

RELATIONS BETWEEN THE BODY MASS INDEX AND THE ANTHROPOMETRIC DIMENSIONS AND THE RESULTS ACHIEVED IN SHOT PUT

Gorana Tešanović¹, Iлона Mihajlović², Goran Bošnjak¹
and Predrag Dragosavljević¹

¹ Faculty of Physical Education and Sport, University of Banja Luka, Bosnia & Herzegovina

² Faculty of Physical Education and Sport, University of Novi Sad, Serbia

Original scientific paper

Abstract

The training process in shot put throwing is based on the development of general and specific preparations. Most of the time is spent on the development of motoric abilities of absolute strength, explosive strength, movement speed, and coordination. Research has shown that apart from the correct throwing technique and the angle that the ball is thrown from, the performance is also influenced by the morphology features of the thrower. It is obvious that top throwers differ in their bodily features. Some are more corpulent, some athletically built with emphasized musculature, some are extremely high, and some short. This research included a sample of 112 secondary school pupils, males, of 15 ± 6 months age difference with an aim to explore the relation between the body mass index and the anthropometric dimensions and the achieved shot put throwing result. The results obtained, showed that there is a statistically important influence by the body mass index on the results achieved in shot put, and that the anthropometric length of the arm, the arm range and body mass can influence the achievement of results in shot put, while the length of the legs plays no statistically important role in the achievement of results.

Key words: body mass index, anthropometric dimensions, shot put, relations

Introduction

Shot put is an athletic discipline dominated by sportspeople with prominent motoric abilities of explosive strength, absolute strength, movement speed, agility and coordination. Correct shot put technique plays a role in the results achievement as well as timely and accurate performance of the kinetic chain. Since the movement chain in the shot put technique begins in lower limbs, that is the feet, that is where the initial force impulse begins, which is then transferred through the legs and the trunk to the arm, which practically implements the force on the ball, it can be said that the kinetic chain in shot put is a system of leverages, where the decisive role in the accomplishment of results is achieved in conjunction between the lower and the upper limbs.

The ball is the heaviest athletic throwing object, and as such, it requires greater strength and consequently greater muscle mass. Evidently, the shot put throwers are the largest and the most massive athletic throwers. When examining results achieved in shot put, one needs to take into account the angle of the throw, where the science has suggested that the most optimal angle in relation to the base above which the ball needs to be thrown is between $36-40^\circ$ for men, and $37-42^\circ$ for women (Tončev, 1991). The anthropology facet which is decisive for achieving results in shot put, apart from motor abilities, also encompassed the morphology features of the sportsperson. To what extent can the height of the thrower, with correct technique and the throw angle, influence the achievement of results? Morphological features describe the bodily construction that is the somatotypical characteristics of the sportsperson.

While in some athletics disciplines the morphological features significantly influence the successfulness, in others their influence is rather small or negligible. In to-date research (Kurelić et al., 1975) the results indicate that the largest part of the variables of morphological features is influenced by: the longitudinal dimension of the skeleton, transversal dimension of the skeleton, the volume and the mass of the body, the subcutaneous fat tissue which is deemed a negative component in the achievement of sports accomplishments on account of it increasing the passive, that is, the ballast mass (acting as a redundant burden). In sports which require a large mass, however, this dimension is positive (throwing disciplines, for example). Even though the measuring of the morphology status that generates information of the longitudinal and transversal dimensions of the skeleton and the body volume plays an unquestionable role for the performance of results in javelin throwing, that relevance is not all that conspicuous as it is in disc throwing and the shot put. That is further corroborated by the fact that the parameter of the absolute range of the body as a height-weight index (Čudinov, 1960) is expressed in javelin throwers as lower values (472) unlike a shot put and disc throwers (567). In female javelin throwers, the index is 420, in comparison with 511 g/cm in female shot put and disc throwers. The misbalance between the intake and the consumption of energy, when the intake surpasses the consumption, results in the accumulation of fat tissue, which is defined as body mass index (BMI) – ratio between the body mass (BM) expressed in kilograms and the body height (BH) expressed in square meters: $BMI = BM / BH^2$,

which is an often neglected component in the training process of sportspeople of all ages. What is the role of BMI in the accomplishment of results in the sport, that is, how much does the BMI influence the motoric abilities? Recently, there has been a lot of research in the BMI on different populations. The relation between the BMI and functional abilities has been proven in the research that included 317 participants of the fifth grade of primary school in an urban and a rural environment (Petrić, 2008).

