Coll. Antropol. **26** Suppl. (2002) 77–83
UDC 572.512:796.43-053.6
Original scientific paper

Anthropometric Characteristics of Elite Junior Male and Female Javelin Throwers

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ABSTRACT

The purpose of this study was to examine the anthropometric characteristics of elite junior javelin throwers on a sample of eleven male and twelve female finalists of the European Junior Championship in Athletics (MEPA 98). The chosen subjects were measured with a set of nine anthropometric variables, according to the methodology recommended by the International Biological Programme. The results show that no common constitutional type of a junior male or female javelin thrower exists, but that the anthropometric characteristics are very individually defined. At least two constitutional types exist for each gender, ensuring equal success in javelin. Correlational analysis shows that no statistically significant correlations exist between the individual anthropometric characteristics of the male and female throwers with their competitive result. Success in this track and field discipline is therefore more a synthesis of anthropometric characteristics and motor abilities, as well as an optimal technique.

Introduction

Javelin throwing belongs to the group of cyclic-acyclic track and field disciplines, for which linear and translatory type of movement is characteristic. Success in this track and field discipline depends on numerous interrelated factors. The result in javelin throwing is defined mainly by proper technique, specific motor abilities, aerodynamic factors and anthropometric characteristics of the athlete[1–5]. The latter are especially important from the viewpoint of the biomechanical characteristics of the javelin throwing technique. As do all the track and field throws, javelin also demands a very specific body constitution of the athlete. Some studies[5-9] show that javelin throwers belong to the mesomorphic constitutional type, according to Sheldon's typology[10]. Its characteristics are increased

Received for publication February 13, 2002

body mass and height, muscularity and pronounced transversal measures, such as shoulder width, as well as joint diameters, especially of the elbow and knee.

From the viewpoint of kinematic and dynamic technique characteristics, maximal release velocity, optimal release angle and release height represent the three most important factors that define the end result in javelin[1,2,11–15]. The correlation of release velocity with the result is, in comparison to some other studies[11,14,16] very high and amounts from r = 0.71 to r = 0.87. The average release velocity of the javelin of the finalists at the Olympic Games in Barcelona in 1992 was 28.3 $m \cdot s^{-1}$ (females 23.0 $m \cdot s^{-1}$). The realization of such high release velocity is therefore the consequence of an efficient transfer of approach velocity of the athlete with the musculo-tendon chain of leg action, hip and shoulder girdle and the action of the elbow and wrist joints. It represents a harmonious inter-muscular co-ordination and action of the stretch reflexes[13]. The second parameter, which defines the javelin's flight and through it the end result, is the release angle. Its optimal value is between 33° and 36° [11,14,17]. The third parameter is the release height, mostly defined by the height of the athlete. The optimal release height is supposed to be 105% of the body height of the athlete[17]. Any deviation from this optimal release height results in a shorter flight parabola of the javelin and with it a poorer result. A release height 10 cm lower than the optimum means a 0.80 $m \cdot s^{-1}$ lower launch velocity and a 4.24 m shorter throw[8].

We can see that anthropometric characteristics of javelin throwers are an important factor, which indirectly affects the technique model and directly the competitive result. In comparison with the other track and field throwing disciplines (shot-put, anvil, discus), javelin throwing does allow a »wider« range for anthropometric characteristics of the athlete. Elite javelin throwers are of two types – »heavy« and »light«. One of the top javelin throwers in the world, the Finn Seppo Rattyu is 1.88 m tall and weighs 100.7 kg. The legendary two-time Olympic winner Jan Zelezny measures 1.86 m in height and weighs only 80 kg. The javelin is a rather light instrument (800 g for males and 600 g for females). Therefore approach velocity is very important, besides the specific power and constitution of the thrower, since it gives the javelin a high release velocity. The morphologic characteristics of the thrower must therefore ensure high velocity and great power in connection with proper technique. Several studies exist, dealing with the anthropometric characteristics of elite javelin throwers and their relation with competitive success. These studies were, as a rule, performed on elite male and female throwers, just a few have been carried out on younger age categories.

