INTERDEPENDENCE BETWEEN THE BODY MASS INDEX AND THE STATIC FORCE LEVEL AND FUNCTIONAL STRENGTH OF SCHOOL-AGE YOUTHS WHO TRAIN AND NON-TRAINING SPORTS SWIMMING

Bartłomiej **CZARNOTA**[ABCD]

Faculty of Physical Education, University of Rzeszow

Keywords:
- obesity
- body mass indeks BMI
- static force
- funcional strenght

Abstract:
Background: The aim of the work is to determine the direction of changes and the degree of interdependence between the considered strength aspect and the BMI index in relation to the studied group. **Material and methods**: The analysis was conducted on 619 people: Anthropometric measurements: the body height measured with Martin's anthropometer and body weight were determined using electronic scales. Based on the results obtained from anthropometric measurements, the body mass index (BMI) . In order to determine selected aspects of physical strength (functional strength and static force). In order to investigate the relationship between the various components, correlation analysis was used. **Results**: Analysis of the correlation between static force and BMI was at the level of r = 0.46 in the group of training swimmers and r = 0.45 for the control group.There was a high statistical significance for the relationship between functional strength and BMI. The correlation coefficient assumed negative values. **Conclusions**: Despite the small strength of correlation, the specificity of the manifested muscular strength determined the direction of correlation in relation to the body mass index. The performed analysis indicated that the specificity of muscle strength is related to the reference to the BMI index.

INTRODUCTION

Recent years bring a number of reports on the risks of obesity. This problem is perceived as an epidemic of the 21st century and concerns both adults and children. What is particularly worrying is the occurrence of overweight in children (Cattaneo et al 2010) and the growing scale of this alarming phenomenon (Cieślik 2006, Nowaczyk et al 2016). An important factor in creating pro-health attitudes in adult life is childhood and school period, seen as a window through which you can influence your whole life (Farpour-Lambert 2015). The development of overweight is promoted by genetic and environmental factors, as well as a positive energy balance that lasts for a long time. The environmental factors responsible for the creation of overweight include drugs, viruses, food and lack of physical activity (Białkowska 2006). Lack of physical activity affects the formation of overweight, which visibly affects the qualitative changes in physical fitness. The relationship between body weight and physical fitness is the real effect of obesity on motor skills.

BMI is recommended as an indicator to assess the incidence of overweight and obesity due to the high correlation with the characteristics measuring the fat component and low dependence on body height (Supranowicz 2003). The presented body mass index was related to the static and functional strength, presenting a different specificity of strength. The static force tested by the Eurofit test is the manifestation of absolute muscular strength and the functional strength - the relative muscular strength (Sozański et al 2015). The onogenesis of the studied period covered the years 10-15 associated with the first manifestations of pubescence affecting the somatic structure of the subjects related to the studied aspects of strength. The factor differentiating the studied groups of adolescents was the aspect of swimming training, which could affect qualitative changes in the somatics and motor skills of the respondents.

The aim of the study

The assumption is that there is a relationship between the values of the BMI index, the presented level of functional strength and static force and membership in the group

The aim of the work is to determine the direction of changes and the degree of interdependence between the considered strength aspect and the BMI index in relation to the studied group.

MATERIAL AND METHODS OF RESEARCH

The analysis was conducted on 619 people: 227 people (36.8%) training swimming and 392 people (63,2%) in the control group. The research was carried out on children training swimming from cities: Tarnów (Unia Tarnów), Dębica (Bobry Dębica), Mielec (Ikar Mielec), 227 people (36,8%). The comparison group consisted of randomly selected children from Rzeszów Primary School No. 25 and Junior High School No. 11 in Rzeszów, 392 people (63.2%)(Czarnota 2010). The calendar age classes have been created so that the integer is the middle of the class (Cieślik 2006).