Pojškić (2007) analyzed the influence of the motor preparedness and morphologic characteristic of students and established that coordination had a statistically important physical influence on the performance of some throwing, jumping and running disciplines of students, and the amount of subcutaneous fat tissue had a negative influence on all depending variables. Sprint effects and pliometric training on morphology characteristics of bodily active men – 151 students, age 18-24, has also been examined, where the applied program showed that there were no major differences in any of the analyzed anthropometric variables between the groups, but the reduction in the percentage of subcutaneous fat was observed, as well as in the body mass and the BMI (Marković, Jukić, Milanović & Metikoš, 2005). From this, a need is derived to further explore the morphological features of shot put throwers, and this research therefore strived to establish a relation between the anthropometric dimensions and the body mass index and the results achieved in shot put. A hypothesis was therefore put forth that there is a statistically important influence of anthropometric dimensions and the body mass index on the results achieved in shot put.

Aim

The subject of the research is the body mass index, anthropometric dimensions – body height, legs' length, arms' length, and the shot put results. The research problem was the relation between the said anthropometric dimensions and the body mass index and the shot put results. The objective of the research is to determine the relation between the anthropometric dimensions and the body mass index and shot put results.

Methods

The research was conducted in September and October 2009 at the city stadium and the premises of the Technical School in Banja Luka. Shot put testing was carried out at the stadium, while the measuring of the anthropometric dimensions, done in accordance with the Martin anthropometer, was carried out at the Technical School, via the Glass Body Fat Scale model, GBF 1001. The said variables were measured by the application of the Institutional Biology Program method (Stojanović, Solarić, Momirović and Vukosavljević, 1975).

To determine the BMI values, we used the International BMI Classification for children and adolescents designed by Cole, T.J. and associates, (2000). The BMI value is calculated in accordance with a formula. The obtained BMI value was compared, taking into account the gender and the chronological age, with table values, and the cohort was then decided (normal body weight, overweight, pretility). The obesity risk is among those children and adolescents whose BMI value is above 85 percentile, whereby those exceeding 95 percent are deemed obese for the age. The pupils had a shot put training for 6 weeks. All measuring was done in the morning hours, and the shot put testing was done after adequate warming up and stretching exercises.

Sample

The whole sample was derived from the population of first grade pupils in Banja Luka secondary schools, with the total of 12 schools. The chronological age of the examinees was between 6 months below or above 15 years of age. The test population encompassed 112 male examinees, which served to design a nomination scale. The sample technique choice was determined by the use of a random number table. The testing was done in the first half of the second semester of the academic 2009/2010 year. All examinees attended the same curriculum and program for secondary schools and did not deal with out-of-school activities. The sample was random, bearing in mind that every pupil had the same chance to be selected, which indicates that the sample was representative thus enabling generalization of obtained data. The selected sample underwent a shot put training lasting 6 weeks.

Variables

The relation between the longitudinal anthropometric dimensions and body mass and the results achieved in shot put are presented via two systems:

- Prediction system: body height, leg length, arm length, arm range, body mass index.
- Criteria system: shot put (5 kg).

Statistical data processing

To process the data, we used the statistical package SPSS 11.0 for Windows. To fully implement the set tasks, and therewith prove or reject the hypothesis of this research, a mathematical-statistic procedure was applied. To formulate sound conclusions, we calculated :

The basic statistical parameters of manifested anthropometric abilities (range, minimal value, maximal value, arithmetic mean, standard deviation, variance); Regression causality between the anthropometric dimension indicators, body mass index and the ball throwing results.

Results

Table 1. Descriptive statistics

	PARAMETERS						
	Range	Minimum	Maximum	Mean / St. error	Std. dev	Variance	
Body height	37.00	158.00	195.00	175.48	.70	7.40	54.79
ITM	20.38	15.90	36.28	20.66	.31	3.27	10.71
Arms range	46.00	155.00	201.00	177.48	.89	9.45	89.33
Arms length	22.00	72.00	94.00	82.54	.41	4.35	18.95
Legs length	24.00	71.00	95.00	82.92	.41	4.33	18.72
Shot put	7.79	5.34	13.13	8.62	.13	1.41	1.98

Table 2. Model and coefficients -- Criterion variable: shot put

MODEL	Non-standardized coefficient		Standardized coefficient	t	Significance
	B	Std. error	Beta		
CONSTANT	-10.15	2.48	-	-4.09	.000
Body height	0.09	.03	.48	2.91	.004
ITM	0.17	.04	.39	4.48	.000
Arms range	0.07	.03	.44	2.02	.046
Arms length	-0.18	.07	-.54	-2.63	.010
Legs length	0.03	.05	.08	0.54	.594