Morphologic characteristics are without doubt a very important factor in the selection process of young talented throwers. In order to establish them, we performed anthropometric measurements of elite junior male and female javelin throwers at the European Junior Championship in Athletics in Ljubljana. The purpose of our study was to examine the anthropometric characteristics of junior elite throwers and their correlation with the competitive results. The values of the morphologic model could be taken into consideration as one of the factors in the selection process of young talented male and female throwers. We can hypothesize that, in spite of the differences in biological development, young male and female throwers have similar morphologic characteristics as their elite senior counterparts.

Material and Methods

The sample of javelin throwers included eleven males (average age 18.6±0.7 years, average height 1.86±0.05 m, average body mass 90.78±9.70 kg, average result in javelin 70.37±5.4 m) and twelve females (average age 18.5±0.6 years, average height 1.69±0.05 m, average mass 68.13±9.91 kg, average result in javelin 52.15±4.84 m), finalists of the European Junior Championship in Athletics held in Ljubljana in 1998. The young athletes were measured with a battery of nine anthropometric measures, according to the procedures of the International Biological Programme (IBP), described also by Mišigoj-Duraković[18]. The measurements were taken immediately prior to the competition by a professionally trained medical team. Permission for anthropometric measuring was given by the technical delegate of the International Amateur Athletic Federation (IAAF), the organizer of the competition and the coaches of the individual athletes. The data was analyzed with the computer program SPEX 1.2. The basic descriptive statistical parameters were computed, as well as Pearson product-moment coefficients to test for correlation with the competitive results.

Results

The results presented in Tables 1 and 2 show the basic anthropometric characteristics of elite male and female junior javelin throwers. For the males, the average body height (BH) is 1.86 m, the highest athlete measured 1.93 m, the shortest 1.78 m. For the females, the average height is 1.69 m, the shortest is 1.63 m and the tallest 1.77 m. Mero et al.[14] found similar values for a sample of eleven male and eleven female finalists of the Barcelona 1992 Olympic Games. The average height of the male throwers was 1.88 m and 1.72 m of the females. The differences in body mass (BM) are larger. The average body mass of male junior throwers is 90.1 kg and female throwers 68.13 kg. In comparison with the Mero et al. study[14] we find that the male athletes in our sample are on the average lighter by about 6 kg and female by only 1.4 kg. The difference between the lightest and the heaviest female thrower is 37.6 kg. On the basis of these results we can also see that our sample of twenty-three male and female junior javelin throwers is very heterogeneous in body height and body mass. In the male competition, A.M., who was the lightest of them all (71 kg), became European Champion and the bronze medal went to the athlete C.F., who has the third largest body-mass in the subject sample (100.2 kg). In the female competition also, the gold medal went to a »lighter« athlete S.N. (64.4 kg). The heaviest female competitor B.H. (93.9 kg) placed only tenth. The male athletes are, on the average, 0.17 m higher and 22.65 kg heavier than their female counterparts. These differences are of course the consequence of biological differences between the genders.

There is no optimal model of body height and mass. These two parameters are very individually defined and correlated with numerous other factors, which generate throwing efficiency in their mutual interaction. Other authors[13,14,16] also found that competitive results in javelin are very independent of the morphologic type of the athlete. The results presented in Table 3 show quite a large range of values in body mass and body height between some elite male and female javelin throwers. Currently the two top javelin throwers in the world, the bearer of the gold medal from Sydney J. Zelezny (CS) and the bearer of the silver medal S. Backley (GB) belong to very different constitutional types. While S. Backley is 1.96 m tall and weighs 95 kg, J. Zelezny's height is 1.86 m and he weighs only 80

kg. The situation is similar for females, the Olympic winner in Sydney T. Hattestad (S) is 8 cm higher and 9 kg heavier than the runner-up M. Maniani-Tzelili (I).

