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# PHYSICAL ACTIVITY AND MACRONUTRIENTS INTAKE INFLUENCE ON NUTRITIONAL STATUS OF POLISH AND BRITISH ADOLESCENTS

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## Key words:

- somatic indicators,
- nutritional status,
- physical activity.

## Abstract:

Results of epidemiologic studies indicate an increase in incidence of nutritional status disorders among children and adolescents, which may be caused by poor dietary habits and low physical activity.

The aim of the study was to assess the influences of physical activity, nutritional intake and eating habits on nutritional status of adolescents populations from Poland and Great Britain.

The study was conducted in the group of 125 girls and boys aged around 17 years.

The nutritional status assessment was based on somatic indicators BMI (Body Mass Index), %FAT (Body Fat), FFM (Fat-Free Mass) obtained by means of impedance technique and on nutritional intake evaluated on the basis of 7. days dietary recall. Physical activity level was assessed by an interview method using Seven Day Physical Activity Recall.

Nutritional status assessment showed in the girls group higher values of body mass and %FAT of British girls, but the differences were insignificant. In the boys group the British were characterized by a higher %FAT and significantly lower FFM.

Evaluation of the dietary intake did not show significant differences between the girls. Polish boys consumed significantly higher amounts of macronutrients in comparison with British boys. Deviations from recommended amounts were observed: an excessive protein and carbohydrates intake in the majority of Polish population, a high energy percentage of fat in diets of nearly 50% Polish boys.

In British population an excessive protein consumption and a low energy intake was observed. The study participants were characterized by low physical activity.

Nutritional status and dietary habits diverge between adolescents from Polish and British populations.

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## INTRODUCTION

Results of epidemiologic studies indicate a systematic increase in incidence of nutritional status disorders among children and adolescents [World Health Organization: WHO 2003]. Metabolic disorders have mainly primal character which means they derive from an excessive or insufficient energy and macronutrients intake [Cole and others 2000, p.1240]. In the adolescent population, the most occurring factors predisposed to dietary disorders are poor dietary habits and low physical activity [Gronowska- Senger 2007, p.18; Gorely and others 2012, s.5; Moreno and others 2007, p.7].

Scientific reports showing a high incidence factor of metabolic, cardiovascular diseases and other health complications resulting from diagnosed children and adolescents obesity seem to be peculiarly significant [Reybrouck and others 1997, p.480]. According to the latest World Health Organization data [WHO 2013] there is an increasing trend of obese children in developed countries, which may be a result of incorrect eating habits [Gronowska-Senger 2007, p.13; Kowieska and others 2007, p.727; Mutch and Clement 2006, p.1959; Socha and others 2010, p.35; Szczepańska and others 2007, p.578, Whitton and others 2011, p.1900]. In ontogenic development, especially during puberty, hormonal factors play a significant role in forming body mass and body content. They affect metabolic processes and modify genetically determined somatic characteristics [Rogol and others 2000, p.522]. **The difference in metabolic processes can depend on changes in hormonal secretion, cells responsiveness, and on diet energy value** [Adlercreutz 1991, p.151].

It has been indicated by the Swedish Public Health Institute that the poor dietary habits of the European Union countries can shorten people's life- expectancy [Pac and others 2010, p.420]. Studies from previous years unambiguously evidence one of the highest ratios of overweight and obesity in population of children and adolescents from Great Britain [Al-Nakeeb and others 2012, p.1492; Whitton and others 2011, p.1899; Hilton and others 2012, p.1688]. Significantly, there is a two- fold increase of British people with metabolic disorders over the period of twenty five years and a significant correlation between obesity prevalence and low physical activity [Hilton and others 2010, p.1689].

It has to be emphasized, that in British education, contrary to Polish system, physical education and sport classes are optional. In Great Britain adolescents aged 16- 18 years study at college which trains for a chosen occupation or prepares for entering an university.

