

INFLUENCE OF SELECTED PHYSIQUE PARAMETERS ON THE RESULTS OF THROWS IN COMBINED EVENTS OF BOYS AGED 17-19

Rafał TATARUCH^{A-F}, Magdalena TATARUCH^{A-F}, Ryszard MARCINÓW^{A-F}

Opole University of Technology, Faculty of Physical Education and Physiotherapy

Keywords:

- Athletics throws
- Physique

Abstract:

Many studies confirm that athletics throws are characterised by a closer connection between the body function and physique than other sports events. Shot putters are characterised by a substantial size, considerable body weight between 100 and 120 kg, even in some individual cases over 130 kg, with a predominant share of lean body mass (muscle tissue), a body weight of from 190 to 200 cm, and long upper limbs, the arm span of which is often more than 210 cm in the best shot putters. The aim of the paper is to try to define the influence of selected physique parameters on the results of widely understood throws in combined events, i.e. rotational and swing throws with the use of equipment of different weight. 60 boys aged 17-19 who do not regularly take part in after-school physical activities were tested. The group studied was subject to some selected anthropometric measurements, i.e. the body height, the length of the lower and upper limb, the body weight and the circumference of the arm and thigh. Simple throwing tests, most common both in physical education classes and sports training, were selected in order to perform the task: discus style standing ball throw with left and right hand, two-handed overarm ball throw, two-handed backwards ball throw, two-handed forwards underarm ball throw, two-handed chest shot put. The appropriately selected test group of boys who do not participate in physical activities and simple throwing tests allowed for the elimination of the influence of the throw technique on the distance. The analysis of the study results demonstrates that the distance was mostly influenced by the body height and lower limb length for a majority of throwing tests. The distribution of the remaining physique parameters is different for each throwing test. Throws with the use of equipment of different weight also had an impact on this relationship.

INTRODUCTION

The main factor contributing to the distance of throws, including athletics throws, is the velocity at which the equipment is thrown out of the thrower's arm. Additional factors, of equal importance, are the angle at which the equipment is thrown out of the arm (parabolic curve of the throw), the height at which the throw began, and external conditions -especially the wind which, in cases of throws against the wind, may contribute to the increase in the distance of discus and javelin throws. In order to achieve the highest level of the first factor listed in particular, the contestant must have as good throwing technique as possible, and, as many specialists claim, an appropriate physique.

Many studies confirm that athletics throws, especially the discus throw, is characterised by a closer connection between the body function and physique, as opposed to other sports events (Fleck 1983, Socha 1994, Migasiewicz and Żukowski 1997). Shot putters are characterised by a substantial size, considerable body weight between 100 and 120 kg, even in some individual cases over 130 kg, with a predominant share of slim body weight (muscle tissue), a body weight of from 190 to 200 cm, and long upper limbs, the arm span of which is often more than 210 cm in the best shot putters. (Forsyth i Sinning 1973, Thorland et al. 1981, Morrow et al. 1982, Roche et al. 1996, Migasiewicz 1999, Orkiszewska 2007).

The studies of many authors show that discus throwers demonstrate the most mesomorphic physique with low body fat among all throwing events (Skibińska 1965, Morrow et al. 1982, Roche et al. 1996, Orkiszewska 2007). On the other hand, according to Skibińska (1965) mesomorphs increase their muscular strength more easily than ectomorphs or endomorphs. The body type of shot putters is characterised by well-developed width ratios, a long trunk in relation to lower limbs and large absolute strength.

Scientific publications most often address advanced competitors who achieve considerable sports success; however, as far as diagnostics and sports selection are concerned, it is necessary to carry out research on people at a lower sports level, or even not training for a particular sports competition at all. The lack of such scientific publications prompted the authors to carry out research concerning the influence of the physique on the results level of men's throws.

The aim of the paper is to try to define the influence of selected physique parameters on the results of widely understood throws in combined events, i.e. rotational and swing throws, one hand and two-handed with the use of equipment of different weight.

The study concerning the relationship between the selected physique parameters and motors abilities and the results of athletics throws was carried out on 60 boys attending the George II of Brieg Secondary Technical School of Building located on ul. Kamienna 3 in Brzeg. The age of the boys tested was between 17 and 19. The boys do not participate in after-school physical activities.

