

## Physical activity and Body-Mass-Index relation in secondary-school students of the Visegrad region

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### Abstract

**Background:** One of the greatest problems of the contemporary society is obesity that manifests itself across all age categories. It is, however, in a direct contradiction to the increase of scientifically proven effects of physical activity (hereinafter referred to as 'PA') on the reduction and elimination of obesity. The question to be asked is: What is the impact of PA on BMI of the monitored study participants? **Objective:** The objective of our research was to analyse the relationship between physical activity (PA) and the body mass index (BMI) of 15 – 17-years-old secondary-school students in four countries of the Visegrad group (V4). **Material and method:** The research was conducted in 2015 and the research sample concerned 2,499 students. Due to incomplete data, or, errors in answers, the statistic processing of the data included only 2,140 students, out of which 880 boys (41 %) and 1,260 girls (58.9 %). The information was gathered by means of an extended version of standardised International Physical Activity Questionnaire (IPAQ). The questionnaires were filled online while at school using the INDARES internet-based system. For the statistical processing of data, we used the methods of ANOVA, Pearson's correlation coefficient, Kruskal-Wallis Test, and Mann Whitney U Test. **Results:** The achieved results confirmed significant differences in engaging in PA on the part of boys ( $p=0.01$ ). There are also differences between grades, and in boys also in different forms of strain; in girls only in the overall volume of PA (0.01). In the context of individual countries, significant differences exist in both boys and girls equally. Pupils from the Slovak Republic report the highest levels of PA, while those from Hungary report the lowest PA ( $p=0.01$ ). When evaluating overall BMI as well as BMI in individual countries, the difference between genders has been confirmed to the boys' disadvantage ( $p=0.01$ ). This statement also applies to comparison of individual countries, where the Czech students have the highest BMI and the Slovak students the lowest.

**Conclusion:** Overall, as well as in terms of specific grades, boys are more physically active than girls. In all cases, they also have higher BMI. No significant relation has been proven between the volume and intensity of PA and BMI in both genders.

**Keywords:** IPAQ, adolescence, secondary school, physical activity, V4 region, Central Europe

### Introduction

Health should not be taken for granted. We should be well-aware of the fact that it is a value we cannot have for free and which we should devote special attention to. The minimal need for physical activity (hereafter referred to as 'PA') is given by the so-called threshold value. It is the amount of PA necessary for healthy development of an organism. For adolescents, the minimal threshold is 60 minutes of PA of moderate-to-vigorous intensity every day [1]. However, the previous research confirms that what currently prevails is hypokinetic way of life, and the related issues are manifested in all ages [2]. A certain satisfaction may be offered by the fact that when PA becomes part of our life style, what we aim confirm or disapprove given the example of secondary-school students – the subject matter of our research, that these are mostly vigorous intensity physical activities [3]. However, a worrying fact is that the amount of PA done continuously decreases. Bunc postulates that the decrease has been approximately by 30 % in the past two decades [4]. When comparing working and weekend days, young people do more physical activities during the week, which is probably because of the school physical activities they engage in [5,6,7]. The same conclusion applies also to engaging obese children's involvement in PA [8]. What is worse is that we monitor a decrease also among individual

grades, or, levels of school education [7]. In their longitudinal study [5], observed changes in PA in children from 9 to 15 years old. They found that every year the original 3 hours of PA which 9-year old children had during the week as well as the weekend decrease by at least 30 minutes. In 15-year old it was already 50 minutes daily and more than half an hour during the weekend. Boys were slightly more active than girls. The recommended limit of moderate PA (60 minutes daily) stopped being achieved by 13.2 years old in boys during the week and by 14.9 years old in girls. In terms of weekends, it was not accomplished by 13.6 years old in boys and 12.7 years old in girls.

The task of contemporary science is not only to warn new generations about these facts but also to offer solutions with which to decrease or eliminate the negative situation. And also in this case, it is best to start from childhood. Bar-Or [9], Junger [10] see the advantage of this approach in the immediate health benefits as well as in the values that children adopt and that transfer to adulthood.

The antipole of PA is physical inactivity which is characterised by minimal energy output in minimal physical movement (sedentary habit, watching TV, surfing on Internet, etc.). From the medical point of view, physical inactivity is the fourth risk factor of various diseases after smoking, high blood pressure and high cholesterol that lead to premature death [11].