Obligatory attendance in physical education classes, according to the Polish education system, may be a factor decreasing the risk of overweight and/or obesity incidence in this age group.

Therefore the aim of the study was to assess the influences of physical activity, nutritional intake and eating habits on nutritional status of adolescents populations from Poland and Great Britain.

## THE MATERIAL AND THE METHODOLOGY

The study was conducted in the group of 125 girls and boys aged around 17 years. The participants were Polish high school students (n=77) and British college students (n=48). Polish population was randomly chosen from high schools of the Cieszyn County. British population comprised of Stockport and Manchester college students. Adolescents from the examined groups differed in physical activity associated with school classes. In the Polish population, physical education lessons accounted to an average of 6 hours per week, in the British population to an average of 3 hours per week, but only amongst a small group who has chosen this subject.

The study was conducted after obtaining a written informed consent from parents or legitimate guardians, and from schools' principals. Tables 1. and 2. present participants somatic build.

**Table 1.** Girls somatic build characteristics (x ± SD)

Indicator	GIRLS n= 61			
	Polish group n= 41		British group n= 20	
	<i>x</i>	<i>SD</i>	<i>x</i>	<i>SD</i>
Age [year]	17,0	± 0,8	17,0	± 0,9
Height [m]	1,7	± 0,1	1,7	± 0,1
Weight [kg]	59,0	± 8,0	61,1	± 15,7
BMI [kg/m <sup>2</sup> ]	21,0	± 2,0	21,8	± 4,7
FAT [%]	23,0	± 6,0	24,0	± 7,0
FFM [kg]	45,0	± 3,6	45,7	± 7,9

**Table 2.** Boys somatic build characteristics ( $x \pm SD$ )

Indicator	BOYS n= 64			
	Polish group n= 36		British group n= 28	
	<i>x</i>	<i>SD</i>	<i>x</i>	<i>SD</i>
Age [year]	17,4	$\pm 0,9$	17,1	$\pm 0,8$
Height [m]	1,8	$\pm 0,1$	1,8	$\pm 0,1$
Weight [kg]	73,6	$\pm 12,7$	67,6	$\pm 8,2$
BMI [kg/m <sup>2</sup> ]	22,5	$\pm 3,3$	21,0	$\pm 2,2$
FAT [%]	12,0	$\pm 5,0$	15,0	$\pm 5,0$
FFM [kg]	64,2***	$\pm 7,3$	57,0	$\pm 4,8$

\*\*\* Significant difference towards British group ( $p < 0,001$ )

The nutritional status assessment conducted among the study participants was based on weight and somatic indicators measurements obtained by means of impedance technique, where Weight Watchers Body Analysis Scale (UK) was used. The measurements included body mass, body mass index (BMI), percentage of body fat content (%FAT) and fat free mass (FFM) was estimated. The data was recorded in the morning after the night rest. BMI and %FAT values were compared with the World Health Organization guidelines [WHO 2009].

In order to evaluate the nutritional status tables of macronutrients intake were also used ("Album photography and food products") [Szponar and others 2000]. Mean daily energy, protein, fat, carbohydrates intakes were calculated on the basis of 7. days dietary recall [Kunachowicz and others 2003]. The obtained values were presented in absolute units and with respect to participants weight (relative units). Then they were compared with the dietary recommendations being in force in Poland [Jarosz and others 2012], United Kingdom [UK Food Standards Agency 2007] and with the WHO dietary guidelines as well [WHO 2001, 2007a, 2007b, 2008]. Participants' physical activity level was assessed by an interview method using Seven Day Physical Activity Recall (SDPAR) created by S. Blair [Blair and others 1985]. This questionnaire obtains data about frequency, intensity and duration of physical activities undertaken over the last 7 days and estimate of daily activity energy expenditure (AEE) in relative units (kcal/kg/d).