Table 3. ANOVA

MODEL	Sum of deviation squares	Degree of freedom	Variance assessment	F - value	Significance
Regression	97.43	5	19.49	16.86	.000
Residual	122.52	106	1.16		
Total	219.95	111			

a Prediction system: ITM, body height, arm length, arm range, leg length
 b Criterion variable: ball throwing

Table 4. Multiple determination coefficient

MODEL	R	R ²	Corrected R ²	Standard error assessment
	.666	.443	.417	1.08

a Prediction system: ITM, body height, arm length, leg length
 b Criterion variable: shot put

By analyzing the presented dispersive parameters in table 1, and by viewing the range of the variance, we see that there is a greater discrepancy of results in shot put, arms range and body height, while there is a greater equalization of body mass index, arms length and legs length. Having analyzed the standard deviation, we see that it is the most important in shot put (1.40768), and then in the body mass index (3.27316), and then in legs length (4.32703), arms length (4.35350), and it is the least in the body height (7.40219) and the arms range (9.45161). Looking at the homogeneousness of the results with the variation coefficient with a view to the ascendant flow, one can see that the biggest value is in the shot put variable (1.982) and the body mass index (10.714), then in the legs length and arms range variable (18.723) and arms length (18.953), and a lesser one is in the body height variable (54.792) and arms range (89.333). Inspecting the basic statistical parameters of the applied variables, one can conclude that the distribution of results in the shot put variable, and body mass index, legs length and arms length do not deviate significantly from

normal distribution (table number 1). In the body height and arms range variable the coefficient of the variance value is somewhat higher, and one can observe a statistical deviation from normal distribution. Determination of regressive correlation between the predicative measuring of anthropometric dimensions and the body mass index and the criterion variable (shot put) individually, was done by the application of regression analysis which includes the following parameters: the correlation coefficient vector (R), the partial correlation coefficient vector (Part R), the standardized partial regression coefficients vector (Beta), the standardized partial regression coefficients vector (t), the importance of the beta coefficient (significance), determination coefficient as a measure for common variability between the criterion variable and the predication variable system, that have an impact on the examined feature (R), coefficient of the multiple correlation between the criterion variable and the predication variables system (R²), size of the F correlation (F) and the level of the F correlation significance (p).

Results obtained by regression analysis in table 3. indicate that at the multivariate level, a statistically significant influence of motor tests was established ($p=.000$) as a predication system, on the results achieved in shot put as a criterion variable. Insight into table 4 shows that a set of motoric tests and the obtained results of the criterion variable have 44.3% of the information in common. The multiple correlation coefficient is .666 which corroborates the previous statement. On the basis of the standardized partial coefficients vector (BETA) and its significance, an analysis was carried out to determine the influence of the body mass index and anthropometric dimensions at a univariate level, which leads to conclusion that the body mass index (.000), body height (.004), arm length (.010) and arm range (.046) do not exert a statically significant influence on the shot put results. It is evident that the leg length variable (.594) has a smaller statistical significance in shot put. Viewing variables individually, one can conclude that a statistically significant influence on results in shot put exists in variable BMI, body height, arm length, and a somewhat smaller influence exists in the arm range variable, whereas the leg length does not have a statistically significant influence.

Discussion and conclusion

Bošnjak (2006) explored anthropometric characteristics and somatotypic features of javelin throwers and conferred that the body structure, more prominently than in other athletic disciplines, influences the results of the throws, and that, consequently, shot put and disk throwers belong to a conspicuously hyperplastic type, and that javelin throwers significantly deviate from this extreme topologic type.

