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## Adaptation and validation of the Physical Activity Questionnaire for Adolescents (PAQ-A) among Polish adolescents

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3 **Adaptation and validation of the Physical Activity Questionnaire for Adolescents**  
4 **(PAQ-A) among Polish adolescents**  
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## Abstract

*Objective.* The lack of a widely accepted questionnaire in Polish language, used to assess the physical activity (PA) of adolescents, create a need to introduce a reliable, repeatable, inexpensive and quick tool. This study was designed for cultural adaptation and validation of the Polish version of the Physical Activity Questionnaires for Adolescents (PAQ-A).

*Design.* Mixed-methods.

*Participants and outcome measures.* Cultural adaptation of the Polish version of the PAQ-A was performed following the standardized questionnaires cultural adaptation process. In a sample of 78 adolescents, aged 14 to 19 yrs, PAQ-A test-retest was administered with 1-week interval. Reliability was analysed by the Intraclass Correlation Coefficient (ICC) and the internal consistency by the Cronbach's  $\alpha$  coefficient. Participants completed the PAQ-A and wore an accelerometer for 7 consecutive days. The PAQ-A was compared against PA parameters obtained using the accelerometer.

*Results.* Test-retest reliability showed ICC = 0.97 for the total score of PAQ-A. Internal consistency was excellent ( $\alpha = 0.93$ ). The PAQ-A was very strongly correlated with steps per day ( $\rho = 0.94$ ) and strongly with MVPA ( $\rho = 0.71$ ) assessed by the accelerometer.

*Conclusions.* The polish version of PAQ-A it is the valuable tool to estimate general levels of PA among children from 14-19 yrs old.

*Keywords.* adaptation, adolescents, physical activity, validation

## Strengths and limitations of this study

- This study provides the first Physical Activity Questionnaires for Adolescents (PAQ-A) cultural adaptation and validation study among Polish adolescents aged 14-19 yrs.
- The Polish version of PAQ-A was compared with an objective measure of physical activity to determine the validity of the PAQ-A using triaxial accelerometry.
- In the study, we used international standards for validating questionnaires.
- In our study, we used cut-points by Butte et al., other cut-points would have yielded different results.

## Introduction

One of the most important factors determining human health is physical activity (PA), which is defined as the body movement resulting from skeletal muscle contraction, during which energy expenditure is increased. PA is an important factor in the prevention of chronic diseases such as obesity, hypertension or cardiovascular disease.<sup>1</sup>

According to the World Health Organization, the low level of PA is the fourth leading risk factor for global mortality.<sup>2</sup> Physical inactivity has become a major issue in public health.<sup>3,4</sup> All over the world, on average one third of adults are physically inactive.<sup>5</sup> The situation is even worse in the developmental age population. The data indicate that 80% of adolescents from 105 countries do not reach the recommended level of PA (60 min per day moderate to vigorous PA (MVPA) for 5 days a week).<sup>6</sup> The level of PA of Polish adolescents is one of the lowest in Europe, in addition, research results show that it is systematically decreasing.<sup>7</sup> With the reduction in the level of PA, an increase in the percentage of children with obesity is observed. Data from UNICEF report show that children in Poland gain weight the most rapidly in Europe. Within a decade, the number of overweight children has doubled in Poland.<sup>8</sup> Increasing the level of PA is a key element in the treatment of many diseases, especially obesity. The assessment of the level of PA is therefore the subject of a strong interest in public health research.

In order to assess the level of PA in adolescents, various objective and subjective methods can be used.<sup>9</sup> Examples of tools used to assess the level of PA are various physiological indicators, laboratory methods, direct observation, motion sensors and self-report measures.<sup>10</sup> Each measurement method, objective or subjective, has its advantages and disadvantages. Certain objective methods, such as heart rate monitoring, and the detection and registration of body movement require special equipment and are more difficult to perform in comparison to subjective measurements. Subjective methods of PA assessment (interviews, questionnaires) are preferred in large epidemiological studies due to their relatively low costs and low workload of the participant.<sup>11</sup>

Due to the lack of commonly accepted questionnaires in the Polish version, used to assess the level of PA of adolescents, there is a need to introduce a reliable, repeatable, inexpensive and quick tool. Such a tool in many countries is Physical Activity Questionnaire for Adolescents (PAQ-A), developed in Canada by Kowalski et al.<sup>12</sup> The results of the authors' research indicated that PAQ-A is a reliable, repeatable, inexpensive, easy and quick tool used

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3 to assess PA in adolescents.<sup>12-14</sup> Cultural adaptation and validation of this questionnaire have  
4 not yet been assessed in Poland. The adaptation of a tool to assess the PA of adolescents will  
5 allow not only for easy and quick large-scale research, but also enables to compare results  
6 among countries.  
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10 The main aim of the study was to assess the reliability and validity of a Polish version of  
11 the PAQ-A in adolescents.  
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## 14 **Methods**

### 15 *Participants*

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18 The study was conducted in accordance with the ethical rules of the Helsinki  
19 Declaration. The study protocol was approved by the Bioethical Commission (REMOVED  
20 FOR REVIEW), approval number 9/05/2012. Prior to study commencement, we obtained  
21 written informed parent/guardian consent and written informed participant assent. We invited  
22 adolescents, aged 14-20 yrs, from 4 randomly selected middle and high schools to participate  
23 in a study (150 informed consents were distributed). Out of this number, 122  
24 parents/adolescents agreed to the participation in the study. Of these, 44 were excluded from  
25 the study for the following reasons: disease or injury preventing standard PA (n=2); removal  
26 of the accelerometer at any time during the study period (n=23); the device showing a  
27 mechanical error and/or operator error (incorrect epoch length, incorrect anthropometry or  
28 incorrect participant identification) (n = 8); and refusal to participate (n=1); failure to return or  
29 incompletely completed survey (n=10). Finally, 78 students (38 girls, 40 boys) were included  
30 in the analysis.  
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### 45 *Initial measurements*

46 Anthropometric measurements (body mass, body weight) were performed under  
47 standard conditions. Body height was measured in an upright position, barefoot, to the nearest  
48 0.1 cm using a portable stadiometer Seca 213. Body mass was assessed with an accuracy of  
49 0.1 kg using a body composition analyser (BC-420, Tanita). Body mass index (BMI) was  
50 calculated as weight (kg)/ height (m)<sup>2</sup>. Based on BMI values, the BMI percentile of individual  
51 participants were calculated. Polish BMI percentile charts specific for age, sex, and body  
52 height were used.<sup>15</sup> Based on the BMI percentile values, underweight (<5th percentile),  
53 healthy weight (between 5th and 85th percentile), overweight (BMI ≥85th percentile and <  
54 95th percentile), or obesity (≥95th percentile) were determined. The definitions of  
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3 underweight, healthy weight, overweight, and obesity were based on the recommendations of  
4 the Centers for Disease Control and Prevention.<sup>16</sup>  
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### 9 ***Physical Activity Questionnaire for Adolescents (PAQ-A)***

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11 The level of PA was assessed using Polish version of PAQ-A.<sup>12</sup> The PAQ-A is a self-  
12 administered, 7-day recall questionnaire that assesses participation in different PA, as well as  
13 activity during Physical Education, lunch break, after school, in the evenings and at weekend.  
14 The PAQ-A has been originally designed for adolescents aged 14 to 20. The questionnaire can  
15 be used to assess the level of PA during the school year, should not be used to assess PA  
16 during holidays. The questionnaire contains 8 questions that evaluate various aspects of PA of  
17 adolescents, taken during the last 7 days (during free time, during physical education classes,  
18 at different times during school days and during the weekend). Each question is scored  
19 according to a five-point scale (1-5), with "1" indicating low and "5" a high level of PA. The  
20 end result is the average value of the points obtained, with the higher scores corresponding to  
21 the higher level of PA. The answer to the last question (9) allows to get information whether  
22 the participant was ill or there were other circumstances that made it impossible to perform  
23 usual PA. However, the last question are not used as a part of the summary activity score.  
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### 37 ***Cultural adaptation of the Polish PAQ-A***

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39 The PAQ-A author's approval was obtained for the process of linguistic adaptation and  
40 validation of the questionnaire. Cultural adaptation of the Polish PAQ-A was performed  
41 following the basic steps of standardized questionnaires cultural adaptation process.<sup>17</sup> The  
42 original version of PAQ-A has been translated into Polish by two independent translators who  
43 are fluent in English but whose native language is Polish. Then, during the meeting of both  
44 translators, both versions of the translations were compared. The final compatible version was  
45 agreed. It was evaluated by specialists in the field of physical education and health sciences,  
46 in terms of the unambiguity of understanding of the content included in the questions, the  
47 transparency of all items and their usefulness. The accepted version of the questionnaire was  
48 translated into English again. Back translation was made by two independent translators who  
49 do not know the original version of PAQ-A, whose native language was English (native  
50 speakers). During the meeting, both versions were compared and one, the most adequate, was  
51 determined. Then all discrepancies between the original version and the version resulting  
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3 from the back translation were carefully analysed and corrected. Subsequently, PAQ-A was  
4 given to young people (n = 20) aged between 14 and 19 yrs in order to detect possible  
5 ambiguities in wording and assess the understanding of the questionnaire. During this  
6 analysis, students were encouraged to consult with researchers these questions or statements  
7 that were unintelligible or misleading. After the appropriate corrections were made, the Polish  
8 version of the research tool was agreed.  
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### 14 *Accelerometry*

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17 The ActiGraph WGT3X-BT monitor device (Pensacola, USA) was used to assess  
18 PA.<sup>18</sup> It is a small device that provides data related to total PA, which includes frequency,  
19 intensity and duration. The Actigraph accelerometer has been shown to be a reliable and valid  
20 tool for the assessment of different types of PA.<sup>19,20</sup> The accelerometer was placed at waist  
21 with a flexible strap above the right hip bone to measure the number and frequency of  
22 participant's movements. The participants were instructed to wear the accelerometer for seven  
23 consecutive days, 24 hours a day, excluding activities in water (bath, swimming pool). The  
24 WGT3X-BT measures accelerations in the range of 0.05 to 2 g, which is digitized by a 12-bit  
25 analog-to digital converter at a rate of 30 Hz. Data was collected in 60s epochs. Non-wear  
26 time was defined as 60 min of consecutive zeros allowing for 2 min of non-zero interruptions.  
27 A wear time of  $\geq 500$  min/a day was used as the criterion for a valid day, and  $\geq 4$  days were  
28 used as the criteria for a valid 7-day period of accumulated data (in this  $\geq 3$  valid weekdays  
29 and  $\geq 1$  valid weekend day).<sup>21</sup> ActiGraph data was analysed using the dedicated Actilife 6.0  
30 software (ActiGraph LLC, Pensacola, Florida, USA). Using the cut-off points acc. Butte et  
31 al., different intensity of PA defined based counts per minute (CPM), including: sedentary  
32 activity (0-819 CPM), light (820-3907 CPM), moderate (3908-6111 CPM), vigorous ( $> 6112$   
33 CPM).<sup>22</sup>  
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### 47 *Procedure*

49 Following agreement to participate in the study, participants were examined (initial  
50 measurements) and received an accelerometer for 7 days. After 7 days, they were asked to  
51 complete the PAQ-A. Participants completed the PAQ-A again one week after completing the  
52 first questionnaire to assess test-retest reliability.  
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## Statistical analysis

Descriptive statistics (n, frequencies (%), mean±SD) were calculated for applicable variables. Test-retest reliability were assessed by intra-class correlation coefficient (ICC).<sup>23</sup> The internal consistency of the questionnaire was analysed using Cronbach's  $\alpha$  coefficient. Removing every item to confirm or exclude redundancy of the individual items was also performed by Cronbach's  $\alpha$ . Values greater than 0.7 deemed acceptable for general research purposes.<sup>24</sup> Validity was assessed by calculating the relationship between the PAQ-A scores and accelerometry-derived PA metrics. It was performed using Spearman's rank correlation coefficients (rho). Statistical significance was established as a  $p$  value less than 0.05. All analyses were carried out using GNU R Software.

## Results

Ninety nine participants provided valid and complete PAQ-A responses. Of those,  $n = 78$  met conservative accelerometry inclusion criteria of  $\geq 3$  valid weekdays and  $\geq 1$  valid weekend day. The mean age of the participants was  $15.7 \pm 1.41$  yrs. The general characteristics of the subjects are presented in Table 1.

Table 1. Sample characteristic

Variables	Total (n=78)	Girls (n=38)	Boys (n=40)
Age [years] <sup>a</sup>	15.70 ± 1.41	15.34 ± 1.30	16.05 ± 1.43
Body height [cm] <sup>a</sup>	167.43 ± 10.49	162.24 ± 7.44	172.26 ± 10.65
Body weight [kg] <sup>a</sup>	60.49 ± 13.09	56.90 ± 12.76	63.90 ± 12.63
BMI percentile <sup>a</sup>	56.66 ± 28.84	58.03 ± 29.41	55.38 ± 28.60
Body mass category <sup>b</sup>			
Underweight	5 (6.41)	3 (7.89)	2 (5.00)
Healthy weight	56 (71.80)	26 (68.42)	30 (75.00)
Overweight	12 (15.38)	5 (13.16)	7 (17.50)
Obesity	5 (6.41)	4 (10.53)	1 (2.50)
<b>PAQ-A<sup>a</sup></b>			
Q1. Spare-time activity: sports	1.85 ± 0.72	1.78 ± 0.72	1.92 ± 0.71
Q2. Activity during physical education classes	3.27 ± 0.94	3.03 ± 0.85	3.50 ± 0.96
Q3. Lunchtime activity	2.59 ± 1.02	2.42 ± 1.08	2.75 ± 0.95
Q4. After-school activity	3.03 ± 1.01	2.76 ± 0.94	3.28 ± 1.01
Q5. Evening activity	2.95 ± 1.16	2.74 ± 1.16	3.15 ± 1.14
Q6. Weekend-activity	2.71 ± 1.11	2.55 ± 1.13	2.85 ± 1.08
Q7. Activity frequency during the last 7 days	2.99 ± 1.23	2.82 ± 1.27	3.15 ± 1.19
Q8. Activity frequency during each day last week	3.09 ± 0.89	2.89 ± 0.87	3.29 ± 0.87
PAQ-A total	2.82 ± 0.79	2.64 ± 0.80	2.99 ± 0.76
<b>Accelerometry<sup>a</sup></b>			
Energy expenditure [kcal/h]	31.01 ± 15.28	25.04 ± 9.65	36.67 ± 17.47
Total MVPA [min/h]	4.02 ± 2.12	3.40 ± 1.94	4.61 ± 2.13
Steps count per day	6928 ± 3064	6184 ± 2650	7635 ± 3289

Data are expressed as: <sup>a</sup> - mean  $\pm$  SD; <sup>b</sup> - n (%)

Abbreviations: MVPA – moderate-to-vigorous physical activity; Q – question

Table 2 presents results, which indicate excellent test-retest reliability for the PAQ-A (ICC=0.97). Similar relationships were found among girls and boys separately (ICC = 0.96 and 0.97 approximately). Regarding individual item analyses, the lowest value (ICC = 0.86) was observed for item 5, which informs about evening activity.

Table 2. Test-retest reliability (ICC - intra-class correlation coefficient) for PAQ-A

Variables	Total (n=78)	Girls (n=38)	Boys (n=40)
PAQ-A total	0.97***	0.96***	0.97***
Q1. Spare-time activity: sports	0.97***	0.96***	0.98***
Q2. Activity during physical education classes	0.87***	0.83***	0.88***
Q3. Lunchtime activity	0.91***	0.92***	0.89***
Q4. After-school activity	0.87***	0.82***	0.88***
Q5. Evening activity	0.86***	0.84***	0.88***
Q6. Weekend-activity	0.91***	0.89***	0.92***
Q7. Activity frequency during the last 7 days	0.96***	0.94***	0.97***
Q8. Activity frequency during each day last week	0.98***	0.97***	0.99***

\*\*\* -  $p < 0.001$

The internal consistency coefficients of the questionnaire are presented in Table 3. The PAQ-A obtained a consistency of Cronbach's  $\alpha = 0.93$ . The internal consistency was reduced after removing single item, which may indicate that no redundant items are included in the questionnaire. Removing first and second items had the lowest values in the internal consistency, showing a high contribution to final test score.

Table 3. Internal consistency for PAQ-A

Variables	Cronbach's coefficient	Correlation (item-total)
PAQ-A total	<b>0.93</b>	--
<b>Reliability if an item is dropped</b>		
Q1. Spare-time activity: sports	0.93	0.43
Q2. Activity during physical education classes	0.93	0.49
Q3. Lunchtime activity	0.92	0.71
Q4. After-school activity	0.92	0.74
Q5. Evening activity	0.91	0.84
Q6. Weekend-activity	0.91	0.81
Q7. Activity frequency during the last 7 days	0.91	0.85
Q8. Activity frequency during each day last week	0.92	0.74

There were significant associations between PAQ-A total scores, its sub-items and accelerometry-derived PA metrics (Table 4). Overall, associations were stronger for the overall PAQ-A score than individual sub-items. The highest correlation was observed for the PAQ-A total score and number steps per day ( $\rho = 0.94$ ), and the lowest for the MVPA ( $\rho = 0.71$ ).