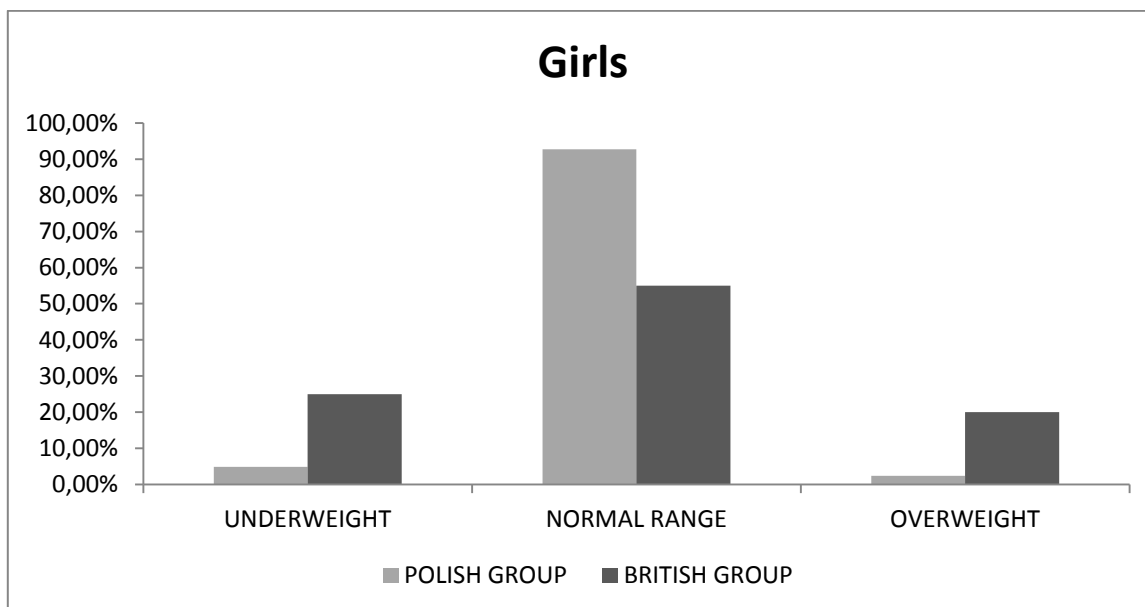
The Statistica package v. 10 (StatSoft Poland, 10.0) was used for data management and analyses. Variables' normal distributions were validated, outliers were rejected, correlations between the variables were checked and ANOVA variance analysis for factorial design was used. A Tukey post- hoc test for different numbers was conducted to determine significant differences between the means. Differences were considered statistically significant at  $p < 0,05$ .

The results were presented as means ( $x$ ) and standard deviations ( $SD$ ).