In the past years, there has been a worldwide decrease in PA of children and the youth which is accompanied by increasing occurrence of overweight and obese children. The lack of PA is equally dangerous for the occurrence of obesity just as overeating which is not the result of being hungry as is generally perceived and can be consciously controlled [12]. While one hour of fast walk per day decreases the risk of obesity by 24 %, and reducing the time spent watching TV by 10 hours a week and increasing the amount of walking to 30 mins a day decreases obesity by 30 % [13]. A sedentary life style and the lack of physical activity of children and the youth is the precondition for physical inactivity in adulthood [14]. Adult individuals who have been continuously obese since childhood suffer not only from psycho-social issues but also increasingly from cardiovascular diseases and diabetes mellitus [15]. The adequate physical weight is ensured mostly by the balance between the intake and output of energy. We intake energy through food and the output of it is ensured by physical activity which is a biological need of every healthy organism. The current way of life changes these natural regulatory mechanisms. Nowadays, nutrition is significantly influenced by the changes in eating habits of the whole families, the predominance of sedentary way of life and media. The consequence is the increase of prevalence of exogenous obesity up to 96 % in childhood with significant impact on younger age categories, whereas endogenous cause of obesity is present only in 4 % of children [15].

While energy output is ensured by physical activity, among other, regular PA is a good prevention of obesity increase as well as a natural tool for reducing it [16]. PA programmes for adolescents can positively influence not only the amount of body fat [17] but can also contribute to decreasing obesity [18]. It is also proven that regular PA in childhood and in adolescent age is necessary for a healthy development of bones and muscle apparatus as well as for maintaining optimal body weight. It is also a source of medical benefits in adulthood and old age [19].

Currently, we use Body Mass Index (hereinafter referred to as BMI) to approximately estimate the degree of obesity. According to these index, found that only a bare half of secondary-school students achieved the recommended healthy range [20]. This index, however, does not reflect the ratio of fat and non-fat body mass in an organism which is why it is not adequate for sport population [21-22].

Based on the above-mentioned findings, it is possible to ask a question whether there is a reciprocal relationship between the amount of PA and BMI. Do these variables influence each other? We have come across similar questions in other studies as well. Gizachew [23] analysed the impact of PA on body weight using several theoretical models. Hendl et al. [4] point to the verifiable impact of active sport in young age on lower BMI in adulthood. Similar conclusions were presented also by Zadarko et al. [24]. who found there is a relation between high BMI and low PA in leisure time and work-related activities in 2,339 female students from the Carpathian Euro-region. On the other hand, we are also aware of studies. in which authors found no relation whatsoever between these two factors. Using a sample of Žilina grammar school students, Beščáková [25] found that there is no general relationship between the number of steps made in a day and BMI in terms of genders. Also, Tlučáková et al. [26] did not prove a connection between the amount of PA and BMI, nor in boys or girls from the sample of 308 grammar school students from Vranov nad Topľou. Ambiguous conclusions call for further monitoring, e.g. according to age categories, study fields, different demographic conditions, etc.

The objective of our research was to analyse the relation between PA and BMI of 15 – 17 years old high-school students in the countries of the Visegrad group – Slovak Republic, Czech Republic, Poland, and Hungary.

## Material and method

The present research which was conducted under the research project within the International Visegrad Fund and was designed in a way where information was gathered from cities with 50 – 200 thousand inhabitants. The following four university departments participated in the project: Faculty of Sports, University of Presov in Presov, Slovak Republic; Palacky University, Czech Republic; Pope John Paul II State School of Higher Education, Biala Podlaska, Poland; University of Pecs, Hungary.

The research took place in the months of April and May 2015 involved secondary-school youth of 15 – 17 years of age (200 students in each category). We did not include students in the last grades for organisational issues of their secondary-school studies. The research sample included 2,499 students. Due to incomplete data, or, errors in answers, the statistical processing of the data included 2,140 students, out of which 880 were boys (41 %) and 1260 were girls (58.9 %). The information regarding their height and weight, amount of weekly PA in the areas of: vigorous- and moderate-intensity PA, walking, PA in school, PA in terms of transportation, PA in terms of household chores, PA in terms of relaxation, sport and recreation was gathered by means of an long version of the standardised International Physical Activity Questionnaire (IPAQ) [27].