Tab. 1. Presentation of numbers including group, sex, age

	SWIMMERS		CONTROL GROUP	
Age	**BOYS**	**GIRLS**		**BOYS**
10	25	15	10	25
11	34	22	11	34
12	24	19	12	24
13	31	12	13	31
14	13	13	14	13
15	9	10	15	9
SUM	136	91	**SUM**	136

Anthropometric measurements were made in accordance with the principles and recommendations of anthropometry in the „Basis of Anthropometry” (Bożiłow, Malinowski 1997); the body height measured with Martin's anthropometer and body weight were determined using electronic scales. Based on the results obtained from anthropometric measurements, the body mass index (BMI) was used to determine the somatic structure of the subjects, giving approximate information about the proportions of body structure and the occurrence of excess weight. In order to determine selected aspects of physical strength (functional strength and static force), dedicated tests of the European Fitness Test Eurofit were used. An attempt was made to clamp the hand on the hand dynamometer and the overhang on the rod with bent arms.

In order to investigate the relationship between the various components of motor fitness Eurofit and the BMI index, correlation analysis was used. The results were supplemented with values of the significance test of the correlation coefficient (*p*), which allowed us to assess whether the dependency found in the sample reflects a more general relationship prevailing in the entire population, or just a matter of chance. To determine the strength and direction of the correlation impact, linear correlation coefficients were used, taking values from the range of -1 to 1 and thus indicating the direction of action. Correlation power is confirmed by the absolute value of the coefficient and the sign about its direction.

TESTS RESULTS

Tab. 2. BMI: descriptive statistics taking into account the group and sex as well as the age of the respondents

Sex	age	Swimmers					Control group				
		$\bar{x}$	*N*	*s*	Min	Max	$\bar{x}$	*N*	*s*	Min	Max
boys	till 10 yrs.	17,3	25	2,0	14,0	22,3	16,9	24	3,0	13,5	23,9
	11	16,7	34	1,7	13,2	20,8	17,2	33	2,7	13,6	23,7
	12	18,0	24	2,1	15,3	22,8	17,6	29	4,0	13,2	34,3
	13	18,5	31	2,0	13,3	23,0	18,9	22	3,0	15,0	27,8
	14	18,3	13	2,3	15,5	22,1	18,9	31	2,6	15,6	26,1
	upper 15 yrs	20,3	9	1,8	17,1	22,9	20,3	29	3,0	16,9	29,9
girls	till 10	16,3	15	2,2	13,0	20,7	16,3	27	2,2	12,6	21,8
	11	16,9	22	2,9	11,7	24,5	17,5	23	3,0	13,6	24,2
	12	17,0	19	1,9	14,3	20,8	17,7	39	2,5	12,4	25,2
	13	18,3	12	2,8	13,6	24,0	19,2	41	3,2	13,5	27,4
	14	18,7	13	1,8	15,8	22,6	19,1	36	3,0	14,4	31,0
	upper 15 yrs	19,2	10	1,8	15,7	21,6	19,7	58	3,2	14,9	30,8

The table above presents the average BMI values in the studied population taking into account age and group membership. The average BMI value of the study period in the group of swimmers is 18.1 at 18.3 in the non-training group. Among girls, the average values are between 17.7 for training swimmers and 18.25 in the group of non-training girls. The above comparison shows that there are no clear differences between groups in the average BMI for both groups.

Tab. 3. Static force: significance of the correlation coefficient *(p)* and its absolute value and direction of impact

Group	**Static force**
Total	**0,45**
	p=0,000
Swimmers	**0,46**
	p=0,000
Control group	**0,45**
	p=0,000