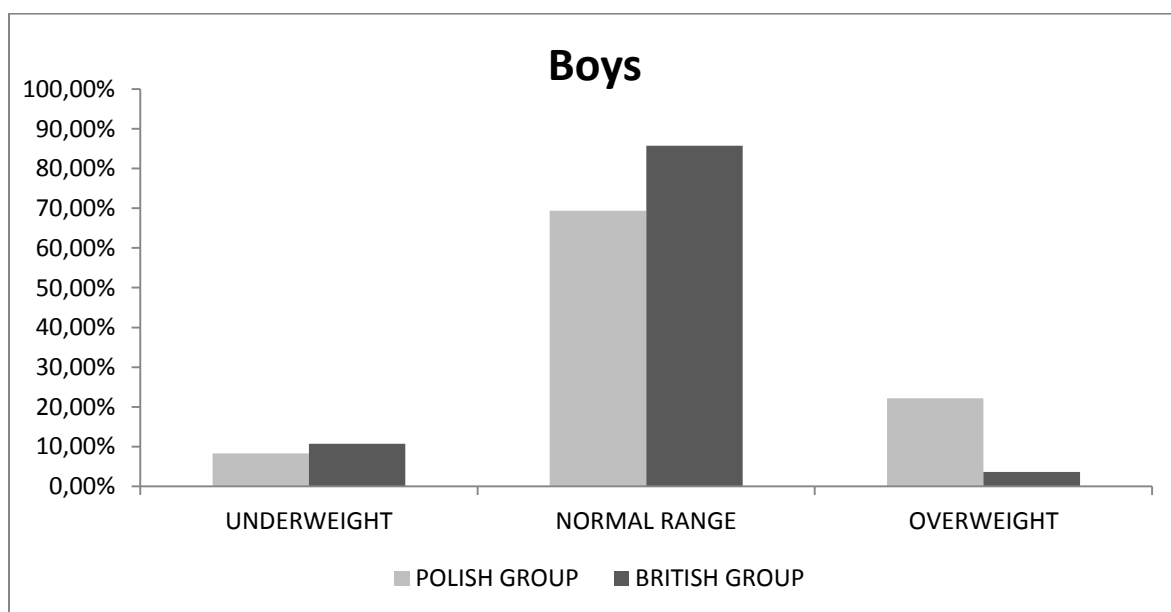
## RESULTS

Analysis of the nutritional status based on somatic indicators showed in the group of girls higher values of body mass and body fat content (%FAT) of British girls, but the differences were insignificant (Table 1). Characteristic of the boys somatic build indicated a tendency of a higher %FAT and significantly lower fat free mass (FFM) of British boys in comparison with Polish peers ( $p < 0.001$ ) (Table 2).

A high %FAT was observed among approximately 40% of girls from both countries. %FAT values below the norm were found amid 14,6% Polish and 20,0% British girls. Deviations from the normal ranges of BMI occurred more frequently in British girls (Fig.1). In the group of boys a tendency of a low adipose tissue was indicated in 66,7% Polish and around 48% British students. %FAT above the norm occurred more often among British boys, nevertheless the majority of these boys was characterized by normal ranges of BMI (Fig.2).



**Fig.1.** Frequency of underweight, normal range and overweight based on BMI among Polish (n=41) and British (n=20) girls



**Fig.2.** Frequency of underweight, normal range and overweight based on BMI among Polish (n=36) and British (n=28) boys

The variance analysis confirmed significant differences in %FAT and FFM between the girls and the boys, a significant affect of nationality on FFM and a joint-affect of sex and nationality on BMI and FFM (Table 4).

**Table 4.** Affect of sex, nationality and joint affect of these factors on somatic indicators: BMI, %FAT and FFM

	BMI		%FAT		FFM	
	F	p	F	p	F	p
<b>Sex</b>	0,23	0,63	90,18	<0,001	195,59	<0,001
<b>Nationality</b>	0,39	0,53	3,32	0,07	8,83	<0,001
<b>Sex * Nationality</b>	4,27	0,04	1,72	0,19	13,23	<0,001

Evaluation of the girls energy and macronutrient intake did not show any significant differences between the subgroups (Table 5). On the contrary, boys from Poland consumed significantly higher amounts of macronutrients than their English peers ( $p < 0,001$ ), which was associated with a higher protein, fat and carbohydrates intake (Table 6).

Dietary intake assessment in the group of girls and boys from Poland showed some deviations from recommended amounts. Importantly there was an excessive relative protein intake (88,9% boys and 56,1% girls), carbohydrates intake (87,8% girls and 94% boys) and a high energy percentage (%energy) of fat in diets of nearly a half of the Polish boys. Similarly in the British population group the majority of boys (78,6%) and a half of girls were characterized by a high consumption of protein, and a low energy intake (85,7% boys and 80% girls).

The dietary intake results were also compared with the World Health Organization recommendations [WHO 2001, 2007a, 2007b, 2008]. The evaluation confirmed an excessive protein and insufficient energy intake in the groups of both countries. Moreover the WHO guidelines indicated too low energy percentage of carbohydrates in diets among the majority of Polish and British boys.

