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BIOMETRIC MODEL AND OPTIMAL AGE FOR REALIZATION IN THE WOMEN'S TRIPLE JUMP DISCIPLINE

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Abstract: *The purpose of the present study includes creating a biometric model of highly qualified female triple jump athletes, as well as establishing the optimal age for achieving a high sports result. The purposes are: 1) Analysis of the anthropometric characteristics of 30 elite triple jumpers with personal achievements over 14.70 m.; 2) To analyze the development of the sports result in the age aspect. The analyzes showed that the optimal age for achieving a high sports result in the triple jump discipline for women is on average 26 years. The female athletes studied by us have an average height of 176 cm, 62 kg. and their BMI is on average 19.6.*
The dynamics of the development of the sports result in terms of age in the athletes we studied gives us reason to conclude that achieving a high result at an early age is not a sign of future development, but we believe that this research of ours will contribute to improving the management and modeling of the training process in an age aspect.

Key words: *triple jump athletes, Biometric model.*

1. Introduction

The knowledge of the sports result development in view of the age aspect may provide important information for the long-term planning of the training process, as well as for making certain adjustments according to the development of a given athlete. That is why this topic has become the focus of a number of authors. The chronological age at which the highest sports results are achieved is different in various sports, as well as in both genders. In some studies, only the age for achieving the highest sports result was investigated, and in others the overall development of the sports result at individual ages was studied [6], [8], [10].

Of interest to us is the development of the sports achievement in the age aspect in the women's triple jump discipline.

2. Methodology

The objective of this study is to create a biometric model of highly qualified female triple jump athletes, as well as establish the optimal age for achieving a high sports

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result. To achieve the objective, we set out the following tasks:

1. Analysis of the anthropometric characteristics of 35 elite female triple jumpers with personal achievements above 14.70 m;
2. To analyze the development of the sports result in terms of age.

As study methods we used literary sources research, as well as statistical processing of the results of the female athletes. The data for the analyzes were taken from the https://worldathletics.org/ website.

3. Results

In Table 1, we are presented the initials, years of age when achieving the highest sports performance, as well as the anthropometric characteristics of the athletes studied. Following the experience of elite female athletes in the triple jump discipline, we chose to analyze the results of 35 highly qualified female athletes with personal bests over 14.70m

The anthropometric characteristics such as height, weight, limb length as well as BMI can be used as indicators for the selection of athletes. In athletics jumps, the height of the competitors is a condition for achieving a greater take-off height on the bounce.

On the other hand, the development of the sports result in an age aspect can be used as a guide for sports specialists in their work with adolescents.

Table 1

Anthropometric characteristics and sports result of the study subjects

Name	PB	Age	kg	H	BMI	Name	PB	Age	kg	H	BMI
I. K.	15,50	29	60	178	18,9	P. T.	15,07	27	62	174	20,5
Y. R.	15,74	26	72	192	19,5	Y. K.	15,04	27	56	169	19,6
F. M.	15,39	32	63	169	22,1	A. P.	15,02	25	63	176	20,3
T. L.	15,36	28	63	173	21,0	M. M.	15,03	27	63	178	19,9
H. D.	15,32	28	62	174	21,5	M. S.	15,03	29	59	173	19,7
C. I.	15,31	30	65	181	19,8	K N.	15,00	26	58	164	21,6
Y. A.	15,29	31	62	172	21,0	O. S.	14,99	28	58	176	18,7
Y. S.	15,28	23	62	165	22,8	B. R.	14,98	26	58	176	18,7
O. R.	15,25	26	63	183	18,8	O. H.	14,96	27	60	175	19,6
S. K.	15,20	26	68	186	19,7	S. R.	14,98	29	64	180	19,8
T. M.	15,20	23	56	176	17,8	V. G.	14,85	26	62	178	19,6
I. P.	15,18	23	62	178	19,6	L. X.	14,90	21	52	171	17,8
R. M.	15,16	26	63	180	19,4	H. M.	14,78	26	62	179	19,4
T. S.	15,16	30	76	185	22,2	A. G.	14,75	25	58	174	19,2
A.H.	15,15	26	63	180	19,4	P. P.	14,73	26	53	170	18,3
N. A.	15,14	30	60	176	19,4	A. P.	14,71	27	59	170	20,4
A. B.	15,09	26	61	174	20,1	C. N.	14,70	22	66	184	19,5
I. L.	15,09	28	68	178	21,5						

