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## **THE PROPORTIONS AND BODY COMPOSITION OF CHILDREN AND ADOLESCENTS AGED 8-18 YEARS ENGAGED IN SPORTS TRAINING WITHIN THE FRAMEWORK OF PODKARPACKIE PROVINCE SPORTS STAFF**

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### **Keywords:**

- young athletes,
- body build,
- body composition.

### **Abstract:**

The aim of this study was an attempt to determine the key indicators of body build and its composition. All tested persons were members of the Podkarpackie Province youth sports staff. The test group consisted of 417 young athletes aged 8-18 years, including 244 boys and 173 girls. The research included measurement of somatic traits and body composition using the Body Composition Analyzer MC-980 by Tanita company. From the conducted analysis it follows that regular sports training affects to a large extent the level of basic body build indicators as well as its composition.

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## **INTRODUCTION**

The quite commonly observed phenomenon of hypokinesia makes the physical activity an essential element of human well-being and health. Any regular physical activity (including sports training) has a positive effect on body composition (Baxter-Jones et al., 1995, Randakova 2005, Ambroży et al., 2007). As a result of its impact the body fat tissue decreases and the lean body mass increases. On the other hand, the assessment of body composition indicates the nutrition status. The knowledge of body composition contributes also to a more detailed understanding of physiological and biochemical processes taking place in the body (Pietraszewska 2002).

Each sports event requires certain predispositions concerning the build of the body, its proportions and composition (Milicerowa 1973). Somatic factors are the basis for sports selection and are genetically and environmentally conditioned. The advantageous features of an athlete's body build are strong musculature and massive skeleton, while the size of fat tissue is an obstacle during physical exercise.

The rational sports training will quite significantly affect some parameters of the structure and composition of the body. The impact of a targeted sports training is particularly important in the initial training period (Pietraszewska 2002 Cabrić 2005). The aim of this study was an attempt to determine the indicators of body build and its composition among young athletes, belonging to the Podkarpackie Province sports staff.

## **MATERIAL AND METHODS**

The material for this study includes results of research conducted among the athletes - members of Podkarpackie Province youth and junior sports staff. The research involved 417 persons aged 8-18 years, including 244 boys and 173 girls. It was conducted in May 2013 with significant help of members of the Students' Scientific Association of Anthropometrics

at the Faculty of Physical Education, University of Rzeszow. The research included an assessment of body composition, i.e. the measurement of body height and weight, the sitting height, the length of seat of the lower limbs. Following parameters were used for the purpose of this study: the BMI index, the Rohrer index, the Manouvrier index, fat free tissue mass (FFM), body fat mass in kg and % (FAT), the total body water (TBW) and the basal metabolic rate indicator (BMR). The values of these parameters were obtained by using the Body Composition Analyzer MC-980 by Tanita company. The complete collected material was processed using the basic methods of mathematical statistics. Both in the category of boys and girls, arithmetic averages and variability measures were calculated. In order to capture gender differences, the sexual dimorphism rate was calculated (Szopa 1985).

## RESULTS

The average values of BMI indicator of Podkarpacie Province best athletes are presented in Table 1. An analysis of these values shows that in the following years of calendar age, both in the category of boys and girls, it increases systematically and is at the level from 15,30 (f) and 15,13 (m) among the 8-year-old athletes to respectively 22,79 and 22,78 among the 17-year-old athletes. With the exception of 8- and 17-year-old boys, the boys are characterized by higher values of this ratio. The largest gender differences are noted among the 10- and 11-year-old young athletes.

**Table 1.** Characteristics of BMI index

Age	Female					Male					d	WD
	x	sd	v	min	max	x	sd	v	min	max		
8	15,30	1,51	9,89	13,5	17,0	15,13	1,57	10,39	13,0	16,5	-0,17	-0,11
9	16,90	1,81	10,70	15,0	18,6	17,48	2,38	13,63	15,6	22,1	0,58	0,28
10	16,14	1,95	12,07	13,1	19,3	19,05	3,21	16,83	15,1	24,6	2,91	1,13
11	17,44	2,71	15,54	14,6	24,3	18,82	2,40	12,77	15,5	23,2	1,38	0,54
12	18,39	2,17	11,82	15,5	23,9	19,20	3,42	17,81	15,3	28,5	0,81	0,29
13	18,89	2,69	14,22	14,1	25,3	19,20	2,53	13,19	15,3	26,5	0,31	0,12
14	20,69	2,80	13,55	15,5	32,2	20,95	2,51	11,97	16,2	25,3	0,26	0,10
15	20,37	3,61	17,71	16,6	32,7	21,61	3,20	14,80	17,2	36,8	1,24	0,36
16	21,20	2,47	11,45	18,2	27,7	21,97	2,24	10,20	19,0	30,7	0,77	0,33
17	22,79	5,62	24,67	19,2	35,4	22,78	2,65	11,62	18,9	28,5	-0,01	0,00
18	21,69	3,05	14,07	16,9	26,2	21,80	2,46	11,30	18,4	27,0	0,11	0,04

