



NATIONAL SPORTS ACADEMY 'V. LEVSKI'

TRACK-AND-FIELD ATHLETICS CHAIR

VIRGINIA SVETOSLAVOVA MILASHKA

**MODELLING OF THE SPORTS TECHNIQUE POTENTIAL OF
FEMALE DISC THROW COMPETITORS IN A QUALIFICATION
ASPECT**

AUTHOR'S REVIEW

**Of the dissertation thesis for granting the educational and scientific degree
of 'DOCTOR' in the professional field 7.6. SPORT, Doctor's Program
'Theory and Methods of Sports Science'**

Director of Studies: Assoc. Prof. Rumyana Ivanova Karapetrova, Ph.D.

Official Scientific Reviews:

Prof. Stefan Stoykov, D.Sc.

Prof. Nadejda Yordanova, D.Sc.

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The dissertation thesis was discussed at an extended scientific collegium of the Track-and-Field Athletics Chair at the National Sports Academy 'V. Levski' held on 27. 02. 2019 and directed to public defense at a scientific board.

The dissertation thesis contains 126 standard pages.

It is illustrated by 54 tables and 32 figures.

The referent literature review contains 158 literary sources: 122 in Cyrilic and 36 in Latin alphabets.

The public defense of the dissertation thesis will be held in A3 Hall at the NSA 'V. Levski', Studentski Grad, Sofia, at a session of the Specialized Scientific Board at 2 PM on 25.05.2019.

The materials are available in the Academy Library.

Notice: The numbering of tables and figures in the Author's Review comply with their numbering in the dissertation thesis.

INTRODUCTION

Disc throw for women is an event in which Bulgaria has conquered almost all summits: a World record, Vice-Olympic titles, bronze Olympic medals, a World title, a European title, bronze medals at European Championships, Olympic Finals, World Finals, European Finals, Balkan Games titles. The only title that our collection misses is the Olympic title.

Five Bulgarian female athletes have achieved results of over 65 m: Tsvetanka Hristova (73,22 m), Maria Vergova-Petkova (71,80 m), Svetla Mitkova (69,72 m), Stefania Simova (67, m), Svetla Bozkakova (67, m).

During the past 5 years only one Bulgarian female disc thrower (Renata Petkova) has crossed the 50 meters.

The decline in Bulgarian standards of the recent past has given us grounds for more profound analysis on the situation, a research and a study on this event included, with the aim to clarify the present state of the event in the world and at home, to draw conclusions and suggest recommendations as well as to outline measures to overcome the situation in which this event is in Bulgaria today.

That is the reason why we initiated a research and a study on the experience gained by the Bulgarian Track-and-Field Athletics School in that event during the most significant period of its development and performance on the world athletics scene aiming at its implementation into the practice of Bulgarian coaches and female competitors.

RESEARCH HYPOTHESIS

Our research hypothesis is grounded on the presumption that modelling of the sports technique potential of female disc throw competitors will outline perspectives for further improvement on the preparation and sports performance of Bulgarian female disc throw competitors.

AIM OF THE STUDY

The aim of the study is: TO IMPROVE THE TRAINING OF FEMALE DISC THROWERS BY MEANS OF A RESEARCH ON THE SPORTS TECHNIQUE ABILITIES OF FEMALE HIGH SPORTS PERFORMANCE COMPETITORS.

OBJECTIVES OF THE STUDY

The achievement of the aim requires the attainment of the following basic objectives:

1. Analysis on the state of the problem under study in scientific and methodological literature.
2. Retrospective analysis on the development of the event on world and national scale.
3. Study on the basic indices of the physical preparation of high performance female disc throwers.
4. Study on the basic indices of disc throw technique of high performance female disc throwers.
5. Study on the capability of sports technique realization of female disc throwers of various sports technique qualifications.
6. Development of criteria of control and assessment on the indices under study.
7. Development of guidelines for implementation of the achieved results into practice.

METHODS OF STUDY

The Object of study is: a part of the best Bulgarian female disc throwers during the whole history of the event in this country.

The Subject of study are:

- Basic points in the development of the event in the world and in this country;
- Sports technique abilities of a female disc thrower in an age aspect;
- A female disc thrower's physical potential;
- A female disc thrower's technique potential;
- A female disc thrower's ability at thorough realization during important competitions;

For the study on the female disc thrower physical potential 18 indices were selected all of which applied to her preparation and control by all outstanding schools in the world, Table 10.

The study on the female disc thrower's technique potential comprises 24 indices (time, amplitude and angle) which study the throw from its start until the drop of the disc, Table 12.

METHODS OF RESEARCH

To achieve the aim and objective set by us we applied the following methods of research:

1. Analysis on science and methods literature.
2. Historiography.
3. Technical device methods of research.
4. Sports pedagogical analysis.

Table

10

INDICES OF PHYSICAL POTENTIAL

<i>Nº</i>	<i>Denomination of Indices</i>	<i>Allowance</i>
1	Sports performance / meters	0,01
2	Height / centimeters	1
3	Weight / kilograms	0,5
4	BMI	0,01
5	Standing disc throw / meters	0,01
6	Disc throw 1.5 kg with rotation / meters	0,01
7	Disc throw 1.25 kg with rotation / meters	0,01
8	Disc throw 0.750 kg with rotation / meters	0,01
9	Two hand forward shotput throw 4 kg / meters	0,01
10	Two hand backward overhead shotput throw 4 kg / meters	0,01
11	30 m low start with a sound signal / seconds	0,01
12	Standing long jump / meters	0,01
13	Standing triple jump / meters	0,01
14	Five-fold standing jump / meters	0,01
15	Back barbel squat / kilograms	0,5
16	Lying barbel clean / kilograms	0,5
17	Overhead barbel snatch / kilograms	0,5
18	Barbel clean turn / kilograms	0,5

Table 12

TECHNIQUE POTENTIAL INDICES

<i>Nº</i>	<i>Denomination of Indices</i>	<i>Allowance</i>
1	Sports performance / meters	0,01
2	Double support duration (start) / seconds	0,01
3	Single support duration (start)	0,01
4	Non-support phase duration / seconds	0,01
5	Single support duration (final effort) / seconds	0,01
6	Double support duration (final effort) / seconds	0,01
7	First stride length / meters	0,01
8	Second stride length / meters	0,01

9	Position of disc away from support at the throw start / meters	0,01
10	Position of disc away from support at the end of the double support / meters	0,01
11	The lowest position of disc away from support during the first stride / meters	0,01
12	Position of disc away from support at the start of the final effort / meters	0,01
13	The lowest position of disc away from support during the final effort / meters	0,01
14	The position of disc at the point of dropping the disc / meters	0,01
15	Lean of body from the support during double support / degrees	1
16	Lean of body from the support during double support / degrees	1
17	Lean of body from the support at the beginning of single support / degrees	1
18	Lean of body from the support at the beginning of final effort (step on right foot) / degrees	1
19	Lean of body from the support at dropping the disc / degrees	1
20	Maximum flexion of right knee joint during single support / degrees	1
21	Angle of right knee joint at the beginning of single support / degrees	1
22	Angle of right knee joint at the point of dropping the disc / degrees	1
23	Angle of left knee joint at the point of dropping the disc / degrees	1
24	Angle of throwing the disc / degrees	1

5. Mathematics and statistics methods

- Variance analysis
- Correlation analysis
- Regression analysis
- Sigma method of developing norms

ANALYSIS ON RESULTS

FEMALE DISC THROW: DEVELOPMENT OF THE EVENT IN THE WORLD AND IN THIS COUNTRY AFTER SETTING THE LATEST RECORDS

Figure 7 shows the development of the event in the world and in this country after 1987 on the background of the World and Bulgarian Records. The World and Bulgarian records, the best performances for the year in the world and at home after 1987 are displayed in it.

The best female disc thrower in Bulgaria over the first years of the period under study (1986-1996) gradually and increasing retreats from the best performance in this country to establish herself steadily within the 48-58 meter range over the following two decades. During the past two years the difference is 22 meters.

Figure 8 graphically displays the performances of the first three throwers at the European Championships in 1998, 2002, 2006, 2010, 2012, 2014 and 2016 as well as the first three throwers at the State National Championships during those years.