Table 4. Spearman's rank correlation between PAQ-A and accelerometry

Variables	Energy expenditure [kcal/h]	MVPA [min/h]	Steps/day
Q1. Spare-time activity: sports	0,58***	0,39***	0,56***
Q2. Activity during physical education classes	0,46***	0,57***	0,52***
Q3. Lunchtime activity	0,51***	0,38***	0,67***
Q4. After-school activity	0,63***	0,55***	0,76***
Q5. Evening activity	0,58***	0,66***	0,83***
Q6. Weekend-activity	0,53***	0,63***	0,83***
Q7. Activity frequency during the last 7 days	0,58***	0,58***	0,82***
Q8. Activity frequency during each day last week	0,66***	0,63***	0,74***
<b>PAQ-A total</b>	<b>0,74***</b>	<b>0,71***</b>	<b>0,94***</b>

Abbreviation: MVPA –moderate-to-vigorous physical activity; \* -  $p < 0.05$ ; \*\* -  $p < 0.01$ ; \*\*\* -  $p < 0.001$

## Discussion

We found in the literature no questionnaires evaluating PA validated for Polish adolescents. Therefore, the present study is a pioneer in obtaining evidence of validity of a questionnaire developed by Kowalski et al. from Canada.<sup>12</sup> We present the first PAQ-A cultural adaptation and validation study among Polish adolescents aged 14-19 yrs. Excellent intraclass correlation and internal consistency, as well as strong or very strong convergent validity with accelerometer-based measures have provided evidence that the PAQ-A total score is a valuable measurement tool for large PA assessment studies with Polish children.

In the present study ICC for individual items of PAQ-A ranged from 0.86 to 0.97 for individual sub-items, which is strong evidence to support a good and excellent reliability.<sup>23</sup> Good ICC are observed for items 2, 4, and 5 (ICC = 0.87, 0.87 and 0.86, respectively), while excellent for the rest of sub-items. The reliability of the PAQ-A was good in other studies conducted in other countries and with adolescents of different races.<sup>14,25,26</sup>

An estimate of Cronbach's coefficient  $\alpha > 0.70$  is usually considered indicative of a reliable questionnaire.<sup>24,27</sup> Our results confirm the internal consistency of the questionnaire ( $\alpha$

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3 = 0.93), which is in accordance with other studies reporting similar results, so Janz et al.  
4 reported 0.72 to 0.88 for PAQ-A measurements;<sup>14</sup> Aggio et al. reported 0.72,<sup>26</sup> and Bervoets  
5 et al. found an  $\alpha$  of 0.76 for Dutch adolescents.<sup>28</sup>  
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10 The PAQ-A was compared with an objective measure of PA to determine the validity  
11 of the PAQ-A using triaxial accelerometry. Accelerometers monitor PA by recording the  
12 acceleration of human movement. Movement sensors, such as pedometers and accelerometers  
13 are suggested as one of the best methods for the evaluation of PA and validation of self-report  
14 instruments of PA.<sup>29</sup> The convergent validity of the PAQ-A was assessed by calculating the  
15 correlation between the PAQ-A total score and different PA measures determined by  
16 accelerometer (energy expenditure, MVPA, number of steps per day). The Spearman correlation  
17 coefficients between the PAQ-A and accelerometer scores ranged from 0.71 to 0.94,  
18 indicating strong or very strong correlation between both instruments. Very strong correlation  
19 was found between the PAQ-A total score and number of steps per day ( $\rho = 0.94$ ). Strong  
20 correlations were observed between the PAQ-A total score and energy expenditure, as well as  
21 MVPA ( $\rho = 0.74$  and  $0.71$ , respectively). These correlations for MVPA were slightly higher  
22 than those obtained in the study reported by Janz et al. ( $\rho = 0.63$ ).<sup>14</sup> Our result does not  
23 concur with a validation study of the PAQ-A conducted on Spanish adolescents, which  
24 showed reasonable validity of the PAQ-A for adolescents aged from 12-17 yrs ( $\rho=0.39$ ).<sup>30</sup>  
25 Much lower than in our study, but significant correlation for MVPA were reported in Chinese  
26 population ( $\rho=0.33$ ). However, study was performed among children aged from 8 to 13 yrs  
27 old.<sup>31</sup> These data confirm a line of evidence suggesting that PA questionnaires for adolescents  
28 correlate better with scores obtain from accelerometer than PA questionnaires for children.<sup>32</sup>  
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41 The assessment of PA is an significant part of understanding patterns and influences of  
42 behaviour, designing interventions, and monitoring. To describe the level of PA, a  
43 standardized, reliable and valid tool is essential. Furthermore, in pediatric population it is  
44 important to use methods which are non-invasive, easy-to-use and time-saving. Among the  
45 available validated self-report measures of PA dedicated to youth, the most promising tool  
46 may be PAQ. The PAQ is easy to use and quick to administer self-report tool. There are two  
47 versions of PAQ depending on age of assessed students. PAQ-Children (PAQ-C) has been  
48 originally designed for children aged 8 to 14 and contains one more question about PA than  
49 PAQ-A (nine questions in total). Last question, both in PAQ-C and PAQ-A, are designed to  
50 identify children or adolescents who had unusual activity during the previous week. Strength  
51 of the both PAQ-C and PAQ-A is that they determine a general PA level for a whole week  
52 rather than trying to estimate overall frequency, intensity and duration with detailed questions.  
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3 The PAQ also provides specific information about activity levels at different periods of the  
4 day (e.g. recess, physical education, after school etc.).<sup>12</sup> Biddle et al. reviewed available self-  
5 report PA instruments developed for use with children and adolescents to assess their  
6 suitability and feasibility for use in population surveillance systems and tracking trends over  
7 time, particularly in Europe. Authors identified 20 activity-based measures of which three  
8 were supported by the majority of the expert group: PAQ-C and PAQ-A, Youth Risk  
9 Behaviour Surveillance Survey and the Teen Health Survey. These PA measurement  
10 instruments demonstrated both reliability and validity but also ease of use.<sup>33</sup>  
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## 18 **Limitations**

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22 There are potential limitations of the study that need to be taken into account when  
23 interpreting the results. The PAQ-A is appropriate for high school students (approximately  
24 ages 14-20) who are currently in the school system. However, the age range of participants  
25 recruited in the current study was 14-19 yrs. This is due to the education system in Poland, in  
26 which students at the age of 19 finish high school. Moreover, no consensus currently exists as  
27 to the most accurate accelerometer sedentary behaviour cut-points for research with pediatric  
28 population.<sup>34</sup> In our study, we used cut-points that have been extensively used in pediatric  
29 research. Other cut-points would have yielded different results. Nonetheless, the relationships  
30 and differences with total PA will continue to be the same because this variable must not be  
31 highly dependent on cutoff values.  
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## 41 **Conclusion**

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43 This is the first study that analyses validity and reliability of PAQ-A in Polish  
44 adolescents, which may help to applicability of the questionnaire. Our results show that the  
45 Polish version of PAQ-A, provide reliable and valid estimates of PA among 14 to 19-year-old  
46 adolescents. Polish version of PAQ-A can be considered as very useful in clinical practice and  
47 epidemiological studies to assess overall level of PA in adolescents.  
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30 in this research.  
31  
32

### 33 **Authors' contributions**

34 JW - development of the concept of research. JW, JBP, KD, JB, PM, JH – data compilation.  
35 KP, AM, JW, PM - analysis and interpretation of data. KP - statistical analysis. JW writing an  
36 manuscript. JPB, JB, KD - substantive review article. AM, PM - overseeing the final article.  
37 All authors read and approved the final version of the manuscript.  
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47 not-for-profit sectors.  
48  
49

### 50 **Conflicts of interest**

51 The authors declare no conflict of interest.  
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### 54 **Data sharing statement**

55 The datasets generated and/or analysed during the current study are not publicly available due  
56 to protect the students' privacy, but are available from the corresponding author on reasonable  
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3 request.  
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6 **Additional file:** Polish version of Physical Activity Questionnaire for Adolescents (PAQ-A)  
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For peer review only

## Kwestionariusz Aktywności Fizycznej dla Młodzieży

### Polish version of the Physical Activity Questionnaire for Adolescents (PAQ-A)

Imię i nazwisko: \_\_\_\_\_

Wiek: \_\_\_\_\_

Płeć: K \_\_\_\_\_ M \_\_\_\_\_

Klasa: \_\_\_\_\_

Podajemy próbę oceny poziomu Twojej aktywności fizycznej w *ostatnich 7 dniach* (w ciągu ostatniego tygodnia). Odnosi się to do aktywności, które powodują, że się pocisz lub jesteś zmęczony/a, albo do zabaw, które sprawiają, że oddychasz z wysiłkiem, takich jak: podskakiwanie, bieganie, wspinanie się itp.

#### Pamiętaj:

- Nie ma złych lub dobrych odpowiedzi - to nie jest sprawdzian.

- Proszę, odpowiedz na wszystkie pytania tak szczerze i dokładnie jak potrafisz - to bardzo ważne.

#### 1. Aktywność fizyczna w Twoim wolnym czasie:

Czy wykonywałeś/aś którekolwiek z następujących czynności w ciągu *ostatnich 7 dni* (ostatniego tygodnia)? Jeśli tak, ile razy w tygodniu? (Zaznacz tylko jedno kółko w rzędzie).

	0	1-2	3-4	5-6	7 lub więcej razy
Skakanie na skakance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wiosłowanie/kajakowanie	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jazda na rolkach	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Zabawa w berka	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Maszerowanie dla sportu	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jazda na rowerze	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jogging/bieganie	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Aerobik	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pływanie	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gra w palanta/baseball	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Taniec	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rugby/football amerykański	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Badminton	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jazda na deskorolce	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Piłka nożna	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hokej na ulicy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Piłka siatkowa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Unihokej	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Piłka koszykowa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jazda na łyżwach	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Narciarstwo biegowe	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hokej na lodzie	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Podnoszenie ciężarów	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gimnastyka	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Piłka ręczna	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jazda na nartach	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tenis ziemny	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tenis stołowy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sporty/sztuki walki	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jazda konna	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Inne:					
_____	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
_____	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

2. **Jak często w ciągu ostatnich 7 dni, w trakcie *lekcji wychowania fizycznego (WF)* byłeś/aś bardzo aktywny/a (intensywne granie, bieganie, skakanie, rzucanie)?**  
(Zaznacz tylko jedną odpowiedź).

Nie brałem udziału w lekcji WF .....

Prawie nigdy .....

Czasami .....

Dosyć często .....

Zawsze .....

3. **Co zazwyczaj robiłeś/aś w czasie przerwy obiadowej w ciągu ostatnich 7 dni oprócz spożywania posiłku? (Zaznacz tylko jedną odpowiedź).**

Siedziałem/am (rozmawiając, czytając, odrabiając zadania domowe) ...

Stałem/am lub spacerowałem/am .....

Trochę biegałem/am lub grałem/am .....

Biegałem/am lub grałem/am dość dużo .....

Biegałem/am lub grałem/am intensywnie przez większość czasu .....

4. **W ciągu ostatnich 7 dni, przez ile dni *zaraz po szkole* uprawiałeś/aś jakiś sport, trenowałeś/aś taniec, lub grałeś/aś w gry, podczas których byłeś/aś bardzo aktywny/a?**  
(Zaznacz tylko jedną odpowiedź).

W żaden dzień .....

1 raz w tygodniu .....

2 lub 3 razy w tygodniu .....

4 razy w tygodniu .....

5 razy w tygodniu .....

5. **W ciągu ostatnich 7 dni, przez ile dni *wieczorami* uprawiałeś/aś jakiś sport, trenowałeś/aś taniec lub grałeś/aś w gry, podczas których byłeś/aś bardzo aktywny/a?**  
(Zaznacz tylko jedną odpowiedź).

W żaden dzień .....

1 raz w tygodniu .....

2 lub 3 razy w tygodniu .....

4 lub 5 razy w tygodniu .....

6 lub 7 razy w tygodniu .....

6. **Podczas ostatniego weekendu, ile razy uprawiałeś/aś jakiś sport, tańczyłeś/aś lub grałeś/aś w gry, podczas których byłeś/aś bardzo aktywny/a?**  
(Zaznacz tylko jedną odpowiedź).

Ani razu .....

1 raz .....

2 lub 3 razy .....

4 lub 5 razy .....

6 lub więcej razy .....

7. Które z następujących pięciu stwierdzeń najlepiej opisują Ciebie w ciągu ostatnich 7 dni? Przeczytaj *wszystkie pięć* stwierdzeń zanim zaznaczysz *jedną* odpowiedź odnoszącą się do Ciebie. (Zaznacz tylko jedną odpowiedź).

Cały lub większość czasu spędzałem/am wykonując rzeczy, które wymagały bardzo mało wysiłku fizycznego

Czasami (1-2 razy w zeszłym tygodniu) byłem/am aktywny/a fizycznie w wolnym czasie (np. uprawiałem/am jakiś sport, biegałem/am, jeździłem/am rowerem, pływałem/am, ćwiczyłem/am aerobik)

Często (3-4 razy w zeszłym tygodniu) byłem/am aktywny/a fizycznie w wolnym czasie

Dosyć często (5-6 razy w zeszłym tygodniu) byłem/am aktywny/a fizycznie w wolnym czasie

Bardzo często (7 lub więcej razy w zeszłym tygodniu) byłem/am aktywny/a fizycznie w wolnym czasie

8. Zaznacz jak często byłeś/aś aktywny/a fizycznie każdego dnia w ciągu ostatniego tygodnia (np. uprawiając jakiś sport, uczestnicząc w grach ruchowych, tańcząc lub wykonując inne formy aktywności fizycznej).

	Wcale	Trochę	Średnio	Często	Bardzo często
Poniedziałek	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wtorek	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Środa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Czwartek	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Piątek	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sobota	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Niedziela	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

9. Czy byłeś/aś chory/a w ciągu ostatniego tygodnia lub zdarzyło się coś, co powstrzymało Cię przed zwykle wykonywaną aktywnością fizyczną? (Zaznacz jedną opcję).

Tak .....

Nie .....

Jeśli tak, to co uniemożliwiło Ci podjęcie tej aktywności? \_\_\_\_\_

**STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology\***  
**Checklist for cohort, case-control, and cross-sectional studies (combined)**

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1, 2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3, 4
Objectives	3	State specific objectives, including any pre-specified hypotheses	4
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	4
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4, 5, 6
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	7
		(b) Describe any methods used to examine subgroups and interactions	7
		(c) Explain how missing data were addressed	
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed	

		<i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	
		(e) Describe any sensitivity analyses	7
<b>Results</b>			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	4
		(b) Give reasons for non-participation at each stage	4
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	7-9
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	
		(b) Report category boundaries when continuous variables were categorized	
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11
Generalisability	21	Discuss the generalisability (external validity) of the study results	11
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).

# BMJ Open

## Adaptation and validation of the Physical Activity Questionnaire for Adolescents (PAQ-A) among Polish adolescents – cross-sectional study

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<b>Primary Subject Heading</b>:	Public health
Secondary Subject Heading:	Sports and exercise medicine
Keywords:	adolescent, physical activity, validation

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Manuscripts

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2  
3 **Adaptation and validation of the Physical Activity Questionnaire for Adolescents**  
4 **(PAQ-A) among Polish adolescents – cross-sectional study**  
5

6  
7 Justyna Wyszynska<sup>1</sup>, Piotr Matłosz<sup>2</sup>, Justyna Podgórska-Bednarz<sup>1</sup>, Jarosław Herbert<sup>2</sup>,  
8 Krzysztof Przednowek<sup>2</sup>, Joanna Baran<sup>1</sup>, Katarzyna Dereń<sup>1</sup>, Artur Mazur<sup>1</sup>  
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## Abstract

*Objective.* The lack of a widely accepted questionnaire used to assess the physical activity of adolescents in the Polish language creates a need to introduce such a valid, reliable, inexpensive and quick tool for assessment. This study was designed to culturally adapt and validate the Physical Activity Questionnaires for Adolescents (PAQ-A) in the Polish language.

*Design.* Cross-sectional study.

*Participants and outcome measures.* Cultural adaptation of the Polish version of the PAQ-A was performed following the standardized questionnaires cultural adaptation process. In a sample of 78 adolescents aged 14 to 19 years, the PAQ-A test-retest was administered within a 1-week interval. Reliability was analysed by the Intraclass Correlation Coefficient (ICC) and internal consistency with Cronbach's  $\alpha$ . Participants completed the PAQ-A, and wore an accelerometer for 7 consecutive days. The PAQ-A was compared to physical activity parameters obtained using the accelerometer.

*Results.* Test-retest reliability showed ICC=0.97 for the total score of PAQ-A. Internal consistency was excellent ( $\alpha=0.93$ ). The PAQ-A was very strongly correlated with steps per day ( $\rho=0.94$ ) and with moderate-to-vigorous physical activity ( $\rho=0.81$ ) assessed by the accelerometer.

*Conclusions.* The Polish version of the PAQ-A is a valuable tool to estimate general levels of physical activity among adolescents from 14-19 years old.

*Keywords.* adaptation, adolescents, physical activity, validation

## Strengths and limitations of this study

- This study provides the first Physical Activity Questionnaire for Adolescents cultural adaptation and validation study among Polish adolescents aged 14-19 years.
- The Polish version of the Physical Activity Questionnaire for Adolescents was compared with a device-based measure of physical activity (triaxial accelerometry) to determine the validity of the questionnaire.
- In this study, we used international standards for validating the questionnaire.
- Limitations of this study are the small sample size and the relatively high dropout rate of participants due to accelerometer non-wear periods.

## Introduction

One of the most important factors determining human health is physical activity (PA), which is defined as body movement resulting from skeletal muscle contraction during which energy expenditure is increased.<sup>1</sup> Physical inactivity is responsible for about 3.2 million deaths per year, being one of the most important risk factors for non-communicable diseases such as coronary heart disease, type 2 diabetes, and cancer.<sup>2</sup> According to the World Health Organization, more than 80% of the world's adolescent population is insufficiently physically active.<sup>3</sup> Increasing evidence suggests that declining PA is a major factor for higher prevalence of childhood obesity.<sup>4</sup> Worldwide, over 340 million children and adolescents aged 5-19 were overweight or obese in 2016.<sup>5</sup> Physical activity is not only an important factor in the prevention of chronic diseases such as obesity, hypertension and cardiovascular diseases<sup>6</sup>; there is also evidence that regular participation in PA has a positive impact on psychosocial wellbeing, cognitive outcomes, and mental health.<sup>7</sup> Accurate measurement of PA is important to understanding the association between PA and health, but also to monitor changes in PA patterns, and to evaluate the effectiveness of interventions.