**Table 2.** Characteristics of Rohrer's index

Age	Female					Male					d	WD
	x	sd	v	min	max	x	sd	v	min	max		
8	1,20	0,11	9,32	1,06	1,38	1,09	0,06	5,19	1,03	1,16	-0,11	-1,29
9	1,24	0,06	4,64	1,19	1,30	1,30	0,17	13,34	1,15	1,63	0,06	0,52
10	1,15	0,13	11,44	0,94	1,49	1,56	0,18	11,60	1,07	1,97	0,41	2,65
11	1,17	0,13	11,39	1,02	1,49	1,25	0,15	12,25	1,05	1,54	0,08	0,57
12	1,15	0,11	9,55	0,98	1,41	1,24	0,19	15,23	1,00	1,74	0,09	0,60
13	1,19	0,24	19,92	0,93	1,51	1,16	0,15	12,51	0,90	1,59	-0,05	-0,26
14	1,21	0,27	22,76	0,97	1,50	1,20	0,16	12,95	0,98	1,56	-0,01	-0,05
15	1,23	0,13	10,70	1,04	1,49	1,24	0,18	14,28	1,00	2,02	0,01	0,06
16	1,33	0,15	11,63	1,16	1,71	1,25	0,13	10,67	1,05	1,69	-0,08	-0,57
17	1,41	0,25	17,70	1,18	2,19	1,28	0,15	12,00	1,01	1,50	-0,13	-0,65
18	1,29	0,19	14,41	1,03	1,55	1,23	0,09	7,73	1,13	1,43	-0,06	-0,43

The Rohrer index indicates the type of body build (Tab. 2). The average values of this parameter are at the level of 1,20 (f) and 1,09 (m) at the age of 8 years to 1,41 for the 17-year-old girls and 1,56 for the 10-year-old boys. Generally, up to the age of 12 years, the boys are characterized by higher values of this parameter. From the age of 13 years, predominance of

young female athletes is observed. The greatest sexual dimorphism occurs at the age of 10 years and is in favor of boys. With the exception of 17-year-old girls, in other age categories, young female athletes can be categorized as persons characterized by a slender physique. Among the young male athletes, 10-year-old boys belong to stout individuals; in most other age groups their representatives feature the medium body build type.

The Manouvrier indicator informs about body proportions. Among girls, the value of this parameter ranges from 88,69 (at the age of 8 years) to 100,50 (at the age of 16 years). Among boys, in turn, the highest values of this parameter are characterized by 15-, 16- and 17-year old male athletes. Generally, it can be said that both girls and boys belong to individuals with medium length and long legs (Tab. 3).

**Table 3.** Characteristics of Manouvrier's index

Age	Female					Male					d	WD
	x	sd	v	min	max	x	sd	v	min	max		
8	88,69	6,76	7,62	80,43	98,47	96,63	5,41	5,60	92,42	104,32	7,94	1,31
9	93,71	4,44	4,74	88,72	97,24	93,48	6,49	6,95	88,19	105,38	-0,23	-0,04
10	95,65	6,17	6,45	87,23	111,85	92,70	8,12	8,76	86,30	104,06	-2,95	-0,41
11	94,82	6,26	6,60	82,76	107,19	92,12	8,86	9,62	88,16	103,65	-2,70	-0,36
12	96,15	6,17	6,42	85,90	108,86	95,46	8,32	8,72	79,31	103,99	-0,69	-0,10
13	97,27	5,97	6,13	86,02	107,05	96,79	6,43	6,65	85,71	102,67	-0,48	-0,08
14	90,36	6,26	6,93	86,03	109,30	94,67	7,58	8,01	80,56	104,12	4,31	0,62
15	93,59	5,41	5,78	85,88	103,61	99,26	9,91	9,98	88,51	103,08	5,67	0,74
16	100,50	5,78	5,75	87,65	103,76	98,55	7,23	7,34	84,78	104,79	-1,95	-0,30
17	92,69	7,44	8,03	80,34	99,40	98,24	5,28	5,38	89,41	100,59	5,55	0,87
18	91,90	4,86	5,29	83,70	97,69	97,94	7,84	8,01	86,81	102,43	6,04	0,94

The fat free tissue mass (FFM) increases both among boys and girls in the subsequent years of calendar age and reaches the highest values at the age of 18 (f) and 17 (m) years. The greatest intragroup diversity is observed among the 11-year-old girls and 12-year-old boys. With the exception of the 9-year-old boys, in other age categories the value of this parameter is dominant among young male athletes. Sexual dimorphism increases with age, reaching the highest values in the final five age categories (Tab. 4).