The following somatic features were tested in the gym (Malanowski and Bożyłow 1997):

- Body weight [kg]
- Body height – height *vertex* [B-v]
- Upper limb length: [a-da] = [B-a] – [B-da III]
- Lower limb length – height *symphision* [B-sy]
- Arm circumference – the highest arm circumference
- Thigh circumference – the highest thigh circumference

The studies concerning athletics throws were carried out at the field of George II of Brieg Secondary Technical School of Building in Brzeg, and the students were dressed in sport outfits and wore sports shoes. Simple skill and throwing tests, most common both in physical education classes and sports training, were selected in order to perform the task:

- Standing long jump
- 3 kg medicine ball overarm throw
- Discus style ball throw
- Overarm ball throw
- Chest ball throw
- Between-legs underarm ball throw
- Backwards overarm ball throw

RESULTS

The body characteristics of the groups tested are shown in Table 1. The differences between the groups tested in the analysed physique parameters and in standing long jump and medicine ball overarm throw are statistically significant in case of comparing the 17 year group with 18 year's and the 18 year group with 19 year's.

Table 1. Body and skill characteristics of the group tested

Age		Body length [cm]	Body weight [kg]	Upper limb length [cm]	Lower limb length [cm]	Arm circumference [cm]	Thigh circumference [cm]	Standing long jump [cm]	3 kg medicine ball overarm throw
17	Avg.	180.80	76.00	75.80	105.40	29.80	55.80	2.19	7.97
	SD	7.16	10.38	3.79	4.99	3.71	5.29	0.18	1.44
18	Avg.	179.80	74.07	75.40	104.73	27.87	54.00	1.88	7.30
	SD	5.89	11.00	5.45	4.37	3.23	7.79	0.25	0.76
19	Avg.	176.20	71.27	74.47	102.33	29.27	54.60	2.08	7.74
	SD	3.90	8.89	4.05	4.25	2.55	4.73	0.30	1.56

The tests of discus style ball throw of different weight, with the right and left arm, and their analysis show the impact of the weight of the ball on the throw distance. The dynamics of a distance change along with the change in the equipment weight, in particular the decrease in the throw distance, indicate that the optimal equipment for this kind of test is a 2 kg ball: the change of a 1 kg ball to a 2 kg ball caused the smallest changes in the distance of the throws. The changes to 3 kg and 4 kg balls caused considerably higher differences in the distance achieved. The analysis carried out showed significant differences between the throws with the use of all weights of balls, both for the right and left arm. The comparison between the results of particular test groups was also made. The comparison of the differences between the 17 year group with the 18 year group, as well as between the 17 year group and the 19 year group, was statistically significant. The comparison between the 18 year group and the 19 year group was not statistically significant.

Apart from the rotational throws, i.e. discus style ball throws, the studied groups also did tests involving overarm different-weight ball throws and chest ball throws (Table 3). The latter test might as well be called two-handed chest shot put. As in previous groups, the test subjects began to throw the lightest balls first, moving on to heavier ones until the heaviest over time. They threw each ball three times, and only the best result of all takes was included.

The result analysis of the overarm ball throws indicates that the most proper weight to perform this test is a 1 kg ball for all three groups. Throws with the balls of higher weight resulted in the decrease in the throw distance. In case of chest ball throw, it is difficult to choose one specific ball weight. It is due to the fact that the distance decreases proportionally to the increase in the ball weight.

Table 2. Results of discus style ball throws with the right and left arm

Age		Discus style ball throw with the left arm				Discus style ball throw with the right arm			
		1 kg [m]	2 kg [m]	3 kg [m]	4 kg [m]	1 kg [m]	2 kg [m]	3 kg [m]	4 kg [m]
17	Avg.	14.80	12.94	10.27	7.70	17.75	16.00	11.68	8.48
	SD	2.59	2.03	1.69	1.67	3.94	3.40	3.67	2.50
18	Avg.	12.88	11.13	8.93	6.93	15.25	13.03	10.51	8.10
	SD	2.66	2.40	2.14	1.37	2.30	2.05	1.92	1.20
19	Avg.	12.70	11.25	8.85	7.19	15.79	14.22	11.07	8.11
	SD	2.85	2.69	2.31	2.04	3.20	3.21	2.79	1.42

The differences between the distances in all throws with the use of the ball of different weight, both in the case of overarm ball throw and chest ball throw, are statistically important in all groups. The comparison between the groups tested did not show significant differences.