To assess PA level, valid and reliable measures are required. The doubly labeled water method is the most widely accepted technique and the gold standard for assessing total energy expenditure, however, it is not often used for research studies as it is expensive, time-intensive, and cannot capture qualitative data.<sup>8</sup> Self-report questionnaires, despite their limitations, are often used due to their low cost and ease of administration, ability to measure large samples and to contextualise PA.<sup>9</sup> Weaknesses of self-report questionnaires include, among others inaccuracies, the tendency to over-report PA levels, inability to use with young children (below the age of 10 or 11), and inability to compare results across studies due to the large number of measures available.<sup>10,11</sup> A more accurate estimate of PA is provided by device-based measures (such as accelerometers, pedometers, heart-rate monitors).<sup>11</sup> An advantage of accelerometers include minute-by-minute monitoring, capturing intensity level, large memory capacities,<sup>8</sup> and feasibility with young children.<sup>12</sup> However, accelerometers do not provide information on both the type and context of PA. Moreover, accelerometers are expensive and require technical expertise, specialized hardware, software, and individual programming.<sup>13</sup> Results of a systematic review that compared PA measures from accelerometers with PA scores of questionnaires, indicated that correlations between questionnaires and accelerometry were weak to moderate.<sup>14</sup> This finding is in agreement with previous reviews.<sup>15,16</sup>

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3 A systematic review by Chinapaw et al. that examined 61 versions of PA questionnaires  
4 for youth found that none of the questionnaires included in the review had acceptable levels of  
5 reliability and validity according to guidelines described in the Qualitative Attributes and  
6 Measurement Properties of Physical Activity Questionnaires.<sup>17</sup> Biddle et al. also reviewed  
7 available self-report PA instruments developed for children and adolescents to assess their  
8 suitability and feasibility for use in population surveillance systems and tracking trends over  
9 time, particularly in Europe. The authors identified 20 activity-based measures, of which three  
10 were supported by the majority of the expert group: the Physical Activity Questionnaire for  
11 Older Children (PAQ-C) and the Physical Activity Questionnaire for Adolescents (PAQ-A),  
12 Youth Risk Behaviour Surveillance Survey, and the Teen Health Survey. These PA  
13 measurement instruments demonstrated both reliability and validity but also ease of use.<sup>9</sup>  
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23 The PAQ-A was developed in Canada by Kowalski et al.<sup>18</sup> Research results by Kowalski  
24 and others indicate that PAQ-A is a reliable, inexpensive, easy and quick tool used to assess  
25 PA in adolescents.<sup>18-20</sup> Cultural adaptation and validation of this questionnaire has not yet  
26 been assessed in Poland. The adaptation of a tool to assess the PA of adolescents in Poland  
27 will allow not only for easy and quick large-scale research, but will also enable result  
28 comparison among countries.  
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34 The main aim of this study was to assess the reliability and validity of a Polish version of  
35 the PAQ-A in adolescents.  
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## 38 **Methods**

### 39 *Study design and setting*

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41 A cross-sectional survey was conducted at 4 randomly selected middle and high  
42 schools in south-eastern Poland. Six classes were randomly selected from the schools  
43 representing students ranging from 14 to 19 years of age.  
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### 49 *The PAQ-A*

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51 The PAQ-A is an 8-item, 7-day PA recall that assesses participation in various types  
52 of PA including activity during physical education, lunch break, after school, during evenings  
53 and weekends. A 9th item not used in the calculation of the activity score asks adolescents if  
54 they were sick or otherwise prevented from engaging in regular PA. The PAQ-A was  
55 originally designed for adolescents aged 14 to 20. The questionnaire can be used to assess the  
56 level of PA during the school year, but not during holidays. Each item is scored according to a  
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3 five-point scale (1-5), with "1" indicating low and "5" a high level of PA. The end result is the  
4 average value of the points obtained, with higher scores corresponding to a higher level of  
5 PA.<sup>18</sup>  
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### 10 ***Translation and cultural adaptation of the Polish PAQ-A***

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12 Author approval was obtained for the process of linguistic adaptation and validation of  
13 the PAQ-A questionnaire. Cultural adaptation of the Polish PAQ-A was performed following  
14 the basic steps of the standardized questionnaires cultural adaptation process.<sup>21</sup> The original  
15 version of PAQ-A was translated into Polish by two independent translators who are fluent in  
16 English but whose native language is Polish. Then, during a meeting of both translators, both  
17 versions of the translations were compared. A final compatible version was then agreed upon.  
18 It was evaluated by specialists in the field of physical education and health sciences, in terms  
19 of the unambiguity of understanding of the content included in the questions, the transparency  
20 of all items and their usefulness. The accepted version of the questionnaire was translated into  
21 English again. The back translation was made by two independent translators who had no  
22 knowledge of the original PAQ-A version, and whose native language was English (native  
23 speakers). During the meeting, both versions were compared and it was determined which one  
24 was most adequate. Then, all discrepancies between the original version and the version  
25 resulting from the back translation were carefully analysed and corrected. Subsequently, the  
26 PAQ-A was given to young people (n=20) aged between 14 and 19 years in order to detect  
27 possible ambiguities in wording and to assess the understanding of the questionnaire. During  
28 this analysis, students were encouraged to consult with researchers concerning questions or  
29 statements that were unintelligible or misleading. After the appropriate corrections were  
30 made, the final Polish version of the research tool was agreed upon. The Polish version of  
31 PAQ-A is presented in supplementary materials (Suppl. 1).  
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### 48 ***Study participants***

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50 The study was conducted in accordance with the ethical rules of the Helsinki  
51 Declaration. The study protocol was approved by the Bioethics Committee of the University  
52 of Rzeszów (Poland), approval number 9/05/2012. Prior to study commencement, we  
53 obtained written informed parent/guardian and participant consent. We invited adolescents,  
54 aged 14-19 years from 4 randomly selected middle and high schools to participate in this  
55 study (150 informed consents were distributed). Out of this number, 122 parents/adolescents  
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3 agreed to participate in the study. Of these, 44 were excluded from the study for the following  
4 reasons: disease or injury preventing standard PA (n=2); participants without valid  
5 accelerometer-measurement period (n=23); the device showing a mechanical error and/or  
6 operator error (n=7); incorrect anthropometry (n=1); refusal to participate (n=1); failure to  
7 return or an incomplete survey (n=10). In total, 78 students (38 girls and 40 boys) were  
8 included in the analysis.  
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### 14 ***Patient and public involvement***

15 Neither patients nor public were involved in the design or planning of this study.  
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### 18 ***Initial measurements***

19 Anthropometric measurements (body mass, body weight) were performed under  
20 standard conditions. Body height was measured in an upright position, barefoot, to the nearest  
21 0.1 cm using a portable stadiometer (Seca 213). Body mass was assessed with an accuracy of  
22 0.1 kg using a body composition analyser (BC-420, Tanita). Body mass index (BMI) was  
23 calculated as weight (kg)/ height (m)<sup>2</sup>. Based on BMI values, the BMI percentile of individual  
24 participants were calculated. Polish BMI percentile charts specific for age, sex, and body  
25 height were used.<sup>22</sup> Based on the BMI percentile values, underweight (<5th percentile),  
26 healthy weight (between 5th and 85th percentile), overweight (BMI ≥85th percentile and <  
27 95th percentile), or obesity (≥95th percentile) were determined. The definitions of  
28 underweight, healthy weight, overweight, and obesity were based on the recommendations of  
29 the Centers for Disease Control and Prevention.<sup>23</sup>  
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### 41 ***Accelerometry***

42 An ActiGraph WGT3X-BT monitor device (Pensacola, USA) was used to assess PA.<sup>24</sup>  
43 It is a small device that provides data related to total PA including the frequency, intensity and  
44 duration. The Actigraph accelerometer has been shown to be a reliable and valid tool for the  
45 assessment of different types of PA.<sup>25,26,27</sup> The accelerometer was placed at the waist with a  
46 flexible strap above the right hip bone to measure the number and frequency of participant  
47 movement. The participants were instructed to wear the accelerometer for seven consecutive  
48 days, 24 hours a day, excluding water-based activities (baths, swimming). The Actigraph  
49 accelerometer measures accelerations in the range of 0.05 to 2 g, which is digitized by a 12-  
50 bit analog-to digital converter at a rate of 30 Hz. Data was collected in 5s epochs. Non-wear  
51 time was defined as 60 minutes of consecutive zeros allowing for 2 minutes of non-zero  
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3 interruptions.<sup>28</sup> A wear time of  $\geq 500$  minutes/day was used as the criterion for a valid day,  
4 and  $\geq 4$  days were used as the criteria for a valid 7-day period of accumulated data (including  
5  $\geq 3$  valid weekdays and  $\geq 1$  valid weekend day).<sup>28</sup> For each participant, the mean moderate-to-  
6 vigorous physical activity (MVPA) (minutes/day) and the mean daily step count were  
7 calculated. The cut-off points from Evenson et al. were selected to determine the time spent  
8 on MVPA level ( $\geq 4012$  counts ng per minute).<sup>29</sup> MVPA time was calculated as the mean  
9 daily minutes  $\geq 2296$  counts per minute from all valid days. Daily step count was calculated  
10 as the mean daily step count from all valid days. ActiGraph data was analysed using dedicated  
11 Actilife 6.0 software (ActiGraph LLC, Pensacola, Florida, USA).  
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### 19 *Procedure*

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22 Following agreement to participate in the study, participants were examined (initial  
23 measurements) and received an accelerometer for 7 days. After 7 days the PAQ-A was  
24 delivered to students during school time in their classroom. Adolescents were asked to  
25 complete the questionnaire at home. Participants completed the PAQ-A again one week after  
26 completing the first questionnaire to assess test-retest reliability.  
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### 31 *Statistical analysis*

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34 Descriptive statistics (n, frequencies (%), mean $\pm$ SD) were calculated for applicable variables.  
35 Test-retest reliability was assessed by intra-class correlation coefficient (ICC).<sup>30</sup> Values of  
36 ICC less than 0.5 are indicative of poor reliability; between 0.5 and 0.75 indicate moderate  
37 reliability; between 0.75 and 0.9 indicate good reliability, and greater than 0.90 indicate  
38 excellent reliability.<sup>31</sup> The internal consistency of the questionnaire was analysed using  
39 Cronbach's  $\alpha$  coefficient. Removing every item to confirm or exclude redundancy of the  
40 individual items was also performed by Cronbach's  $\alpha$ . Values of  $\alpha$  greater than 0.7 were  
41 deemed acceptable for general research purposes.<sup>32</sup> Validity was assessed by calculating the  
42 relationship between PAQ-A scores and accelerometry-derived PA metrics using Spearman's  
43 rank correlation coefficients( $\rho$ ). Values from 0.1 to 0.2 indicate poor correlation; from 0.3  
44 to 0.5 fair; from 0.6 to 0.7 moderate and  $\geq 0.8$  very strong correlation.<sup>33</sup> Statistical significance  
45 was established as a  $p$  value less than 0.05. All analyses were carried out using GNU R  
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## Results

In total, 78 adolescents provided valid data for the PAQ-A and accelerometer measurements. The mean age of the participants was  $15.7 \pm 1.41$  years. The mean non-wear time recorded by the accelerometers was 477 minutes per day (minimum 326; maximum 840 minutes). The general characteristics of the participants are presented in Table 1.

**Table 1.** Sample characteristic

Variables	Total (n=78)	Girls (n=38)	Boys (n=40)
Age [years] <sup>a</sup>	15.70 ± 1.41	15.34 ± 1.30	16.05 ± 1.43
Age [years] <sup>b</sup>			
14	12 (15.4)	8 (10.3)	4 (5.1)
15	14 (18.0)	7 (9.0)	7 (9.0)
16	16 (20.5)	9 (11.5)	7 (9.0)
17	12 (15.4)	4 (5.1)	8 (10.3)
18	11 (14.1)	3 (3.8)	8 (10.3)
19	13 (16.6)	7 (9.0)	6 (7.6)
Body height [cm] <sup>a</sup>	167.43 ± 10.49	162.24 ± 7.44	172.26 ± 10.65
Body weight [kg] <sup>a</sup>	60.49 ± 13.09	56.90 ± 12.76	63.90 ± 12.63
BMI percentile <sup>a</sup>	56.66 ± 28.84	58.03 ± 29.41	55.38 ± 28.60
Body mass category <sup>b</sup>			
Underweight	5 (6.41)	3 (7.89)	2 (5.00)
Healthy weight	56 (71.80)	26 (68.42)	30 (75.00)
Overweight	12 (15.38)	5 (13.16)	7 (17.50)
Obesity	5 (6.41)	4 (10.53)	1 (2.50)
<b>PAQ-A<sup>a</sup></b>			
Q1. Spare-time activity: sports	1.85 ± 0.72	1.78 ± 0.72	1.92 ± 0.71
Q2. Activity during physical education classes	3.27 ± 0.94	3.03 ± 0.85	3.50 ± 0.96
Q3. Lunchtime activity	2.59 ± 1.02	2.42 ± 1.08	2.75 ± 0.95
Q4. After-school activity	3.03 ± 1.01	2.76 ± 0.94	3.28 ± 1.01
Q5. Evening activity	2.95 ± 1.16	2.74 ± 1.16	3.15 ± 1.14
Q6. Weekend-activity	2.71 ± 1.11	2.55 ± 1.13	2.85 ± 1.08
Q7. Activity frequency during the last 7 days	2.99 ± 1.23	2.82 ± 1.27	3.15 ± 1.19
Q8. Activity frequency during each day last week	3.09 ± 0.89	2.89 ± 0.87	3.29 ± 0.87
PAQ-A total	2.82 ± 0.79	2.64 ± 0.80	2.99 ± 0.76
<b>Accelerometry<sup>a</sup></b>			
MVPA [minutes/day]	44.71 ± 17.24	39.86 ± 15.63	49.32 ± 17.61
Steps count per day	6928 ± 3064	6184 ± 2650	7635 ± 3289

Data are expressed as: <sup>a</sup> - mean ± SD; <sup>b</sup> - n (%)

Abbreviations: MVPA – moderate-to-vigorous physical activity; Q – question

Table 2 presents results which indicate excellent test-retest reliability for the PAQ-A (ICC=0.97). Similar relationships were found among girls and boys separately (ICC=0.96 and 0.97, respectively). Regarding individual item analyses, the lowest value (ICC=0.86) was observed for item 5, which informs about evening activity. The obtained correlations presented in Table 2 show statistical significance at the level of  $p < 0.01$ .

**Table 2.** Test-retest reliability (ICC - intra-class correlation coefficient) for PAQ-A

Variables	Total (n=78)	Girls (n=38)	Boys (n=40)
PAQ-A total	0.97	0.96	0.97
Q1. Spare-time activity: sports	0.97	0.96	0.98
Q2. Activity during physical education classes	0.87	0.83	0.88
Q3. Lunchtime activity	0.91	0.92	0.89
Q4. After-school activity	0.87	0.82	0.88
Q5. Evening activity	0.86	0.84	0.88
Q6. Weekend-activity	0.91	0.89	0.92
Q7. Activity frequency during the last 7 days	0.96	0.94	0.97
Q8. Activity frequency during each day last week	0.98	0.97	0.99

The internal consistency coefficients of the questionnaire are presented in Table 3. The PAQ-A obtained an internal consistency of  $\alpha=0.93$ . The internal consistency was reduced after removing single items, which may indicate that no redundant items are included in the questionnaire. Removing the first and second items had the lowest values in internal consistency, showing a high contribution to final test score.

**Table 3.** Internal consistency for PAQ-A

Variables	Cronbach's coefficient, $\alpha$	Correlation (item-total)
PAQ-A total	<b>0.93</b>	--
<b>Reliability with items (Q1-Q8) individually removed</b>		
Q1. Spare-time activity: sports	0.93	0.43
Q2. Activity during physical education classes	0.93	0.49
Q3. Lunchtime activity	0.92	0.71
Q4. After-school activity	0.92	0.74
Q5. Evening activity	0.91	0.84
Q6. Weekend-activity	0.91	0.81
Q7. Activity frequency during the last 7 days	0.91	0.85
Q8. Activity frequency during each day last week	0.92	0.74

Table 4 presents correlation between PAQ-A and accelerometry. Overall, associations were stronger for the overall PAQ-A score than individual sub-items. A higher correlation was observed between the PAQ-A total score and the number steps per day ( $\rho=0.94$ ) than between PAQ-A total score and MVPA ( $\rho=0.81$ ). The obtained Spearman correlation coefficients show statistical significance at the level of  $p < 0.01$ .



