]. These measurable ways to calculate physical activity are nowadays most often used in international [3, 10, 21, 22, 32] and intra-population comparisons [6, 13, 29] to identify groups that are least physically active.

The Canada Fitness Survey (CFS) questionnaire was the most popular tool for estimating fitness or physical activity levels of Canadians. A huge survey carried out in the early nineteen eighties included 4,831 men and 5,448 women. It consisted of 13 500 households – a nationally representative sample of the Canadian population [8].

Information collected on the basis of the CFS was compiled with data acquired using various questionnaires used in the UK, Canada and the United States to compare percentages of people with impaired relative weight in age categories from 20 to 64 years [30]. Using a questionnaire previously published for the British survey, the Canadian and United States data were analysed and the prevalence of excessive weight was compared for particular ages [30]. On the basis of the data collected through the CFS questionnaire, concerning elements of lifestyle in relation to social status, factors for cardiovascular disease in women and men were also identified [16, 26].

The Canada Fitness Survey has two components: a questionnaire on health and lifestyle and a physical measures component. The extended version allows one to also obtain information on physical activity of the respondents, and other demographic features. Questions included in the section on lifestyle allow us to characterize the type and frequency of physical activity undertaken in a week, during the last month and last year. In the CFS physical activity level was defined on the basis of leisure-time activity. Subjects who reported that they engaged in

physical activity for less than 3 hours per week for less than 9 months of the year were defined as sedentary [7].

Determination of the level of physical activity in a measurable manner with the CFS questionnaire (MET measure) facilitates the use of data for comparisons between populations in space and time, which can contribute to the search for pathogenic factors of many diseases associated with elements of lifestyle.

The aim of the study was to determine the weekly energy expenditure measuring MET/min/week based on data collected through the Canada Fitness Survey (CFS), according to the classification used in the International Physical Activity Questionnaire (IPAQ) and verification of the adapted method to assess the level of physical activity in Polish students of physical education.

Material and methods

The study involved 116 female students and 276 male students of physical education at Kazimierz Wielki University in Bydgoszcz. The characteristics of the groups are presented in tables 1 and 2. The physical activity was evaluated with the Canada Fitness Survey (CFS) questionnaire. Information on activities undertaken during the last week were converted to MET/min/week loads. To facilitate the identification of zones of intensity of physical activity, the CFS questionnaire used examples of typical exercise with different levels of intensity [2, 24]. Applying the IPAQ criteria, students were assigned to three levels of physical activity: insufficient, sufficient and high [5]. Body composition was evaluated by electric bioimpedance (BIA) with the Tanita BC 418 MA device (Japan). In order to assess the accuracy of the division adopted from IPAQ to the CFS questionnaire, the tissue composition of students with different levels of physical activity was evaluated.

A two-way analysis of variance (ANOVA) examined the main effects of sex and physical activity, and one-way analysis between physical activity levels. The significance of differences between means was evaluated post hoc with Scheffé's test. The effect size (ES) in ANOVA was evaluated by eta square and interpreted as follows: $0.01 \leq \eta^2 < 0.06$ small, $0.06 \leq \eta^2 < 0.14$ medium and $\eta^2 \geq 0.14$ large [9]. Pearson's correlation coefficient was used to evaluate correlations between all parameters. For the statistical analyses, the value of $\alpha = 0.05$ was considered as significant. All computations were performed with STATISTICA software (v. 12.0, StatSoft, USA).