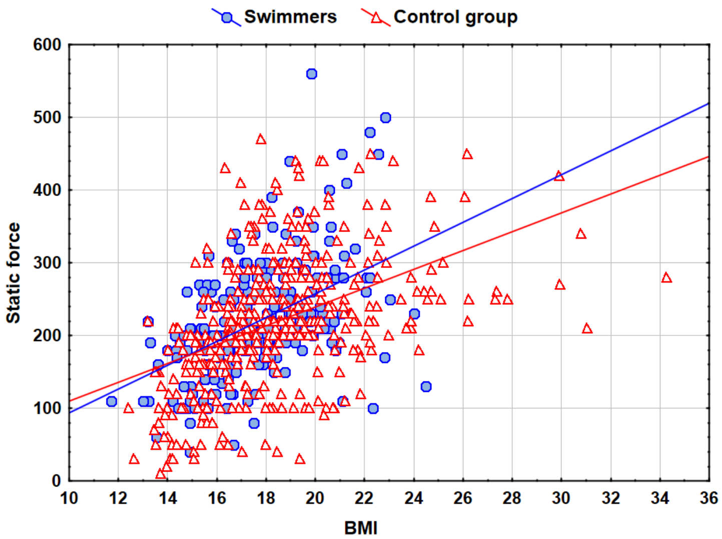

Fig. 1. Relationship between static force and BMI for the studied groups - scatter plot.

Analysis of the correlation between static force and BMI was at the level of r = 0.46 in the group of training swimmers and r = 0.45 for the control group, shaping at a level close to the correlation referred to as the average. The correlation coefficient for both groups was positive. Very high statistical significance was found for the analyzed dependence in the group of swimmers and control group at the level of p <0.001.

Tab. 4. Functional strength: significance of the correlation coefficient *(p)* and its absolute value and direction of impact

Group	Functional strength
Total	**-0,27**
	p=0,000
Swimmers	**-0,23**
	p=0,001
Control group	**-0,27**
	p=0,000

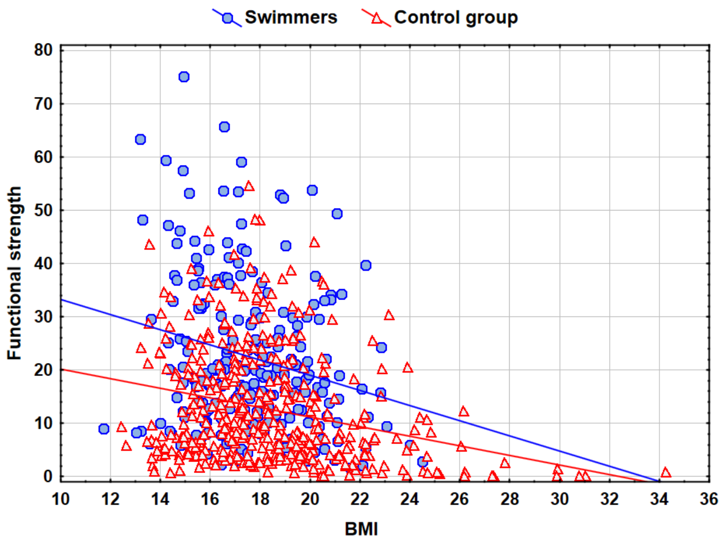

Fig. 2. Relationship between functional strength and BMI for the surveyed groups - scatter plot.

There was a high statistical significance for the relationship between functional strength and BMI. The correlation coefficient assumed negative values. The absolute values of the correlation coefficient were in the analyzed analysis slightly below the correlation referred to as weak and qualified as lack of correlation.

DISCUSSION

The analysis of the correlation between the BMI index and the analyzed capacities was to indicate the dependence and direction of changes for each of the studied groups and in relation to the whole studied population.