**Table 4.** Spearman's rank correlation between PAQ-A and accelerometry

Variables	MVPA [minutes/day]	Steps/day
Q1. Spare-time activity: sports	0.56	0.56
Q2. Activity during physical education classes	0.46	0.52
Q3. Lunchtime activity	0.58	0.67
Q4. After-school activity	0.73	0.76
Q5. Evening activity	0.70	0.83
Q6. Weekend-activity	0.65	0.83
Q7. Activity frequency during the last 7 days	0.68	0.82
Q8. Activity frequency during each day last week	0.60	0.74
<b>PAQ-A total</b>	<b>0.81</b>	<b>0.94</b>

Abbreviation: q – question; MVPA –moderate-to-vigorous physical activity

## Discussion

We found no questionnaires evaluating PA validated for Polish adolescents in the literature. Therefore, the present study is at the forefront of obtaining evidence for the validity of the questionnaire developed by Kowalski et al.<sup>18</sup> We present the first PAQ-A cultural adaptation and validation study among Polish adolescents aged 14-19 years. In general, the results of the present study show excellent reliability of the PAQ-A and a very strong correlation of the PAQ-A to accelerometer measurements. Our validity coefficients are higher than previously reported by other validation studies with adolescents.<sup>20,34,35</sup>

In the present study, the ICC for individual items of the PAQ-A ranged from 0.86 to 0.97 which is strong evidence to support good and excellent reliability.<sup>31</sup> Good ICC values were observed for items 2, 4, and 5 (ICC=0.87, 0.87 and 0.86, respectively), and excellent ICC values were found for the others. For the final score of the PAQ-A, test-retest reliability showed ICC = 0.97, which is strong evidence to support reliability of the PAQ-A in this target population. The reliability of the PAQ-A ranged from poor (ICC=0.40) among Vietnamese adolescents,<sup>36</sup> to good in other studies conducted in other countries with adolescents of different races.<sup>20,37,38</sup> Aggio et al. observed that the modified PAQ-A score was stable over time among British adolescents (ICC=0.78),<sup>38</sup> which was comparable with original research,<sup>19</sup> and subsequent reliability studies among Spanish adolescents (ICC=0.71).<sup>34</sup>

An estimate of Cronbach's coefficient  $\alpha$  greater than 0.70 is usually considered to be indicative of a reliable questionnaire.<sup>32</sup> In our study, Cronbach's  $\alpha$  coefficients showed excellent internal consistency ( $\alpha=0.93$ ), higher in comparison to the original,<sup>19</sup> and other

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3 modified versions of the PAQ-A.<sup>20,34,38</sup> Item-total correlations were the lowest for questions  
4 on spare-time activity, activity during physical education classes and lunchtime, which is  
5 consistent with previous findings.<sup>20,34,38,39</sup> Janz et al. reported that Cronbach's  $\alpha$  for the PAQ-  
6 A ranged from 0.72 to 0.88. Moreover, authors suggested that that completing the  
7 questionnaire during the summer months did not reduce the standardized  $\alpha$  for the PAQ-A.<sup>20</sup>  
8 Among British adolescents Cronbach's  $\alpha$  coefficient for the modified PAQ-A score showed  
9 acceptable inter-item reliability ( $\alpha=0.72$ ). Item-total correlations showed how well each item  
10 correlated with the composite of the remaining items; correlations ranged from  $\alpha = 0.24$  to  
11 0.54 with all additional and modified questions exceeding  $\alpha=0.30$ .<sup>38</sup> Bervoets et al. also  
12 showed an acceptable reliability of PAQ-A for Dutch adolescents. Of all 94 PAQ-A  
13 questionnaires completed by adolescents, Cronbach's  $\alpha$  was 0.76.<sup>39</sup>

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22 The PAQ-A was compared with device-based measures of PA to determine the  
23 validity of the PAQ-A using triaxial accelerometry. Accelerometers monitor PA by recording  
24 the acceleration of human movement. Movement sensors, such as pedometers and  
25 accelerometers are suggested as one of the best methods for evaluation of PA and validation  
26 of PA self-report instruments.<sup>40</sup> The convergent validity of the PAQ-A was assessed by  
27 calculating the correlation between the PAQ-A total score and different PA measures  
28 determined by an accelerometer (MVPA and number of steps per day). Very strong  
29 correlations were observed between the PAQ-A total score and number of steps per day  
30 ( $\rho=0.94$ ) and with MVPA ( $\rho=0.81$ ). This correlation for MVPA was higher than that  
31 obtained in the study reported by Janz et al. ( $\rho = 0.63$ ).<sup>20</sup> Our results do not concur with a  
32 validation study of the PAQ-A conducted on Spanish adolescents, which showed reasonable  
33 validity of the PAQ-A for adolescents aged from 12-17 years ( $\rho=0.39$ ).<sup>34</sup> A correlation with  
34 MVPA much lower than in our study, but significant, was reported in a Chinese population  
35 ( $\rho=0.33$ ) of children aged from 8 to 13 years old.<sup>35</sup> These data confirm a line of evidence  
36 suggesting that PA questionnaires for adolescents correlate better with scores obtained from  
37 an accelerometer than PA questionnaires for younger children.<sup>17</sup>

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3 questionnaires. Results from a systematic review of 57 studies that examined the correlation  
4 of questionnaire-derived PA measures with accelerometry-derived PA measures, indicate that  
5 overall correlations for total PA range from  $\rho=0.14$  to  $\rho=0.58$ . Of the reviewed studies,  
6 only one third report correlations equal to or higher than 0.40.<sup>14</sup>  
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10 Among the available validated self-report measures of PA dedicated to youth, one of  
11 the most promising tools may be PAQ-A.<sup>9</sup> The PAQ-A is an easy to use and a quick to  
12 administer self-report tool. The strength of the PAQ-A is that it determines a general PA level  
13 for a whole week rather than trying to estimate overall frequency, intensity and duration with  
14 detailed questions. The PAQ-A also provides specific information about activity levels during  
15 different periods of the day (e.g. recess, physical education, after school etc.).<sup>18</sup>  
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20 Excellent intra-class correlation and internal consistency, as well as very strong  
21 convergent validity with accelerometer-based measures have provided evidence that the PAQ-  
22 A can be a useful tool for large PA assessment studies with Polish adolescents.  
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## 26 27 **Limitations**

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30 Potential limitations of this study need to be taken into account when interpreting the  
31 results. The PAQ-A is appropriate for high school students between approximately 14-20  
32 years of age who are currently in the school system. However, the age range of participants  
33 recruited in the current study was 14-19 years. The difference in age range is due to the  
34 education system in Poland, in which students finish high school at the age of 19. The  
35 relatively small sample size can also be considered as a limitation, however, the sample size  
36 was similar to the original validation studies.<sup>19</sup> Another limitation in our study is the missing  
37 of a sleeping diary, the relatively high dropout rate of participants due to accelerometer non-  
38 wear periods and a lack of data on their age, sex, BMI and PA level.  
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## 48 **Conclusion**

49 This is the first study that analyses the validity and reliability of PAQ-A in Polish  
50 adolescents which may help to assess the applicability of the questionnaire. Our results show  
51 that the Polish version of PAQ-A provides reliable and valid estimates of PA among 14 to 19-  
52 year-old adolescents. The Polish version of PAQ-A can be considered as very useful in  
53 clinical practice and epidemiological studies to assess overall levels of PA in adolescents.  
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### 16 **Authors' contributions**

17 JW - development of the concept of research. JW, JBP, KD, JB, PM, JH – data compilation.  
18 KP, AM, JW, PM - analysis and interpretation of data. KP - statistical analysis. JW writing an  
19 manuscript. JPB, JB, KD - substantive review article. AM, PM - overseeing the final article.  
20 All authors read and approved the final version of the manuscript.  
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30 not-for-profit sectors.  
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33

### 34 **Conflicts of interest**

35 The authors declare no conflict of interest.  
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### 38 **Data sharing statement**

39 The datasets generated and/or analysed during the current study are not publicly available due  
40 to protect student privacy, but are available from the corresponding author on reasonable  
41 request.  
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47 **Supplementary file no 1.** Polish version of Physical Activity Questionnaire for Adolescents  
48 (PAQ-A)  
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## Kwestionariusz Aktywności Fizycznej dla Młodzieży

### Polish version of the Physical Activity Questionnaire for Adolescents (PAQ-A)

Imię i nazwisko: \_\_\_\_\_

Wiek: \_\_\_\_\_

Płeć: K \_\_\_\_\_ M \_\_\_\_\_

Klasa: \_\_\_\_\_

Podajemy próbę oceny poziomu Twojej aktywności fizycznej w *ostatnich 7 dniach* (w ciągu ostatniego tygodnia). Odnosi się to do aktywności, które powodują, że się pocisz lub jesteś zmęczony/a, albo do zabaw, które sprawiają, że oddychasz z wysiłkiem, takich jak: podskakiwanie, bieganie, wspinanie się itp.

#### Pamiętaj:

- Nie ma złych lub dobrych odpowiedzi - to nie jest sprawdzian.

- Proszę, odpowiedz na wszystkie pytania tak szczerze i dokładnie jak potrafisz - to bardzo ważne.

#### 1. Aktywność fizyczna w Twoim wolnym czasie:

Czy wykonywałeś/aś którekolwiek z następujących czynności w ciągu *ostatnich 7 dni* (ostatniego tygodnia)? Jeśli tak, ile razy w tygodniu? (Zaznacz tylko jedno kółko w rzędzie).

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Wiosłowanie/kajakowanie	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jazda na rolkach	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Zabawa w berka	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Maszerowanie dla sportu	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jazda na rowerze	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jogging/bieganie	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Aerobik	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pływanie	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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Taniec	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rugby/football amerykański	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Badminton	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jazda na deskorolce	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Piłka nożna	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hokej na ulicy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Piłka siatkowa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Unihokej	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Piłka koszykowa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jazda na łyżwach	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Narciarstwo biegowe	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hokej na lodzie	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Podnoszenie ciężarów	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gimnastyka	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Piłka ręczna	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jazda na nartach	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tenis ziemny	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tenis stołowy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sporty/sztuki walki	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jazda konna	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Inne:					
_____	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
_____	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



2. Jak często w ciągu ostatnich 7 dni, w trakcie *lekcji wychowania fizycznego (WF)* byłeś/aś bardzo aktywny/a (intensywne granie, bieganie, skakanie, rzucanie)?

(Zaznacz tylko jedną odpowiedź).

- 1  
2  
3  
4 Nie brałem udziału w lekcji WF ..... O  
5 Prawie nigdy ..... O  
6 Czasami ..... O  
7 Dosyć często ..... O  
8 Zawsze ..... O  
9  
10  
11  
12

3. Co zazwyczaj robiłeś/aś w czasie przerwy obiadowej w ciągu ostatnich 7 dni oprócz spożywania posiłku? (Zaznacz tylko jedną odpowiedź).

- 13  
14  
15  
16 Siedziałem/am (rozmawiając, czytając, odrabiając zadania domowe) ... O  
17 Stałem/am lub spacerowałem/am ..... O  
18 Trochę biegałem/am lub grałem/am ..... O  
19 Biegałem/am lub grałem/am dość dużo ..... O  
20 Biegałem/am lub grałem/am intensywnie przez większość czasu ..... O  
21  
22  
23  
24

4. W ciągu ostatnich 7 dni, przez ile dni zaraz po szkole uprawiałeś/aś jakiś sport, trenowałeś/aś taniec, lub grałeś/aś w gry, podczas których byłeś/aś bardzo aktywny/a? (Zaznacz tylko jedną odpowiedź).

- 25  
26  
27  
28  
29  
30 W żaden dzień ..... O  
31 1 raz w tygodniu ..... O  
32 2 lub 3 razy w tygodniu ..... O  
33 4 razy w tygodniu ..... O  
34 5 razy w tygodniu ..... O  
35  
36  
37  
38

5. W ciągu ostatnich 7 dni, przez ile dni wieczorami uprawiałeś/aś jakiś sport, trenowałeś/aś taniec lub grałeś/aś w gry, podczas których byłeś/aś bardzo aktywny/a? (Zaznacz tylko jedną odpowiedź).

- 39  
40  
41  
42  
43 W żaden dzień ..... O  
44 1 raz w tygodniu ..... O  
45 2 lub 3 razy w tygodniu ..... O  
46 4 lub 5 razy w tygodniu ..... O  
47 6 lub 7 razy w tygodniu ..... O  
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6. Podczas ostatniego weekendu, ile razy uprawiałeś/aś jakiś sport, tańczyłeś/aś lub grałeś/aś w gry, podczas których byłeś/aś bardzo aktywny/a? (Zaznacz tylko jedną odpowiedź).

- 52  
53  
54  
55  
56  
57 Ani razu ..... O  
58 1 raz ..... O  
59 2 lub 3 razy ..... O  
60 4 lub 5 razy ..... O  
6 lub więcej razy ..... O

7. Które z następujących pięciu stwierdzeń najlepiej opisują Ciebie w ciągu ostatnich 7 dni? Przeczytaj *wszystkie pięć* stwierdzeń zanim zaznaczysz *jedną* odpowiedź odnoszącą się do Ciebie. (Zaznacz tylko jedną odpowiedź).

Cały lub większość czasu spędzałem/am wykonując rzeczy, które wymagały bardzo mało wysiłku fizycznego

Czasami (1-2 razy w zeszłym tygodniu) byłem/am aktywny/a fizycznie w wolnym czasie (np. uprawiałem/am jakiś sport, biegałem/am, jeździłem/am rowerem, pływałem/am, ćwiczyłem/am aerobik)

Często (3-4 razy w zeszłym tygodniu) byłem/am aktywny/a fizycznie w wolnym czasie

Dosyć często (5-6 razy w zeszłym tygodniu) byłem/am aktywny/a fizycznie w wolnym czasie

Bardzo często (7 lub więcej razy w zeszłym tygodniu) byłem/am aktywny/a fizycznie w wolnym czasie

8. Zaznacz jak często byłeś/aś aktywny/a fizycznie każdego dnia w ciągu ostatniego tygodnia (np. uprawiając jakiś sport, uczestnicząc w grach ruchowych, tańcząc lub wykonując inne formy aktywności fizycznej).

	Wcale	Trochę	Średnio	Często	Bardzo często
Poniedziałek	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wtorek	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Środa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Czwartek	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Piątek	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sobota	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Niedziela	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

9. Czy byłeś/aś chory/a w ciągu ostatniego tygodnia lub zdarzyło się coś, co powstrzymało Cię przed zwykle wykonywaną aktywnością fizyczną? (Zaznacz jedną opcję).

Tak .....

Nie .....

Jeśli tak, to co uniemożliwiło Ci podjęcie tej aktywności? \_\_\_\_\_

**STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology\***  
**Checklist for cohort, case-control, and cross-sectional studies (combined)**

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1, 2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3, 4
Objectives	3	State specific objectives, including any pre-specified hypotheses	4
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	4,7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4,5,6,7
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	5,6
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4, 5, 6,7
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	4,5,6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	7
		(b) Describe any methods used to examine subgroups and interactions	7
		(c) Explain how missing data were addressed	
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed	

		<i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	
		(e) Describe any sensitivity analyses	7
<b>Results</b>			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5,6
		(b) Give reasons for non-participation at each stage	5,6
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7,8
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	7-10
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	
		(b) Report category boundaries when continuous variables were categorized	
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	10
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10,11,12
Generalisability	21	Discuss the generalisability (external validity) of the study results	12
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).

# BMJ Open

## Adaptation and validation of the Physical Activity Questionnaire for Adolescents (PAQ-A) among Polish adolescents – cross-sectional study

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3 **Adaptation and validation of the Physical Activity Questionnaire for Adolescents**  
4 **(PAQ-A) among Polish adolescents – cross-sectional study**  
5

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## Abstract

*Objective.* The lack of a widely accepted questionnaire used to assess the physical activity of adolescents in the Polish language creates a need to introduce such a valid, reliable, inexpensive and quick tool for assessment. This study was designed to culturally adapt and validate the Physical Activity Questionnaires for Adolescents (PAQ-A) in the Polish language.

*Design.* Cross-sectional study.

*Participants and outcome measures.* Cultural adaptation of the Polish version of the PAQ-A was performed following the standardized questionnaires cultural adaptation process. In a sample of 78 adolescents aged 14 to 19 years, the PAQ-A test-retest was administered within a 1-week interval. Reliability was analysed by the Intraclass Correlation Coefficient (ICC) and internal consistency with Cronbach's  $\alpha$ . Participants completed the PAQ-A, and wore an accelerometer for 7 consecutive days. The PAQ-A was compared to physical activity parameters obtained using the accelerometer.

*Results.* Test-retest reliability showed ICC=0.97 for the total score of PAQ-A. Internal consistency was excellent ( $\alpha=0.93$ ). The PAQ-A was very strongly correlated with steps per day ( $\rho=0.94$ ) and with moderate-to-vigorous physical activity ( $\rho=0.81$ ) assessed by the accelerometer.

*Conclusions.* The Polish version of the PAQ-A is a valuable tool to estimate general levels of physical activity among adolescents from 14-19 years old.

*Keywords.* adaptation, adolescents, physical activity, validation

## Strengths and limitations of this study

- This study provides the first Physical Activity Questionnaire for Adolescents cultural adaptation and validation study among Polish adolescents aged 14-19 years.
- The Polish version of the Physical Activity Questionnaire for Adolescents was compared with a device-based measure of physical activity (triaxial accelerometry) to determine the validity of the questionnaire.
- In this study, we used international standards for validating the questionnaire.
- Limitations of this study are the small sample size and the relatively high dropout rate of participants due to accelerometer non-wear periods.



## Introduction

One of the most important factors determining human health is physical activity (PA), which is defined as body movement resulting from skeletal muscle contraction during which energy expenditure is increased.<sup>1</sup> Physical inactivity is responsible for about 3.2 million deaths per year, being one of the most important risk factors for non-communicable diseases such as coronary heart disease, type 2 diabetes, and cancer.<sup>2</sup> According to the World Health Organization, more than 80% of the world's adolescent population is insufficiently physically active.<sup>3</sup> Increasing evidence suggests that declining PA is a major factor for higher prevalence of childhood obesity.<sup>4</sup> Worldwide, over 340 million children and adolescents aged 5-19 were overweight or obese in 2016.<sup>5</sup> Physical activity is not only an important factor in the prevention of chronic diseases such as obesity, hypertension and cardiovascular diseases<sup>6</sup>; there is also evidence that regular participation in PA has a positive impact on psychosocial wellbeing, cognitive outcomes, and mental health.<sup>7</sup> Accurate measurement of PA is important to understanding the association between PA and health, but also to monitor changes in PA patterns, and to evaluate the effectiveness of interventions.