**Table 5.** Daily nutrient and energy intake of Polish and British girls ( $x \pm SD$ )

Intake index	Girls n= 61			
	Polish group n= 41		British group n= 20	
	<i>x</i>	<i>SD</i>	<i>x</i>	<i>SD</i>
<b>Protein [g/d]</b>	59,5	±19,7	54,1	±16,9
<b>[%] energy</b>	<b>13,6%</b>	±2,4	<b>13,3%</b>	±3,5
<b>Protein [g/kg/d]</b>	1,0	±0,4	0,9	±0,4
<b>Fat [g/d]</b>	58,5	±22,4	56,0	±19,5
<b>[%] energy</b>	<b>29,3%</b>	±5,3	<b>30,1%</b>	±4,3
<b>Carbohydrates [g/d]</b>	255,5	±91,5	236,9	±81,9
<b>[%] energy</b>	<b>57,1%</b>	±6,1	<b>56,2%</b>	±6,5
<b>Energy intake [kcal/d]</b>	1786,3	±588,0	1676,1	±515,6

**Table 6.** Daily nutrient and energy intake of Polish and British boys ( $x \pm SD$ )

Intake index	Boys n= 69			
	Polish group n= 36		British group n= 28	
	<i>x</i>	<i>SD</i>	<i>x</i>	<i>SD</i>
<b>Protein[g/d]</b>	121,5***	±36,1	86,2	±32,5
<b>[%] energy</b>	<b>15,2%</b>	±2,0	<b>16,4%</b>	±3,3
<b>Protein [g/kg/d]</b>	1,7**	±0,6	1,3	±0,5
<b>Fat [g/d]</b>	122,2***	±39,2	68,5	±22,9
<b>[%] energy</b>	<b>34,3%**</b>	±4,7	<b>29,7%</b>	±5,7
<b>Carbohydrates [g/d]</b>	403,7***	±105,8	281,5	±96,3
<b>[%] energy</b>	<b>50,5%</b>	±5,4	<b>53,0%</b>	±6,9
<b>Energy intake [kcal/d]</b>	3200,7***	±806,7	2105,9	±605,1

\*\* Significant differences towards the British group ( $p < 0,01$ )

\*\*\* Significant differences towards the British group ( $p < 0, 001$ )

Variance analysis showed a significant affect of sex and nationality on and energy intake, additionally joint affect of sex and nationality on fat intake was observed (Table 7.).

**Table 7.** Sex, nationality and joint effect of specified factors on relative values-(g/kg/d) of protein, fat, carbohydrates and energy intake

	Protein intake [g/kg/d]		Fat intake [g/kg/d]		Carbohydrates intake [g/kg/d]		Energy intake [kcal/d]	
	F	p	F	p	F	p	F	p
<b>Sex</b>	36,1	0,00	17,9	<0,001	4,9	0,03	15,83	<0,001
<b>Nationality</b>	8,0	0,01	15,9	<0,001	7,4	0,01	5,16	0,02
<b>Sex* Nationality</b>	3,0	0,09	13,9	<0,001	3,4	0,07	1,84	0,18

Physical activity (PA) level defined by energy expenditure (kcal/kg/d) and time (hrs/d) accumulated for PA was similar in groups of boys and girls from both countries (Table 8). Physical activity energy expenditure (PAEE) was below the recommended level in a high percentage of the study participants: in girls group among 68,3% Polish and 65,0% British girls, in boys group among 72,2% Polish and 75,0% British boys.

The criteria of 60 minutes of daily physical activity was not accomplished by a similar percentage of girls: 24,4% Polish and 25% British. A significantly higher percentage of British boys comparing with Polish peers (42,9% vs.11,1%) was characterized by a physical activity below the recommended level.