Correlations were examined in the entire population, as well as separately among swimmers and non-trainees. Both analyzed correlations were statistically significant, while their impact was negligible. The impact of BMI on static force is close to the average and achieves a level of poor correlation in both groups. The direction of influence in the dependences under consideration was opposite and so for positive static force it assumed positive values and for negative force it was negative values. Thus, it can be pointed out that the specifics of the strength tests made affected this. For the static force test indicating the potential of absolute muscle strength, weight gain showed no negative consequences, the correlation took positive values. Together with improved results, an increase in BMI in both groups was also noted. It pays attention to this state of affairs (Maciaszek 2000), indicating that increased body weight does not adversely affect static force. Similar observations can be found in (Barańska 2009) indicating a positive correlation of body mass and strength of hand grip at the level of r = 0.66. Positive BMI correlation values in the static force test do not mean unambiguously that obese people are stronger. The strong correlation of BMI with lean mass (FFM - fat free mas) returns weight (Monyeki et al 2005) indicating BMI correlations with lean body mass at the level of r = 0.7, with a significance level of $p < 0.001$. Thus, the recorded increase in BMI may account for increasing muscle mass, which could be reflected in the performer attempt. One should also remember about the age factor of the respondents. The studied period covered the years 10-15 which in the case of absolute muscle strength are a period of increase in natural strength capabilities (Sharkey et al. 2012). In order to rule out the age factor in the future one should use regression analysis, which optimizes the age factor.

For functional strength, which is a sign of relative muscle strength, a decrease in results with increasing BMI was noted. The quotient of absolute muscle strength to the weight of the exerciser plays a key role in the test. Despite the high significance for the sample made, the impact of BMI on functional strength can be classified as no dependence: in swimmers, non-training group and the entire examined population. In the non-training group, this relationship approached the level described as a weak correlation r = -0.27. The negative influence of the mass in the aspect of overhang on the stick presents (Zieniewicz et al. 1999) proving the deterioration of the results of the trial along with progressing overweight. (Osiński 2000) draws attention to the fact that with relative body mass and absolute strength the relative strength decreases, creating preferences for people with small body dimensions, while sensitizing to the reference to the specificity of the developmental age.

Authors (Rauch et al. 2012) note that obese children and adolescents to compensate for higher body mass to muscle performance have increased muscle power and strength. When referring to the analysis performed, it should be remembered that increasing muscle power and strength at the expense of body weight will bring measurable effects to a greater extent in relation to the specificity of the strength test, preferring the maximum strength.

The analysis carried out between the BMI index and the level of static and functional force indicated the strength and direction of changes for each of the studied groups and in relation to the whole studied population. The correlation of the BMI index and the analyzed aspects of muscular strength remained at the level of weak dependence and the limit of the lack of dependence. High statistical significance for the performed tests was noted. Despite the small strength of correlation, the specificity of the manifested muscular strength determined the direction of correlation in relation to the body mass index.

SUMMARY

The study addresses the issue of the relationship between BMI and selected manifestations of muscular strength. For the comparison, training and non-training groups for sport swimming were selected, static and functional strength tests were performed. The topic of the direction of changes and the degree of interdependence between the considered strength aspect and the BMI index with respect to the studied group was taken. Correlations were examined in the entire population, as well as separately among swimmers and non-trainees. Both analyzed relationships were statistically significant, while their impact was negligible, the direction of correlation in the tests was indicated.

CONCLUSIONS

1. There was no evidence of a changed correlation force between the performed sample and the BMI index depending on the group membership. In each of the analyzed samples in the training and non-training group, the impact force was similar.
2. The specifics of the sample defined the direction of changes between the BMI and the analyzed aspect of strength. For the dependence of BMI and static force, there was a positive direction and negative for dependence with functional strength. Belonging to the group did not affect the direction of correlation. Both analyzed correlations were statistically significant, while their strength was negligible.
3. The performed analysis indicated that the specificity of muscle strength is related to the reference to the BMI index.