To assess PA level, valid and reliable measures are required. The doubly labeled water method is the most widely accepted technique and the gold standard for assessing total energy expenditure, however, it is not often used for research studies as it is expensive, time-intensive, and cannot capture qualitative data.<sup>8</sup> Self-report questionnaires, despite their limitations, are often used due to their low cost and ease of administration, ability to measure large samples and to contextualise PA.<sup>9</sup> Weaknesses of self-report questionnaires include, among others inaccuracies, the tendency to over-report PA levels, inability to use with young children (below the age of 10 or 11), and inability to compare results across studies due to the large number of measures available.<sup>10,11</sup> A more accurate estimate of PA is provided by device-based measures (such as accelerometers, pedometers, heart-rate monitors).<sup>11</sup> An advantage of accelerometers include minute-by-minute monitoring, capturing intensity level, large memory capacities,<sup>8</sup> and feasibility with young children.<sup>12</sup> However, accelerometers do not provide information on both the type and context of PA. Moreover, accelerometers are expensive and require technical expertise, specialized hardware, software, and individual programming.<sup>13</sup> Results of a systematic review that compared PA measures from accelerometers with PA scores of questionnaires, indicated that correlations between questionnaires and accelerometry were weak to moderate.<sup>14</sup> This finding is in agreement with previous reviews.<sup>15,16</sup>

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2  
3 A systematic review by Chinapaw et al. that examined 61 versions of PA questionnaires  
4 for youth found that none of the questionnaires included in the review had acceptable levels of  
5 reliability and validity according to guidelines described in the Qualitative Attributes and  
6 Measurement Properties of Physical Activity Questionnaires.<sup>17</sup> Biddle et al. also reviewed  
7 available self-report PA instruments developed for children and adolescents to assess their  
8 suitability and feasibility for use in population surveillance systems and tracking trends over  
9 time, particularly in Europe. The authors identified 20 activity-based measures, of which three  
10 were supported by the majority of the expert group: the Physical Activity Questionnaire for  
11 Older Children (PAQ-C) and the Physical Activity Questionnaire for Adolescents (PAQ-A),  
12 Youth Risk Behaviour Surveillance Survey, and the Teen Health Survey. These PA  
13 measurement instruments demonstrated both reliability and validity but also ease of use.<sup>9</sup>

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23 The PAQ-A was developed in Canada by Kowalski et al.<sup>18</sup> Research results by Kowalski  
24 and others indicate that PAQ-A is a reliable, inexpensive, easy and quick tool used to assess  
25 PA in adolescents.<sup>18-20</sup> Cultural adaptation and validation of this questionnaire has not yet  
26 been assessed in Poland. The adaptation of a tool to assess the PA of adolescents in Poland  
27 will allow not only for easy and quick large-scale research, but will also enable result  
28 comparison among countries.

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34 The main aim of this study was to assess the reliability and validity of a Polish version of  
35 the PAQ-A in adolescents.

## 36 37 38 **Methods**

### 39 40 41 *Study design and setting*

42  
43 A cross-sectional survey was conducted at 4 randomly selected middle and high  
44 schools in south-eastern Poland. Six classes were randomly selected from the schools  
45 representing students ranging from 14 to 19 years of age.

### 46 47 48 49 *The PAQ-A*

50  
51 The PAQ-A is an 8-item, 7-day PA recall that assesses participation in various types  
52 of PA including activity during physical education, lunch break, after school, during evenings  
53 and weekends. A 9th item not used in the calculation of the activity score asks adolescents if  
54 they were sick or otherwise prevented from engaging in regular PA. The PAQ-A was  
55 originally designed for adolescents aged 14 to 20. The questionnaire can be used to assess the  
56 level of PA during the school year, but not during holidays. Each item is scored according to a  
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3 five-point scale (1-5), with "1" indicating low and "5" a high level of PA. The end result is the  
4 average value of the points obtained, with higher scores corresponding to a higher level of  
5 PA.<sup>18</sup>  
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### 10 ***Translation and cultural adaptation of the Polish PAQ-A***

11  
12 Author approval was obtained for the process of linguistic adaptation and validation of  
13 the PAQ-A questionnaire. Cultural adaptation of the Polish PAQ-A was performed following  
14 the basic steps of the standardized questionnaires cultural adaptation process.<sup>21</sup> The original  
15 version of PAQ-A was translated into Polish by two independent translators who are fluent in  
16 English but whose native language is Polish. Then, during a meeting of both translators, both  
17 versions of the translations were compared. A final compatible version was then agreed upon.  
18 It was evaluated by specialists in the field of physical education and health sciences, in terms  
19 of the unambiguity of understanding of the content included in the questions, the transparency  
20 of all items and their usefulness. The accepted version of the questionnaire was translated into  
21 English again. The back translation was made by two independent translators who had no  
22 knowledge of the original PAQ-A version, and whose native language was English (native  
23 speakers). During the meeting, both versions were compared and it was determined which one  
24 was most adequate. Then, all discrepancies between the original version and the version  
25 resulting from the back translation were carefully analysed and corrected. Subsequently, the  
26 PAQ-A was given to young people (n=20) aged between 14 and 19 years in order to detect  
27 possible ambiguities in wording and to assess the understanding of the questionnaire. During  
28 this analysis, students were encouraged to consult with researchers concerning questions or  
29 statements that were unintelligible or misleading. After the appropriate corrections were  
30 made, the final Polish version of the research tool was agreed upon. The Polish version of  
31 PAQ-A is presented in supplementary materials (Suppl. 1).  
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### 48 ***Study participants***

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50 The study was conducted in accordance with the ethical rules of the Helsinki  
51 Declaration. The study protocol was approved by the Bioethics Committee of the University  
52 of Rzeszów (Poland), approval number 9/05/2012. Prior to study commencement, we  
53 obtained written informed parent/guardian and participant consent. We invited adolescents,  
54 aged 14-19 years from 4 randomly selected middle and high schools to participate in this  
55 study (150 informed consents were distributed). Out of this number, 122 parents/adolescents  
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3 agreed to participate in the study. Of these, 44 were excluded from the study for the following  
4 reasons: disease or injury preventing standard PA (n=2); participants without valid  
5 accelerometer-measurement period (n=23); the device showing a mechanical error and/or  
6  
7 operator error (n=7); incorrect anthropometry (n=1); refusal to participate (n=1); failure to  
8  
9 return or an incomplete survey (n=10). In total, 78 students (38 girls and 40 boys) were  
10  
11 included in the analysis.  
12

### 13 ***Patient and public involvement***

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15 Neither patients nor public were involved in the design or planning of this study.  
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### 18 ***Initial measurements***

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20 Anthropometric measurements (body mass, body weight) were performed under  
21 standard conditions. Body height was measured in an upright position, barefoot, to the nearest  
22 0.1 cm using a portable stadiometer (Seca 213). Body mass was assessed with an accuracy of  
23 0.1 kg using a body composition analyser (BC-420, Tanita). Body mass index (BMI) was  
24 calculated as weight (kg)/ height (m)<sup>2</sup>. Based on BMI values, the BMI percentile of individual  
25 participants were calculated. Polish BMI percentile charts specific for age, sex, and body  
26 height were used.<sup>22</sup> Based on the BMI percentile values, underweight (<5th percentile),  
27 healthy weight (between 5th and 85th percentile), overweight (BMI ≥85th percentile and <  
28 95th percentile), or obesity (≥95th percentile) were determined. The definitions of  
29 underweight, healthy weight, overweight, and obesity were based on the recommendations of  
30 the Centers for Disease Control and Prevention.<sup>23</sup>  
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### 41 ***Accelerometry***

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43 An ActiGraph WGT3X-BT monitor device (Pensacola, USA) was used to assess PA.<sup>24</sup>  
44 It is a small device that provides data related to total PA including the frequency, intensity and  
45 duration. The Actigraph accelerometer has been shown to be a reliable and valid tool for the  
46 assessment of different types of PA.<sup>25,26,27</sup> The accelerometer was placed at the waist with a  
47 flexible strap above the right hip bone to measure the number and frequency of participant  
48 movement. The participants were instructed to wear the accelerometer for seven consecutive  
49 days, 24 hours a day, excluding water-based activities (baths, swimming). The Actigraph  
50 accelerometer measures accelerations in the range of 0.05 to 2 g, which is digitized by a 12-  
51 bit analog-to digital converter at a rate of 30 Hz. Data was collected in 5s epochs. Non-wear  
52 time was defined as 60 minutes of consecutive zeros allowing for 2 minutes of non-zero  
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3 interruptions.<sup>28</sup> A wear time of  $\geq 500$  minutes/day was used as the criterion for a valid day,  
4 and  $\geq 4$  days were used as the criteria for a valid 7-day period of accumulated data (including  
5  $\geq 3$  valid weekdays and  $\geq 1$  valid weekend day).<sup>28</sup> For each participant, the mean moderate-to-  
6 vigorous physical activity (MVPA) (minutes/day) and the mean daily step count were  
7 calculated. The cut-off points from Evenson et al. were selected to determine the time spent  
8 on MVPA level ( $\geq 2296$  counts per minute).<sup>29</sup> MVPA time was calculated as the mean daily  
9 minutes  $\geq 2296$  counts per minute from all valid days. Daily step count was calculated as the  
10 mean daily step count from all valid days. ActiGraph data was analysed using dedicated  
11 Actilife 6.0 software (ActiGraph LLC, Pensacola, Florida, USA).

### 12 13 14 15 16 17 18 19 20 21 22 ***Procedure***

23 Following agreement to participate in the study, participants were examined (initial  
24 measurements) and received an accelerometer for 7 days. After 7 days the PAQ-A was  
25 delivered to students during school time in their classroom. Adolescents were asked to  
26 complete the questionnaire at home. Participants completed the PAQ-A again one week after  
27 completing the first questionnaire to assess test-retest reliability.

### 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 ***Statistical analysis***

Descriptive statistics (n, frequencies (%), mean $\pm$ SD) were calculated for applicable  
variables. Test-retest reliability was assessed by one-way random-effects intra-class  
correlation coefficient (ICC).<sup>30</sup> Values of ICC less than 0.5 are indicative of poor reliability;  
between 0.5 and 0.75 indicate moderate reliability; between 0.75 and 0.9 indicate good  
reliability, and greater than 0.90 indicate excellent reliability.<sup>31</sup> The internal consistency of the  
questionnaire was analysed using Cronbach's  $\alpha$  coefficient. Removing every item to confirm  
or exclude redundancy of the individual items was also performed by Cronbach's  $\alpha$ . Values of  
 $\alpha$  greater than 0.7 were deemed acceptable for general research purposes.<sup>32</sup> Additionally, an  
item-total correlation values were calculated. Values for an item-total correlation greater or  
equal than 0.3 are considered as acceptable.<sup>33</sup> Validity was assessed by calculating the  
relationship between PAQ-A scores and accelerometry-derived PA metrics using Spearman's  
rank correlation coefficients (rho). Values from 0.1 to 0.2 indicate poor correlation; from 0.3  
to 0.5 fair; from 0.6 to 0.7 moderate and  $\geq 0.8$  very strong correlation.<sup>34</sup> Statistical significance  
was established as a  $p$  value less than 0.05. All analyses were carried out using GNU R  
Software.

## Results

In total, 78 adolescents provided valid data for the PAQ-A and accelerometer measurements. The mean age of the participants was  $15.7 \pm 1.41$  years. The mean non-wear time recorded by the accelerometers was 477 minutes per day (minimum 326; maximum 840 minutes). The general characteristics of the participants are presented in Table 1.

**Table 1.** Sample characteristic

Variables	Total (n=78)	Girls (n=38)	Boys (n=40)
Age [years] <sup>a</sup>	15.70 ± 1.41	15.34 ± 1.30	16.05 ± 1.43
Age [years] <sup>b</sup>			
14	12 (15.4)	8 (10.3)	4 (5.1)
15	14 (18.0)	7 (9.0)	7 (9.0)
16	16 (20.5)	9 (11.5)	7 (9.0)
17	12 (15.4)	4 (5.1)	8 (10.3)
18	11 (14.1)	3 (3.8)	8 (10.3)
19	13 (16.6)	7 (9.0)	6 (7.6)
Body height [cm] <sup>a</sup>	167.43 ± 10.49	162.24 ± 7.44	172.26 ± 10.65
Body weight [kg] <sup>a</sup>	60.49 ± 13.09	56.90 ± 12.76	63.90 ± 12.63
BMI percentile <sup>a</sup>	56.66 ± 28.84	58.03 ± 29.41	55.38 ± 28.60
Body mass category <sup>b</sup>			
Underweight	5 (6.41)	3 (7.89)	2 (5.00)
Healthy weight	56 (71.80)	26 (68.42)	30 (75.00)
Overweight	12 (15.38)	5 (13.16)	7 (17.50)
Obesity	5 (6.41)	4 (10.53)	1 (2.50)
<b>PAQ-A<sup>a</sup></b>			
Q1. Spare-time activity: sports	1.85 ± 0.72	1.78 ± 0.72	1.92 ± 0.71
Q2. Activity during physical education classes	3.27 ± 0.94	3.03 ± 0.85	3.50 ± 0.96
Q3. Lunchtime activity	2.59 ± 1.02	2.42 ± 1.08	2.75 ± 0.95
Q4. After-school activity	3.03 ± 1.01	2.76 ± 0.94	3.28 ± 1.01
Q5. Evening activity	2.95 ± 1.16	2.74 ± 1.16	3.15 ± 1.14
Q6. Weekend-activity	2.71 ± 1.11	2.55 ± 1.13	2.85 ± 1.08
Q7. Activity frequency during the last 7 days	2.99 ± 1.23	2.82 ± 1.27	3.15 ± 1.19
Q8. Activity frequency during each day last week	3.09 ± 0.89	2.89 ± 0.87	3.29 ± 0.87
PAQ-A total	2.82 ± 0.79	2.64 ± 0.80	2.99 ± 0.76
<b>Accelerometry<sup>a</sup></b>			
MVPA [minutes/day]	44.71 ± 17.24	39.86 ± 15.63	49.32 ± 17.61
Steps count per day	6928 ± 3064	6184 ± 2650	7635 ± 3289

Data are expressed as: <sup>a</sup> - mean ± SD; <sup>b</sup> - n (%)

Abbreviations: MVPA – moderate-to-vigorous physical activity; Q – question

Table 2 presents results which indicate excellent test-retest reliability for the PAQ-A (ICC=0.97). Similar relationships were found among girls and boys separately (ICC=0.96 and 0.97, respectively). Regarding individual item analyses, the lowest value (ICC=0.86) was



observed for item 5, which informs about evening activity. The obtained correlations presented in Table 2 show statistical significance at the level of  $p < 0.01$ .

**Table 2.** Test-retest reliability (ICC - intra-class correlation coefficient) for PAQ-A

Variables	Total (n=78)	Girls (n=38)	Boys (n=40)
PAQ-A total	0.97	0.96	0.97
Q1. Spare-time activity: sports	0.97	0.96	0.98
Q2. Activity during physical education classes	0.87	0.83	0.88
Q3. Lunchtime activity	0.91	0.92	0.89
Q4. After-school activity	0.87	0.82	0.88
Q5. Evening activity	0.86	0.84	0.88
Q6. Weekend-activity	0.91	0.89	0.92
Q7. Activity frequency during the last 7 days	0.96	0.94	0.97
Q8. Activity frequency during each day last week	0.98	0.97	0.99

Abbreviation: Q – question

The internal consistency coefficients of the questionnaire are presented in Table 3. The PAQ-A obtained an internal consistency of  $\alpha=0.93$ . Cronbach's  $\alpha$  indicators for the questionnaire with individual questions removed also had values above 0.9. Item-total correlation values were the lowest for the first and second questions (0.43 and 0.49, respectively). All item-total correlation values exceeded the cutoff of 0.30 indicating each question was related to the overall questionnaire.

**Table 3.** Internal consistency for PAQ-A

Variables	Cronbach's coefficient, $\alpha$	Correlation (item-total)
PAQ-A total	<b>0.93</b>	--
<b>Reliability with items (Q1-Q8) individually removed</b>		
Q1. Spare-time activity: sports	0.93	0.43
Q2. Activity during physical education classes	0.93	0.49
Q3. Lunchtime activity	0.92	0.71
Q4. After-school activity	0.92	0.74
Q5. Evening activity	0.91	0.84
Q6. Weekend-activity	0.91	0.81
Q7. Activity frequency during the last 7 days	0.91	0.85
Q8. Activity frequency during each day last week	0.92	0.74

Abbreviation: Q – question

Table 4 presents correlation between PAQ-A and accelerometry. Overall, associations were stronger for the overall PAQ-A score than individual sub-items. A higher correlation was observed between the PAQ-A total score and the number steps per day ( $\rho=0.94$ ) than



between PAQ-A total score and MVPA ( $\rho=0.81$ ). The obtained Spearman correlation coefficients show statistical significance at the level of  $p < 0.01$ .

