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Relationship between body construction and physical fitness of children aged 10-12

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Authors' Contribution:
A - Study Design; **B** - Data collection; **C** - Statistical analysis; **D** - Data interpretation; **E** - Manuscript Preparation; **F** - Literature search; **G** -Funds Collection

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Abstract:

Introduction and work purpose: Physical activity is an important factor determining the quality of life. The human body structure is diverse. Obese children are ashamed of their figure and are more introverted. The aim of the study was to assess the relationship between body structure and physical fitness in children aged 10-12 years.
Material and method: 33 people participated in the study, including 16 boys and 17 girls. The International Physical Fitness Test was used to assess physical fitness, such tests as standing long jump, hand strength measurement, relative strength measurement, pendulum run, sit down backwards and forward bends of the torso while standing. However, in order to determine the body structure, anthropometric measurements of body weight, body height and circumference of the waist, hips, relaxed and flexed and tense arms, forearms, thighs and calves were performed.
Results: Significant statistical differences between the somatic features and the sex of the participants were shown in all the results except the thigh circumference. On the other hand, between the physical fitness and gender of the children, statistical significance was demonstrated in the measurement of hand strength, measurement of relative strength, and forward tilt while standing.
Conclusions: The obtained results allow to conclude that body structure is related to the physical fitness of children aged 10-12 years. Overweight and obese children are less physically fit than their peers with normal body weight. Girls are characterized by a higher level of physical fitness than boys only in trials measuring relative strength and flexibility. Students with a normal BMI show a lower level of hand strength than their peers with above-standard body build.

Keywords: body structure, International Physical Fitness Test, anthropometric measurements

Wstęp

In everyday life, man is accompanied by movement and effort. Regardless of whether the person is physically active or prefers a sedentary lifestyle. Physical activity is an important factor in quality of life. It improves well-being, inhibits the development of many civilization diseases, and also ensures the proper development of the musculoskeletal system. [Zawadzka et al. 2015, p. 150]. There is no single definition that explains the term physical fitness. In 1968, WHO accepted this term as the possibility of effective performance of muscle work [Osiński 2003 p. 19]. Przewęda believes that a physically fit person is one who, regardless of the situation in which he or she may find himself, can cope in life [Maszczak 2017, p. 64]. The term is defined variously. Movement toughens children and improves the mental condition of young people. It makes self-esteem increase [Zawadzka et al. 2015, p. 150]. Most of the physical activities we undertake are work or everyday activities. From an early age, man shapes physical fitness and its high level in the future will lead to the improvement of everyday life. A fit and well-built person has greater self-confidence. The human body structure is diverse. Thinner adolescents are much more mobile. Obese children are ashamed of their figure and are more introverted. Today, access to technology has an impact on low physical fitness. You should instill in the youngest a habit of daily movement. Movement gives a person health benefits. Physical fitness reduces the risk of developing cardiovascular diseases, has a positive effect on the

improvement of body composition - reduces obesity, improves concentration, and contributes to the improvement of mental health. It is important that the parents and the child are physically active, because they are role models for them. Walking or cycling together can instill good habits in a child. We should educate the child to do sports from an early age. Therefore, it is important that parents and their children are physically active. Sport teaches the principles of fair play, discipline, success and failure, facilitates coping with emotions, cooperation in a group and significantly increases self-confidence.

The aim of the study was to assess the relationship between body composition and physical fitness in children aged 10-12 years, as well as to examine the difference in physical fitness of girls and boys.

Materiał i metoda

The study focused on children between the ages of 10 and 12. 33 people took part in the research, including 16 boys and 17 girls. The research took place at the Primary School No. Of the Holy Father John Paul II in Chmielnik, with the consent of the management and obtaining the written consent of the guardians of the studied students. Each person was informed about the tests that will be performed.

Table 1. Average age of girls and boys

	$\bar{x}$	sd
Girls	10,47	0,62
Boys	10,88	0,81
Girls and boys	10,67	0,74

In order to assess physical fitness, the International Physical Fitness Test was used, from which the following tests were performed:

- long jump from a place,
- hand strength measurement,
- relative strength measurement,
- pendulum run,
- sit down from lying backwards,
- bends the torso forward while standing.