LITERATURE

1. Barańska E., Gajewska E.: *Ocena sprawności motorycznej występującej u dzieci z nadwagą i otyłością*. Nowiny Lekarskie 2009, 78, 3–4, 182–185
2. Białkowska M.: *Przyczyny epidemii otyłości.* Dziewiąte Warsztaty Antropologiczne im. Profesora Janusza Charzewskiego. 2006 p.6 - 11
3. Bożiłow W., Malinowski A.: *Podstawy Antropometrii*. PWN, 1997.
4. Cattaneo A,. Monasta L, Stamatakis E., S. Lioret, K. Castetbon, F. Frenken, Y. Manios, G. Moschonis, S. Savva, A. Zaborskis, A. I. Rito, M. Nanu, J. Vignerová, M. Caroli, J. Ludvigsson, F. S. Koch, L. Serra-Majem, L. Szponar, F. Van Lenthe, J. Brug.: *Overweight and obesity in infants and pre-school children in the European Union: a review of existing data*. Obesity Reviews 2010, 11, (5), p. 389–398
5. Cieślik J., Mrowicka B.: *Struktura zmienności fenotypowej względnej masy ciała w ontogenezie progresywnej – wyodrębniona metodą Cole'a*. Dziewiąte Warsztaty Antropologiczne im. Profesora Janusza Charzewskiego. 2006 p.12 – 23
6. Czarnota B.: *Ocena stopnia i kierunku odchyleń reakcji fenotypowych organizmu dziecka na obciążenie pływackim treningiem sportowym.* Rzeszów 2010.
7. Farpour-Lambert N.J., Baker J.L., Hassapidou M., Holm J.C., Nowicka P., O'Malley G., Weiss R.: *Childhood Obesity Is a Chronic Disease Demanding Specific Health Care - a Position Statement from the Childhood Obesity Task Force (COTF) of the European Association for the Study of Obesity (EASO).* Obesity Facts, The European Journal of Obesity 2015, 8: p.342–349
8. Maciaszek J.: *Związki czynników sprawności fizycznej – związanych ze zdrowiem, badanych testem Eurofit – z wysokością, masą, oraz otłuszczeniem ciała u dzieci poznańskich w wieku 10-14 lat*. Rocz. Nauk. AWF Poznań, 2000, 49, 9, p. 91 - 105
9. Monyeki M A. , Koppes L L., Kemper H C., Monyeki K D., Toriola A L., Pienaar A E., Twisk J W.: *Body composition and physical fitness of undernourished South African rural primary school children*. European Journal of Clinical Nutrition (2005) 59, p.877–883
10. Nathalie J. Farpour-Lambert, Jennifer L. Baker, Maria Hassapidou, Jens Christian Holm, Paulina Nowicka, Grace O'Malley, Ram Weiss.: *Childhood Obesity Is a Chronic Disease Demanding Specific Health Care - a Position Statement from the Childhood Obesity Task Force (COTF) of the European Association for the Study of Obesity (EASO).* Obesity Facts, The Europena Journal of Obesity. 2015;8: p. 342–349.
11. Nowaczyk M., Waszak M., Cieślik K.: *The incidence of excess weight and obesity assessment amongst the population of the children from Leszno using various research method.* Scientific Review of Physical Culture, vol 6, issue 1. Rzeszów 2016.
12. Osiński W.: *Antropomotryka*. Poznań 2003.

13. Rauch R., Veilleux L-N., Rauch F., Bock D., Welisch E., Filler G., Robinson T., Burrill E, Norozi K.: *Muscle force and power in obese and overweight children.* Journal Musculoskelet Neuronal Interact 2012; 12(2): p. 80-83.
14. Sozański H., Sadowski J., Czerwiński J.: *Podstawy teorii i technologii treningu sportowego*. Warszawa-Biała Podlaska 2015.
15. Supranowicz P.: *Względna trafność samooceny sylwetki i wskaźnika BMI*. Roczn. PZH, 2003, 54, NR 3, 301–309.
16. Sharkey B J., Gaskil S.; *Fizjologia sportu dla trenerów*. Warszawa 2013.
17. Zieniewicz A., Skład M., Popławska H., Saczuk J.: *Poziom wybranych cech somatycznych oraz motoryka dziewcząt o zróżnicowanym stopniu otłuszczenia*. Rocznik Naukowy, IWFiS w Białej Podlaskiej, 1999. IV, p.89-112