**Table 4.** Spearman's rank correlation between PAQ-A and accelerometry

Variables	MVPA [minutes/day]	Steps/day
Q1. Spare-time activity: sports	0.56	0.56
Q2. Activity during physical education classes	0.46	0.52
Q3. Lunchtime activity	0.58	0.67
Q4. After-school activity	0.73	0.76
Q5. Evening activity	0.70	0.83
Q6. Weekend-activity	0.65	0.83
Q7. Activity frequency during the last 7 days	0.68	0.82
Q8. Activity frequency during each day last week	0.60	0.74
<b>PAQ-A total</b>	<b>0.81</b>	<b>0.94</b>

Abbreviation: MVPA – moderate-to-vigorous physical activity; Q – question

## Discussion

We found no questionnaires evaluating PA validated for Polish adolescents in the literature. Therefore, the present study is at the forefront of obtaining evidence for the validity of the questionnaire developed by Kowalski et al.<sup>18</sup> We present the first PAQ-A cultural adaptation and validation study among Polish adolescents aged 14-19 years. In general, the results of the present study show excellent reliability of the PAQ-A and a very strong correlation of the PAQ-A to accelerometer measurements. Our validity coefficients are higher than previously reported by other validation studies with adolescents.<sup>20,35,36</sup>

In the present study, the ICC for individual items of the PAQ-A ranged from 0.86 to 0.97 which is strong evidence to support good and excellent reliability.<sup>31</sup> Good ICC values were observed for items 2, 4, and 5 (ICC=0.87, 0.87 and 0.86, respectively), and excellent ICC values were found for the others. For the final score of the PAQ-A, test-retest reliability showed ICC = 0.97, which is strong evidence to support reliability of the PAQ-A in this target population. The reliability of the PAQ-A ranged from poor (ICC=0.40) among Vietnamese adolescents,<sup>37</sup> to good in other studies conducted in other countries with adolescents of different races.<sup>20,38,39</sup> Aggio et al. observed that the modified PAQ-A score was stable over time among British adolescents (ICC=0.78),<sup>39</sup> which was comparable with original research,<sup>19</sup> and subsequent reliability studies among Spanish adolescents (ICC=0.71).<sup>35</sup>

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3 An estimate of Cronbach's coefficient  $\alpha$  greater than 0.70 is usually considered to be  
4 indicative of a reliable questionnaire.<sup>32</sup> In our study, Cronbach's  $\alpha$  coefficients showed  
5 excellent internal consistency ( $\alpha=0.93$ ), higher in comparison to the original,<sup>19</sup> and other  
6 modified versions of the PAQ-A.<sup>20,35,39</sup> Item-total correlations were the lowest for questions  
7 on spare-time activity, activity during physical education classes and lunchtime, which is  
8 consistent with previous findings.<sup>20,35,39,40</sup> Janz et al. reported that Cronbach's  $\alpha$  for the PAQ-  
9 A ranged from 0.72 to 0.88. Moreover, authors suggested that that completing the  
10 questionnaire during the summer months did not reduce the standardized  $\alpha$  for the PAQ-A.<sup>20</sup>  
11 Among British adolescents Cronbach's  $\alpha$  coefficient for the modified PAQ-A score showed  
12 acceptable inter-item reliability ( $\alpha=0.72$ ). Item-total correlations showed how well each item  
13 correlated with the composite of the remaining items; correlations ranged from  $\alpha = 0.24$  to  
14 0.54 with all additional and modified questions exceeding  $\alpha=0.30$ .<sup>39</sup> Bervoets et al. also  
15 showed an acceptable reliability of PAQ-A for Dutch adolescents. Of all 94 PAQ-A  
16 questionnaires completed by adolescents, Cronbach's  $\alpha$  was 0.76.<sup>40</sup>

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18 The PAQ-A was compared with device-based measures of PA to determine the  
19 validity of the PAQ-A using triaxial accelerometry. Accelerometers monitor PA by recording  
20 the acceleration of human movement. Movement sensors, such as pedometers and  
21 accelerometers are suggested as one of the best methods for evaluation of PA and validation  
22 of PA self-report instruments.<sup>41</sup> The convergent validity of the PAQ-A was assessed by  
23 calculating the correlation between the PAQ-A total score and different PA measures  
24 determined by an accelerometer (MVPA and number of steps per day). Very strong  
25 correlations were observed between the PAQ-A total score and number of steps per day  
26 ( $\rho=0.94$ ) and with MVPA ( $\rho=0.81$ ). This correlation for MVPA was higher than that  
27 obtained in the study reported by Janz et al. ( $\rho = 0.63$ ).<sup>20</sup> Our results do not concur with a  
28 validation study of the PAQ-A conducted on Spanish adolescents, which showed reasonable  
29 validity of the PAQ-A for adolescents aged from 12-17 years ( $\rho=0.39$ ).<sup>35</sup> A correlation with  
30 MVPA much lower than in our study, but significant, was reported in a Chinese population  
31 ( $\rho=0.33$ ) of children aged from 8 to 13 years old.<sup>36</sup> These data confirm a line of evidence  
32 suggesting that PA questionnaires for adolescents correlate better with scores obtained from  
33 an accelerometer than PA questionnaires for younger children.<sup>17</sup>

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35 The assessment of PA plays a significant role in understanding patterns and influences  
36 of behaviour, designing interventions, and monitoring. To describe the level of PA, a  
37 standardized, reliable and valid tool is essential. Furthermore, in the pediatric population, it is  
38 important to use methods which are non-invasive, easy-to-use and time-saving. Until the  
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3 development of movement sensors, such as pedometers or accelerometers, the assessment  
4 method for PA has been self-report. The magnitude of correlation between PA recall  
5 questionnaires for youth and device-based PA measures is different for different  
6 questionnaires. Results from a systematic review of 57 studies that examined the correlation  
7 of questionnaire-derived PA measures with accelerometry-derived PA measures, indicate that  
8 overall correlations for total PA range from  $\rho=0.14$  to  $\rho=0.58$ . Of the reviewed studies,  
9 only one third report correlations equal to or higher than 0.40.<sup>14</sup>

15 Among the available validated self-report measures of PA dedicated to youth, one of  
16 the most promising tools may be PAQ-A.<sup>9</sup> The strength of the PAQ-A is that is an easy to use,  
17 relatively inexpensive, and a quick to administer self-report tool. The PAQ-A also provides  
18 specific information about activity levels during different periods of the day (e.g. recess,  
19 physical education, after school etc.) as well as a general PA level for a whole week.  
20 However, questionnaire do not estimate precise amount, frequency, intensity and duration of  
21 PA, what is essential e.g. in accurate examination of dose-response relationship between PA  
22 and health or evaluation the effectiveness of PA-enhancing interventions.<sup>18</sup> Both self-report  
23 and device-based measures of PA have its strengths and limitations, thus for measuring PA a  
24 combination of the device-based measures (such as accelerometers) and self-report  
25 questionnaires seems most promising.<sup>42</sup>

34 Excellent intra-class correlation and internal consistency, as well as very strong  
35 convergent validity with accelerometer-based measures have provided evidence that the PAQ-  
36 A can be a useful tool for large PA assessment studies with Polish adolescents.

## 41 **Limitations**

44 Potential limitations of this study need to be taken into account when interpreting the  
45 results. The PAQ-A is appropriate for high school students between approximately 14-20  
46 years of age who are currently in the school system. However, the age range of participants  
47 recruited in the current study was 14-19 years. The difference in age range is due to the  
48 education system in Poland, in which students finish high school at the age of 19.

53 The relatively small sample size can also be considered as a limitation, however, the  
54 sample size was similar to the original validation study.<sup>19</sup>

56 Another limitation in our study is the missing of a sleeping diary, the relatively high  
57 dropout rate of participants due to accelerometer non-wear periods and a lack of data on their  
58 age, sex, BMI and PA level.

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3 The fact that participants completed the PAQ-A at home can also be considered as a  
4 limitation of the study. However, researchers emphasized to participants that the questionnaire  
5 responses need to refer to the week they wore the accelerometer.  
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8 In our study, we did not adjust for differences in non-wear periods in the  
9 accelerometer measurements, however other studies showed that wear time significantly  
10 affects the assessment of sedentary activity but not MVPA.<sup>43,44</sup>  
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13 Some authors suggest that internal consistency is not relevant for PA questionnaires  
14 because items refer to different aspects of the construct, e.g., duration versus frequency or  
15 sports versus work and these items do not need to be highly correlated.<sup>45</sup> However, we  
16 decided to include these analyzes, as it allows to compare our results with the results of other  
17 authors.  
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## 23 **Conclusion**

24 This is the first study addressing the validity and reliability of PAQ-A in Polish  
25 adolescents which may help to assess the applicability of the questionnaire. Our results show  
26 that the Polish version of PAQ-A provides reliable and valid estimates of PA among 14 to 19-  
27 year-old adolescents. The Polish version of PAQ-A can be considered as very useful in  
28 clinical practice and epidemiological studies to assess overall levels of PA in adolescents.  
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16  
17

### 18 **Authors' contributions**

19 JW - development of the concept of research. JW, JPB, KD, JB, PM, JH – data compilation.  
20 KP, AM, JW, PM - analysis and interpretation of data. KP - statistical analysis. JW writing an  
21 manuscript. JPB, JB, KD - substantive review article. AM, PM - overseeing the final article.  
22 All authors read and approved the final version of the manuscript.  
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29

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32 not-for-profit sectors.  
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34  
35

### 36 **Conflicts of interest**

37 The authors declare no conflict of interest.  
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39

### 40 **Data availability statement**

41 Data are available upon reasonable request.  
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44

45 **Supplementary file no 1.** Polish version of Physical Activity Questionnaire for Adolescents  
46 (PAQ-A)  
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## Kwestionariusz Aktywności Fizycznej dla Młodzieży

### Polish version of the Physical Activity Questionnaire for Adolescents (PAQ-A)

Imię i nazwisko: \_\_\_\_\_

Wiek: \_\_\_\_\_

Płeć: K \_\_\_\_\_ M \_\_\_\_\_

Klasa: \_\_\_\_\_

Podejmujemy próbę oceny poziomu Twojej aktywności fizycznej w *ostatnich 7 dniach* (w ciągu ostatniego tygodnia). Odnosi się to do aktywności, które powodują, że się pocisz lub jesteś zmęczony/a, albo do zabaw, które sprawiają, że oddychasz z wysiłkiem, takich jak: podskakiwanie, bieganie, wspinanie się itp.

#### Pamiętaj:

- Nie ma złych lub dobrych odpowiedzi - to nie jest sprawdzian.

- Proszę, odpowiedz na wszystkie pytania tak szczerze i dokładnie jak potrafisz - to bardzo ważne.

#### 1. Aktywność fizyczna w Twoim wolnym czasie:

Czy wykonywałeś/aś którekolwiek z następujących czynności w ciągu *ostatnich 7 dni* (ostatniego tygodnia)? Jeśli tak, ile razy w tygodniu? (Zaznacz tylko jedno kółko w rzędzie).

	0	1-2	3-4	5-6	7 lub więcej razy
Skakanie na skakance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wiosłowanie/kajakowanie	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jazda na rolkach	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Zabawa w berka	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Maszerowanie dla sportu	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jazda na rowerze	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jogging/bieganie	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Aerobik	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pływanie	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gra w palanta/baseball	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Taniec	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rugby/football amerykański	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Badminton	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jazda na deskorolce	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Piłka nożna	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hokej na ulicy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Piłka siatkowa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Unihokej	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Piłka koszykowa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jazda na łyżwach	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Narciarstwo biegowe	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hokej na lodzie	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Podnoszenie ciężarów	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gimnastyka	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Piłka ręczna	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jazda na nartach	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tenis ziemny	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tenis stołowy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sporty/sztuki walki	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jazda konna	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Inne:					
_____	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
_____	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

2. **Jak często w ciągu ostatnich 7 dni, w trakcie *lekcji wychowania fizycznego (WF)* byłeś/aś bardzo aktywny/a (intensywne granie, bieganie, skakanie, rzucanie)?**  
(Zaznacz tylko jedną odpowiedź).

1  
2  
3  
4 Nie brałem udziału w lekcji WF ..... O  
5 Prawie nigdy ..... O  
6 Czasami ..... O  
7  
8 Dosyć często ..... O  
9 Zawsze ..... O  
10  
11  
12

- 13 3. **Co zazwyczaj robiłeś/aś w czasie przerwy obiadowej w ciągu ostatnich 7 dni oprócz spożywania**  
14 **posiłku? (Zaznacz tylko jedną odpowiedź).**

15  
16 Siedziałem/am (rozmawiając, czytając, odrabiając zadania domowe) ... O  
17 Stałem/am lub spacerowałem/am ..... O  
18 Trochę biegałem/am lub grałem/am ..... O  
19 Biegałem/am lub grałem/am dość dużo ..... O  
20 Biegałem/am lub grałem/am intensywnie przez większość czasu ..... O  
21  
22  
23  
24

- 25 4. **W ciągu ostatnich 7 dni, przez ile dni *zaraz po szkole* uprawiałeś/aś jakiś sport, trenowałeś/aś**  
26 **taniec, lub grałeś/aś w gry, podczas których byłeś/aś bardzo aktywny/a?**  
27 **(Zaznacz tylko jedną odpowiedź).**

28  
29 W żaden dzień ..... O  
30 1 raz w tygodniu ..... O  
31 2 lub 3 razy w tygodniu ..... O  
32 4 razy w tygodniu ..... O  
33 5 razy w tygodniu ..... O  
34  
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- 39 5. **W ciągu ostatnich 7 dni, przez ile dni *wieczorami* uprawiałeś/aś jakiś sport, trenowałeś/aś taniec**  
40 **lub grałeś/aś w gry, podczas których byłeś/aś bardzo aktywny/a?**  
41 **(Zaznacz tylko jedną odpowiedź).**

42  
43 W żaden dzień ..... O  
44 1 raz w tygodniu ..... O  
45 2 lub 3 razy w tygodniu ..... O  
46 4 lub 5 razy w tygodniu ..... O  
47 6 lub 7 razy w tygodniu ..... O  
48  
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- 52 6. **Podczas ostatniego weekendu, ile razy uprawiałeś/aś jakiś sport, tańczyłeś/aś lub grałeś/aś w gry,**  
53 **podczas których byłeś/aś bardzo aktywny/a?**  
54 **(Zaznacz tylko jedną odpowiedź).**

55  
56 Ani razu ..... O  
57 1 raz ..... O  
58 2 lub 3 razy ..... O  
59 4 lub 5 razy ..... O  
60 6 lub więcej razy ..... O

7. Które z następujących pięciu stwierdzeń najlepiej opisują Ciebie w ciągu ostatnich 7 dni? Przeczytaj *wszystkie pięć* stwierdzeń zanim zaznaczysz *jedną* odpowiedź odnoszącą się do Ciebie. (Zaznacz tylko jedną odpowiedź).

- Cały lub większość czasu spędzałem/am wykonując rzeczy, które wymagały bardzo mało wysiłku fizycznego
- Czasami (1-2 razy w zeszłym tygodniu) byłem/am aktywny/a fizycznie w wolnym czasie (np. uprawiałem/am jakiś sport, biegałem/am, jeździłem/am rowerem, pływałem/am, ćwiczyłem/am aerobik)
- Często (3-4 razy w zeszłym tygodniu) byłem/am aktywny/a fizycznie w wolnym czasie
- Dosyć często (5-6 razy w zeszłym tygodniu) byłem/am aktywny/a fizycznie w wolnym czasie
- Bardzo często (7 lub więcej razy w zeszłym tygodniu) byłem/am aktywny/a fizycznie w wolnym czasie

8. Zaznacz jak często byłeś/aś aktywny/a fizycznie każdego dnia w ciągu ostatniego tygodnia (np. uprawiając jakiś sport, uczestnicząc w grach ruchowych, tańcząc lub wykonując inne formy aktywności fizycznej).

	Wcale	Trochę	Średnio	Często	Bardzo często
Poniedziałek	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wtorek	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Środa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Czwartek	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Piątek	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sobota	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Niedziela	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

9. Czy byłeś/aś chory/a w ciągu ostatniego tygodnia lub zdarzyło się coś, co powstrzymało Cię przed zwykle wykonywaną aktywnością fizyczną? (Zaznacz jedną opcję).

Tak .....

Nie .....

Jeśli tak, to co uniemożliwiło Ci podjęcie tej aktywności? \_\_\_\_\_

**STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology\***  
**Checklist for cohort, case-control, and cross-sectional studies (combined)**

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1, 2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3, 4
Objectives	3	State specific objectives, including any pre-specified hypotheses	4
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	4,7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4,5,6,7
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	5,6
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4, 5, 6,7
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	4,5,6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	7
		(b) Describe any methods used to examine subgroups and interactions	7
		(c) Explain how missing data were addressed	
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed	

		<i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	
		(e) Describe any sensitivity analyses	7
<b>Results</b>			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5,6
		(b) Give reasons for non-participation at each stage	5,6
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7,8
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	7-10
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	
		(b) Report category boundaries when continuous variables were categorized	
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	10
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10,11,12
Generalisability	21	Discuss the generalisability (external validity) of the study results	12
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).

# BMJ Open

## Adaptation and validation of the Physical Activity Questionnaire for Adolescents (PAQ-A) among Polish adolescents – cross-sectional study

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Keywords:	adolescent, physical activity, validation

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3 **Adaptation and validation of the Physical Activity Questionnaire for Adolescents**  
4 **(PAQ-A) among Polish adolescents – cross-sectional study**  
5

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8 Krzysztof Przednowek<sup>2</sup>, Joanna Baran<sup>1</sup>, Katarzyna Dereń<sup>1</sup>, Artur Mazur<sup>1</sup>  
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## Abstract

*Objective.* The lack of a widely accepted questionnaire used to assess the physical activity of adolescents in the Polish language creates a need to introduce such a valid, reliable, inexpensive and quick tool for assessment. This study was designed to culturally adapt and validate the Physical Activity Questionnaires for Adolescents (PAQ-A) in the Polish language.

*Design.* Cross-sectional study.

*Participants and outcome measures.* Cultural adaptation of the Polish version of the PAQ-A was performed following the standardized questionnaires cultural adaptation process. In a sample of 78 adolescents aged 14 to 19 years, the PAQ-A test-retest was administered within a 1-week interval. Reliability was analysed by the Intraclass Correlation Coefficient (ICC) and internal consistency with Cronbach's  $\alpha$ . Participants completed the PAQ-A, and wore an accelerometer for 7 consecutive days. The PAQ-A was compared to physical activity parameters obtained using the accelerometer.

*Results.* Test-retest reliability showed ICC=0.97 for the total score of PAQ-A. Internal consistency was excellent ( $\alpha=0.93$ ). The PAQ-A was very strongly correlated with steps per day ( $\rho=0.94$ ) and with moderate-to-vigorous physical activity ( $\rho=0.81$ ) assessed by the accelerometer.