The questionnaires were filled online while at school using the INDARES internet-based system. For the statistical processing of the data and its verification, we used the methods of ANOVA, Pearson's correlation coefficient Kruskal-Wallis Test, and Mann Whitney U Test.

According to the IPAQ, data of the physical activity categories were as follows: low with 600/MET/week activity level; moderate with 600-1500/MET/week; and vigorous with above 1500/MET/week.

## Results

Based on the results, we can refute our premise that gender does not play a key role in engaging of the study participants in PA. Boys' activity expressed in MET minutes per week is more pronounced not only in absolute numbers but also in special sport-recreational activities performed in leisure time (table 1).

Table 1 Physical activity MET/week/sex

	male	female	Sig.
MET total	<b>7264.64</b>	<b>6187.46</b>	.00
Vigorous MET total	<b>2500.34</b>	<b>1844.99</b>	.00
Moderate MET total	<b>2844.74</b>	<b>2123.05</b>	.00
Walking MET total	<b>1919.56</b>	<b>2219.42</b>	.01
Job-Related Physical Activity total MET	2269.03	2014.47	.96
Transportation Physical Activity total MET	1357.82	1213.3	.76
Housework, house maintenance, and caring for family total MET	1173.93	1007.95	.31
Recreation, Sport, And Leisure-Time Physical Activity total MET	<b>2463.87</b>	<b>1951.75</b>	.00

Note. MET = metabolic equivalent, statistics = Mann-Whitney U test,

We were therefore interested in how the relationship of students toward PA manifests itself in the first three years of their studies (table 2). We reiterate that the research sample did not include students in their last year for organisational issues of their study. The results show that the interest of students in PA changes throughout their study. For both boys and girls, the highest amount of PA was monitored in the second grade and the lowest when entering a secondary school.

Table 2 Mean physical activity MET/week/grade/sex

	male			female		
	1 st grade	2 nd grade	3 rd grade	1 st grade	2 nd grade	3 rd grade
MET total	<b>8209.71*</b>	<b>9207.08*</b>	<b>8227.26*</b>	<b>6479.90*</b>	<b>6795.22*</b>	<b>6750.54*</b>
Vigorous MET total	<b>2863.43*</b>	<b>3093.33*</b>	<b>2628.47*</b>	1886.11	2132.35	1795.28
Moderate MET total	<b>3199.55*</b>	<b>3624.39*</b>	<b>3088.85*</b>	2043.34	2246.17	2330.89
Walking MET total	<b>2146.73*</b>	<b>2489.36*</b>	<b>2509.94*</b>	<b>2550.44*</b>	<b>2416.70*</b>	<b>2624.37*</b>
Job-Related Physical Activity total MET	<b>3078.88*</b>	<b>3240.94*</b>	<b>2721.81*</b>	<b>2283.43*</b>	<b>2512.62*</b>	<b>2282.55*</b>
Transportation Physical Activity total MET	<b>1675.96*</b>	<b>1876.25*</b>	<b>1896.94*</b>	<b>1418.09*</b>	<b>1489.71*</b>	<b>1496.79*</b>
Housework, house maintenance, and caring for family total MET	<b>1274.33*</b>	<b>1413.83*</b>	<b>1070.26*</b>	981.43	899.60	1010.31
Recreation, Sport, And Leisure-Time Physical Activity total MET	2180.53	2676.07	2538.25	1796.95	1893.29	1960.89

Note. MET = metabolic equivalent, statistics = Kruskal-Walis test, \* $p \leq 0.05$

When comparing PA of secondary-school students in terms of different countries, we have found the most significant differences in boys. The highest amount of the overall PA (table 3) was found in boys from the Slovak Republic (10,281 MET-min/week) and the lowest in Hungarian boys (4503 MET-min/week).