**Table 4.** Characteristics of FFM index

Age	Female					Male					d	WD
	x	sd	v	min	max	x	sd	v	min	max		
8	23,38	2,08	8,88	21,5	25,8	25,80	4,61	17,88	19,1	28,9	2,42	0,72
9	26,43	3,68	13,93	22,5	29,8	26,35	2,05	7,78	23,3	29,0	-0,08	-0,03
10	27,95	4,13	14,76	21,6	36,4	32,50	5,49	16,91	25,3	41,3	4,55	0,95
11	33,11	5,52	16,66	23,7	45,1	36,39	5,06	13,91	25,8	45,3	3,28	0,62
12	38,09	3,12	8,19	30,5	44,3	39,80	7,83	19,69	28,6	57,9	1,71	0,31
13	40,11	5,94	14,82	27,1	53,0	46,52	8,30	17,85	31,2	63,4	6,41	0,90
14	41,50	3,43	8,26	35,1	47,9	54,99	7,33	13,32	33,1	65,8	13,49	2,51
15	41,51	3,72	8,95	36,5	50,5	57,79	7,74	13,39	41,0	76,2	16,28	2,84
16	43,78	3,40	7,76	39,0	50,8	59,70	6,77	11,35	51,5	84,4	15,92	3,13
17	45,56	4,94	10,83	42,0	55,5	63,92	7,06	11,04	53,2	83,2	18,36	3,06
18	46,08	3,65	7,93	39,7	51,1	61,40	10,36	16,87	44,4	78,1	15,32	2,19

The characteristics of fat mass (FAT) in young athletes (in % - I; in kg - II) are shown in Tab. 5. From the analysis of these values it follows that both in the group of boys and girls the amount of fat increases with age, reaching in the oldest girls group the level of 14,77 kg, which represents 23,47% of the total body weight. Among boys, the ratio of fat in the total body weight significantly decreases with age and is almost twice lower than among girls. While sexual dimorphism is relatively low up to the age of 11 years, and in this respect it

features boys, from the age of 12 years on, a much higher adiposity rate can be observed among the young female athletes.

**Table 5.** Characteristics of FAT index

Age		Female					Male					d	WD
		x	s	v	min	max	x	sd	v	min	max		
8	I	11,28	5,02	44,50	6,0	16,0	11,35	2,12	18,66	9,2	13,5	0,07	0,02
	II	3,00	1,46	48,69	1,4	4,6	3,40	1,23	36,10	1,9	4,5	0,40	0,30
9	I	15,90	9,96	62,64	4,4	21,0	16,02	6,13	38,28	9,8	26,0	0,12	0,01
	II	6,43	3,68	13,93	22,5	29,0	5,28	2,90	54,85	2,9	10,0	-21,15	-6,43
10	I	11,38	5,96	52,39	2,0	22,1	16,93	6,50	38,39	7,7	25,0	5,55	0,89
	II	3,86	2,45	63,43	0,5	8,1	7,07	3,71	52,48	2,3	13,0	3,21	1,04
11	I	13,94	8,62	61,82	1,3	30,0	14,64	5,10	34,82	5,5	23,0	0,70	0,10
	II	6,27	5,32	84,79	0,4	19,5	6,56	3,14	47,84	1,9	13,0	0,29	0,07
12	I	19,94	7,66	38,41	6,3	34,3	13,12	6,46	49,23	6,6	34,0	-6,82	-0,97
	II	10,65	6,64	62,37	2,1	32,1	6,64	5,30	79,85	2,4	23,0	-4,01	-0,67
13	I	18,91	8,69	45,97	2,8	32,0	11,13	5,43	48,79	2,5	26,0	-7,78	-1,10
	II	10,41	6,29	60,45	0,9	22,6	6,10	3,82	62,71	1,2	17,0	-4,31	-0,85
14	I	23,90	6,04	25,27	11,4	34,4	11,63	4,30	36,97	4,3	25,0	-12,27	-2,37
	II	13,46	4,71	35,00	4,5	25,2	7,54	3,68	48,81	1,9	18,3	-5,92	-1,41
15	I	19,63	5,06	25,78	6,8	30,2	12,26	5,57	45,41	3,3	36,8	-7,37	-1,39
	II	10,44	3,75	35,91	2,8	18,1	8,67	6,71	77,39	1,5	44,3	-1,77	-0,34
16	I	22,55	7,53	33,39	2,5	34,8	11,47	3,05	26,63	5,9	17,5	-11,08	-2,09
	II	13,37	5,92	44,29	1,1	25,0	7,90	2,85	36,15	3,4	17,3	-5,47	-1,25
17	I	21,89	7,82	35,73	17,1	38,7	11,70	3,59	30,68	5,5	19,1	-10,19	-1,79
	II	13,93	9,46	67,90	8,7	35,0	8,79	4,01	45,57	3,6	19,6	-5,14	-0,76
18	I	23,47	6,23	26,55	12,6	33,3	10,39	4,18	40,24	6,5	19,0	-13,08	-2,51
	II	14,77	5,84	39,55	5,7	25,5	7,53	4,74	63,01	3,4	3,4	-7,24	-1,37