Variance analysis of the study parameter Table 2

		PB	Age	Kg	Height	BMI
N	Valid	35	35	35	35	35
	Missing	0	0	0	0	0
Mean		15.0951	26.71	61.77	176.20	19.917
Median		15.0900	26.00	62.00	176.00	19.600
Std. deviation		.23069	2.480	4,697	5.845	1.1945
Skewness		.382	-.167	.693	.299	.575
Kurtosis		.615	.158	2.023	.691	.115
Range		1.04	11	24	28	5,0
Minimum		14.70	21	52	164	17.8
Maximum		15.74	32	76	192	22.8
	V%	1.528268	9.284072	7.604193	3.317286	5.997191

To propose a biometric model of a highly skilled female triple jumper, we processed the data using a variance analysis. The results are listed in Table 2. Overall, the data sample is almost uniform and the degree of uniformity is determined by the coefficient of variation (V%), which varies within 1.52 – 9.28%. The personal achievement of the female athletes has an average value of 15.09 m. As the optimal age for achieving the highest sports achievement, the average value of 26 years can be accepted. The height of the female athletes studied has a minimum value of 164 cm and a maximum of 192 cm, and the average value is 176 cm. The weight of the study athletes varies between 52-76 kg. Using the mean values from the variance analysis we can propose the following biometric model of a highly qualified female triple jump competitor (Table 3).

Biometric model of a highly qualified female triple jump competitor Table 3

Personal Best	Age	Kg	Height	BMI
15,09	26	62	176	19.6

It is known that sports specialization in athletics jumping begins at the age of 14-15, and 7 to 10 years of purposeful training work is required to reach high sports achievements. As we followed the sports result dynamics of the study individuals, we found that in the age group under 18 (U18), only 12 of the athletes had an officially registered result. In the next age under 20 (U20). Female athletes grow in their twenties, so we decided to follow the sports achievement dynamics of these female athletes (Table 4).

Dynamics of the sports result in the age aspect Table 4

Name	U 18	U 20	20-21	22-23	24-25	26-27	28-29
Y. R.		13.65	15.02	15.02	15.41	15.74	
T. L.		13.88	13.88	14.94	15.32		
C. I.	12.90	13.71	13.91	13.91	14.29	14.99	15.31
T. M.	12.82	14.62	14.62	15.20			
A.H.		12.98	14.27	14.27	14.78	15.15	

Name	U 18	U 20	20-21	22-23	24-25	26-27	28-29
A. P.	12.22	14.19	14.67	14.85	15.02		
M. M.		12.98	14.27	14.40	14.73	15.03	
M. S.	13.08	13.54	13.54	14.06	14.53	15.03	
K N.		12.99	13.39	14.08	14.91	15.00	
O. S.	13.32	13.63	13.63	14.41	14.83	14.98	
B. R.	13.48	14.04	14.64	14.64	14.89	14.98	
O. H.		13.23	13.23	14.78	14.78	14.96	
S. R.		12.90	13.64	14.15	14.57	14.93	14.98
V. G.	13.02	13.75	14.37	14.65	14.65	14.85	
L. X.	13.83	14.38	14.90				
H. M.	13.28	13.85	13.85	14.71	14.71	14.78	
A. G.	13.69	13.69	14.71	14.71	14.75		
P. P.	12.92	14.35	14.72	14.72	14.73		
A. P.	12.60	13.52	14.39	14.39	14.39	14.71	
C. N.		13.89	14.22	14.70			

As we followed the development of the sports result dynamics, we found that in the U18 age, out of the twelve athletes with registered achievements, seven achieved a result above 13.00 m. The results of the athletes at this age ranged from 12.22 m and reached 13.83 m. In the next age (U20), fifteen of the female athletes achieved a result above 13.50 m, and five of them crossed the border of 14.00 m. The variation analysis of the sports achievement dynamics (Table 5) gives us reason to believe that the optimal age for achieving a result over 14.00 m is between 20-21 years, and for a result of over 14.50 m, between 22-23 years of age. In the range of 20-21 years, the highest difference between the minimum and maximum result of the female athletes has been noticed, namely 1.79 m, after which this difference decreases and the lowest difference in the achievements is reported in those being 26-27 years old.