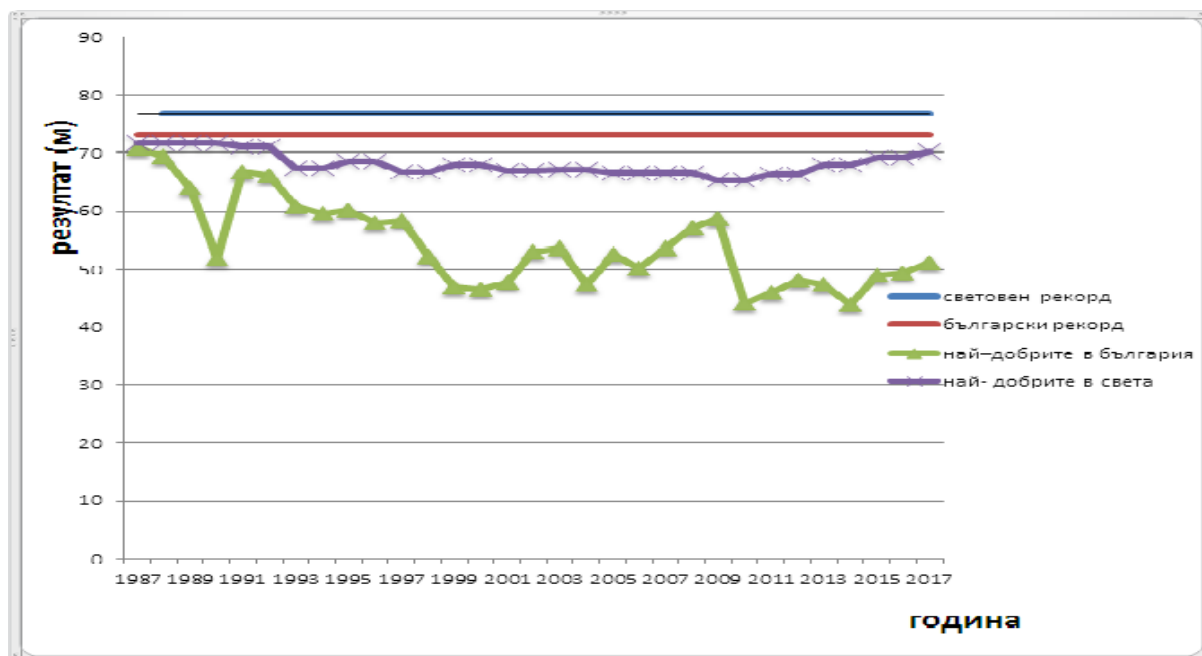


Fig. 7 Dynamics of development in the best Bulgarian disc throw performance, women, for the period of 187 - 2017

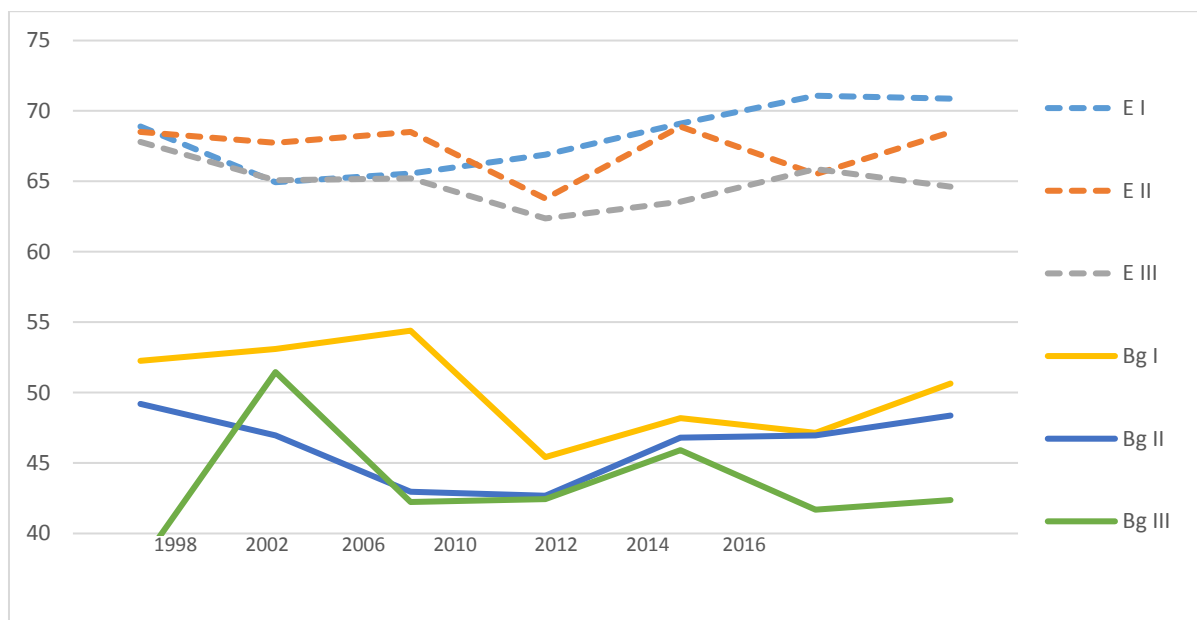


Fig 8. The best three performances at the European and State National Championships.

2. The level of the Bulgarian female disc throwers related to the best European performers marks, generally speaking, a difference within the range of 17-20 m between the performances of the best three Bulgarian and the best three European disc throwers.

A STUDY ON THE DYNAMICS OF SPORTS PERFORMANCE IN FEMALE DISC THROWING IN AGE ASPECT

The aim of this study is to follow the changes in sports performance in this event of the best competitors in the world in age aspect.

We studied the development in the highest performance of the 102 best competitors in the event from the everlasting ranking list up to 31.12.2016 with performances from 76,80 to 65,94 m.

The variance analysis on the data comprises information about the sports performances of the persons under study aged 15-46, a wide range in which the world elite female disc throwers register performance from 49,91 m (at the age of 15) up to the impressive 61,02 (at the age of 46), Table 14.

It has been determined that the best period to realize one's competitive potential is the age of 23 – 33 yet preserving the individual nature sports abilities in realization.

Table 14

VARIATION ANALYSIS ON SPORTS PERFORMANCE IN AGE ASPECT

		N	R	min	max	X cp.	S	V%	As	Ex			N	R	min	max	X cp.	S	V%	As	Ex
възраст	15 г.	3	13,05	44,69	57,74	49,91	6,91	13,84	1,46	.	възраст	31 г.	30	17,15	56,13	73,28	64,39	4,11	6,38	-0,25	-0,07
	16 г.	9	16,07	46,29	62,36	51,89	4,54	8,75	1,61	3,69		32 г.	28	16,64	56,32	72,96	64,67	3,65	5,65	-0,06	0,06
	17 г.	19	14,47	51,39	65,86	57,28	4,07	7,10	0,41	-0,35		33 г.	24	11,14	60,08	71,22	65,31	2,71	4,15	0,22	-0,19
	18 г.	24	30,40	41,24	71,64	57,65	7,05	12,24	-0,28	0,27		34 г.	19	16,57	55,11	71,68	63,83	4,24	6,64	-0,49	0,16
	19 г.	36	23,72	50,68	74,40	61,06	4,92	8,06	0,28	0,14		35 г.	18	17,47	51,70	69,17	61,19	5,09	8,32	-0,29	-0,67
	20 г.	25	21,77	52,79	74,56	61,67	4,69	7,61	0,75	0,99		36 г.	16	12,16	55,16	67,32	62,94	3,83	6,08	-0,96	-0,03
	21 г.	30	16,88	54,22	71,10	61,54	4,19	6,81	0,44	-0,55		37 г.	13	12,16	55,30	67,46	62,99	3,91	6,20	-0,73	-0,67
	22 г.	35	21,90	51,46	73,36	62,40	4,42	7,08	-0,01	0,44		38 г.	7	6,62	61,44	68,06	65,30	2,58	3,96	-0,53	-1,32
	23 г.	48	19,73	54,11	73,84	64,28	4,46	6,94	-0,15	-0,34		39 г.	7	11,98	57,16	69,14	64,02	4,69	7,32	-0,28	-1,64
	24 г.	49	19,13	54,95	74,08	65,08	4,24	6,52	0,09	-0,01		40 г.	6	15,64	51,46	67,10	60,82	5,92	9,73	-0,59	-0,29
	25 г.	42	18,92	57,88	76,80	65,20	4,40	6,75	0,42	-0,05		41 г.	6	14,38	51,78	66,16	60,63	5,51	9,09	-0,90	-0,33
	26 г.	46	17,18	55,34	72,52	65,74	3,87	5,89	-0,95	0,93		42 г.	5	5,63	59,24	64,87	61,05	2,35	3,85	1,44	1,41
	27 г.	31	14,57	58,35	72,92	64,97	3,72	5,72	0,01	-0,89		43 г.	4	13,71	54,18	67,89	61,56	5,63	9,15	-0,55	1,67
	28 г.	42	14,56	57,74	72,30	65,29	3,42	5,23	-0,31	0,18		44 г.	5	16,60	46,06	62,66	57,57	7,32	12,72	-1,28	0,43
	29 г.	40	16,36	55,78	72,14	65,70	3,40	5,18	-0,68	0,78		45 г.	1		64,09	64,09	64,09	.		.	.
	30 г.	40	21,62	52,94	74,56	64,46	4,25	6,59	-0,06	1,08		46 г.	1		61,02	61,02	61,02	.		.	.