Discussion

Besides the body mass and height, their ratio is also important[4]. This ratio manifests itself in the Body Mass Index (BMI = BM / BH^2). The range of BMI for young male throwers is from 21.45 to 31.70 kg/m^2 and for females 21.11 to 30.00 kg/m^2 (Tables 1 and 2). The mean BMI for males was 26.31 kg/m^2 and for females 23.77 kg/m^2. The javelin-throwing finalists at the Olympic Games in Los Angeles in 1984 had a mean BMI of 26.63 kg/m^2 (males) and 23.48 kg/m^2 (females) (Table 4 and Figure 1). At the games in Barcelona in 1992, the average BMI amounted to 26.86[14]. Elite senior javelin throwers are therefore somewhat heavier and higher than their junior counterparts of both genders. These results lead us to conclude that the anthropometric model of young javelin throwers, from the viewpoint of body mass and body height, is very similar to that of elite throwers, pointing to a narrow selection, since the sample represents twenty-three finalists of the European Junior Championship in Athletics. Achieving top results at the junior level is obviously generated by similar factors as in the elite senior competition.

The importance of transversal measures as predictors of success in javelin throwing has been established also by other authors[7,19]. One of the most important is shoulder width, which amounts to 42.69 ± 2.3 cm for male throwers, while the values for females are lower 37.97 ± 2.13 cm. Shoulders are that body segment, which is the key generator of release efficiency in the muscular chain action in javelin throwing. Konstandinov[20]

TABLE 1
ANTHROPOMETRIC CHARACTERISTICS AND THEIR CORRELATION (R) WITH COMPETITIVE RESULTS IN ELITE MALE JUNIOR JAVELIN THROWERS

	Name	Country	RE	BW	BH	RH	SW	PW	KD	TC	SC	BMI
1	M.A.	POL	78.42	71.0	1.82	230.0	38.2	27.3	9.1	54.2	37.2	21.45
2	A.J.	FIN	77.6	87.7	1.90	246.0	42.7	27.6	10.0	59.3	40.7	24.56
3	F.C.	D	75.86	100.2	1.78	231.0	42.8	30.0	10.2	65.9	43.8	31.70
4	G.S.	SLO	73.06	89.1	1.92	250.0	41.8	29.1	10.8	58.5	40.2	24.47
5	J.V.	FIN	71.4	102.0	1.82	241.0	43.6	37.2	10.0	64.7	44.4	30.81
6	B.A.	D	70.22	101.1	1.87	246.0	43.2	29.5	10.5	65.0	43.2	28.96
7	W.T.	DEN	68.52	95.4	1.87	237.0	42.8	27.8	10.7	66.2	42.8	27.65
8	P.D.	GRB	67.36	89.9	1.88	240.0	43.2	29.4	10.3	63.0	41.7	25.46
9	C.K.	LIT	64.32	94.9	1.93	252.0	45.7	30.2	10.7	61.8	41.8	25.54
10	P.F.	I	63.96	89.8	1.90	250.0	46.2	32.4	9.7	58.4	38.6	24.87
11	A.A	LAT	63.34	77.5	1.80	237.0	39.4	28.6	10.2	55.7	39.5	23.91
		X	70.37	90.78	1.86	241.82	42.69	29.92	10.20	61.15	41.26	26.31
		SD	5.43	9.70	0.05	7.61	2.34	2.81	0.50	4.19	2.26	3.12
		R		–0.11	–0.27	–0.41	–0.44	–0.23	–0.37	–0.04	–0.01	0.05

RE = competitive result in javelin (m); BW = body mass (kg); BH = body height (m); RH = reach height (cm); SW = shoulder width (cm); PW = pelvic width (cm; KD = knee diameter (cm); TC = thigh circumference (cm); SC = shank circumference (cm); BMI = body mass index

TABLE 2
ANTHROPOMETRIC CHARACTERISTICS AND THEIR CORRELATION (R) WITH COMPETITIVE RESULTS IN ELITE FEMALE JUNIOR JAVELIN THROWER