**Table 8.** Physical activity energy expenditure (PAEE) and time accumulated daily for physical activity (PA) of girls and boys from Poland and Great Britain ( $x \pm SD$ )

Physical activity	Girls				Boys			
	Polish group n= 41		British group n= 20		Polish group n= 36		British group n= 28	
	x	SD	x	SD	x	SD	x	SD
<b>PA energy expenditure [kcal/kg/d]</b>	8,6	±4,7	8,8	±5,3	8,7	±4,1	7,4	±5,2
<b>Time accumulated for PA [hrs/d]</b>	1,8	±0,9	1,8	±1,1	1,5	±0,6	1,4	±1,0

## DISCUSSION

In each period of human development, especially in puberty, well- balanced diet promotes health and forms healthy eating patterns [Wojtaś and Kollajtis-Dołowy 2011, p.947; Kowieska and others 2007, p.727].

The nutritional status assessment has become meaningful in the recent years due to an increase in overweight and obesity incidence amongst children and adolescents, particularly in developed countries [Gronowska- Senger 2007, p.12; Klimatskaya and others 2010, p.225; Ottevaere and others 2011, p.2]. Eating habits and an adequate physical activity level decides on somatic build , physical capacity and prevents a development of many civilization diseases [Ottevaere and others 2011, p.2; Celejowa 2007, p.218; Zając and others 2008, p.14]. Nutritional status analysis plays an integral part in studies on child development, identifying the risk of a nutritional status disorder and effectiveness of dietary therapy [Sibilska and Książyk 2011, p.580]

Epidemiological research findings acknowledge a high percentage of obesity among boys (16,8%) and girls (15,2%) aged 2-15 years and overweight amongst approximately 14% British adolescents [Hagell and Coleman 2012, p.4]. Similarly in Poland the incidence of childhood and adolescence overweight and obesity has shown a steep increase. It refers to

around 2,5- 12% young people [European Food Safety Authority 2010, p.13; Sikorska-Wiśniewska 2007, p.73].

During this ontogenic period a dominance of anabolism over catabolism, as well as greater nutrients and energy requirements induced by physical activity, require adherence to the dietary requirements. This will create an optimal physical and mental development, good functioning of the immune system and will prevent many diseases in adulthood [Kowieska and others 2007, p.727; Wojtaś and Kołajtis-Dołowy 2011, p.947].

The present study indicated a higher risk of excess body fat among the group of girls from both countries and more frequent incidence of body mass deviations. Dimorphic differences were observed with reference to populations of Polish and British adolescents. In the boys group a higher percentage of an excessive adipose tissue, related to the tendency of lower physical activity, was stated.

A relatively small percentage of nutritional status disorder indicating malnutrition was observed in the study. This finding corresponds with reports from Polish research, showing that the malnutrition problem, expressed by BMI, refers to a small percentage of Polish youth aged 16- 18 years: 8,5% boys and 6,7% girls [Szponar and Ołtarzewski 2004, p.14]. The observation of a low percentage of underweight British girls and boys acknowledges the literature evidence [Department of Health 2010 p.1]. Malnutrition finds its explanation in the observation of a low energy intake of the majority girls from both countries [Paradowska-Stankiewicz and Grzybowski 2007, p.936].

Analyzing the present study, sexual dimorphism effect on somatic indicators can be clearly observed. These differences depend on hormonal secretion specific for each sex. In boys a higher testosterone secretion causes an increase of muscular tissue, in girls estrogens extraction effects adipose tissue increase [Malinowski and Strzałko 1989, p.176; Veldhuis and others 2005, p.117]. Variance analysis indicated a significant affect of sexual dimorphism on %FAT and FFM, but there was no significant affect on BMI.

The nutritional status assessment results based on BMI, %FAT, FFM values induced undertaking a study on nutrition intake and physical activity level. The estimate of macronutrients intake was made based on 7.days dietary recall. During the dietary interview weekend days were also taken into consideration.

Protein, fat and carbohydrates intakes were compared with the nutrition recommendations elaborated by Polish and English institutions and characteristic for this age group [Jarosz and others 2012, UK Food Standards Agency 2007].