In order to be useful for the sports practice we have developed a table containing assessment on sports performance in the age aspect based on the data displayed above and on the large number of persons under study which includes the age of 17-37. The reason for that is the small number studied cases in the age periods not included in the table (Table 16). The assessment is by a seven grade scale: **very high, high, above medium, medium, below medium, low, very low.**

Table

16

ASSESSMENT SCALE OF SPORTS PERFORMANCE FROM THE AGE ASPECT

		изследвани случаи	оценка (м)						
			много висока	висока	над средната	средна	под средната	ниска	много ниска
възраст	17	19	над 65,42	61,36-65,42	59,33-61,35	55,26-59,32	53,22-55,25	49,14-53,21	под 49,14
	18	24	над 71,75	64,71-71,75	61,19-64,70	54,14-61,18	50,61-54,13	43,55-50,60	под 43,55
	19	36	над 70,90	65,99-70,90	63,53-65,98	58,61-63,52	56,15-58,60	51,22-56,14	под 51,22
	20	25	над 71,05	66,37-71,05	64,03-66,36	59,34-64,02	56,99-59,33	52,29-56,98	под 52,29
	21	30	над 69,92	65,74-69,92	63,65-65,73	59,46-63,64	57,36-59,45	53,16-57,35	под 53,16
	22	35	над 71,24	66,83-71,24	64,62-66,82	60,20-64,61	57,99-60,19	53,56-57,98	под 53,56
	23	48	над 73,20	68,75-73,20	66,52-68,74	62,06-66,51	59,83-62,05	55,36-59,82	под 55,36
	24	49	над 73,56	69,33-73,56	67,21-69,32	62,97-67,20	60,85-62,96	56,60-60,84	под 56,60
	25	42	над 74,00	69,61-74,00	67,41-69,60	63,01-67,40	60,81-63,00	56,40-60,80	под 56,40
	26	46	над 73,48	69,62-73,48	67,69-69,61	63,82-67,68	61,88-63,81	58,00-61,87	под 58,00
	27	31	над 72,41	68,70-72,41	66,84-68,69	63,12-66,83	61,26-63,11	57,53-61,25	под 57,33
	28	42	над 72,13	68,72-72,13	67,01-68,71	63,59-67,00	61,88-63,58	58,45-61,87	под 58,45
	29	40	над 72,50	69,11-72,50	67,41-69,10	64,01-67,40	62,31-64,00	58,90-62,30	под 58,90
	30	40	над 72,96	68,72-72,96	66,60-68,71	62,35-66,59	60,22-62,34	55,96-60,21	под 55,96
	31	30	над 72,61	68,51-72,61	66,46-68,50	62,35-66,45	60,29-62,34	56,17-60,28	под 56,17
	32	28	над 71,97	68,33-71,97	66,51-68,32	62,86-66,50	61,03-62,85	57,37-61,01	под 57,37
	33	24	над 70,73	68,03-70,73	66,68-68,02	63,97-66,67	62,61-63,96	59,89-62,60	под 59,89
	34	19	над 72,31	68,08-72,31	65,96-68,07	61,72-65,96	59,60-61,71	55,35-59,59	под 55,35
	35	18	над 71,37	66,29-71,31	63,75-66,28	58,66-63,74	56,11-58,65	51,01-56,10	под 51,01
	36	16	над 70,60	66,78-70,60	64,87-66,77	61,04-64,86	59,12-61,03	55,28-59,11	под 55,28
	37	13	над 70,81	66,91-70,81	64,96-66,90	61,05-64,95	59,09-61,04	55,17-59,08	под 55,17

Based on the data of the variance analysis we can outline the following trends in the sports performance of world level female disc throwers: aged 19: about 60 m; over the age 24: about 65 m, aged 24-33: a period of stable performance of over 65 m and over the age of 33 we also found high and stable achievements, a proof of sports longevity in the disc throwing event.

A STUDY ON THE PHYSICAL POTENTIAL OF A FEMALE DISC THROWER

A STUDY ON THE ANTHROPOMETRIC INDICES OF THE BEST FEMALE DISC THROWERS IN THE WORLD AND IN THIS COUNTRY

Athletics throwing includes events in which female disc thrower's anthropometric indices are of crucial importance for both the selection of the most gifted persons (in terms of physical indices) and for the process of preparation and sports technique improvement. All this has given us grounds to follow up the situation concerning the basic anthropometric indices for the world and Bulgarian elite.

METHODS

We hereby study the basic anthropometric indices of the first 50 placed in the everlasting ranking list and the first 18 in the Bulgarian ranking list: Height (cm), Weight (kg) and Body Mass Index (LMI).

Sports performance is the starting point.

Figure 11 shows the distribution of cases according to the Height Index.

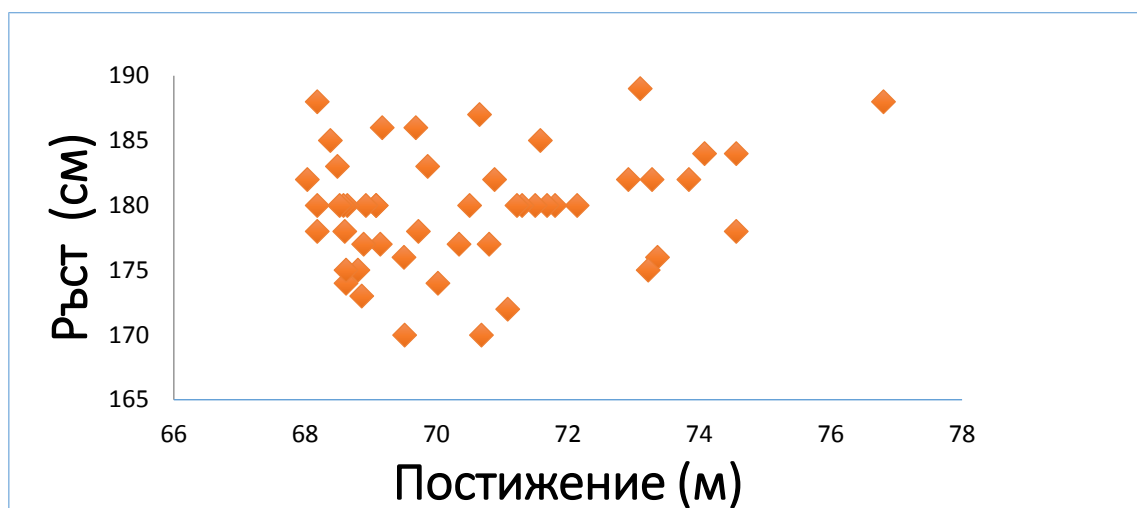


Fig. 11 Distribution of cases according the Height Index, World Elite.

Figure 14 displays the distribution of cases according to the Height Index of the Bulgarian elite.

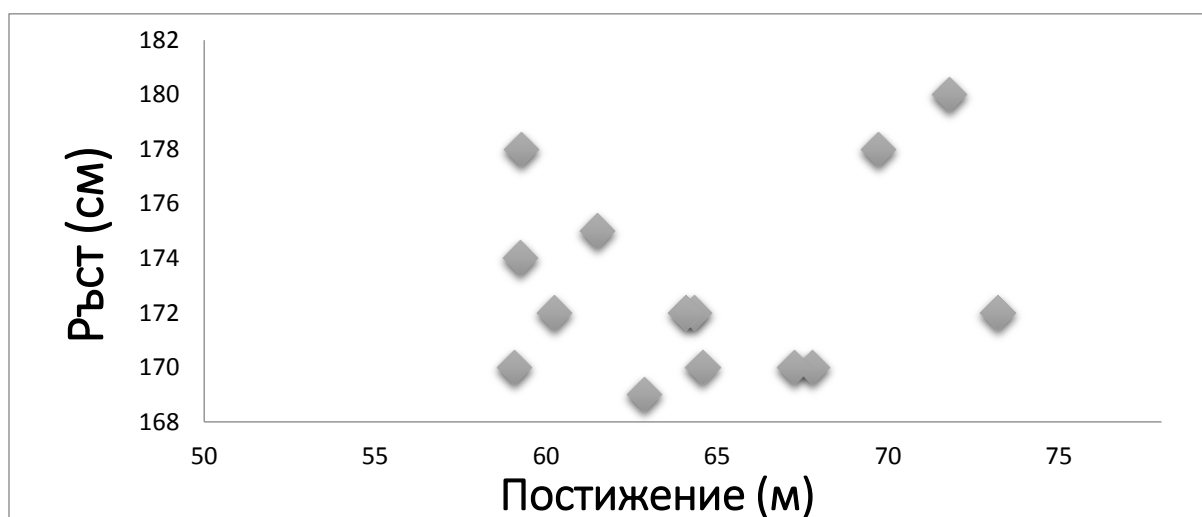


Fig. 14 Distribution of cases according to the Height Index, Bulgarian Elite.

SUMMARY

The general conclusions for all indices under study in both groups of athletes, the World and Bulgarian elite are as follows:

1. Homogeneity of the data sample.
2. No correlation between sports performance and the indices under study in the studied samples of competitors registering performances within the range of 65-75 m for both the World and Bulgarian elite has been observed.

A STUDY ON THE SPECIFIC SPORTS TECHNIQUE ABILITIES OF A FEMALE DISC THROWER

We have followed the changes in five basic specific exercises, used in the preparation of female disc throwers: **sports performance (m), standing disc throw (m), disc throw 1,5 kg with rotation (m), disc throw 1,25 kg with rotation (m), disc throw 0,75 kg with rotation.**

Table 21 shows the variance analysis on the research data.