Table 3. Results of overarm ball throws and chest ball throws

Age		Overarm ball throw				Chest ball throw			
		1 kg [m]	2 kg [m]	3 kg [m]	4 kg [m]	1 kg [m]	2 kg [m]	3 kg [m]	4 kg [m]
17	Avg.	12.66	8.97	7.47	6.55	10.87	8.46	7.16	6.18
	SD	1.58	0.90	0.86	0.74	0.98	1.01	0.75	0.77
18	Avg.	11.47	8.79	6.81	5.93	9.74	7.75	6.51	5.73
	SD	1.74	1.26	0.78	0.69	1.03	1.02	0.87	0.65
19	Avg.	12.09	9.11	7.63	6.69	10.16	8.03	6.52	5.95
	SD	2.46	1.73	1.55	1.64	1.32	1.27	0.86	0.96

Table 4. Results of underarm ball throws and backwards overarm ball throws

Age		Between-legs underarm ball throw				Backwards overarm ball throw			
		1 kg [m]	2 kg [m]	3 kg [m]	4 kg [m]	1 kg [m]	2 kg [m]	3 kg [m]	4 kg [m]
17	Avg.	15.43	13.76	11.83	10.39	16.78	13.23	10.97	9.18
	SD	1.80	1.66	1.58	1.22	2.48	2.65	1.87	2.09
18	Avg.	14.42	12.87	10.71	9.09	15.42	12.82	10.47	8.85
	SD	2.22	2.15	1.60	1.41	2.25	1.88	1.28	1.20
19	Avg.	13.93	12.99	10.94	9.39	16.75	13.84	11.46	9.57
	SD	3.28	2.63	2.18	1.91	4.45	3.62	2.87	2.58

In case of underarm ball throws, the optimal weight of the equipment can also be told. The best results, and simultaneously the smallest changes resulting from the throws with a more and more heavier ball, were achieved while throwing a 1 kg ball. Another increase in the ball weight caused a considerable decrease in the results. On the other hand, as far as backwards overarm ball throw is concerned, it can be unequivocally stated that a 1 kg ball is best suited to strength and technique capacity of the groups tested. Backwards throws with more and more heavier balls resulted in a significant reduction of the throw distance. The

differences in the results of throws with particular balls of more and more heavier weight were statistically significant. This significance was shown in both throws analysed in Table 4. However, it was not shown in the comparison of particular throws.

Table 5 shows the results of the Pearson correlation of particular athletics throws with the selected physique parameters of the boys tested. Due to only small differences between the groups tested in the physique and the particular throws, the analysis was carried out with all groups joined together. The most common and statistically significant result relationship in particular throws is the body weight. It has a significant effect on all discus style throws (with balls of each weight), with both the left and right arm. The body height has a slight effect on overarm 3kg ball throw as well.

A big impact on the distance in discus style throw with both the right and left arm was also noticed in case of the arm circumference and thigh circumference, but the latter's influence was somewhat smaller. Arm circumferences also had a significant impact on the distance of chest ball throws with all four types of ball. Unfortunately, upper and lower limb circumferences, as well as other parameters measured that define the physique, had no significant impact on the distance in backwards overarm ball throws and between-legs underarm ball throws.

Forwards between-left underarm ball throws and backwards overarm ball throws proved to be least dependent on the physique. The only correlation in the above-mentioned tests was observed for throws with a 4 kg ball.

Table 5. Correlation of the throw results with the selected physique parameters of the boys tested (the statistically significant correlation ($p \leq 0,05$) was written in bold).

Variable		Body height	Body weight	Upper limb length	Lower limb length	Arm circumference	Thigh circumference
Discus style ball throw with the left arm	1 kg	-0.07	0.35	0.03	-0.05	0.42	0.31
	2 kg	-0.12	0.31	0.03	-0.11	0.45	0.31
	3 kg	-0.04	0.43	0.14	-0.12	0.51	0.39
	4 kg	0.14	0.54	0.18	-0.13	0.62	0.42
Discus style ball throw with the right arm	1 kg	0.14	0.45	0.10	-0.14	0.45	0.37
	2 kg	0.14	0.43	0.09	-0.14	0.43	0.34
	3 kg	0.07	0.44	0.04	-0.26	0.46	0.34
	4 kg	0.19	0.46	0.11	-0.13	0.35	0.32
Overarm ball throw	1 kg	0.02	0.34	0.01	0.00	0.43	0.42
	2 kg	0.18	0.29	0.09	0.07	0.29	0.33
	3 kg	0.17	0.32	0.15	0.00	0.47	0.38
	4 kg	0.15	0.27	0.13	0.02	0.38	0.26
Chest ball throw	1 kg	0.05	0.33	0.16	-0.10	0.52	0.41
	2 kg	0.15	0.37	0.09	-0.15	0.47	0.26
	3 kg	0.32	0.35	0.18	0.04	0.39	0.22
	4 kg	0.11	0.35	0.04	-0.09	0.46	0.36
Between-legs underarm ball throw	1 kg	0.17	0.26	0.09	0.01	0.28	0.24
	2 kg	0.21	0.29	0.14	-0.05	0.31	0.26
	3 kg	0.13	0.18	0.17	-0.06	0.26	0.19
	4 kg	0.21	0.20	0.24	0.00	0.33	0.12
Backwards overarm ball throw	1 kg	0.02	0.12	0.05	-0.03	0.18	0.11
	2 kg	-0.02	0.18	0.01	-0.14	0.25	0.19
	3 kg	0.04	0.16	0.07	-0.10	0.19	0.20
	4 kg	0.02	0.20	0.07	-0.12	0.33	0.26