The following anthropometric measurements were made in the Study:

- body weight,
- body height,
- waist circumference,
- hip circumference,
- relaxed arm circumference,
- circumference of the flexed and tense arm,
- forearm circumference,
- thigh circumference,
- calf circumference.

School scales were used to determine body weight and height. A tailor's tape measure was used to measure all circumferences. At the time of taking each of the measurements, the students were dressed in skimpy clothes. Based on the results obtained, the following indicators were calculated:

- BMI
- Rohrer indicator

- WHR
- Skerljia indicator
- WHtR

Wyniki

Table 2. Somatics – characteristics.

Variable	GIRLS					BOYS					d	P
	$\bar{x}$	sd	V	min	max	$\bar{x}$	sd	V	min	max		
body weight (kg)	36,18	8,58	23,73	23,90	53,40	52,91	20,73	39,18	28,10	93,80	16,73	0,01*
body height (cm)	143,92	7,50	5,21	132,00	156,30	151,99	9,35	6,15	140,00	166,70	8,07	0,01*
waist circumference (cm)	65,01	7,79	11,98	54,20	79,50	80,81	15,54	19,23	60,70	111,30	15,79	0,0001**
hip circumference (cm)	76,31	8,05	10,54	64,00	91,20	87,41	12,47	14,27	69,90	112,50	11,09	0,01*
thigh circumference (cm)	40,04	6,36	15,90	28,00	49,10	43,52	8,05	18,49	34,30	59,50	3,48	0,18
Calf circumference (cm)	30,42	3,11	10,22	25,10	36,20	34,92	5,45	15,60	27,10	44,30	4,50	0,01*
Arm circumference - relaxed (cm)	21,52	2,62	12,17	17,50	25,50	25,44	4,65	18,28	18,10	34,00	3,91	0,01*
Arm circumference - bent and tense (cm)	22,75	2,76	12,13	18,50	27,00	27,30	5,32	19,49	19,60	37,40	4,55	0,01*
Forearm circumference (cm)	18,64	2,12	11,37	14,00	21,50	21,98	3,36	15,29	17,40	28,10	3,34	0,0001**
*Statistical significance at the level of α = 0.05; ** statistical significance at the level of α = 0.001												

Based on the results collected in Table 2, it can be concluded that boys are characterized by a higher mean of the results in all investigated anthropometric measurements than girls. They are characterized by higher weight and height, average body circumference of the waist, hips, thigh, calf, forearm and the relaxed and tense arm. When analyzing the coefficient of variation of the given parameters, it can be noticed that the differences in terms of sex are smaller, but boys are characterized by greater variability. All results (except for the thigh circumference) showed statistical significance.

Table 3. Fitness of the examined girls and boys

Variable	GIRLS					BOYS					d	P
	$\bar{x}$	s	V	min	max	$\bar{x}$	sd	V	min	max		
Long jump (cm)	137,86	21,61	15,68	100,00	178,00	142,01	25,23	17,77	101,00	185,20	4,14	0,62
Hand strength measurement (kg)	18,76	8,71	46,40	9,00	33,00	33,25	11,23	33,79	20,00	55,00	14,49	0,0001**
Relative strength measurement (s)	6,99	5,56	79,53	0,92	18,50	3,27	2,30	70,39	0,43	7,04	-3,73	0,02*
Pendulum run (s)	12,93	0,99	7,66	11,39	14,50	12,90	1,57	12,13	10,16	15,15	-0,03	0,95
Sit down from lying backwards (-)	13,06	3,17	24,29	5,00	18,00	13,25	5,21	39,31	5,00	26,00	0,19	0,90
Forward torso bends while standing (cm)	5,53	5,25	94,86	-9,00	15,00	-2,06	6,22	-301,73	-14,00	8,00	-7,59	0,0001**

*Statistical significance at the level α=0,05; ** statistical significance at the level α=0,001

Taking into account the results from Table 3, one can see differences between physical fitness depending on gender. Among the trials - standing long jump, hand strength, boys had better results, while girls obtained better results in the measurement of relative strength and flexibility. During the swing run and during the sitting positions from lying down, the values of both sexes differed slightly. Girls were characterized by greater differentiation in the measurement of hand strength, relative strength and the forward tilt of the torso, while boys were characterized by greater variability in the remaining samples. Statistical significance was demonstrated by the correlation between

the measurements of hand strength, relative strength, forward bends of the torso while standing, and the sex of the respondents.