Table

21

VARIANCE ANALYSIS ON: SPORTS TECHNIQUE ABILITIES

	n	Xmin	Xmax	R	X	S	V	As	Ex
Performance/m	30	48.84	73.22	24.38	65.06	3.85	8.23	-1.06	1.69
Standing disc throw/m	30	41,0	61,64	20,64	52,50	2.28	8.92	0.76	0.61
Disc throw 1,5 kg with rotation/m	30	37,02	55,60	18,58	45,45	2.02	7.48	0.19	-0.48
Disc throw 1,25 kg with rotation/m	30	39	61,20	22,20	49,20	3.37	8.09	-0.75	0.66
Disc throw 0,750 kg with rotation	30	56	81,20	25,20	64,65	4.01	9.31	-0.94	-0.85

The correlation analysis on the data shows that the correlation between the indices under study and the sports performance is over 0,81.

The latter allows the use of the regression model in the development of a model. Table 23 includes Linear regression models. In this case, sports performance (Y) is a function of the respective index (X). This enables the determination of the sports performance corresponding to the respective level of development of that index (ability).

Table 24 presents Reverse regression models.

We also suggest a second possibility: a quality assessment on the development of the respective performance (ability) based on the grounds of the Sigma Method, Table 25. It contains five grades. The grades are **low**, **below medium**, **medium**, **above medium** and **high**.

Table 23

LINEAR MODELS			
Indices	Models	Sy/x	R
Standing disk throw 1 kg/m	$Y = -0,24 + 1,16.X$	2,01	0,93
Disk throw 1,5 kg with rotation/m	$Y = 9,46 + 1,15.X$	1,99	0,85
Disc throw 1,25 m with rotation/m	$Y = 41,02 + 0,47.X$	2,22	0,90
Disc throw 0,75 kg with rotation/m	$Y = 39,07 + 0,41.X$	2,45	0,88

Table 24

REVERSE MODELS			
№	Indices	Модел	Sy/x R
1	Standing disk throw 1 kg/m	$Y = 9,11 + 0,70.X$	0,95
2	Disk throw 1,5 kg with rotation/m	$Y = -1,01 + 0,78.X$	0,84
3	Disc throw 1,25 m with rotation/m	$Y = 15 + 0,61.X$	0,88
4	Disc throw 0.75 kg with rotation/m	$Y = 33,05 + 0,58.X$	2,45 0,83

Table 25

ASSESSMENT TABLE: SPECIFIC SPORTS TECHNIQUE ABILITIES

Assessment	Performance/m	Shotput throw forward/m	Shotput throw backward/m
low	below 55.2	below 16.3	below 18.1
Below medium	from 55.2 to 59	from 16.3 to 17.3	from 18.1 to 19.15
Medium	from 59 to 66.6	from 17.3 to 19.3	from 19.15 to 21.25
Above medium	from 66.6 to 70.4	from 19.3 to 20.3	from 21.25 to 22.3
High	over 70.4	over 20.3	over 22.3

A STUDY ON THE COMPLEX SPEED-STRENGTH ABILITIES OF A FEMALE DISCK THROWER

The object of study are 14 of the best Bulgarian female disc throwers throughout the whole history of the event in this country their sports performances ranging from 59,08 m to 73,22 m.

We have followed up the changes in sports performance in two basic speed-strength exercises, Table 26.

Table 26

INDICES UNDER STUDY

Index	Name of Index	Allowance
SP/m	Sports performanc / m	0,01
SPT fw	Shotput 4 kg throw with both hands forward / m	0,01
SPT bw	Shotput 4 kg throw with both hands backward overhead / m	0,01

Table 27 displays the results of the variance anslysis on the data under study.

Table

VARIANCE ANALYSIS: COMPLEX SPEED-STRENGTH ABILITIES									
	<i>n</i>	<i>Xmin</i>	<i>Xmax</i>	<i>R</i>	<i>X</i>	<i>S</i>	<i>V</i>	<i>As</i>	<i>Ex</i>
<i>CP/M</i>	30	46.6	73.2	26.6	62.8	7.6	12.08	-0.55	-0.44
<i>XΓ_{HH}/M</i>	30	14	20.8	6.8	18.3	2	10.78	-0.74	-0.85
<i>XΓ_{H3}/M</i>	30	15.5	23.4	7.9	20.2	2.1	10.24	-0.59	-0.59

We have observed an extremely high correlation grade between the indices under study and sports performance of over 0,892 which allows the implementation of the regression method.

Table 29 includes the Linear regression models and Table 30 includes the Reverse regression models. This allows the determination of both the level of development of the respective ability (index) for an individual performance and the corresponding sports performance of the respective level of that ability (index).

Table 29

LINEAR REGRESSION MODELS			
Index	Regression model	Sy/x	r
Shotput throw forward	$Y = 0 + 3.43.X$	3.486	0.892
Shotput throw backward	$Y = -3.51 + 3.28.X$	3.44	0.895

Table 30

REVERSE REGRESSION MODEL			
Index	Regression model	Sy/x	R
Shotput throw forward	$Y = 3.72 + 0.23.X$	0.906	0.892
Shotput throw backward	$Y = 1.75 + 0.30.X$	0.579	0.962

Table 31 offers a 5 grade scale of assessment on the indices under study developed on the grounds of the sigma method.

The grades are low, below medium, medium, above medium and high.

Table 31

ASSESSMENT TABLE: COMPLEX SPEED-STRENGTH ABILITIES

<i>Grade</i>	<i>Performance/m</i>	<i>Shotput throw forward/m</i>	<i>Shotput throw backward/m</i>
Low	below 55.2	below 16.3	below 18.1
Below medium	from 55.2 to 59	from 16.3 to 17.3	from 18.1 to 19.15
Medium	from 59 to 66.6	from 17.3 to 19.3	from 19.15 to 21.25
Above medium	from 66.6 to 70.4	from 19.3 to 20.3	from 21.25 to 22.3
High	above 70.4	above 20.3	above 22.3

A STUDY ON THE SPEDED-STRENGTH ABILITIES OF THE LOWER LIMBS

The object of study are the speed-strength abilities of the lower limbs of a part of the best Bulgarian female disc throwers with performances ranging within 48,84-73,22 m.

The subject of study are their speed-strength abilities.

We have followed up the changes in four basic strength exercises applied to the preparation of the female disc throwers: 30 meters low start with a sound signal in seconds (30 m LS), standing long jump in meters (SLJ/m), standing triple jump in meters (STJ/m) and standing fiive-fold jump in meters (5-fold J/m).

Table 32 displays the variance analysis on the data under study.

Table 32

VARIANCE ANALYSIS ON THE SPEE-DSTRENGTH ABILITIES OF THE LOWER LIMBS

	n	Xmin	Xmax	R	X	S	V	As	Ex
LS	30	48.84	73.22	24.38	65.06	5.35	8.23	-1.06	1.69
30 m LS.	30	4.20	4.80	0.60	4.46	0.18	3.92	0.36	-0.41
SLJ/m/M	30	2.50	3.00	0.50	2.72	0.12	4.48	0.18	-0.54
STJ/m	30	6.78	8.40	1.62	7.66	0.37	4.89	-0.55	0.28
5-fold SJ/m	30	12.20	14.40	2.20	13.49	0.57	4.21	-0.54	-0.25

In order to apply the results from the study we suggest linear and reverse regression models. The implementation of the regression analysis is possible with all indices because of the fact that $R > 0,5$.

Table 34 displays the linear regression models. In this case sports performance (Y) represents the function of the respective index (X). This enables the determination of the sports performance in correspondance to the respective level of development of this index (ability).

Table 34

LINEAR REGRESSION MODELS			
Index	Regression model	Sy/x	r
30 m LS/sec	$Y = 110.21 - 10.11.X$	$Sy/x = 5.14$	$r = -0.331$
SLJ/m	$Y = -9.5 + 27.39.X$	$Sy/x = 4.256$	$r = 0.624$
STJ/m	$Y = -14.86 + 10.43.X$	$Sy/x = 3.723$	$r = 0.73$
5-foldJ/ m	$Y = -3.41 + 5.07.X$	$Sy/x = 4.59$	$r = 0.538$

Table 35 displays the reverse regression models. In this case the respective index (Y) represents the function of the sports result (X). This enables the determination of development of the respective index (Y) corresponding to a certain sports performance.

Table 35

REVERSE REGRESSION MODELS			
<i>Index</i>	<i>Regression model</i>	<i>S_{y/x}</i>	<i>R</i>
<i>30 m LS/sec</i>	$Y = 5.17 - 0.01.X$	$S_{y/x} = 0.168$	$r = -0.331$
<i>SLJ/m</i>	$Y = 1.8 + 0.01.X$	$S_{y/x} = 0.097$	$r = 0.624$
<i>STJ/m</i>	$Y = 4.34 + 0.05.X$	$S_{y/x} = 0.26$	$r = 0.73$
<i>S 5-fold/m</i>	$Y = 9.78 + 0.06.X$	$S_{y/x} = 0.487$	$r = 0.538$

We also offer another possibility for assessment on the development of the respective performance (ability) produced on the basis of Sigma method, Table 36.