It should be noted that two of the athletes studied reached their personal achievements at a later stage, but we believe that this does not affect to a large extent the general age dynamics of the development of sports results.

Variation analysis of the sports achievement dynamics Table 5

		U 18	U 20	20-21	22-23	24-25	26-27
N	Valid	12	20	20	19	17	13
	Missing	8	0	0	1	3	7
Mean		13.0967	13,6885	14.1935	14.5574	14.7818	15.0100
Std. Error of Mean		.13166	.11056	,11852	.08084	.06924	.06855
Median		13.0500	13.7000	14.2700	14.6500	14.7500	14.9800
Std. Deviation		.45608	.49446	.53006	.35235	.28549	.24715
Skewness		-.177	-.014	-.253	-.190	.650	2.269
Kurtosis		-.034	-.603	-1.090	-.679	.891	7.010
Range		1.61	1.72	1.79	1.29	1.12	1.03
Minimum		12.22	12.90	13.23	13.91	14.29	14.71
Maximum		13.83	14.62	15.02	15.20	15.41	15.74
	V%	3.482389	3.612203	3.734508	2.420456	1.931347	1.646572

Based on the logistic regularity in the dynamics of sports achievements and the obtained average values of the athletes, we believe that the coaches should not skimp on the development of their athletes. Based on the data obtained, we recommend optimal results for different ages as a guideline for optimal growth of sports performance (Table 6).

Recommended model of optimal sports result in age aspect Table 6

Age	**16-17**	**18-19**	**20-21**	**22-23**	**24-25**	**26-27**
Rezults	13,10 м.	13,70 м.	14,20 м.	14,50 м.	14,80 м.	15,00 m.

3. Discussion

Knowing the development of sports performance in terms of age can provide coaches with valuable information to successfully manage the development of adolescent athletes. There are numerous publications that examine the changes in sports performance of athletes with advancing age [1], [2], [6], [10].

The model characteristics of athletes have an important role in predicting sports performance and in the selection of athletes in the respective sport. There are different types of models in sports, some of which are developed based on physical characteristics and others based on biological characteristics.

For decades, anthropometric have been used to create biological models in elite sport. In the scientific literature, there are various publications related to the study of the anthropometric indicators of both highly qualified and adolescent athletes [4], [5], [12[.

The data from our study of the optimal age for achieving the best result in the women's triple jump discipline basically reconfirms the statements made by a number of authors. Hollings et al. [6], determined 25.5 ± 2.8 (n=30) as the optimal age for achieving a personal best in the women's triple jump discipline.

Whereas, analyzing the results of the participants in the Summer Olympic Games in London 2012, Longo et. al. [7], determined that the optimal age for achieving a personal best in athletics jumping for women was 28 years. We should emphasize, however, that in the last study cited the age characteristics of the participants in all jumps were analyzed, which may provide clarity for the observed difference of nearly two years. As we analyzed the sports achievement dynamics in the different age groups, we were able to establish an optimal result for each of them. As we have already mentioned, a number of authors share the opinion that sports specialization in athletics jumps begins at the age of 14-15, and to reach high sports achievements 7 to 10 years of purposeful training work are required [9].

As we followed up the results of the persons analyzed by us, we found that basically the female athletes who achieved a result above 14 m in the age of U20 also achieved their personal best earlier. Of all 30 highly skilled female triple jumpers we have studied, only four were in the top 30 at U20 age. This finding confirms to some extent the results of the study by Boccia et. al. [3], that achieving a high result at an early age is not a mandatory condition for further development.

4. Conclusions

The analyzes showed that the optimal age for achieving a high sports result in the

women's triple jump discipline is 26 years on the average. The female athletes studied by us have an average height of 176 cm, 62 kg and average BMI 19.6. The dynamics of the sports result development in terms of age in the athletes we studied gives us the reason to conclude that achieving a high result at an early age is not a sign for future development; we however believe that this study will contribute to improve the management and modeling of the training process in the age aspect.

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