Table 3 Mean physical activity MET/week/country/male

	Slovakia	Poland	Czech Republic	Hungary	p
MET total	<b>10280.5</b>	<b>7520.20</b>	<b>9086.01</b>	<b>4502.78</b>	.00
Vigorous MET total	<b>4043.92</b>	<b>2235.99</b>	<b>3143.44</b>	<b>1667.05</b>	.00
Moderate MET total	<b>3402.57</b>	<b>3135.13</b>	<b>3407.76</b>	<b>1954.89</b>	.00
Walking MET total	<b>2834.01</b>	<b>2149.09</b>	<b>2534.81</b>	<b>880.84</b>	.00
Job-Related Physical Activity total MET	<b>4802.28</b>	<b>2116.72</b>	<b>3375.56</b>	<b>558.56</b>	.00
Transportation Physical Activity total MET	<b>1776.96</b>	<b>1857.03</b>	<b>1587.47</b>	<b>458.26</b>	.00
Housework, house maintenance, and caring for family total MET	<b>1348.45</b>	<b>1105.66</b>	<b>1661.48</b>	<b>934.33</b>	.01
Recreation, Sport, And Leisure-Time Physical Activity total MET	2352.80	2440.78	2461.50	2551.62	.451

Note. MET – metabolic equivalent, statistics: Kruskal-Walis Test

The differences in PA of girls among individual countries were not so significant as in boys, though the order of countries according to their amount of PA remained the same (table 4). Also in this case, the highest overall PA was found in girls from the Slovak Republic (7288 MET-min/week) and the lowest in Hungarian girls (4067 MET-min/week).

The differences in PA of girls among individual countries were not so significant as in boys, though the order of countries according to their amount of PA remained the same (table 4). Also in this case, the highest overall PA was found in girls from the Slovak Republic (7288 MET-min/week) and the lowest in Hungarian girls (4067 MET-min/week).

Another observed variable was height- and weight-based index BMI. Similarly to the overall PA, significant differences between genders were shown also when analysing BMI (table 5). While  $\frac{3}{4}$  of the monitored students fall into the normal range in terms of weight, 12.2 % of boys and 8.9 % of girls are overweight (table 6).

The objective of our research was to analyse whether there is a relationship between the observed variables, that is, performed PA and the students' BMI. When using Pearson's correlation coefficient (where applicable we also used Spearman correlation coefficient for cross reference), we found that there is no significant relationship between individual forms of performed PA for both the overall BMI and individual BMI categories.

Table 4 Mean physical activity MET/week/country/female

	Slovakia	Poland	Czech Republic	Hungary	Sig.
MET total	<b>7287.49</b>	<b>5862.05</b>	<b>7164.81</b>	<b>4067.33</b>	.00
Vigorous MET total	<b>2607.97</b>	<b>1479.75</b>	<b>1964.13</b>	<b>1279.00</b>	.00
Moderate MET total	<b>1951.92</b>	<b>2415.56</b>	<b>2297.22</b>	<b>1744.39</b>	.00
Walking MET total	<b>2727.60</b>	<b>1966.74</b>	<b>2903.46</b>	<b>1043.94</b>	.00
Job-Related Physical Activity total MET	<b>2982.31</b>	<b>1813.81</b>	<b>2382.14</b>	<b>711.41</b>	.00
Transportation Physical Activity total MET	<b>1299.32</b>	<b>1521.80</b>	<b>1620.38</b>	<b>229.53</b>	.00
Housework, house maintenance, and caring for family total MET	<b>965.21</b>	<b>840.94</b>	<b>1132.71</b>	<b>1074.60</b>	.00
Recreation, Sport, And Leisure-Time Physical Activity total MET	<b>2040.66</b>	<b>1685.49</b>	<b>2029.58</b>	<b>2051.79</b>	.00

Note. MET – metabolic equivalent, statistics: Kruskal-Walis Test

Table 5 BMI – description according to the gender

sex	Mean	Std. deviation	F	p
male	<b>21.82</b>	3.316	30.457	≤ 0.001
female	<b>21.01</b>	3.369		
total	21.34	3.370		

Note. BMI - Body mass index, statistics: Anova, F – testing criterion

Table 6 BMI category – descriptives

sex	underweight		normal weight		overweight	
	count	row n %	count	row n %	count	row n %
male	97	11.0	676	76.8	107	12.2
female	232	18.4	916	72.7	112	8.9
total	329	15.4	1592	74.4	219	10.2