Table 36

ASSESSMENT TABLE ON SPEED-STRENGTH ABILITIES OF THE LOWER LIMBS					
<i>Grade</i>	<i>AR/m</i>	<i>30 Mls/SEC</i>	<i>SLJ/m</i>	<i>STJ/m</i>	<i>5-fold J/m</i>
<i>Low</i>	below 55.2	above 4.64	above 2.6	Below 7.21	Below 12.92
<i>Below medium</i>	from 55.2 to 59	from 4.53 to 4.64	from 2.6 to 2.66	from 7.21 to 7.48	from 12.92 to 13.26
<i>Medium</i>	to 59 to 66.6	from 4.40 to 4.53	from 2.66 to 2.74	from 7.48 to 7.71	from 13.26 to 13.51
<i>Above medium</i>	from 66.6 to 70.4	from 4.32 to 4.40	from 2.74 to 2.80	from 7.71 to 7.93	from 13.51 to 13.86
<i>High</i>	from 70.4	below 4.32	above 2.80	above 7.93	above 13.86

A STUDY ON THE STRENGTH ABILITIES OF THE FEMALE DISC THROWER

The object of study are the best 14 Bulgarian female disc throwers in this country throughout the history of the event their performance ranging from 59,08 m to 73,22 m.

We have followed up the changes in the performance in all four fundamental power exercises: back barbel squat, clean from lying position, snatch overhead and power clean turn.

Table 38 displays the variance analysis on the research data.

The correlation analysis on the data shows a definitely high grade of correlation between all of them: $R > 0,766$.

For the implementation of the results from the research we offer linear and reverses regression models.

Table 38

VARIANCE ANALYSIS: STRENGTH ABILITIES									
	<i>N</i>	<i>Xmin</i>	<i>Xmax</i>	<i>R</i>	<i>X</i>	<i>S</i>	<i>V</i>	<i>As</i>	<i>Ex</i>
<i>Result</i>	30	46.6	73.2	26.6	62.8	7.6	12.08	-0.55	-
<i>Barbell</i>	30	100	180	80	146.5	24.5	16.7	-0.33	-
<i>squat</i>									1.09
<i>Clean</i>									
<i>from</i>	30	75	207.5	132.5	118.2	29.1	24.61	0.80	1.50
<i>lying</i>									
<i>position</i>									
<i>Snatch</i>	30	60	107.5	47.5	82.3	13.5	16.44	-0.43	-
								17.1	-
<i>Turn</i>	30	75	147.5	72.5	111.9	19.2	7	0.37	-
									0.73

Table 40 displays the linear regression models.

Table 41 displays the reverse regression models.

Table 40

LINEAR REGRESSION MODELS			
<i>Index</i>	<i>Regression model</i>	<i>Sy/x</i>	<i>r</i>
<i>Barbel squat</i>	$Y = 25.16 + 0.26.X$	$Sy/x = 4.319$	$r = 0.829$
<i>Clean from lying position</i>	$Y = 39.22 + 0.2.X$	$Sy/x = 4.966$	$r = 0.766$
<i>Snatch</i>	$Y = 21.6 + 0.5.X$	$Sy/x = 3.473$	$r = 0.893$
<i>Power clean turn</i>	$Y = 24.66 + 0.34.X$	$Sy/x = 3.891$	$r = 0.864$

Таблица 41

REVERSE REGRESSION MODELS			
<i>Index</i>	<i>Regression model</i>	<i>Sy/x</i>	<i>r</i>
<i>Barbel squat</i>	$Y = -21.43 + 2.67.X$	$Sy/x = 13.921$	$r = 0.829$
<i>Clean from lying position</i>	$Y = -66.25 + 2.93.X$	$Sy/x = 19.025$	$r = 0.766$
<i>Snatch</i>	$Y = -17.76 + 1.59.X$	$Sy/x = 6.191$	$r = 0.893$
<i>Power clean turn</i>	$Y = -25.52 + 2.19.X$	$Sy/x = 9.851$	$r = 0.864$

We also offer another possibility for a quality assessment on the level of development of the respective performance (ability) based on the Sigma method, Table 42.

Table 42

ASSESSMENT TABLE : STRENGTH ABILITIES

<i>Assessment</i>	<i>Performanc e/m</i>	<i>Barbel squat/kg</i>	<i>Clean from lying position/kg</i>	<i>Snatch/kg</i>	<i>Turn/kg</i>
<i>Low</i>	below 55.2	below 122	below 89.1	below 68.8	below 92.7
<i>Below medium</i>	from 55.2 to 59	from 122 to 134.25	from 89.1 to 103.65	from 68.8 to 75.55	from 92.7 to 102.3
<i>Medium</i>	from 59 to 66.6	from 134.25 to 158.75	from 103.65 to 132.75	from 75.55 to 89.05	From 102.3 to 121.5
<i>Above medium</i>	from 66.6 to 70.4	from 158.75 to 171	from 132.75 to 147.3	from 89.05 to 95.8	from 121.5 to 131.1
<i>High</i>	over 70.4	over 171	over 147.3	over 95.8	over 131.1

A STUDY ON THE TECHNIQUE POTENTIAL OF THE FEMALE DISC THROWER

TIME CHARACTERISTICS OF THE DISC THROW

The object of study are the time characteristics of 18 attempts performed by Renata Petkova, the disc throw State National Champion over the recent five years with a personal record of 51,09 m. The following performances range from 34,72 to 49,96 m.

We have followed up the changes occurred in six indices, Table 43.

Table 43

STUDIED INDICES

<i>Index</i>	<i>Name</i>	<i>Allowance</i>
<i>L[m]</i>	Sports performance/m	0,01
<i>X1[S]</i>	Duration of double support – start/sec	0,01
<i>X2[S]</i>	Duration of single support – start/sec	0,01
<i>X3[S]</i>	Duration of non-support phase/sec	0,01
<i>X4[S]</i>	Duration of single support – final effort/sec	0,01
<i>X5[S]</i>	Duration of double support – final effort/sec	0,01

For better reading of the medium, maximum and minimum values of the indices they are shown in Fig. 23

It is evident that the double support duration (X1[S]) varies within the largest range. The swing (R) is within the range of 0,86 – 1,58 sec. The trend is as follows: we observe an increase in sports performance parallel to an increase in double support duration. The latter is confirmed by the correlation coefficient, $r = 0,689$ (Table 45). The more gradual beginning of the start has a positive effect on the overall execution of the motor act later.

The rest of the characteristics under observation are of very low values of the swing R which necessitates a detailed discussion.

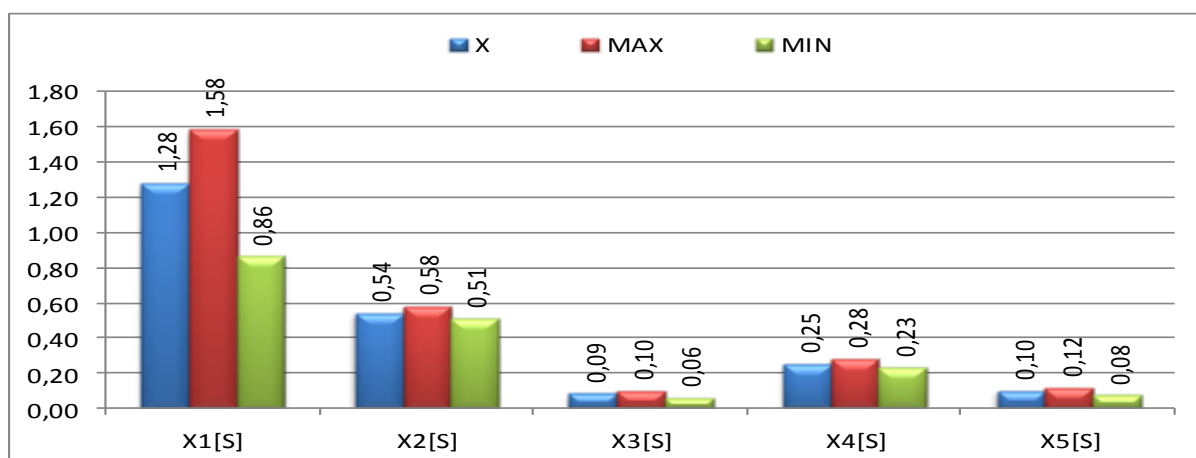


Fig. 23. Dynamics of changes in time characteristics.

The significant correlation between the studied indices and sports performance ($r > 0,450$) are of great interest. In this case, sports performance enters a significant interrelation with X1[S] (which has been mentioned above), with X2[S] (duration of the single support at the start - $r = -0,615$) and with X3 (duration of non-support phase - $r = 0,701$).

This presumes that the longer contact with the support during the double support (a negative correlation) followed by a shorter duration of the single support is a sign of an accelerated entry into the throw.

The lengthening of the non-support phase duration suggests that its shortening in time and space is an indication of 'running through' the start resulting in an ineffective overtake of the disc during the rotation as well as in an ineffective preparation for the final effort.

The lengthening of the path and the duration of impact on the disc during the final effort, which is a necessary condition for the acceleration of the disc during the final effort (proved by V. Tutevich, 1969), is also confirmed by our study, index X5 (double support phase duration) ($r = 0,493$).

AMPLITUDE CHARACTERISTICS OF DISC THROW

The object of study are the amplitude characteristics of indices significant for the throw followed up in 18 attempts performed by Renata Petkova, the disc throw

State National Champion with a personal record of 51,09 m for the recent five years. The attempts under study range from 34,72 to 49,96 m.