	Name	Country	RE	BW	BH	RH	SW	PW	KD	TC	SC	BMI
1	S.N.	HUN	61.76	64.4	1.67	215.0	38.4	27.7	9.0	56.4	37.9	23.08
2	W.S.	F	57.34	68.1	1.71	220.0	40.4	29.6	9.2	60.7	39.8	23.32
3	R.B.	F	55.78	68.2	1.67	217.0	39.0	26.6	9.8	56.0	38.6	24.53
4	L.L.	FIN	55.74	72.3	1.74	223.0	39.5	31.6	9.2	58.8	38.5	23.94
5	J.M.	CZ	55.24	66.9	1.68	216.0	39.1	27.9	9.4	55.3	37.0	23.72
6	G.A.	HUN	50.54	56.3	1.62	209.0	36.7	29.4	8.7	52.0	34.7	21.48
7	K.S.	GB	49.46	61.8	1.69	215.0	36.2	30.6	9.5	55.8	36.5	21.68
8	S.S.	D	49.36	67.2	1.76	224.0	38.8	27.7	9.4	57.9	38.7	21.74
9	Z.S.	D	49.22	65.3	1.63	213.0	37.6	27.6	8.9	55.6	37.7	24.86
10	B.H.	CZ	47.72	93.9	1.77	228.0	39.0	26.4	9.4	60.2	42.2	30.00
11	L.A.	FIN	46.92	76.3	1.72	225.0	38.6	27.9	9.5	53.6	38.0	25.77
12	D.L.	SLO	46.72	56.8	1.64	207.0	32.3	28.2	8.3	45.1	35.1	21.11
		X	52.15	68.13	1.69	217.67	37.97	28.43	9.19	55.62	37.89	23.77
		SD	4.84	9.91	0.05	6.49	2.13	1.56	0.41	4.17	2.01	2.45
		R		–0.14	–0.06	–0.03	0.51	0.15	0.42	0.14	–0.13	–0.14

RE = competitive result in javelin (m); BW = body mass (kg); BH = body height (m); RH = reach height (cm); SW = shoulder width (cm); PW = pelvic width (cm; KD = knee diameter (cm); TC = thigh circumference (cm); SC = shank circumference (cm); BMI = body mass index

TABLE 3
ANTHROPOMETRIC CHARACTERISTICS (BODY MASS, BODY HEIGHT, BODY MASS INDEX) AND COMPETITIVE RESULTS OF ELITE MALE AND FEMALE JAVELIN THROWERS

	Males (name)	RE	BW	BH	BMI
1	Zelezny	98.48	80.0	1.86	23.12
2	Backley	91.46	95.0	1.96	24.74
3	Rättyu	96.96	100.7	1.88	28.52
4	Härkönen	86.76	89.0	1.90	24.65
5	Ottlez	85.74	95.0	1.86	27.45
6	Eldebrink	83.30	93.0	1.90	25.76
7	Petranoff	81.40	98.0	1.86	28.32
	X	89.16	92.96	1.89	26.08
	SD	6.65	6.80	0.04	2.06

	Females (name)	RE	BW	BH	BMI
1	Hattestad	68.91	70.0	1.73	23.41
2	Mannini – Tzelili	67.51	60.0	1.65	22.06
3	Sandreson	66.56	71.0	1.70	24.56
4	Lillak	69.00	74.0	1.81	22.63
5	Whitebread	67.14	67.0	1.66	24.36
6	Laakasalo	66.40	70.0	1.71	23.97
	X	67.59	68.67	1.71	23.50
	SD	1.13	4.80	0.06	0.99

stresses in his study that shoulder width is an important selection criterion of potential young throwers. Bicristal width of the pelvis is 29.92 ± 2.81 cm for males and 28.43 ± 1.56 cm for females. The rather small difference is the consequence of specific anatomic requirements characteristic for females. The diameter of the knee joint which defines the morphologic structure of the lower extremities is 10% wider in males than in females. The diameter of the knee is an important fac-

TABLE 4
ANTHROPOMETRIC CHARACTERISTICS (MEANS) AND COMPETITIVE RESULTS OF JAVELIN THROWING FINALISTS AT THE OLYMPIC GAMES IN LOS ANGELES (1984) AND BARCELONA (1992)

	O.G. Los Angeles, 1984				O.G. Barcelona, 1992			
	RE	BH	BW	BMI	RE	BH	BW	BMI
Males	82.46	1.88	94.0	26.63	80.74	1.89	95.9	26.86
Females	66.09	1.72	71.6	24.02	60.50	1.72	69.5	23.48