Table 4. Correlation of physical fitness and somatic features in girls

Variable	Long jump from a place	Hand strength measurement	Relative strength measurement	Pendulum run	Sit down from lying backwards	Bends the torso forward while standing
Body weight (g)	-0,02	**0,58**	-0,25	**-0,53**	0,30	-0,02
Body weight (kg)	-0,02	**0,58**	-0,25	**-0,53**	0,30	-0,02
Body height	0,16	**0,78**	0,09	**-0,71**	**0,57**	0,26
BMI	-0,17	0,33	-0,41	-0,29	0,07	-0,22
Rohrer's indicator	-0,27	0,08	**-0,51**	-0,05	-0,14	-0,36
WHR	-0,20	-0,45	**-0,72**	0,13	**-0,56**	**-0,52**
Skerljia's indicator	-0,05	0,38	-0,26	-0,30	0,21	-0,09
WHtR	-0,35	-0,16	**-0,73**	0,04	-0,36	**-0,64**
Waist circumference	-0,21	0,21	**-0,57**	-0,29	-0,05	-0,41
Hip circumference	-0,12	0,46	-0,29	-0,40	0,24	-0,19
Thigh circumference	0,03	**0,56**	-0,18	**-0,48**	0,36	0,02
Calf circumference	-0,07	**0,61**	-0,20	-0,47	0,32	0,02
Circumference RR - relaxed	-0,11	**0,49**	-0,30	-0,45	0,20	-0,09
Circumference RR – bent and tense	-0,12	0,44	-0,26	-0,37	0,15	-0,04
Forearm circumference	-0,26	0,36	-0,39	-0,22	0,10	-0,27

Table 4 shows the correlation between physical fitness and somatic features in girls. Parameters showing a significant statistical dependence are described in more detail using the charts below.

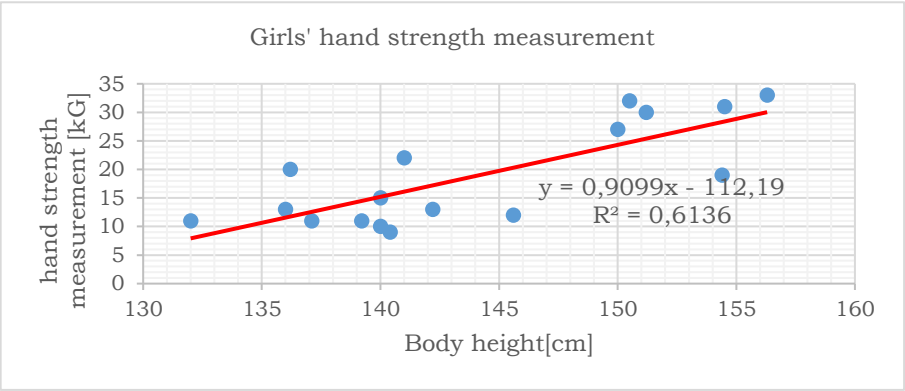

Figure 1.
Girls'measurement of hand strength in girls depending on the height of the body.

Figure 1 shows the dependence of body height on the measurement of hand strength in the female gender. The conducted research shows that the correlation takes a positive direction. When the values of the body height in girls increase, the value in the measurement of hand strength also increases.

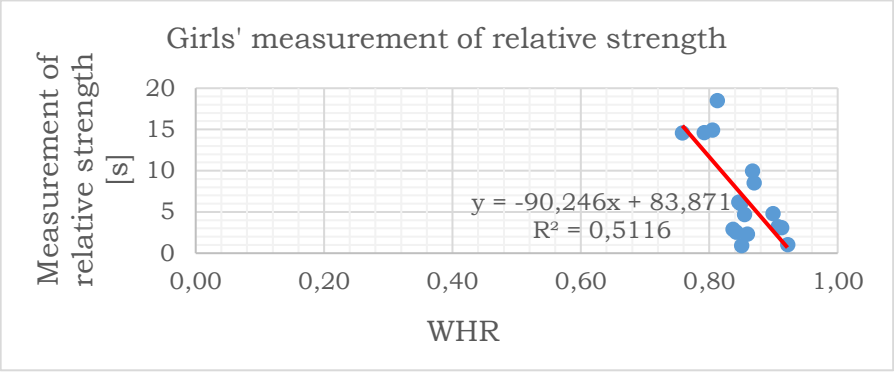

Figure 2.
Girls'measurement of relative strength depending on the WHR value.