Results

Table 1 presents the results for female students of physical education in categories of physical activity adapted

Table 1. Mean ($\pm$ SD) values of anthropometric characteristics and physical activity in the three groups of women

Variables	Total, n = 116; 100%	INSA, n = 27; 23.3%	SA, n = 53; 45.7%	HA, n = 36; 31.0%	F	p	η^2
Age [years]	21.1 $\pm$ 1.6	21.3 $\pm$ 1.5	21.0 $\pm$ 1.5	21.0 $\pm$ 1.7	0.429	0.652	0.008
Height [cm]	168.0 $\pm$ 6.6	168.9 $\pm$ 9.0	167.4 $\pm$ 6.0	168.2 $\pm$ 5.6	0.430	0.652	0.008
Body mass [kg]	61.5 $\pm$ 9.5	63.0 $\pm$ 11.9	61.1 $\pm$ 10.0	61.1 $\pm$ 6.6	0.426	0.654	0.007
BMI index [kg $\cdot$ m ⁻²]	21.6 $\pm$ 3.2	22.0 $\pm$ 3.0	21.8 $\pm$ 3.0	21.0 $\pm$ 3.7	0.903	0.408	0.016
FAT _{BIA} [%]	24.8 $\pm$ 5.7	26.8 $\pm$ 4.9	25.3 $\pm$ 5.9	22.7 $\pm$ 5.6 ^a	4.649	0.011	0.076
FAT _{BIA} [kg]	15.7 $\pm$ 6.1	17.4 $\pm$ 6.7	15.9 $\pm$ 6.7	14.1 $\pm$ 4.4	2.373	0.098	0.040
FFM _{BIA} [kg]	45.9 $\pm$ 4.7	45.6 $\pm$ 5.6	45.2 $\pm$ 4.5	47.0 $\pm$ 3.9	1.743	0.180	0.030
Total physical activity (TPA) [MET/min/week]	2491.8 $\pm$ 1420.2	1002.8 $\pm$ 454.1	2289.8 $\pm$ 922.7 ^a	3905.8 $\pm$ 1175.1 ^{ab}	77.282	0.000	0.578
Number of days spent on physical activity (DTPA) [-]	3.1 $\pm$ 1.0	1.6 $\pm$ 0.5	3.3 $\pm$ 0.5 ^a	3.9 $\pm$ 0.4 ^{ab}	195.808	0.000	0.776
Vigorous intensity (VI) [MET/min/week]	965.8 $\pm$ 716.5	342.8 $\pm$ 224.4	631.1 $\pm$ 286.0 ^a	1925.8 $\pm$ 333.2 ^{ab}	296.526	0.000	0.840
Number of days spent on vigorous intensity (DVI) [-]	2.7 $\pm$ 1.3	1.5 $\pm$ 0.8	2.1 $\pm$ 0.9 ^a	4.3 $\pm$ 0.5 ^{ab}	127.197	0.000	0.692

INSA – insufficient activity, SA – sufficient activity, HA – high activity; ^a – significantly different from INSA, $p < 0.05$, ^b – significantly different from SA, $p < 0.05$.

Table 2. Mean ($\pm$ SD) values of anthropometric characteristics and physical activity in the three groups of men