In the subsequent years of calendar age the total body water amount (TBW) increases in both research groups reaching the utmost values of 33,75 in the group of 18-year-old girls, and 46,79 among the 17-year-old boys. The sexual dimorphism value is in favor of the boys, and up to the age of 13 years it is at a level below 1,0 sd. From the age of 14 years on, the sexual dimorphism rate fluctuates within the range of 2,18 and 3,13 sd (Tab. 6).

**Table 6.** Characteristics of TBW index

Age	Female					Male					d	WD
	x	sd	v	min	max	x	sd	v	min	max		
8	17,13	1,53	8,95	15,7	18,9	18,90	3,38	17,89	14,0	21,2	1,77	0,72
9	19,37	2,68	13,82	16,5	21,8	19,30	1,49	7,74	17,1	21,2	-0,07	-0,03
10	20,45	3,01	14,72	15,8	26,6	23,77	4,02	16,92	18,5	30,2	3,32	0,94
11	24,24	4,02	16,60	17,4	33,0	26,64	3,71	13,95	18,9	33,2	2,40	0,62
12	27,89	2,29	8,20	22,3	32,4	29,14	5,74	19,69	20,9	42,4	1,25	0,31
13	29,36	4,36	14,86	19,8	38,8	34,06	6,08	17,85	22,8	46,4	4,70	0,90
14	30,38	2,50	8,23	25,7	35,1	40,25	5,37	13,34	24,2	48,2	9,87	2,49
15	30,40	2,72	8,96	26,7	37,0	42,31	5,67	13,40	30,0	55,8	11,91	2,84
16	32,05	2,49	7,76	28,6	37,2	43,70	4,96	11,34	37,7	61,8	11,65	3,13
17	33,34	3,61	10,83	30,7	40,6	46,79	5,18	11,07	38,9	60,9	13,45	3,06
18	33,75	2,66	7,88	29,1	37,4	44,95	7,60	16,90	32,5	57,2	11,20	2,18

The numerical characteristics of basal metabolic rate (BMR) is presented in Tab. 7. Among both male and female athletes, the size of basal metabolic rate increases with the age, whereby the girls are characterized by significantly lower values of this indicator. The greatest sexual dimorphism is observed among 16- and 17-year-old boys. The group of young men features also a greater intragroup diversity.

**Table 7.** Characteristics of BMR index

Age	Female					Male					d	WD
	x	sd	v	min	max	x	sd	v	min	max		
8	1028,50	49,17	4,78	976,00	1081,00	1167,50	123,08	10,54	992,00	1255,00	139,00	1,61
9	1115,33	123,27	11,05	973,00	1188,00	1216,50	86,22	7,09	1121,00	1366,00	101,17	0,97
10	1118,58	79,70	7,13	1007,00	1265,00	1357,73	145,35	10,71	1159,00	1554,00	239,15	2,13
11	1224,81	128,67	10,50	1027,00	1502,00	1422,21	130,45	9,17	1169,00	1643,00	197,00	1,52
12	1355,00	92,01	6,79	1149,00	1548,00	1484,13	203,55	13,72	1220,00	2023,00	129,13	0,87
13	1380,72	141,24	10,23	1125,00	1687,00	1597,02	178,04	11,15	1274,00	1960,00	216,30	1,35
14	1425,38	82,57	5,79	1278,00	1629,00	1771,40	169,94	9,59	1339,00	2054,00	346,02	2,74
15	1388,33	73,81	5,32	1271,00	1547,00	1838,95	214,57	11,67	1452,00	2728,00	450,62	3,12
16	1434,60	89,47	6,24	1298,00	1614,00	1857,62	149,66	8,06	1668,00	2423,00	423,02	3,54
17	1446,71	121,24	8,38	1349,00	1705,00	1897,00	139,72	7,37	1723,00	2313,00	450,29	3,45
18	1464,40	91,73	6,26	1310,00	1623,00	1779,50	236,84	13,31	1409,00	2220,00	315,10	1,92