When analyzing graph 2, it can be seen that the WHR value affects the results in the attempt to measure relative strength in girls. The test results show that the correlation takes a negative direction. When the WHR values increase, the results in the measurement of relative strength decrease.

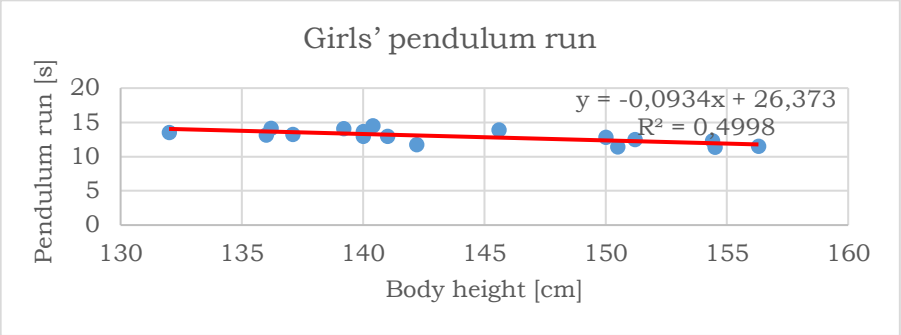

Figure 3.
Girls' pendulum run depending on the value of the height of the body.

Figure 3 shows the dependence of how body height influences the results obtained in the grils' pendulum run. Research shows that the correlation turned negative. As the height of the body increases, the values of the shuttle run decrease.

Table 5. *Correlation of physical fitness and somatic features among boys.*

Variable	Long jump from a place	Hand strength measurement	Relative strength measurement	Pendulum run	Sit down from lying backwards	Bends the torso forward while standing
Body weight (g)	**-0,73**	**0,83**	**-0,76**	**0,57**	-0,33	0,30
Body weight(kg)	**-0,73**	**0,83**	**-0,76**	**0,57**	-0,33	0,30
Body height	**-0,58**	**0,83**	**-0,63**	0,29	-0,07	0,00
BMI	**-0,73**	**0,78**	**-0,77**	**0,62**	-0,39	0,42
Rohrer's indicator	**-0,70**	**0,70**	**-0,75**	**0,65**	-0,43	**0,51**
WHR	**-0,62**	**0,65**	**-0,69**	**0,52**	**-0,60**	0,44
Skerljia's indicator	**-0,76**	**0,65**	**-0,78**	**0,68**	-0,42	0,40
WHtR	**-0,65**	**0,71**	**-0,75**	**0,58**	-0,44	0,50
Waist circumference	**-0,70**	**0,82**	**-0,78**	**0,55**	-0,37	0,37
Hip circumference	**-0,68**	**0,85**	**-0,78**	**0,52**	-0,27	0,34
Thigh circumference	**-0,76**	**0,75**	**-0,77**	**0,61**	-0,34	0,29
Calf circumference	**-0,65**	**0,85**	**-0,71**	**0,53**	-0,32	0,47
Circumference RR - relaxed	**-0,71**	**0,82**	**-0,71**	**0,59**	-0,38	0,45
Circumference RR – bent and tense	**-0,71**	**0,82**	**-0,69**	**0,61**	-0,36	0,46
Forearm circumference	**-0,57**	**0,88**	**-0,76**	0,39	-0,31	0,42

Table 5 contains numerical data on the correlation between physical fitness and somatic features among boys. Parameters showing a significant statistical dependence are described in more detail using the following charts:

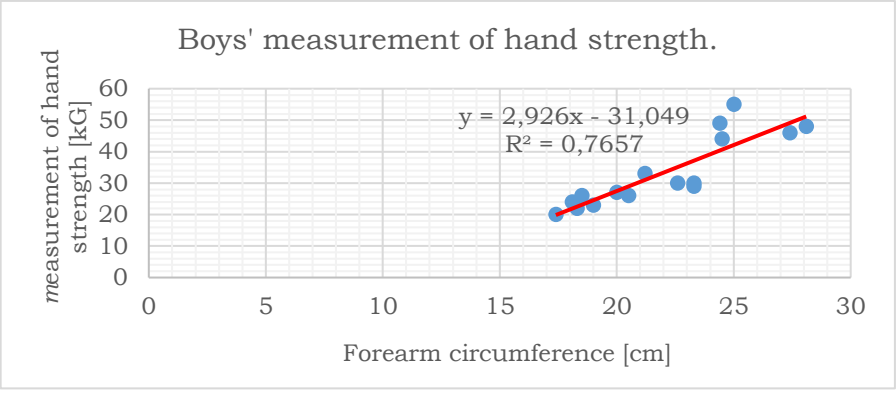

Figure 4.
Boys' measurement of hand strength depending on the value of the arm circumference.

Figure 4 shows how the value of arm circumference affects the boys' measurement of hand strength. Research shows that the correlation was positive. When the values of the arm circumference of students increase, the results of the relative strength measurement also increase.

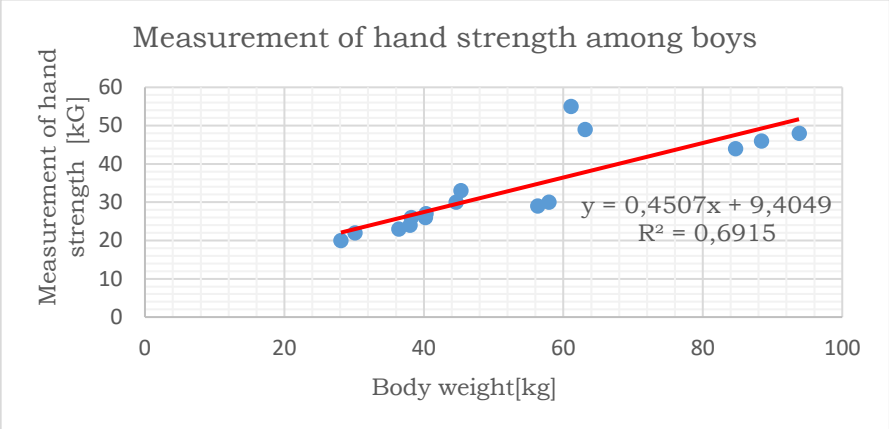

Figure 5.
Measurement of hand strength among boys depending on the value of body weight.

Figure 5 shows the relationship of body weight with the results of the students' hand strength measurement. Observations show that the correlation coefficient is positive. In the case when the boys' body weight increases, the values of the relative strength measurement also increase.

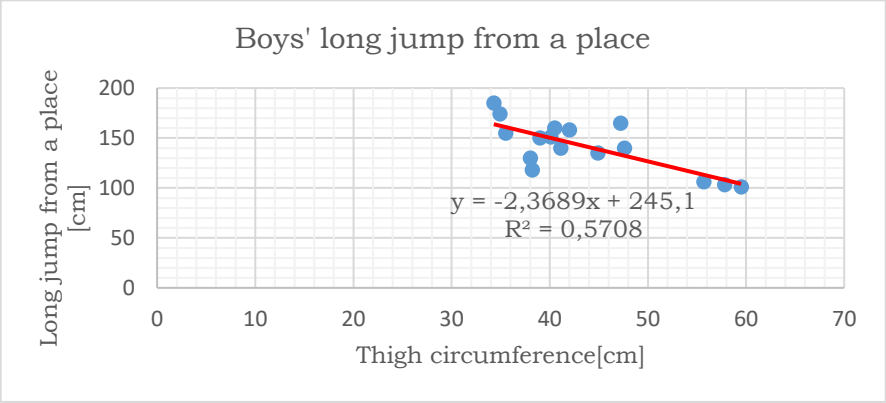

Figure 6.
Boys'long jump depending on the value of the thigh circumference.