We have followed up the changes which occur in nine indices, Table 45.

For easier reading of the medium, maximum and minimum values of the indices they are shown in Fig. 25

Table 45

INDICES UNDER STUDY		
Index	Name	Allowance
L[m]	Sports performance / m	0,01
X1[m]	Length of first stride (start) / m	0,01
X2[m]	Length of second stride (final effort) / m	0,01
X3[m]	Disc position away from support at the throw start / m	0,01
X4[m]	Disc position away from support at the end of double support / m	0,01
X5[m]	Disc lowest position away from support during the final effort / m	0,01
X6[m]	Disc position away from support at the beginning of final effort / m	0,01
X7[m]	Disc lowest position away from support during final effort / m	0,01
X8[m]	Disc position away from support at the point of dropping the disc / m	0,01

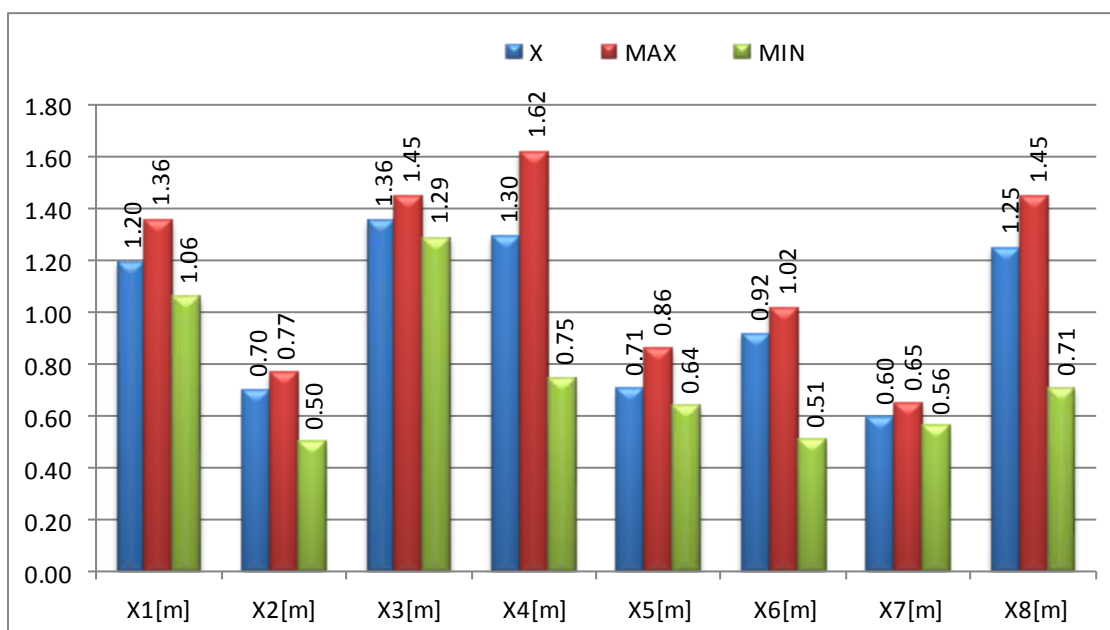


Fig.

25 Dynamics of amplitude characteristics

X4 (disc position away from support at the end of double support during the start) exhibits the highest values of the swing, the difference between the maximal and the minimal results in the sample of the range under study.

It is followed by X8 (disc position away from support at the point of dropping the disc) and X6 (disc position away from support at the beginning of the final effort).

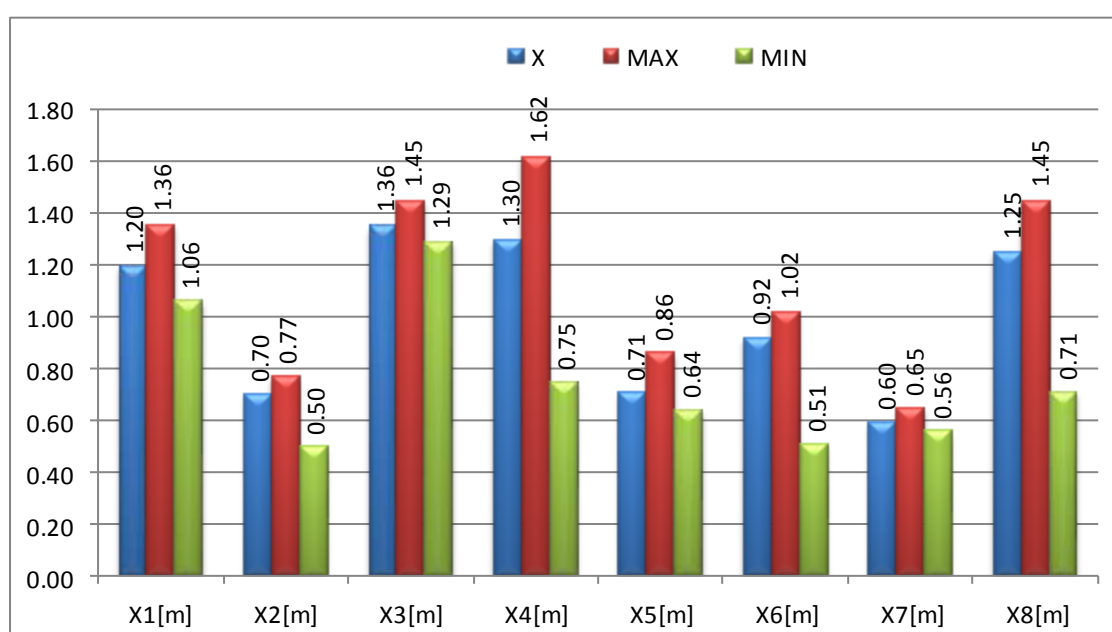


Fig. 25 Dynamics of amplitude characteristics

These two indices are integrally correlated as a part of the final effort which explains the similarity in their character as well as their effect on each other ($r = 0,834$).

Sports performance (L) comes into significant correlation with the following amplitude indices:

- X2[m] (length of second stride) – $r = 0,823$;
- X3[m] (disc position away from support at the beginning of throw) – $r = -0,785$;

- X5[m] (the lowest position of disc away from support during the final effort) – $r = -0,693$.

The high degree of correlation with index X2[m] completes the information from the previous correlation of sports performance which reflects the correlation between sports performance and second stride duration.

The negative correlation with X3[m] suggests that the lower movement of the disc during the final effort is a precondition for its poor orientation as a result of either a smaller or larger angle of throwing.

The correlation with X5[m] (the lowest disc position away from support in the final effort) completes the above mentioned judgement, i.e. it is not reasonable the angle of throwing the disc to vary within a large range on the vertical plane.

The correlations between the very indices under study followed up in one of the next chapters are of great interest.

ANGLE CHARACTERISTICS OF DISC THROW

The object of study are the angle characteristics of indices significant for the throw followed up in 18 attempts performed by Renata Petkova, the State National disc throw champion, with a personal record of 51,09 meters. The attempts under study range from 34,72 to 49,96 meters.

We have followed up the changes which occurred in 10 indices, Table 47.

For easier reading the average, maximal and minimal index values are presented in Fig. 27.

The highest value of the swing with the angle indices is observed for X6[gr] – the right knee joint angle at the beginning of the single support, X7[gr] – the right knee joint angle at the point of dropping the disc and X8[gr] – the left knee joint angle at the point of dropping the disc.

This circumstance is visually presented in Fig. 27 where significant differences between the minimal and maximal values of the characteristics quoted above are observed in the sample under study.

We have observed significant degrees of correlation between sports performance and angle indices with index X4[gr] (body lean from support at dropping the disc – $r = -0,660$) and index X8[gr] (left knee joint angle at the moment of dropping the disc – $r = 0,790$).

The explanation for index X4[gr] is easy and logical. In this case, the widening of this angle reflects the ‘flight’ of the disc in a forward direction at the final effort (the angle is measured according to the horizontal plane in a back to forward direction according to the direction of the throw).