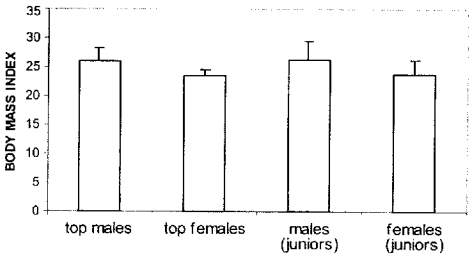

Fig. 1. Comparison of body mass index between finalists of the Olympic Games in Barcelona in 1992 and finalists at the European Junior Championship in Athletics in Ljubljana in 1998.

tor from the biomechanical point of view. Larger knee width namely means a more economic distribution of the pressure generated by the reaction of the surface in the release action. The standard deviations show that the subjects are very homogeneous. We can therefore conclude that a mesomorphic constitution of young throwers is one of the most important selection factors.

Circumferences of the lower extremities (circumference of the thigh, circumference of the shank) represent muscular mass on the active segments of the body, which produce force in the approach phase and in the last three strides of the delivery action. The average circumference of the thigh of males is 61.15 ± 4.1 cm, and females 55.62 ± 4.17 cm. The difference in shank circumference between the male and the female athletes is 3.4 cm. A study by Milanović[7] showed that the thigh and shank circumferences are statistically significant positive predictors of the competitive result in javelin throwing.

The second goal of the current study, besides analyzing anthropometric characteristics of young javelin throwers, was to find if statistically significant correlations exist between the individual anthropometric characteristics and the competitive result in javelin throwing. The Pearson correlation coefficients (Tables 1 and 2) show that no significant correlations exist at the 5% error level between the anthropometric variables and the competitive result, both for males and females. This fact is rather surprising but the results prove that success in this discipline is markedly individually defined and dependent on an optimal inter-relation of anthropometric characteristics, basic and specific motor abilities, as well as the level of technique of the athletes. The variables reach-height and shoulder -width have the highest correlations with the competitive result, but are still not statistically significant. Even if the male and female athletes, who competed in the finals of the European Junior Championship in Athletics, represent a rather selected sample, their anthropometric characteristics are very heterogeneous. The competitive result in javelin throwing is obviously a synthesis of many inter-dependent factors and morphology is just one of them.

Studying morphologic characteristics of young javelin throwers is important, both from the viewpoint of selection of talents, as well as planning and execution of the training process. Javelin thro-

wing is a specific track and field discipline, which does demand a certain anthropometric profile of the athletes, but this profile has a rather wide range for anthropometric characteristics. Top results in this category are achieved both by tall athletes with relatively low body mass, as well as those with great body mass and of lesser body height. Correlation analysis did not give statistically significant associations between the anthropometric characteristics of young elite male and female javelin throwers and their competitive results. It is obvious that in this period we still cannot speak of an ideal constitutional model of a javelin thrower. The competitive result is the resultant of morphologic characteristics, basic and specific motor abilities, as well as a bio-mechanically optimal execution of the throwing technique.

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ANTROPOMETRIJSKE OSOBINE VRHUNSKIH JUNIORSKIH BACAČA KOPLJA

SAŽETAK

Cilj istraživanja bio je ispitati antropometrijske osobine vrhunskih juniorskih bacača koplja. Istraživanje je provedeno na uzorku od jedanaest muških i dvanaest ženskih finalista Europskog juniorskog prvenstva u atletici (MEPA 98). Mjereno je devet antropometrijskih varijabli prema propozicijama Internacionalnog biološkog programa. Rezultati su pokazali da niti kod muškaraca, niti kod žena ne postoji jedinstven tip konstitucije tijela koji bi bio svojstven bacačima koplja, već su antropometrijske osobine svojstvene pojedincima. Podjednak uspjeh u bacanju koplja osiguravaju najmanje dva tipa tjelesne konstitucije u oba spola. Antropometrijske osobine nisu u značajnoj korelaciji s postignutim rezultatom. Uspjeh u bacanju koplja temelji se na spoju antropometrijskih osobina, motoričkih sposobnosti i optimalne tehnike.