By looking at diagram 6, you can see how the circumference of the thigh affects the distance jump among the male. Research shows that the correlation coefficient is negative. At the moment when the values of thigh circumference increase in boys, the distance of the long jump is shortened.

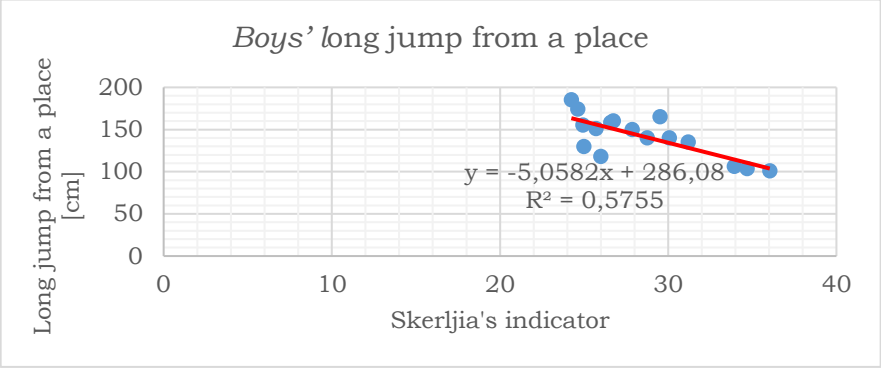

Figure 7.
Boys' long jump depending on the value of the Skerlja Index.

Figure 7 illustrates how the value of the Skerlja Index affects the distance in long jump from a place among students. The conducted research shows that the correlation is negative. As the values of the Skerlja Index increase among boys, the results of the long jump decrease.

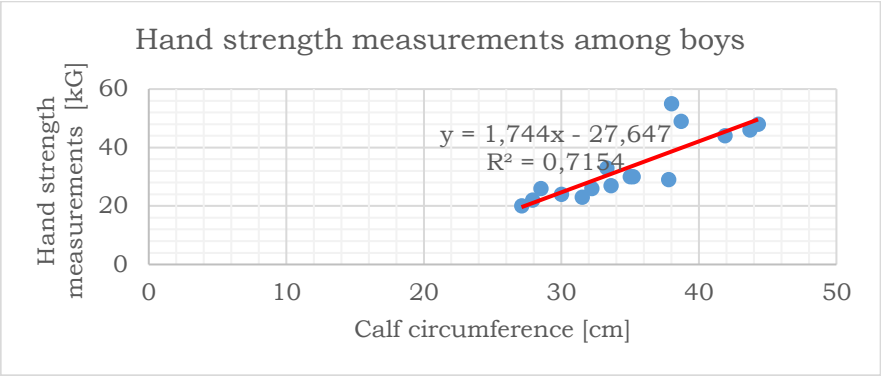

Figure 8.
Measurement of hand strength among boys depending on the value of the calf circumference.

Figure 8 shows the dependence of the calf circumference on the measurement of hand strength in boys. Observations show that the correlation coefficient is positive. When the male calf circumference increases, the hand strength measurements also increase.

Discussion

When comparing the results in the above work with the research of other authors about the relationship between the body structure and physical fitness of children aged 10-12 years, some differences can be noticed.

The first research question was whether overweight and obese children are characterized by lower physical fitness than their peers with normal body weight? Analyzing the work of Barańska and Gajewska, we can see that their research showed the same conclusions as in the above work. In both cases, the correlation between body weight and hand strength takes a positive direction, so when body weight increases, the value of the second feature also increases. Additionally, the same relations are observed in the case of the correlation of body mass and flexibility, here they take the negative direction, i.e., the greater the body weight, the weaker the results of the person during the forward lean. [Barańska 2009, p. 184]. Moreover, the above work also shows that a significant correlation is visible in comparison with the agility test. Here, the correlation takes a negative direction, which means that when the body weight increases, the time of the pendulum run also increases.

The above research question is correct, and it is caused by the following factors. First, students who have more body fat do not interact with peers who actively spend their free time. The second reason is the feeling of shame at the sight of their appearance, which is why they choose to watch TV instead of participating in additional physical activity classes, so their condition does not improve, or even worsen. The last reason is showing reluctance to take physical education lessons, in which certain shortcomings or poor results may come to light, which may be associated with ridicule on the part of peers [Bąkowicz 2013, p.282].