Table 47

INDICES UNDER STUDY

<i>Index</i>	<i>Name</i>	<i>Allowance</i>
<i>L[m]</i>	Sports performance / m	0,01
<i>X1[gr]</i>	Body lean from support during double support at the beginning of the start / degrees	1
<i>X2[gr]</i>	Body lean from support during single support at the beginning of the start / degrees	1
<i>X3[gr]</i>	Body lean from support during double support at the beginning of the final effort (step on the right foot) / degrees	1
<i>X4[gr]</i>	Body lean from support at dropping the disc / degrees	1
<i>X5[gr]</i>	Maximum flexion of the right knee joint during single support / degrees	1
<i>X6[gr]</i>	Angle of the right knee joint at the beginning of single support during final effort	1
<i>X7[gr]</i>	Angle of the right knee joint at the point of dropping the disc / degrees	1
<i>X8[gr]</i>	Angle of the left knee joint at the point of dropping the disc / degrees	1
<i>X9[gr]</i>	Angle of dropping the disc / degrees	1

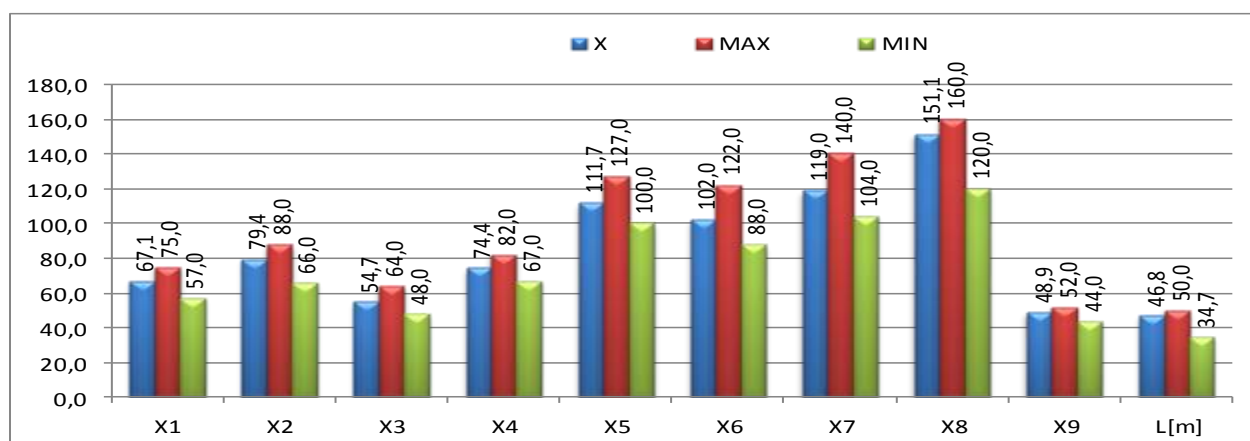


Fig. 27 Dynamics of angle characteristics

The explanation of index X8[gr] is a proof of sports practice and scientific research on throw technique, i.e. it is considered to be reasonably carried out in all types of throws, disc throw included, where execution is completed on the forward stepping leg which is maximally extended or even over extended (over 180 degrees).

CORRELATION BETWEEN THE STUDIED INDICES OF THE FEMALE DISC THROWER' TECHNIQUE POTENTIAL

As an addition for easier reading together with the table we also offer a graphic presentation of the significant correlations, Fig. 29. This allows the follow-up of both the significant correlation with sports performance and the correlation between separate indices of one or different groups as well as with the rest whose values are insignificant.мн.

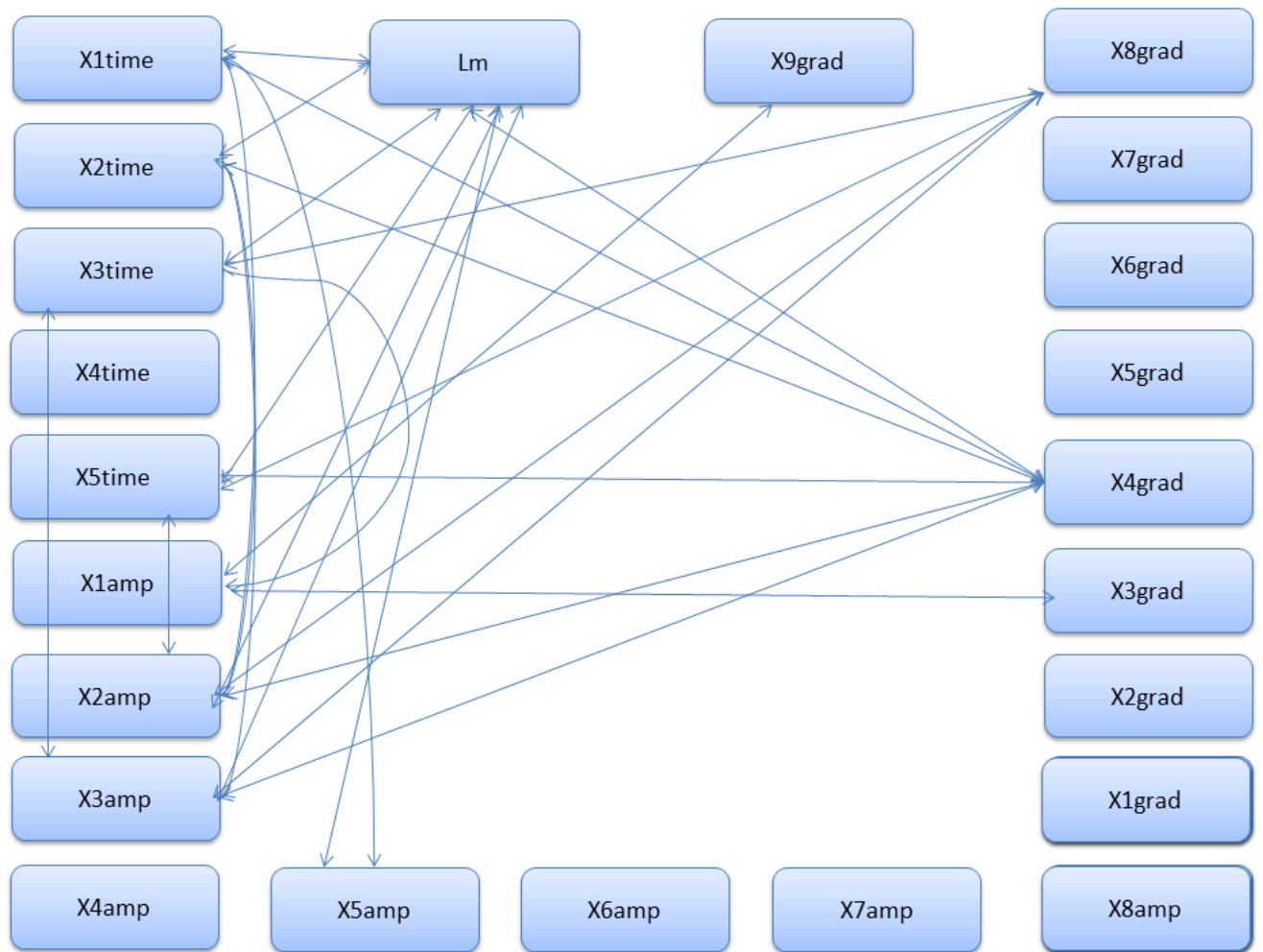


Fig. 29 Significant correlations (presented by an arrow)

A STUDY ON THE CAPABILITY TO REALIZE SPORTS TECHNIQUE ABILITIES

The aim of each athlete is to achieve high sports performance on one hand and on another to realize and even to exceed one's own available sports technique abilities at the most important competition of the year.

We have followed up 21 female disc throwers of the European elite placed on the first three positions during the recent 7 championships as well as 21 Bulgarian female disc throwers occupying the first three positions at the State National Championships in the years of the European Championships.

We have followed up the changes occurring in 7 indices which provide information about the expression of their abilities:

1. Placement at the European Competition (E) and at the State National Championship (Bg).
2. The best performance achieved during the year of the European and Bulgarian Championships measured in meters, S1.
3. The performance at the European (E) and the Bulgarian (Bg) Championships measured in meters, S2.
4. The difference S1-S2 measured in meters.
5. The correlation S2/S1 in %.
6. A comparative analysis on the average values in % (X) of the first, second and third positions at both Championships.

According to the degree of realization of the first in Europe and at home.

What do we find for the champions (correlation S2/S1% presented in average values), Fig. 30.

There is a certain prevalence of the Bulgarian disc throwers according the degree of their realization: in five of the events (1998, 2002, 2006, 2012 and 2014 r) they achieve personal records at the most important competition of the year against two of the European elite.

Fig. 31 presents the degree of realization of those placed second at the studied European Championships and the second at the Bulgarian Championships in the years under study. The picture of the silver medalists is similar: in four cases a hundred percent realization of the Bulgarians against none of the European elite.