SUMMARY AND CONCLUSION

It may have been expected that the changes in the equipment weight to more and more heavier in throwing tests would have an effect on the throw distance inversely proportionally to the ball weight. However, the tests and analyses allowed for the determination of which weight of the balls is appropriate to perform such tests. For the authors, the appropriate ball weight is a maximum weight of the ball with which the exercising person may still retain the proper technique, or do a throw without the deterioration of the throwing technique. Such advice may be helpful for coaches and athletics instructors who attempt to introduce various types of equipment into their training. The results that were achieved during the analysis allow for the conclusion that in order to develop the strength of the exercise beginners 1 kg and 2 kg balls should be used. For a more strength-focused training, 3 kg balls are appropriate, but 4 kg balls should not be used in training beginner boys.

The research result analysis allows for the conclusion that for a majority of throwing tests the throw distance was mostly influenced by the body height and arm and thigh circumferences. The question of why the lower and upper limb length had no effect whatsoever on the distance of any throw is interesting. According to physical formulas, the lever arm length (in this case the upper limb length) and the height of the point at which the equipment is thrown (in this case the lower limb length and the body height) should have a significant impact on the distance. Unfortunately, there was no such relationship. However, it should be kept in mind that the boy group tested do not have the appropriate technique of doing particular throws. They had not done such tests before. It would be advisable to conduct an experiment involving an interval throwing training, in which the participants would learn the technique of particular throws.

The effect of the body height and the lengths of the limbs on the results of the majority of the tests performed is not supported in other papers concerning this subject. A team of authors published comprehensive studies, edited by Teresa Socha (1999), on the physique of competitors in many athletics events, including shot putters, in three age categories: minor junior, junior, senior. In their study, the authors indicated the characteristic features for this group. These were the above-mentioned body height, the length of the limbs, and the shoulder and hip widths. In the groups tested, these authors showed that there are only slight differences between the groups of particular throwing events. However, it should be emphasised once more that the group tested had not performed such tests before, hence their inability to do the throws correctly as far as the technique is concerned.

REFERENCES

1. Fleck S., Kraemer W. J. 2004.: *Designing resistance training programs*. Champaign, Human Kinetics.
2. Forsyth H. L., Sinning W. E. 1973.: The anthropometric estimation of body density and lean body weight of male athletes. *Medicine and Science in Sports* 5, s. 174-180.
3. Malanowski A., Bożilow W. 1997.: *Podstawy antropometrii. Metody, techniki, normy*. Wydawnictwo Naukowe PWN.
4. Migasiewicz J. 1999.: Zróżnicowanie dymorficzne wybranych cech morfofunkcjonalnych kobiet i mężczyzn uprawiających rzut dyskiem. *Wychowanie Fizyczne i Sport*, 3, s. 111-120.
5. Migasiewicz J., Żukowski R., 1997.: Somatyczne i motoryczne uwarunkowania osiągnięć sportowych młodych miotaczy kulą. *Wychowanie Fizyczne i Sport* 3, s. 71-77.

6. Orkiszewska A. 2007.: Morphological diversity of athletes. *Reserch Yearbook* vol. 13, nr 2, s. 249-253.
7. Morrow J. R., Disch J. C., Ward P. E., Donovan T. J., Katch F. I., Katch V. L., Weltman A. L., Tellez T. 1982.: Anthropometric, strength and performance characteristic of American world class throwers. *Journal of Sports Medicine* 22, s. 73-79.
8. Roche A. F., Heymsfield S. B., Lohman T. G. 1996.: *Human body composition*. Human Kinetics.
9. Skibińska A. 1964.: Budowa somatyczna juniorów lekkiej atletyki. *Wychowanie Fizyczne i Sport* t. VIII, 4, s.455-481.
10. Socha S. (red.) 1994.: *Rzuty i wieloboje lekkoatletyczne. Podstawy treningu*. AWF Katowice.
11. Socha T. (red.) 1999.: *Charakterystyka morfologiczna czołowych lekkoatletek i lekkoatletów polskich. Zmienność biologiczna człowieka* vol. 6, Uniwersytet Jagielloński, Kraków.
12. Thorland W. G., Johnson G. O., Fagot T. G., Gerald D., Hammer R. W. 1981.: Body composition and somatotype characteristics of Junior Olympic athletes. *Medicine and Science in Sport and Exercise* 13, s. 332-338.