Note. BMI - Body mass index

## Discussion

The presented results of PA from the research project within the International Visegrad Fund show the differences in PA performance from the viewpoint of the gender of the monitored secondary-school students. Apart from the fact that boys are more physically active in general, they also show higher values of vigorous- and moderate-intensity PA and sport activity ( $p = 0.01$ ) in comparison to girls. Their structure of performed PA consists especially of walking in which they have better results than boys ( $p = 0.01$ ) and moderate PA and work-related activities but in smaller amount than boys ( $p = 0.01$ ). When comparing research results achieved in the neighbouring countries, we can conclude that our sample shows higher PA in all comparisons. Polish youth aged 16 – 18 showed PA expressed in MET/minutes/week in the amount of 2,640 (boys) and 2,219 (girls) [28]. Ukrainian youth aged 17 – 22 showed higher results by one third. Boys showed PA value in the amount of 3,863 and girls 3,365 MET/minutes/week [29]. The highest value of PA according to Bergier et al [30] was given by Lithuanian secondary-school students aged 17 – 4,895 (boys) and 4,404 (girls). Just as in our research also other comparisons showed boys' physical activity higher than in girls.

When analysing performed PA in individual grades we found that it changes over the course of their studies. In overall amount, significant changes ( $p = 0.01$ ) appear in both boys and girls. For both boys and girls, the highest amount of PA was monitored in the second grade and the lowest when entering a secondary-school. In boys, these changes in the intensity of PA is also shown in individual forms apart from sport activities. In girls, the changes are evident not only in overall PA but also in the amount of walking, work-related PA, and PA in terms of transport.

Significant differences ( $p = 0.01$ ) occur also when comparing performed PA in terms of individual countries of V4. The differences are in both boys and girls, in overall PA as well as the PA of individual disciplines, apart from sport-recreational activities of boys. The highest value of overall PA is shown by boys from the Slovak Republic and the lowest by Hungarian boys, where the difference between these two countries is almost two-fold. In girls, the differences in PA of individual countries were not as significant as in boys, but the order of the countries according to their PA level remained the same (table 4). In terms of individual disciplines of PA, in Slovak boys the largest amount is found in work-related PA and vigorous-intensity PA. In Poland, it is moderate PA and sport-recreational activity, in the Czech Republic, it is work-related PA and moderate PA, and in Hungary, it is sport-recreational activity and moderate PA. The largest part of the structure of overall PA of Slovak girls includes work-related PA and walking, in Poland it is moderate PA and walking, in the Czech Republic it is walking and work-related PA, and in Hungary it is similarly to boys, sport-recreational activity and moderate PA.

Apart from the data on overall PA of students, we were also interested in its intensity. Using the Kruskal Wallis test, also here we found differences in the intensity of PA between the two genders ( $p = 0.05$ ). In both cases, which is rather positive, the PA is of vigorous intensity. However, while in boys it is up to 64.3 % of vigorous intensity PA, in girls it is only a bit over half (53.6 %).

As the objective of our research was to analyse whether there is a relationship between the observed variables, that is, performed PA and their height- and weight-based BMI, another observed variable was their height and weight BMI. Similarly to analysing overall PA, also when analysing BMI significant differences between genders ( $p = 0.01$ ) were observed. In general, boys are higher and they weight more. When splitting the research sample into three categories, we found that while  $\frac{3}{4}$  of the monitored students fall into the normal range in terms of weight, 11% of boys and 18.4% girls are underweight, and 12.2 % of boys and 8.9 % of girls are overweight. These results are slightly better than the ones from our previous research carried out on secondary-school students in the Prešov region [31].

Comparing the relationship between performed PA and BMI we found that there is no significant connection between overall BMI, as well as the BMI categories, and individual disciplines of performed PA. This finding applies to both overall PA, its individual disciplines, and the findings achieved in individual countries. This finding put us in the group of authors such as [25-26]. and others whose research studies have not confirmed any relationship between the amount of PA (or the number of steps) of secondary-school students and the index of their body mass in general as well as in terms of the two genders.

## Conclusion

To conclude we can observe that secondary-school boys are physically more active than girls not only in general but also in terms of sport activities in their leisure time. When analysing PA in specific grades we found the increase with age, with the second-grade boys reporting the highest levels of PA in. In terms of individual countries of V4, Slovak students are the most physically active, and Hungarian students are the least physically active. Overall BMI was higher in boys and, consequently, we also found a higher number of obese children in this category. Based on the correlation analyses between observed variables (PA and BMI), we found that in none of the cases the result that we achieved could confirm at least a minimal relationship between the two variables.

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