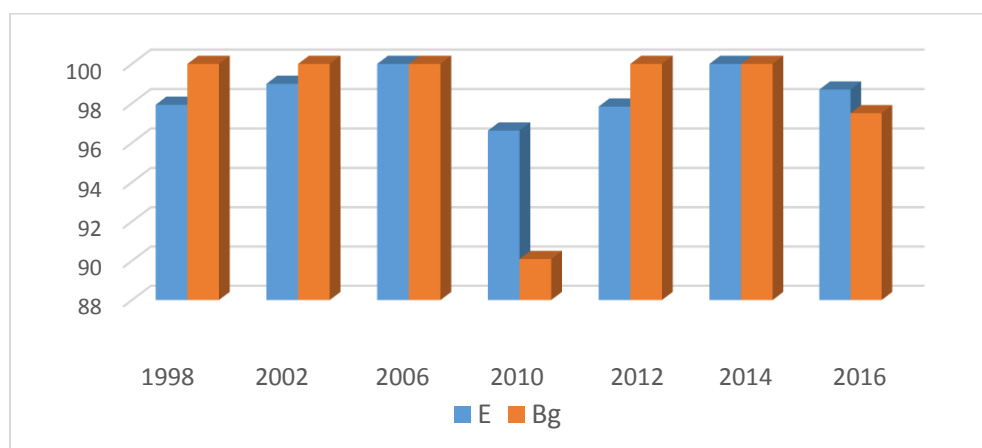


Fig. 30 Degree of realization of the first in Europe and in Bulgaria

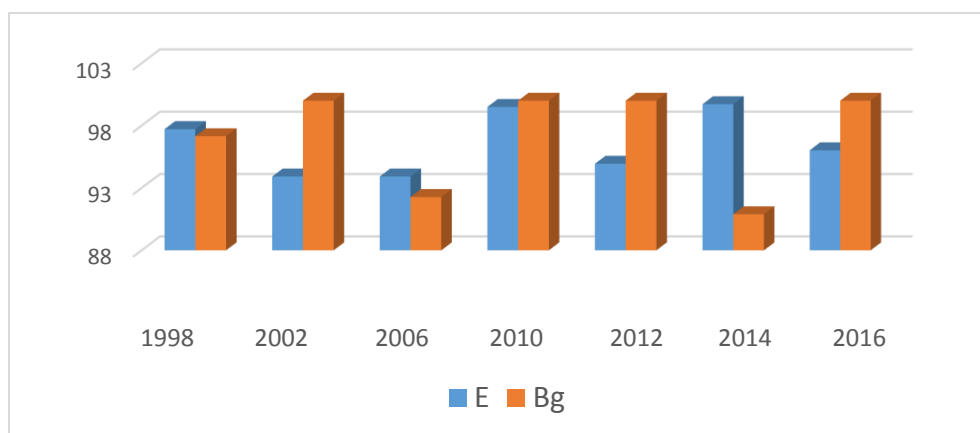


Fig. 31 Degree of realization of the second in Europe and in Bulgaria

Fig. 32 presents the degree of realization of those placed third at the studied European Championships and the third at the Bulgarian Championships in the years under study. The picture of the bronze medalists is similar: in four cases a hundred percent realization of our girls against one of the European elite.

Our general conclusion is as follows: the better realization of the available sports technique abilities of the Bulgarian female disc throwers at the most important competitions in the year is a relative advantage in case of their participation in competitions of a higher rank such as European Championships. This conclusion is grounded on the fact that the considerably lower sports technique abilities cannot be compensated by any mental abilities.

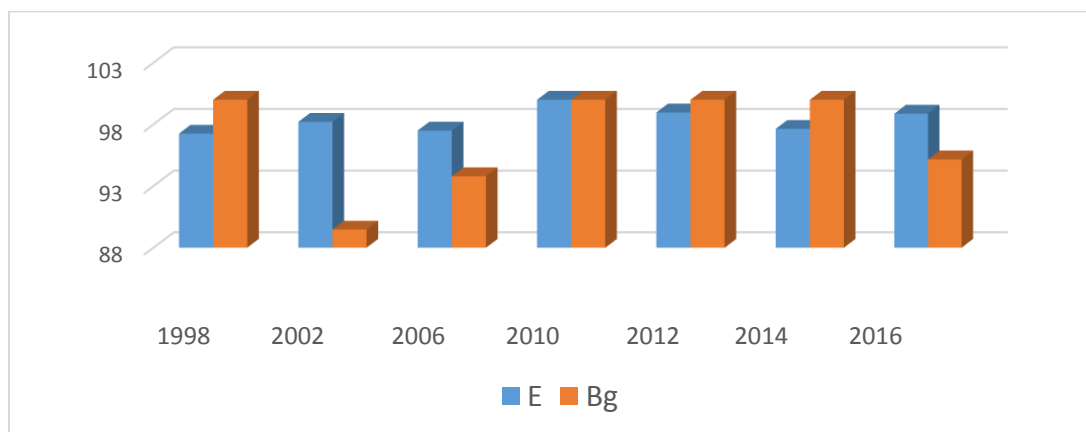


Fig. 32 Degree of realization of the third in Europe and in Bulgaria.

On the other hand, we can suggest that the higher level of a certain competition presumes a higher level of mental tension which results in a greater probability for negative emotions, a condition for incomplete sports realization.

IMPLEMENTATION OF THE RESULTS FROM THE STUDY INTO SPORTS PRACTICE

In relation to the female disc thrower's technique potential.

In this particular case, the presented technique abilities of the disc thrower who has proved herself in sports practice as well as the trends in disc throw time and space parameters connected with the change in sports performance can be borrowed and implemented to the technique preparation of our growing-up female disc throwers.

In relation to the female disc thrower's physical potential.

Besides the use of the regression models (linear and reverse) to calculate the respective values of sports performance or the respective index of physical potential we also suggest complete tables including an operational description of the respective disc thrower's abilities as well as a plan for her preparation in accordance to her sports technique abilities at the current moment or in the near future.

In Table 51 we offer model characteristics of the disc thrower's specific sports technique abilities within the range of 40-70 meters developed on the data base of the best Bulgarian female disc throwers.

Table 51							
SPECIFIC SPORTS TECHNIQUE ABILITIES OF A FEMALE DISC THROWER IN A QUALIFICATION ASPECT							
<i>Sports Performance/m Indices</i>	<i>40</i>	<i>45</i>	<i>50</i>	<i>55</i>	<i>60</i>	<i>65</i>	<i>70</i>
Standing disc throw / m	37	40	44	48	52	56	60
Disc throw 1,5 kg with rotation / m	30	34	38	42	46	50	54
Disc throw 1,25 kg with rotation / m	37	40	44	48	52	55	58
Disc throw 0,750 kg with rotation / m	49	54	59	63	67	71	76

CONCLUSION AND RECOMMENDATION

- 1. The Bulgarian disc throwers have left a lasting trace in the history of this event on a worldwide scale which is a guarantee for the high information level of the science research data included in the study.**
- 2. We have observed a certain decline with the European elite (about 10%) and a significant fall with the Bulgarian elite (over 30%) off their standards noted at the end of 1980s. This is presented in figures as follows:**
 - 17,26 meters average distance of Bulgarian away from European champions;**
 - 20,06 meters average distance of the second Bulgarians away from the second positions in Europe;**
 - 21,86 meters average distance of the thirds positions at home away from those in Europe.**
- 3. The age of 25 is determined as the peak in sports performance of female disc throwing event. Its gradual increase is observed at the age of 17-25 and its decline at the age of 25-37.**
- 4. There is no significant correlation between sports performance and the anthropometric indices of the studied Bulgarian and World elite in the female disc throwing event in the period of high sports performance, 60 – 75 meters.**
- 5. The female disc thrower's anthropometric signs vary as follows:**
 - height: world elite – 170-189 cm, average values - 179,8 cm; Bulgarian elite - 169-180 cm, average values - 173,1 cm;**
 - weight – world elite – 78-110 kg, average values - 93,8 kg; Bulgarian elite - 75-110 kg, average values – 86,9 kg;**
 - BMI – world elite – 18-34, average values – 28,9; Bulgarian elite - 23,7-34, average values - 29.**
- 6. Methods are suggested to follow up the development and changes in physical potential which provides opportunities for precise diagnosis on the level of development of the following:**
 - the specific sports technique abilities;**
 - the complex speed-strength abilities;**
 - lower limbs speed-strength abilities;**
 - strength abilities.**

- 7. The study on the time, amplitude and angle parameters of the throw allows the knowledge about its inner and outer ballistics as well as about its rhythmic structure.**
- 8. The higher degree of sports technique performance at an important competition does not always correlate to the female disc thrower's level of sports technique abilities.**

SUMMARY

The study presented here has given us grounds to define the current state of the disc throw event in Bulgaria as absolutely unsatisfactory on the background of European and World standards.

The level of sports performance in this country today is compared to that in the 1950s when we have taken our first serious steps in this event.

The present study is both an evidence for the conclusions made above and for the opportunity to use the experience of the Bulgarian female disc throwers of the recent past, experience which by no means gives way to that of the world elite.

As first and definitely a relevant indicator, we can accept the physical development of a contemporary Bulgarian female disc thrower related to that of her predecessors in the most successful period of the event in this country.

The revival of the event in this country can be expected as a result of the activities on the part of the athletics throwing events experts as well as on the part the responsible institutions whose change in attitude should create adequate conditions for the practice of the event and for the development of the athletics throwing events as a whole.

Scientific publications referent to the topic of the dissertation thesis

- 1. Карапетрова, Румяна, Вержиния Милашка, Ивайло Лазаров (2016) - Антропометричните признаци на съвременния дискохвърляч. Magazine: „Лека атлетика и наука“, NSA. ISSN 1310-3303. pp. 81-86.*
- 2. Милашка, Вержиния, Григор Гутев, Румяна Карапетрова (2017) - Проследяване динамиката на спортните постижения във възрастов аспект в дисциплината мятане диск за жени. Magazine: „Лека атлетика и наука“, NSA. ISSN 1310-3303. pp. 63-69.*

3. Карапетрова, Румяна, Вержиния Милашка, Ивайло Лазаров, Георги Стойков, Стефан Стойков (2018) – Комплексните скоростно-силови възможности на дискохвърлячката. International science conference 'European standards in sports education', Vratsa. I and B, Vratsa. ISBN: 978-619-7281-38-5. Pp. 134-139.
4. Милашка, Вержиния (2018) – Силовите възможности на дискохвърлячката. Magazine: „Лека атлетика и наука“, NSA. ISSN 1310-3303.