Literature

- Bošnjak, G. (2006). *Relacije antropoloških obeležja sa rezultatskom efikasnošću u bacanju koplja kod srednjoškolske omladine*. /Dissertation/. Novi Sad: Fakultet fizičke kulture.
- Brooks-Gunn J, Burrow C, Warren MP. (1988). Attitudes toward eating and body weight in different groups of female adolescent athletes. *Int J of Eating Disorders*, 7(6), 749–757.
- Cole, T., Bellizzi, M., Flegal, K., & Dietz, W. (2000). Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMI 2000*; 320, 1240- 1243.
- Čudinov, V.I. (1960). Zavisimost absolutnoj i odnositeljnoj sili čeloveka ot veličini jevo mišićnoj masi. *Teorija i prakтика fizičeskoj kulturi*, 11, 828-831. Moskva.
- Idrizović, Dž., Idrizović, K., Stanković, S., Nićin, Đ., & Marušić, R. (2001). *Osnovi antropomotorike – teorija*. Podgorica: Univerzitet Crne Gore.
- Kurelić, N., Momirović, K., Stojanović, M., Radojević, Ž., & Viskić-Štalec, N. (1975). *Struktura i razvoj morfoloških i motoričkih dimenzija omladine*. Beograd: Institut za naučna istraživanja.
- Marković, G., Jukić, I., Milanović, D., & Metikoš, D. (2005). Efekti sprinterskog i pliometrijskog treninga na morfološke karakteristike tjelesno aktivnih muškaraca. *Kinesiology* 37(1), 32-39.
- Petrić, V. (2009). Povezanost indeksa tjelesne mase i funkcionalnih sposobnosti te razlike u istima između učenika urbanih naselja i ruralnih sredina. In Neljak B. (ed.), 18. *Ijetna škola, Zbornik radova*, (pp. 214-220). *Hrvatski kineziološki savez*. Zagreb.
- Stojanović, M., Momirović, K., Vukosavljević, R., & Solarić, S. (1975). Struktura antropometrijskih dimenzija. *Kineziologija*, 5(1-2), 194-208.
- Tešanović, G. (2009). *Relacije nekih antropomotoričkih sposobnosti sa postignutim rezultatom u bacanju vortex-a*. /Master thesis/. Banjaluka: Fakultet fizičkog vaspitanja i sporta.
- Tončev, I. (1991). *Atletika - tehnika i obučavanje*. Novi Sad: FFK.

In their paper, Idrizović et al. (2001) pointed out to a necessity of becoming familiar of laws in relations between morphology characteristics and motoric abilities because motoric abilities can only manifest via the morphology structure of the entity, and that the efficiency of motoric manifestation directly depends on the anthropometric dimensions. In this research, the objective was to determine the relation between the anthropometric dimensions and the body mass index and the results achieved in shot put.

The applied regression analysis and the predication variables coefficient correlation analysis and the criterion variable showed that there was a statistically significant importance between the body mass index, anthropometric dimensions – body height, arm length, arm range and results achieved in shot put, while no statistical significance was observed in leg length. In line with the said research and the results obtained in this research one can conclude that the morphology space, that is, anthropometric dimensions and the body mass index play an important role in the achievement of results in shot put.

When it comes to anthropometric dimensions that have an influence of the achievement of results in shot put, this research has shown that attention should be paid to arm length, arm range, body height and body mass index, as some of the said dimensions may lead to the achievement of better results in shot put, while the leg length has no influence of the result. This research has shown that there is not a single element or factor that can be neglected in the training process and that each of them may be decisive for the accomplishment of a better result, both in shot put as well as in other sport disciplines.

RELACIJE INDEKSA TJELESNE MASE I ANTROPOMETRIJSKIH DIMENZIJA S POSTIGNUTIM REZULTATOM U BACANJU KUGLE

Sažetak

Trenažni proces bacanja kugle bazira se na razvoju opće i specifične pripreme, gdje se najviše vremena utroši na razvoj motoričkih sposobnosti apsolutne snage, eksplozivne snage, brzine pokreta, agilnosti i koordinacije. Istraživanja su pokazala da na rezultat u bacanju kugle, pored pravilne izvedbe tehnike bacanja, kuta pod kojim se izbacuje kugla, utječu i morfološke karakteristike bacača. Evidentno je da se vrhunski bacači kugle razlikuju građom tijela, neki su korpulentniji, neki „atletske“ građe sa izraženom muskulaturom, neki su izrazito visoki, neki niži. Ovim istraživanjem su se, na uzorku od 112 učenika srednje škole, muškog spola, uzrasta $15 \text{ g} \pm 6$ mjeseci, željele istražiti relacije indeksa tjelesne mase i antropometrijskih dimenzija sa postignutim rezultatom u bacanju kugle. Dobiveni rezultati su pokazali da postoji statistički značajan utjecaj indeksa tjelesne mase na postignuti rezultat u bacanju kugle, te da antropometrijske dimenzije dužina ruke, raspon ruku i tjelesna težina mogu utjecati na ostvarivanje rezultata u bacanju kugle, dok dužina noge nema značajnu ulogu u ostvarivanju rezultata.

Ključne riječi: indeks tjelesne mase, antropometrijske dimenzije, bacanje kugle, relacije

Received: June 1, 2010

Accepted: December 20, 2010

Correspondence to:

Gorana Tešanović, MSc

University of Banja Luka

Faculty of physical education and sport

78000 Banja Luka, Vojv.P. Bojevića 1a, Bosnia & Herzegovina

Tel: + 387 65 6801846

E-mail: gole.tesanovic@gmail.com