## DISCUSSION

High sports achievements depend on many variables (Pietraszewska 2002, Krakowiak et al. 2008, Pilewska et al. 2013). According to Milicerowa, to capture the body traits which significantly affect the sports result, the top athletes of the given sports event should be examined (Milicerowa 1973). As the selection factors qualifying the athlete to a particular sport specialization, adequate somatic properties should be regarded. They are genetically (body height, its proportions, to a lesser extent the body mass) and environmentally (especially the fat mass as a result of the absence of physical activity) determined. In studies by Napierała et al., it was stated that people doing the martial arts present mostly leptosomatic physique while in men the silhouette changes with age from leptosomatic to athletic type (Napierała M., et al., 2013). On the other hand, the research conducted on a group of sprinters at different sports levels (national team members and athletes from sports clubs in Bydgoszcz) showed that in both cases the sprinters presented similar morphological characteristics, i.e. with the small percentage of fat tissue they featured a high percentage of lean body mass (LBM) and the mesomorphic body type was predominant among them (Krakowiak et al. 2008). The results of research conducted by Pilewska et al. indicate an increased participation of lean body mass in boys engaged in sports gymnastics at the stage of basic and targeted training (Pilewska et al. 2013). In the literature you can find studies showing that within the same training group, the type of body build is highly diversified; from athletic through leptosomatic to pyknic one (Cieślicka, Żukow 2013). It was also found out, that several weeks of physical activity of moderate intensity affects the loss of weight and reduction of fat tissue (Janiszewska et al. 2013, Ambroży et al. 2007). Among the most female students from the faculty of physical education, the body mass gain greater than that among the general population is caused by a dominant share of lean body mass in body composition (Smolarczyk et al. 2013). The body composition of young people at puberty indicates the dominance of lean body mass in boys and an increased fatness in girls (Burdukiewicz et al. 2012).

The analysis of individual body composition parameters of the examined Podkarpackie Province best young athletes shows substantial correctness which is an effect of regular training on a young body. During the whole period of ontogenesis there is a significant BMI increase. According to many researchers, the value of this indicator provides information about obesity or emaciation (Burdukiewicz et al. 2012 Cabrić et al.2005). In the case of athletes, it is unreliable, because in many cases, the excessive body weight is due to the significant growth of muscle tissue. The analysis conducted in the group of girls shows that initially there is a slight fat tissue increase. However, in subsequent years, a significant increase in lean tissue mass is noted, which undoubtedly results from the applied training loads.

Among young athletes, this phenomenon takes a slightly different course. In this case, gradual decrease (expressed in %) of body fat rate in the total body mass along with a considerable increase of fat free tissue is observed. Considering the sex diversity, it is noted that in almost all age categories, the fat mass is higher in girls, while lean body mass elements achieve higher values in boys.

Body proportions are particularly important in the context of the given sports event. In this study, the Manouvrier indicator was used. The obtained results show that young persons who are engaged in sports training feature considerable advantages of leg length in relation to the total body height. In comparison to the Rohrer indicator values, the examined individuals may be included (except for certain categories of age among girls) in the group with a slim physique (mesomorphic type).

The effect of increased physical activity (intense training) is an increase in metabolism. In the present study, we focused on the basal metabolic rate (BMR). Both among boys and girls, the BMR values increase systematically in the subsequent age categories which certainly is closely related to the intensive training work. The content of water in the body also increases which can be explained by increase in fat free tissue mass.

## CONCLUSIONS

1. Physical activity, i.e. regular sports training affects to a large extent the level of body build indicators, as well as some selected body composition elements.
2. The body build and its proportions, as well as the body composition should become a basic element used in the selection of young athletes to practice the given sports event.
3. Sexual differentiation is manifested by a greater rate of lean body mass in boys as opposed to girls, among whom a greater adiposity is observed.

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