Variables	Total, n = 276; 100%	INSA, n = 28; 10.2%	SA, n = 132; 47.8%	HA, n = 116; 42.0%	F	p	η^2
Age [years]	21.2 $\pm$ 1.7	21.2 $\pm$ 1.7	21.3 $\pm$ 1.9	21.1 $\pm$ 1.5	0.559	0.572	0.004
Height [cm]	180.8 $\pm$ 6.9	179.1 $\pm$ 8.2	180.4 $\pm$ 6.8	181.6 $\pm$ 6.5	1.900	0.152	0.014
Body mass [kg]	77.5 $\pm$ 9.3	73.9 $\pm$ 8.6	78.8 $\pm$ 9.3 ^a	76.8 $\pm$ 9.2	3.754	0.025	0.027
BMI index [kg $\cdot$ m ⁻²]	23.7 $\pm$ 2.3	23.0 $\pm$ 2.5	24.2 $\pm$ 2.3	23.3 $\pm$ 2.2 ^b	6.490	0.002	0.045
FAT _{BIA} [%]	12.5 $\pm$ 4.3	12.2 $\pm$ 4.9	13.3 $\pm$ 4.1	11.5 $\pm$ 4.3 ^b	5.669	0.004	0.040
FAT _{BIA} [kg]	9.8 $\pm$ 4.1	9.2 $\pm$ 4.2	10.7 $\pm$ 4.1	9.0 $\pm$ 4.0 ^b	5.871	0.003	0.041
FFM _{BIA} [kg]	67.6 $\pm$ 7.1	64.8 $\pm$ 7.3	68.1 $\pm$ 6.8	67.8 $\pm$ 7.3	2.634	0.074	0.019
Total physical activity (TPA) [MET/min/week]	2955.5 $\pm$ 1378.1	1127.1 $\pm$ 687.9	2422.5 $\pm$ 908.4 ^a	4003.3 $\pm$ 1114.8 ^{ab}	133.735	0.000	0.495
Number of days spent on physical activity (DTPA) [-]	3.5 $\pm$ 0.7	1.9 $\pm$ 0.4	3.5 $\pm$ 0.5 ^a	3.8 $\pm$ 0.4 ^{ab}	197.196	0.000	0.591
Vigorous intensity (VI) [MET/min/week]	1202.9 $\pm$ 662.7	476.6 $\pm$ 286.3	744.0 $\pm$ 249.9 ^a	1900.4 $\pm$ 314.4 ^{ab}	620.911	0.000	0.820
Number of days spent on vigorous intensity (DVI) [-]	3.1 $\pm$ 1.3	1.7 $\pm$ 0.9	2.3 $\pm$ 0.9 ^a	4.3 $\pm$ 0.5 ^{ab}	276.543	0.000	0.670

INSA – insufficient activity, SA – sufficient activity, HA – high activity; ^a – significantly different from INSA, $p < 0.05$, ^b – significantly different from SA, $p < 0.05$.

from IPAQ: high, sufficient and insufficient level. There were significant differences observed between the groups in total physical activity performed in a week (total physical activity – TPA) and intensive activity (vigorous intensity – VI) expressed in MET/min/week and the number of days in which it was performed ($p < 0.01$). It was found that the percentage of total fat in the body composition of female students with a high level of physical activity (3905.8 ± 1175.1 MET/min/week) was on average 4.1% smaller ($p < 0.01$) compared to their colleagues in whom the level was insufficient (2491.8 ± 1420.2 MET/min/week). Along with the decline in physical activity levels in women, there was an increase in the value of body mass index (BMI from 21.0 to 22.0) and percentage of body fat in their body composition (from 22.7% to 26.8%). In female students there was a significant association between FAT% and all analysed characteristics of physical activity (TPA MET/min/week – 0.274, vigorous intensity (VI) – 0.216 and the number of days spent on these activities per week, respectively – 0.199 (DTPA) and – 0.202 (DVI), $p < 0.05$).

Table 2 presents the characteristics of physical activity and tissue composition of students. In the groups of men differentiated regarding physical activity, there were significant differences in the average values of TPA, DTPA, VI and DVI ($p < 0.001$). Students with high physical activity had a significantly lower percentage of fat in the body composition compared to the group with a sufficient level ($p < 0.01$), whereas men with a sufficient level of physical activity had the heaviest weight. Their average body weight differed significantly only compared to the men with insufficient physical activity ($p < 0.01$). In male students, a significant association was found between all the components of the tissue analysed and the adopted variables of physical activity (FAT% vs. TPA – 0.145, VI – 0.203 and DTPA – 0.187; FATkg correlated with TPA – 0.123, VI – 0.186 and DTPA – 0.178; FFMkg vs. DVI – 0.131). BMI significantly correlated with intensive activity (VI) and number of days during which it was practised (DVI), respectively – 0.162 and – 0.140 ($p < 0.05$).