*Conclusions.* The Polish version of the PAQ-A is a valuable tool to estimate general levels of physical activity among adolescents from 14-19 years old.

*Keywords.* adaptation, adolescents, physical activity, validation

## Strengths and limitations of this study

- This study provides the first Physical Activity Questionnaire for Adolescents cultural adaptation and validation study among Polish adolescents aged 14-19 years.
- The Polish version of the Physical Activity Questionnaire for Adolescents was compared with a device-based measure of physical activity (triaxial accelerometry) to determine the validity of the questionnaire.
- In this study, we used international standards for validating the questionnaire.
- Limitations of this study are the small sample size and the relatively high dropout rate of participants due to accelerometer non-wear periods.

## Introduction

One of the most important factors determining human health is physical activity (PA), which is defined as body movement resulting from skeletal muscle contraction during which energy expenditure is increased.<sup>1</sup> Physical inactivity is responsible for about 3.2 million deaths per year, being one of the most important risk factors for non-communicable diseases such as coronary heart disease, type 2 diabetes, and cancer.<sup>2</sup> According to the World Health Organization, more than 80% of the world's adolescent population is insufficiently physically active.<sup>3</sup> Increasing evidence suggests that declining PA is a major factor for higher prevalence of childhood obesity.<sup>4</sup> Worldwide, over 340 million children and adolescents aged 5-19 were overweight or obese in 2016.<sup>5</sup> Physical activity is not only an important factor in the prevention of chronic diseases such as obesity, hypertension and cardiovascular diseases<sup>6</sup>; there is also evidence that regular participation in PA has a positive impact on psychosocial wellbeing, cognitive outcomes, and mental health.<sup>7</sup> Accurate measurement of PA is important to understanding the association between PA and health, but also to monitor changes in PA patterns, and to evaluate the effectiveness of interventions.

To assess PA level, valid and reliable measures are required. The doubly labeled water method is the most widely accepted technique and the gold standard for assessing total energy expenditure, however, it is not often used for research studies as it is expensive, time-intensive, and cannot capture qualitative data.<sup>8</sup> Self-report questionnaires, despite their limitations, are often used due to their low cost and ease of administration, ability to measure large samples and to contextualise PA.<sup>9</sup> Weaknesses of self-report questionnaires include, among others inaccuracies, the tendency to over-report PA levels, inability to use with young children (below the age of 10 or 11), and inability to compare results across studies due to the large number of measures available.<sup>10,11</sup> A more accurate estimate of PA is provided by device-based measures (such as accelerometers, pedometers, heart-rate monitors).<sup>11</sup> An advantage of accelerometers include minute-by-minute monitoring, capturing intensity level, large memory capacities,<sup>8</sup> and feasibility with young children.<sup>12</sup> However, accelerometers do not provide information on both the type and context of PA. Moreover, accelerometers are expensive and require technical expertise, specialized hardware, software, and individual programming.<sup>13</sup> Results of a systematic review that compared PA measures from accelerometers with PA scores of questionnaires, indicated that correlations between questionnaires and accelerometry were weak to moderate.<sup>14</sup> This finding is in agreement with previous reviews.<sup>15,16</sup>

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2  
3 A systematic review by Chinapaw et al. that examined 61 versions of PA questionnaires  
4 for youth found that none of the questionnaires included in the review had acceptable levels of  
5 reliability and validity according to guidelines described in the Qualitative Attributes and  
6 Measurement Properties of Physical Activity Questionnaires.<sup>17</sup> Biddle et al. also reviewed  
7 available self-report PA instruments developed for children and adolescents to assess their  
8 suitability and feasibility for use in population surveillance systems and tracking trends over  
9 time, particularly in Europe. The authors identified 20 activity-based measures, of which three  
10 were supported by the majority of the expert group: the Physical Activity Questionnaire for  
11 Older Children (PAQ-C) and the Physical Activity Questionnaire for Adolescents (PAQ-A),  
12 Youth Risk Behaviour Surveillance Survey, and the Teen Health Survey. These PA  
13 measurement instruments demonstrated both reliability and validity but also ease of use.<sup>9</sup>

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23 The PAQ-A was developed in Canada by Kowalski et al.<sup>18</sup> Research results by Kowalski  
24 and others indicate that PAQ-A is a reliable, inexpensive, easy and quick tool used to assess  
25 PA in adolescents.<sup>18-20</sup> Cultural adaptation and validation of this questionnaire has not yet  
26 been assessed in Poland. The adaptation of a tool to assess the PA of adolescents in Poland  
27 will allow not only for easy and quick large-scale research, but will also enable result  
28 comparison among countries.

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34 The main aim of this study was to assess the reliability and validity of a Polish version of  
35 the PAQ-A in adolescents.

## 36 37 38 **Methods**

### 39 40 41 *Study design and setting*

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43 A cross-sectional survey was conducted at 4 randomly selected middle and high  
44 schools in south-eastern Poland. Six classes were randomly selected from the schools  
45 representing students ranging from 14 to 19 years of age.

### 46 47 48 49 *The PAQ-A*

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51 The PAQ-A is an 8-item, 7-day PA recall that assesses participation in various types  
52 of PA including activity during physical education, lunch break, after school, during evenings  
53 and weekends. A 9th item not used in the calculation of the activity score asks adolescents if  
54 they were sick or otherwise prevented from engaging in regular PA. The PAQ-A was  
55 originally designed for adolescents aged 14 to 20. The questionnaire can be used to assess the  
56 level of PA during the school year, but not during holidays. Each item is scored according to a  
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3 five-point scale (1-5), with "1" indicating low and "5" a high level of PA. The end result is the  
4 average value of the points obtained, with higher scores corresponding to a higher level of  
5 PA.<sup>18</sup>  
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### 10 ***Translation and cultural adaptation of the Polish PAQ-A***

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12 Author approval was obtained for the process of linguistic adaptation and validation of  
13 the PAQ-A questionnaire. Cultural adaptation of the Polish PAQ-A was performed following  
14 the basic steps of the standardized questionnaires cultural adaptation process.<sup>21</sup> The original  
15 version of PAQ-A was translated into Polish by two independent translators who are fluent in  
16 English but whose native language is Polish. Then, during a meeting of both translators, both  
17 versions of the translations were compared. A final compatible version was then agreed upon.  
18 It was evaluated by specialists in the field of physical education and health sciences, in terms  
19 of the unambiguity of understanding of the content included in the questions, the transparency  
20 of all items and their usefulness. The accepted version of the questionnaire was translated into  
21 English again. The back translation was made by two independent translators who had no  
22 knowledge of the original PAQ-A version, and whose native language was English (native  
23 speakers). During the meeting, both versions were compared and it was determined which one  
24 was most adequate. Then, all discrepancies between the original version and the version  
25 resulting from the back translation were carefully analysed and corrected. Subsequently, the  
26 PAQ-A was given to young people (n=20) aged between 14 and 19 years in order to detect  
27 possible ambiguities in wording and to assess the understanding of the questionnaire. During  
28 this analysis, students were encouraged to consult with researchers concerning questions or  
29 statements that were unintelligible or misleading. After the appropriate corrections were  
30 made, the final Polish version of the research tool was agreed upon. The Polish version of  
31 PAQ-A is presented in supplementary materials (Suppl. 1).  
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### 48 ***Study participants***

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50 The study was conducted in accordance with the ethical rules of the Helsinki  
51 Declaration. The study protocol was approved by the Bioethics Committee of the University  
52 of Rzeszów (Poland), approval number 9/05/2012. Prior to study commencement, we  
53 obtained written informed parent/guardian and participant consent. We invited adolescents,  
54 aged 14-19 years from 4 randomly selected middle and high schools to participate in this  
55 study (150 informed consents were distributed). Out of this number, 122 parents/adolescents  
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3 agreed to participate in the study. Of these, 44 were excluded from the study for the following  
4 reasons: disease or injury preventing standard PA (n=2); participants without valid  
5 accelerometer-measurement period (n=23); the device showing a mechanical error and/or  
6 operator error (n=7); incorrect anthropometry (n=1); refusal to participate (n=1); failure to  
7 return or an incomplete survey (n=10). In total, 78 students (38 girls and 40 boys) were  
8 included in the analysis.  
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### 14 ***Patient and public involvement***

16 Neither patients nor public were involved in the design or planning of this study.

### 18 ***Initial measurements***

20 Anthropometric measurements (body mass, body weight) were performed under  
21 standard conditions. Body height was measured in an upright position, barefoot, to the nearest  
22 0.1 cm using a portable stadiometer (Seca 213). Body mass was assessed with an accuracy of  
23 0.1 kg using a body composition analyser (BC-420, Tanita). Body mass index (BMI) was  
24 calculated as weight (kg)/ height (m)<sup>2</sup>. Based on BMI values, the BMI percentile of individual  
25 participants were calculated. Polish BMI percentile charts specific for age, sex, and body  
26 height were used.<sup>22</sup> Based on the BMI percentile values, underweight (<5th percentile),  
27 healthy weight (between 5th and 85th percentile), overweight (BMI ≥85th percentile and <  
28 95th percentile), or obesity (≥95th percentile) were determined. The definitions of  
29 underweight, healthy weight, overweight, and obesity were based on the recommendations of  
30 the Centers for Disease Control and Prevention.<sup>23</sup>  
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### 41 ***Accelerometry***

43 An ActiGraph WGT3X-BT monitor device (Pensacola, USA) was used to assess PA.<sup>24</sup>  
44 It is a small device that provides data related to total PA including the frequency, intensity and  
45 duration. The Actigraph accelerometer has been shown to be a reliable and valid tool for the  
46 assessment of different types of PA.<sup>25,26,27</sup> The accelerometer was placed at the waist with a  
47 flexible strap above the right hip bone to measure the number and frequency of participant  
48 movement. The participants were instructed to wear the accelerometer for seven consecutive  
49 days, 24 hours a day, excluding water-based activities (baths, swimming). The Actigraph  
50 accelerometer measures accelerations in the range of 0.05 to 2 g, which is digitized by a 12-  
51 bit analog-to digital converter at a rate of 30 Hz. Data was collected in 5s epochs. Non-wear  
52 time was defined as 60 minutes of consecutive zeros allowing for 2 minutes of non-zero  
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3 interruptions.<sup>28</sup> A wear time of  $\geq 500$  minutes/day was used as the criterion for a valid day,  
4 and  $\geq 4$  days were used as the criteria for a valid 7-day period of accumulated data (including  
5  $\geq 3$  valid weekdays and  $\geq 1$  valid weekend day).<sup>28</sup> For each participant, the mean moderate-to-  
6 vigorous physical activity (MVPA) (minutes/day) and the mean daily step count were  
7 calculated. The cut-off points from Evenson et al. were selected to determine the time spent  
8 on MVPA level ( $\geq 2296$  counts per minute).<sup>29</sup> MVPA time was calculated as the mean daily  
9 minutes  $\geq 2296$  counts per minute from all valid days. Daily step count was calculated as the  
10 mean daily step count from all valid days. ActiGraph data was analysed using dedicated  
11 Actilife 6.0 software (ActiGraph LLC, Pensacola, Florida, USA).

### 12 13 14 15 16 17 18 19 ***Procedure***

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22 Following agreement to participate in the study, participants were examined (initial  
23 measurements) and received an accelerometer for 7 days. After 7 days the PAQ-A was  
24 delivered to students during school time in their classroom. Adolescents were asked to  
25 complete the questionnaire at home. Participants completed the PAQ-A again one week after  
26 completing the first questionnaire to assess test-retest reliability.

### 27 28 29 30 31 32 ***Statistical analysis***

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34 Descriptive statistics (n, frequencies (%), mean $\pm$ SD) were calculated for applicable  
35 variables. Test-retest reliability was assessed by one-way random-effects intra-class  
36 correlation coefficient (ICC).<sup>30</sup> Values of ICC less than 0.5 are indicative of poor reliability;  
37 between 0.5 and 0.75 indicate moderate reliability; between 0.75 and 0.9 indicate good  
38 reliability, and greater than 0.90 indicate excellent reliability.<sup>31</sup> The internal consistency of the  
39 questionnaire was analysed using Cronbach's  $\alpha$  coefficient. Removing every item to confirm  
40 or exclude redundancy of the individual items was also performed by Cronbach's  $\alpha$ . Values of  
41  $\alpha$  greater than 0.7 were deemed acceptable for general research purposes.<sup>32</sup> Additionally, an  
42 item-total correlation values were calculated. Values for an item-total correlation greater or  
43 equal than 0.3 are considered as acceptable.<sup>33</sup> Validity was assessed by calculating the  
44 relationship between PAQ-A scores and accelerometry-derived PA metrics using Spearman's  
45 rank correlation coefficients (rho). Values from 0.1 to 0.2 indicate poor correlation; from 0.3  
46 to 0.5 fair; from 0.6 to 0.7 moderate and  $\geq 0.8$  very strong correlation.<sup>34</sup> Statistical significance  
47 was established as a  $p$  value less than 0.05. All analyses were carried out using GNU R  
48 Software.



## Results

In total, 78 adolescents provided valid data for the PAQ-A and accelerometer measurements. The mean age of the participants was  $15.7 \pm 1.41$  years. The mean non-wear time recorded by the accelerometers was 477 minutes per day (minimum 326; maximum 840 minutes). The general characteristics of the participants are presented in Table 1.

**Table 1.** Sample characteristic

Variables	Total (n=78)	Girls (n=38)	Boys (n=40)
Age [years] <sup>a</sup>	15.70 ± 1.41	15.34 ± 1.30	16.05 ± 1.43
Age [years] <sup>b</sup>			
14	12 (15.4)	8 (10.3)	4 (5.1)
15	14 (18.0)	7 (9.0)	7 (9.0)
16	16 (20.5)	9 (11.5)	7 (9.0)
17	12 (15.4)	4 (5.1)	8 (10.3)
18	11 (14.1)	3 (3.8)	8 (10.3)
19	13 (16.6)	7 (9.0)	6 (7.6)
Body height [cm] <sup>a</sup>	167.43 ± 10.49	162.24 ± 7.44	172.26 ± 10.65
Body weight [kg] <sup>a</sup>	60.49 ± 13.09	56.90 ± 12.76	63.90 ± 12.63
BMI percentile <sup>a</sup>	56.66 ± 28.84	58.03 ± 29.41	55.38 ± 28.60
Body mass category <sup>b</sup>			
Underweight	5 (6.41)	3 (7.89)	2 (5.00)
Healthy weight	56 (71.80)	26 (68.42)	30 (75.00)
Overweight	12 (15.38)	5 (13.16)	7 (17.50)
Obesity	5 (6.41)	4 (10.53)	1 (2.50)
<b>PAQ-A<sup>a</sup></b>			
Q1. Spare-time activity: sports	1.85 ± 0.72	1.78 ± 0.72	1.92 ± 0.71
Q2. Activity during physical education classes	3.27 ± 0.94	3.03 ± 0.85	3.50 ± 0.96
Q3. Lunchtime activity	2.59 ± 1.02	2.42 ± 1.08	2.75 ± 0.95
Q4. After-school activity	3.03 ± 1.01	2.76 ± 0.94	3.28 ± 1.01
Q5. Evening activity	2.95 ± 1.16	2.74 ± 1.16	3.15 ± 1.14
Q6. Weekend-activity	2.71 ± 1.11	2.55 ± 1.13	2.85 ± 1.08
Q7. Activity frequency during the last 7 days	2.99 ± 1.23	2.82 ± 1.27	3.15 ± 1.19
Q8. Activity frequency during each day last week	3.09 ± 0.89	2.89 ± 0.87	3.29 ± 0.87
PAQ-A total	2.82 ± 0.79	2.64 ± 0.80	2.99 ± 0.76
<b>Accelerometry<sup>a</sup></b>			
MVPA [minutes/day]	44.71 ± 17.24	39.86 ± 15.63	49.32 ± 17.61
Steps count per day	6928 ± 3064	6184 ± 2650	7635 ± 3289

Data are expressed as: <sup>a</sup> - mean ± SD; <sup>b</sup> - n (%)

Abbreviations: MVPA – moderate-to-vigorous physical activity; Q – question

Table 2 presents results which indicate excellent test-retest reliability for the PAQ-A (ICC=0.97). Similar relationships were found among girls and boys separately (ICC=0.96 and 0.97, respectively). Regarding individual item analyses, the lowest value (ICC=0.86) was observed for item 5, which informs about evening activity. The obtained correlations presented in Table 2 show statistical significance at the level of  $p < 0.01$ .

**Table 2.** Test-retest reliability (ICC - intra-class correlation coefficient) for PAQ-A

Variables	Total (n=78)	Girls (n=38)	Boys (n=40)
PAQ-A total	0.97	0.96	0.97
Q1. Spare-time activity: sports	0.97	0.96	0.98
Q2. Activity during physical education classes	0.87	0.83	0.88
Q3. Lunchtime activity	0.91	0.92	0.89
Q4. After-school activity	0.87	0.82	0.88
Q5. Evening activity	0.86	0.84	0.88
Q6. Weekend-activity	0.91	0.89	0.92
Q7. Activity frequency during the last 7 days	0.96	0.94	0.97
Q8. Activity frequency during each day last week	0.98	0.97	0.99

Abbreviation: Q – question

The internal consistency coefficients of the questionnaire are presented in Table 3. The PAQ-A obtained an internal consistency of  $\alpha=0.93$ . Cronbach's  $\alpha$  indicators for the questionnaire with individual questions removed also had values above 0.9. Item-total correlation values were the lowest for the first and second questions (0.43 and 0.49, respectively). All item-total correlation values exceeded the cutoff of 0.30 indicating each question was related to the overall questionnaire.