Considering the second research question, whether girls score lower in physical fitness tests than their peers, we deal with different results. In his work, Matczak analyzed several trials and compared the results of girls and boys. In the long jump test, the girls achieved lower results compared to their peers - the same conclusions can be drawn from their own research. The same situation occurs in the hand strength test - the male showed more hand strength. In the case of an attempt to hang on the bar, we observe the first non-compliance. In Matczak's case, the students maintained the sag for an average of 5.15 s,

while the boys held 8.54 s, which means that they showed greater strength of the observed feature. On the other hand, the authors' own research shows that girls showed better efficiency in the above sample, reaching the average sag time of 6.99 s, where in the case of the male this result was at the level of 3.27 s. In Matczak's, the students showed greater agility than their colleagues, while the own research shows that the boys were more agile in the above test by 0.03 seconds. In Matczak's, the girls again showed a higher level, reaching an average level of 21.96 sit-ups, while colleagues 21.81. From our own research, the situation is the opposite. The boys had greater abdominal muscle strength, as evidenced by the recorded result of 13.25 sit-ups, and their friends - 13.06. In the last attempt - bending the torso forward while standing - in both cases the girls showed greater flexibility [Matczak 2020, pp. 48-50].

The statement that girls score lower on physical fitness tests than their peers is partly correct. The female gender shows higher results only in the flexibility test and in the measurement of relative strength, while in the long jump, hand strength measurement, pendulum run and measurement of abdominal muscle strength, the opposite sex performs better. This is due to a different body composition. Boys have more muscle mass. In addition, the age of 10-12 among students is the time of the pubertal jump, when fatty tissue is deposited and the center of gravity changes. [Wolański 1986]. On the other hand, the male sex shows excessive interest in physical activity, which results from their physiological needs, willingness to impress their peers and competition [Jaczewski 2003, p.106].

Analyzing the last research question, whether children with overweight and obesity have greater hand strength than people with normal body weight, we can see some similarities resulting from our own research and those of Barańska and Gajewska. The authors showed a relationship between body weight and a hand muscle strength. The correlation takes a positive direction, which means that when one value (body weight) grows, the other trait (hand strength) also grows. The same results are presented in the above work [Barańska 2009, p. 184].

The claim that overweight and obese children have greater hand strength than their peers with normal body weight is correct. This is due to the greater amount of kinetic energy related to the body weight [Bąkowicz 2013, s.283].

Conclusion

1. The first conclusion that arises after studying the above work is the fact that the body structure of children aged 10-12 shows statistical significance with the level of physical fitness in the studied group.
2. On the basis of the International Physical Fitness Test, we can see many differences between the children's results.
3. The next conclusion is that people who are overweight and obese, who show lower physical fitness than their counterparts with normal body weight, except for the hand strength test, where they scored higher. This fact is due to the greater kinetic energy associated with body weight.
4. When comparing the results on the basis of gender - in a significant number of trials - boys showed higher results. Tests in which the male gender was better were: long jump from a place, hand strength measurement, pendulum run, and measurement of sit down from lying backwards. Only in the flexibility test and relative strength measurement, the girls achieved more satisfactory values.
5. All results of measurements of somatic features with sex showed statistical significance (except for the circumference of the thigh).
6. The statistical significance with the sex of the examined persons was demonstrated by the measurement of hand strength, the measurement of relative strength and the bending of the torso while standing.

7. The studied correlation of physical fitness and somatic features among the female took a positive direction between hand strength and body height. The described feature included the negative direction between the measurement of relative strength and the WHR value, also between the measurement of relative strength and WHR, and the agility test and body height.
8. The analyzed correlation of physical fitness and somatic features in the male sex showed a positive direction between the size of the forearm circumference and hand strength as well as the value of body weight and the measurement of hand strength. On the other hand, a significant relationship, which has taken the negative direction, is found between the value of the thigh circumference and the distance of a long jump from a place and the Skerljia Index and again the long jump from the place.

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