A high relative protein consumption and the tendency of a low energy intake were the meaningful observations characterizing populations from both countries. Protein has a crucial effect on biochemical processes [Zajac and others 2008, p.110]. Interestingly, protein intake was above the recommended levels among girls and boys from both countries. Controlling protein consumption is vital in order to prevent nitrogen balance disorders, which could be an additional strain on kidney function [Celejowa 2007, p.221; Gawęcki and Mossor-Pietraszewska 2004, p.232]. An excessive protein intake can also lead to disorders in bone mineralization [Bolesławska and others 2011, p.555]. The observation of a high protein consumption corresponds with the results from studies carried out among young people from Poland and Great Britain [Bolesławska and others 2011, p.555; Whitton and others 2011, p.1912].

Carbohydrates intake evaluation, showed considerable deviations from recommended level among the Polish group. A high carbohydrates consumption can lead to body mass and body fat increase [Gawęcki and Mossor-Pietraszewska 2004, p.223; Zajac and others 2008, p.117]. The incidence of a high %FAT in the girls group from both countries confirms the effect of an excessive carbohydrates intake. A high consumption of these substances is justifiable with physically active people, but a relatively high percentage of Polish participants

did not follow the PA guidelines. The results also indicate that boys and girls consumed high amounts of saccharose which is present in sweets and sweetened drinks. It corresponds with the other studies results [Gronowska- Senger 2007, p.13; Kowieska and others 2007, p.727, Ottevaere and others 2011, p.2].

Fat intake admittedly consistent with recommendations, was higher among Polish boys comparing with British peers. The same introspection was found in the energy intake (Table 6).

Significantly higher intakes of macronutrients and energy was observed in Poles in comparison with the British. An interesting result of the study is a tendency of low adipose tissue with simultaneous higher fat free mass in the population of Polish boys. This tendency can be a result of regulation mechanisms, more favourable energy sources metabolism and a higher physical activity level [Gertig and Przysławski 2006, p.256]. Comparing the carbohydrates intake with the World Health Organization guidelines did not confirm excessive consumption. It might have been due to some differences in dietary norms designation in the observed countries [Jarosz and others 2012, UK Food Standards Agency 2007, WHO 2001, 2007a, 2007b, 2008].

The observation of a lower %FAT and a significantly higher FFM in the population of Polish boys and a significant affect of sex, nationality on the somatic indicators and macronutrients intake, inclined assessing relations between mentioned variables and physical activity energy expenditure (PAEE). The assessment showed that Polish students were more physically active, which was indicated by a higher PAEE (kcal/kg/d) and a higher mean time (hrs/d) committed to physical activity. However, questionnaire surveys have limitations which may mean that the above conclusions are not right. It may be also inaccurate to say that girls were more active than boys, as the differences found were insignificant. Moreover it would be contradictory with the reports from the studies carried out in Great Britain and the United States of America, which indicate lower physical activity of girls in comparison with boys from the same age group [Agbuga 2011, p.80; Bretzing and Wilkinson 2011, p.58; Gorely and others 2012, p.5]

The questionnaire showed more British girls in part-time physical jobs than boys which could explain the above observations of the study.

The low physical activity energy expenditure recorded by adolescents despite having sufficient time devoted to PA is alarming. The findings suggest too low intensity of physical exertions taken by the study participants. It corresponds with the reports from Poland, England and other developed countries, which indicate a decline in adolescents participation in various forms of physical culture [Gorely and others 2012, p.13; Gronowska- Senger 2007, p.18; Bergier and others 2012, p.109; Centers for Disease Control and Prevention 2012, p.35].

From the present results it can be concluded that nutritional status and dietary habits diverge between adolescents from Polish and British populations. Low physical activity of the girls and the boys, and low physical exercise intensity among the population of British boys are the significant study observations.

In conclusion, increasing an intensity of physical exertions may have a beneficial effect on the control of metabolic processes and on maintaining desirable body mass and body content even under conditions of an excessive macronutrient intake.

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