**Table 3.** Internal consistency for PAQ-A

Variables	Cronbach's coefficient, $\alpha$	Correlation (item-total)
PAQ-A total	<b>0.93</b>	--
<b>Reliability with items (Q1-Q8) individually removed</b>		
Q1. Spare-time activity: sports	0.93	0.43
Q2. Activity during physical education classes	0.93	0.49
Q3. Lunchtime activity	0.92	0.71
Q4. After-school activity	0.92	0.74
Q5. Evening activity	0.91	0.84
Q6. Weekend-activity	0.91	0.81
Q7. Activity frequency during the last 7 days	0.91	0.85
Q8. Activity frequency during each day last week	0.92	0.74

Abbreviation: Q – question

Table 4 presents correlation between PAQ-A and accelerometry. Overall, associations were stronger for the overall PAQ-A score than individual sub-items. A higher correlation was observed between the PAQ-A total score and the number steps per day ( $\rho=0.94$ ) than between PAQ-A total score and MVPA ( $\rho=0.81$ ). The obtained Spearman correlation coefficients show statistical significance at the level of  $p < 0.01$ .

**Table 4.** Spearman's rank correlation between PAQ-A and accelerometry

Variables	MVPA [minutes/day]	Steps/day
Q1. Spare-time activity: sports	0.56	0.56
Q2. Activity during physical education classes	0.46	0.52
Q3. Lunchtime activity	0.58	0.67
Q4. After-school activity	0.73	0.76
Q5. Evening activity	0.70	0.83
Q6. Weekend-activity	0.65	0.83
Q7. Activity frequency during the last 7 days	0.68	0.82
Q8. Activity frequency during each day last week	0.60	0.74
<b>PAQ-A total</b>	<b>0.81</b>	<b>0.94</b>

Abbreviation: MVPA – moderate-to-vigorous physical activity; Q – question

## Discussion

We found no questionnaires evaluating PA validated for Polish adolescents in the literature. Therefore, the present study is at the forefront of obtaining evidence for the validity of the questionnaire developed by Kowalski et al.<sup>18</sup> We present the first PAQ-A cultural adaptation and validation study among Polish adolescents aged 14-19 years. In general, the results of the present study show excellent reliability of the PAQ-A and a very strong correlation of the PAQ-A to accelerometer measurements. Our validity coefficients are higher than previously reported by other validation studies with adolescents.<sup>20,35,36</sup>

In the present study, the ICC for individual items of the PAQ-A ranged from 0.86 to 0.97 which is strong evidence to support good and excellent reliability.<sup>31</sup> Good ICC values were observed for items 2, 4, and 5 (ICC=0.87, 0.87 and 0.86, respectively), and excellent ICC values were found for the others. For the final score of the PAQ-A, test-retest reliability showed ICC = 0.97, which is strong evidence to support reliability of the PAQ-A in this target population. The reliability of the PAQ-A ranged from poor (ICC=0.40) among Vietnamese adolescents,<sup>37</sup> to good in other studies conducted in other countries with adolescents of different races.<sup>20,38,39</sup> Aggio et al. observed that the modified PAQ-A score was stable over time among British adolescents (ICC=0.78),<sup>39</sup> which was comparable with original research,<sup>19</sup> and subsequent reliability studies among Spanish adolescents (ICC=0.71).<sup>35</sup>

An estimate of Cronbach's coefficient  $\alpha$  greater than 0.70 is usually considered to be indicative of a reliable questionnaire.<sup>32</sup> In our study, Cronbach's  $\alpha$  coefficients showed excellent internal consistency ( $\alpha=0.93$ ), higher in comparison to the original,<sup>19</sup> and other

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3 modified versions of the PAQ-A.<sup>20,35,39</sup> Item-total correlations were the lowest for questions  
4 on spare-time activity, activity during physical education classes and lunchtime, which is  
5 consistent with previous findings.<sup>20,35,39,40</sup> Janz et al. reported that Cronbach's  $\alpha$  for the PAQ-  
6 A ranged from 0.72 to 0.88. Moreover, authors suggested that that completing the  
7 questionnaire during the summer months did not reduce the standardized  $\alpha$  for the PAQ-A.<sup>20</sup>  
8 Among British adolescents Cronbach's  $\alpha$  coefficient for the modified PAQ-A score showed  
9 acceptable inter-item reliability ( $\alpha=0.72$ ). Item-total correlations showed how well each item  
10 correlated with the composite of the remaining items; correlations ranged from  $\alpha = 0.24$  to  
11 0.54 with all additional and modified questions exceeding  $\alpha=0.30$ .<sup>39</sup> Bervoets et al. also  
12 showed an acceptable reliability of PAQ-A for Dutch adolescents. Of all 94 PAQ-A  
13 questionnaires completed by adolescents, Cronbach's  $\alpha$  was 0.76.<sup>40</sup>

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22 The PAQ-A was compared with device-based measures of PA to determine the  
23 validity of the PAQ-A using triaxial accelerometry. Accelerometers monitor PA by recording  
24 the acceleration of human movement. Movement sensors, such as pedometers and  
25 accelerometers are suggested as one of the best methods for evaluation of PA and validation  
26 of PA self-report instruments.<sup>41</sup> The convergent validity of the PAQ-A was assessed by  
27 calculating the correlation between the PAQ-A total score and different PA measures  
28 determined by an accelerometer (MVPA and number of steps per day). Very strong  
29 correlations were observed between the PAQ-A total score and number of steps per day  
30 ( $\rho=0.94$ ) and with MVPA ( $\rho=0.81$ ). This correlation for MVPA was higher than that  
31 obtained in the study reported by Janz et al. ( $\rho = 0.63$ ).<sup>20</sup> Our results do not concur with a  
32 validation study of the PAQ-A conducted on Spanish adolescents, which showed reasonable  
33 validity of the PAQ-A for adolescents aged from 12-17 years ( $\rho=0.39$ ).<sup>35</sup> A correlation with  
34 MVPA much lower than in our study, but significant, was reported in a Chinese population  
35 ( $\rho=0.33$ ) of children aged from 8 to 13 years old.<sup>36</sup> These data confirm a line of evidence  
36 suggesting that PA questionnaires for adolescents correlate better with scores obtained from  
37 an accelerometer than PA questionnaires for younger children.<sup>17</sup>

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50 The assessment of PA plays a significant role in understanding patterns and influences  
51 of behaviour, designing interventions, and monitoring. To describe the level of PA, a  
52 standardized, reliable and valid tool is essential. Furthermore, in the pediatric population, it is  
53 important to use methods which are non-invasive, easy-to-use and time-saving. Until the  
54 development of movement sensors, such as pedometers or accelerometers, the assessment  
55 method for PA has been self-report. The magnitude of correlation between PA recall  
56 questionnaires for youth and device-based PA measures is different for different  
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3 questionnaires. Results from a systematic review of 57 studies that examined the correlation  
4 of questionnaire-derived PA measures with accelerometry-derived PA measures, indicate that  
5 overall correlations for total PA range from  $\rho=0.14$  to  $\rho=0.58$ . Of the reviewed studies,  
6 only one third report correlations equal to or higher than 0.40.<sup>14</sup>  
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10 Among the available validated self-report measures of PA dedicated to youth, one of  
11 the most promising tools may be PAQ-A.<sup>9</sup> The strength of the PAQ-A is that is an easy to use,  
12 relatively inexpensive, and a quick to administer self-report tool. The PAQ-A also provides  
13 specific information about activity levels during different periods of the day (e.g. recess,  
14 physical education, after school etc.) as well as a general PA level for a whole week.  
15 However, questionnaire do not estimate precise amount, frequency, intensity and duration of  
16 PA, what is essential e.g. in accurate examination of dose-response relationship between PA  
17 and health or evaluation the effectiveness of PA-enhancing interventions.<sup>18</sup> Both self-report  
18 and device-based measures of PA have its strengths and limitations, thus for measuring PA a  
19 combination of the device-based measures (such as accelerometers) and self-report  
20 questionnaires seems most promising.<sup>42</sup>  
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29 Excellent intra-class correlation and internal consistency, as well as very strong  
30 convergent validity with accelerometer-based measures have provided evidence that the PAQ-  
31 A can be a useful tool for large PA assessment studies with Polish adolescents.  
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### 36 **Limitations**

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39 Potential limitations of this study need to be taken into account when interpreting the  
40 results. The PAQ-A is appropriate for high school students between approximately 14-20  
41 years of age who are currently in the school system. However, the age range of participants  
42 recruited in the current study was 14-19 years. The difference in age range is due to the  
43 education system in Poland, in which students finish high school at the age of 19.  
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48 The relatively small sample size can also be considered as a limitation, however, the  
49 sample size was similar to the original validation study.<sup>19</sup>  
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51 Another limitation in our study is the missing of a sleeping diary, the relatively high  
52 dropout rate of participants due to accelerometer non-wear periods and a lack of data on their  
53 age, sex, BMI and PA level.  
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56 The fact that participants completed the PAQ-A at home can also be considered as a  
57 limitation of the study. However, researchers emphasized to participants that the questionnaire  
58 responses need to refer to the week they wore the accelerometer.  
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3 In our study, we did not adjust for differences in non-wear periods in the  
4 accelerometer measurements, because the measurement was carried out 24 hours/day.<sup>43</sup>

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6 Some authors suggest that internal consistency is not relevant for PA questionnaires  
7 because items refer to different aspects of the construct, e.g., duration versus frequency or  
8 sports versus work and these items do not need to be highly correlated.<sup>44</sup> However, we  
9 decided to include these analyzes, as it allows to compare our results with the results of other  
10 authors.  
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## 17 **Conclusion**

18 This is the first study addressing the validity and reliability of PAQ-A in Polish  
19 adolescents which may help to assess the applicability of the questionnaire. Our results show  
20 that the Polish version of PAQ-A provides reliable and valid estimates of PA among 14 to 19-  
21 year-old adolescents. The Polish version of PAQ-A can be considered as very useful in  
22 clinical practice and epidemiological studies to assess overall levels of PA in adolescents.  
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### **Authors' contributions**

JW - development of the concept of research. JW, JPB, KD, JB, PM, JH – data compilation. KP, AM, JW, PM - analysis and interpretation of data. KP - statistical analysis. JW writing an manuscript. JPB, JB, KD - substantive review article. AM, PM - overseeing the final article. All authors read and approved the final version of the manuscript.

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### **Conflicts of interest**

The authors declare no conflict of interest.

### **Data availability statement**

Data are available upon reasonable request.

**Supplementary file no 1.** Polish version of Physical Activity Questionnaire for Adolescents (PAQ-A)

## Kwestionariusz Aktywności Fizycznej dla Młodzieży

### Polish version of the Physical Activity Questionnaire for Adolescents (PAQ-A)

Imię i nazwisko: \_\_\_\_\_

Wiek: \_\_\_\_\_

Płeć: K \_\_\_\_\_ M \_\_\_\_\_

Klasa: \_\_\_\_\_

Podejmujemy próbę oceny poziomu Twojej aktywności fizycznej w *ostatnich 7 dniach* (w ciągu ostatniego tygodnia). Odnosi się to do aktywności, które powodują, że się pocisz lub jesteś zmęczony/a, albo do zabaw, które sprawiają, że oddychasz z wysiłkiem, takich jak: podskakiwanie, bieganie, wspinanie się itp.

#### Pamiętaj:

- Nie ma złych lub dobrych odpowiedzi - to nie jest sprawdzian.

- Proszę, odpowiedz na wszystkie pytania tak szczerze i dokładnie jak potrafisz - to bardzo ważne.

#### 1. Aktywność fizyczna w Twoim wolnym czasie:

Czy wykonywałeś/aś którekolwiek z następujących czynności w ciągu *ostatnich 7 dni* (ostatniego tygodnia)? Jeśli tak, ile razy w tygodniu? (Zaznacz tylko jedno kółko w rzędzie).

	0	1-2	3-4	5-6	7 lub więcej razy
Skakanie na skakance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wiosłowanie/kajakowanie	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jazda na rolkach	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Zabawa w berka	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Maszerowanie dla sportu	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jazda na rowerze	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jogging/bieganie	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Aerobik	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pływanie	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gra w palanta/baseball	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Taniec	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rugby/football amerykański	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Badminton	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jazda na deskorolce	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Piłka nożna	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hokej na ulicy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Piłka siatkowa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Unihokej	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Piłka koszykowa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jazda na łyżwach	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Narciarstwo biegowe	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hokej na lodzie	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Podnoszenie ciężarów	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gimnastyka	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Piłka ręczna	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jazda na nartach	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tenis ziemny	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tenis stołowy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sporty/sztuki walki	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jazda konna	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Inne:					
_____	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
_____	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

2. **Jak często w ciągu ostatnich 7 dni, w trakcie *lekcji wychowania fizycznego (WF)* byłeś/aś bardzo aktywny/a (intensywne granie, bieganie, skakanie, rzucanie)?**  
(Zaznacz tylko jedną odpowiedź).

1  
2  
3  
4 Nie brałem udziału w lekcji WF ..... O  
5 Prawie nigdy ..... O  
6 Czasami ..... O  
7  
8 Dosyć często ..... O  
9 Zawsze ..... O  
10  
11  
12

- 13 3. **Co zazwyczaj robiłeś/aś w czasie przerwy obiadowej w ciągu ostatnich 7 dni oprócz spożywania**  
14 **posiłku? (Zaznacz tylko jedną odpowiedź).**

15  
16 Siedziałem/am (rozmawiając, czytając, odrabiając zadania domowe) ... O  
17 Stałem/am lub spacerowałem/am ..... O  
18 Trochę biegałem/am lub grałem/am ..... O  
19 Biegałem/am lub grałem/am dość dużo ..... O  
20 Biegałem/am lub grałem/am intensywnie przez większość czasu ..... O  
21  
22  
23  
24

- 25 4. **W ciągu ostatnich 7 dni, przez ile dni *zaraz po szkole* uprawiałeś/aś jakiś sport, trenowałeś/aś**  
26 **taniec, lub grałeś/aś w gry, podczas których byłeś/aś bardzo aktywny/a?**  
27 **(Zaznacz tylko jedną odpowiedź).**

28  
29 W żaden dzień ..... O  
30 1 raz w tygodniu ..... O  
31 2 lub 3 razy w tygodniu ..... O  
32 4 razy w tygodniu ..... O  
33 5 razy w tygodniu ..... O  
34  
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- 39 5. **W ciągu ostatnich 7 dni, przez ile dni *wieczorami* uprawiałeś/aś jakiś sport, trenowałeś/aś taniec**  
40 **lub grałeś/aś w gry, podczas których byłeś/aś bardzo aktywny/a?**  
41 **(Zaznacz tylko jedną odpowiedź).**

42  
43 W żaden dzień ..... O  
44 1 raz w tygodniu ..... O  
45 2 lub 3 razy w tygodniu ..... O  
46 4 lub 5 razy w tygodniu ..... O  
47 6 lub 7 razy w tygodniu ..... O  
48  
49  
50  
51

- 52 6. **Podczas ostatniego weekendu, ile razy uprawiałeś/aś jakiś sport, tańczyłeś/aś lub grałeś/aś w gry,**  
53 **podczas których byłeś/aś bardzo aktywny/a?**  
54 **(Zaznacz tylko jedną odpowiedź).**

55  
56 Ani razu ..... O  
57 1 raz ..... O  
58 2 lub 3 razy ..... O  
59 4 lub 5 razy ..... O  
60 6 lub więcej razy ..... O

7. Które z następujących pięciu stwierdzeń najlepiej opisują Ciebie w ciągu ostatnich 7 dni? Przeczytaj *wszystkie pięć* stwierdzeń zanim zaznaczysz *jedną* odpowiedź odnoszącą się do Ciebie. (Zaznacz tylko jedną odpowiedź).

- Cały lub większość czasu spędzałem/am wykonując rzeczy, które wymagały bardzo mało wysiłku fizycznego
- Czasami (1-2 razy w zeszłym tygodniu) byłem/am aktywny/a fizycznie w wolnym czasie (np. uprawiałem/am jakiś sport, biegałem/am, jeździłem/am rowerem, pływałem/am, ćwiczyłem/am aerobik)
- Często (3-4 razy w zeszłym tygodniu) byłem/am aktywny/a fizycznie w wolnym czasie
- Dosyć często (5-6 razy w zeszłym tygodniu) byłem/am aktywny/a fizycznie w wolnym czasie
- Bardzo często (7 lub więcej razy w zeszłym tygodniu) byłem/am aktywny/a fizycznie w wolnym czasie

8. Zaznacz jak często byłeś/aś aktywny/a fizycznie każdego dnia w ciągu ostatniego tygodnia (np. uprawiając jakiś sport, uczestnicząc w grach ruchowych, tańcząc lub wykonując inne formy aktywności fizycznej).

	Wcale	Trochę	Średnio	Często	Bardzo często
Poniedziałek	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wtorek	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Środa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Czwartek	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Piątek	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sobota	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Niedziela	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

9. Czy byłeś/aś chory/a w ciągu ostatniego tygodnia lub zdarzyło się coś, co powstrzymało Cię przed zwykle wykonywaną aktywnością fizyczną? (Zaznacz jedną opcję).

Tak .....

Nie .....

Jeśli tak, to co uniemożliwiło Ci podjęcie tej aktywności? \_\_\_\_\_

**STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology\***  
**Checklist for cohort, case-control, and cross-sectional studies (combined)**

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1, 2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3, 4
Objectives	3	State specific objectives, including any pre-specified hypotheses	4
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	4,7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4,5,6,7
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	5,6
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4, 5, 6,7
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	4,5,6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	7
		(b) Describe any methods used to examine subgroups and interactions	7
		(c) Explain how missing data were addressed	
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed	



		<i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	
		(e) Describe any sensitivity analyses	7
<b>Results</b>			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5,6
		(b) Give reasons for non-participation at each stage	5,6
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7,8
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	7-10
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	
		(b) Report category boundaries when continuous variables were categorized	
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	10
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10,11,12
Generalisability	21	Discuss the generalisability (external validity) of the study results	12
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).