Discussion

Unification of testing procedures in order to conduct multi-dimensional analysis of empirical data for the purposes of identification of pathogens is a very important element of the epidemiological strategies pursued by the WHO [31]. The data collected in time make it possible to track changes in successive generations, as well as to identify the pathogenic factors [13, 26]. Differences in the test or protocols used make direct comparisons difficult, and the results are not comparable. Determining the direction and intensity of the observed trends is possible when

the compared data concern the same sex and population of the same age, and the material was collected according to a similar test method. Such methodological constraints were used to show the trend of overweight and obesity in the adult US population [14] and in order to compile groups at risk of overweight and obesity in the United Kingdom, Canada and the United States [30].

The extensive material used for the analysis was collected over the years with various questionnaires: Canada Fitness Survey (CFS), Canadian Health Measures Survey (CHMS), Canadian Physical Activity, Fitness and Lifestyle Approach (CPAFLA) and the Physical Activity Readiness Questionnaire (PAR-Q). It was only after the application of a unified method that the data could be compared [26]. The converter rate adapted from the IPAQ to determine physical activity in the CFS, verified by analysing the composition of the body tissue in the examined students of physical education, can be an effective tool used in similar comparisons. Accuracy of the division into three levels of physical activity depending on the BMI of respondents used in IPAQ has already been confirmed in the work by Biernat and Tomaszewski [6]. In the studies on students from selected universities in Warsaw, it was found that in the group with high levels of physical activity, there were only people with normal relative weight. In analyses of body composition in young training people, increased BMI does not indicate an increased fraction of fat in body composition [18], but it is a good predictor of fat in an average population [19]. Probably for this reason, there was no greater relationship between the weight-height proportions and the level of activity of the surveyed students of physical education, whereas this correlation was confirmed in relation to the fraction of fat in body composition (especially in women). The CFS information declared by the respondents, concerning the length and intensity of efforts in a week and converted into metabolic equivalents of work (METs), according to the procedure used in the IPAQ [24], allowed the calculation of average energy expenditure for women at 2492 MET/min/week and for men at 2956 MET/min/week. These data are consistent with the weekly workload that was found in students of the Warsaw Academy of Physical Education using the IPAQ, in terms of gender (women 2470 and men 4034 MET/min/week) [21], and in students of similar studies in Beijing (respectively 1982 and 2843 MET/min/week) [32].

The compared students constitute a population of physically active people, whose learning programme includes compulsory sports classes. However, the differences in the level of activity depend largely on the involvement in sports activities associated with practising sports. This is probably the reason why a review of sources also revealed significantly higher mean MET values for activities undertaken in a week by students of physical education at

Charles University in Prague (women 10964, men 9525 MET/min/week) [21] and Olomulcu (respectively 5296 and 6456 MET/min/week) [32], as well as in female students (mostly players) from Poznan [28]. According to the classification adopted in the paper, a high level of physical activity was found in 38.8% of subjects (42% of men and 31% of women), a sufficient level in 47.2% (respectively 47.8 and 45.7%) and a insufficient level in 14% (in terms of gender 10.2% and 23.3%). It seems alarming that there was a high percentage of people who do not meet even the conditions for a sufficient level although similar fractions in the population studying physical education have been identified in Beijing (12% of female students and 19% of male students) [32]. In other reports determining the level of physical activity in this group of students, the percentages of people with insufficient levels of physical activity ranged only from 2.4% to 5.5% in men and 6.2% in women [21,32]. In contrast, this type of study using the IPAQ conducted among low-activity students of the humanities at the University of Silesia also showed less than 2.5% of women and 1.5% of men with the lowest levels of activity [17]. Therefore, adopting a measurable way of determining the physical activity from the IPAQ to the CFS seems to be accurate, and the recalculated information on the activities undertaken in a week can be analysed over time and referred to other aspects of lifestyle and health of the respondents.

Conclusions

Based on data collected using the Canada Fitness Survey (CFS) on the type and frequency of physical activity during a week, we can determine the level of activity in a measurable way, using the IPAQ classification. There is a significant relationship between thus determined physical activity levels and body composition in both women and men, which proves the accuracy of the adopted method of converting weekly energy expenditure to MET/min/week.

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