

NATIONAL SPORTS ACADEMY
“Vassil Levski”
Department “Basketball, Volleyball, Handball”

ASS. PROF. MARIANA ALEKSIEVA BORUKOVA, PH.D.

**COMPLEX SYSTEM FOR CONTROL
AND ASSESSMENT OF PHYSICAL
DEVELOPMENT AND SPECIFIC
WORKING ABILITY OF
ADOLESCENT BASKETBALL
PLAYERS**

**AUTHOR’S SUMMARY OF
DISSERTATION**

Sofia, 2022

The dissertation comprises 287 standard pages. It is visualized with 46 figures, 42 tables, two appendixes, a normative database with methodological guidelines for its use, and a protocol for testing. The reference list includes 230 literary sources, of which 140 are in Cyrillic, 83 in Latin, and 7 are Internet-based sources.

The defense of the dissertation will be held on 21.09.2022 at 2 p.m. at A3 Hall of NSA “Vassil Levski” at a meeting of the scientific jury in scientific specialty Theory and Methods of Physical Education and Sports Training (incl. МЛФ), professional field 7.6. Sport.

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Author’s summary of dissertation

for conferring the scientific degree

“DOCTOR OF SCIENCE”

in professional field 7.6. *Sport*

REVIEWERS:

- 1.prof. Daniela Dasheva, D.Sc.
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Sofia, 2022

INTRODUCTION

Worldwide, conducting systematic research and control of sports-competitive activities is a severe premise to a well-programmed and managed training process. A review of the literature shows that along with the term management, the term control is almost always used as well. In sports literature, control more or less is viewed as a small part of the whole management of the training process. In the term control, no author includes the functions which are so important for the management, such as designing and respectively making corrections in the training plans.

The scientific and practical knowledge of sports specialists in the field of basketball is extremely important for achieving highly efficient control. We have a rich experience in conducting sports-pedagogical testing with basketball players; however, some questions arise which do not receive a satisfactory answer. The work with adolescent basketball players in Bulgaria is not subjected to clear norms and requirements for control of the organized educational-training process. The lack of an integrated approach and an updated system for control of the sports preparation of young players is a major problem in selecting certain age groups.

We found that the already implemented test batteries impede the systematic control on behalf of coaches. The correct conducting of these tests requires more than one training session.

There are different tests for measurement in the control of sports preparation, but they need to be updated, substantiated, and unified. There are some tests, but they are related to the measurement of a set of play indicators which contribute differently to the victory in the different age groups.

The implementation of a test battery together with an updated normative system would be beneficial and would facilitate the work of coaches as regards the optimization of the educational-training process.

I.THEORETICAL GROUNDS OF CONTROL IN BASKETBALL METHODOLOGICAL CONCEPT

Control in any sphere cannot be viewed simply as a check aiming at sanctioning the digression. It is an automatic process which captures the conditions leading to deviations and reacts quickly so that they can be prevented and eliminated. Control is part of a person's cognitive activity where some information is collected, and the actual state of an object is evaluated with the aim of its purposeful (preliminarily planned) development and perfection. The primary objective control in the field of sports mastery is to optimize the training and competitive process based on objective information about the effect of the applied actions on the athlete(Jeliazkov&Dasheva, 2006). Control in sport integrates scientific-applied achievements in different scientific fields – chemistry, biology, physics, computer science, etc.

There are several types of control in sport: **in educational-training activities; in sports-competitive activities; in the effect of the training load and recovery.**

The training process should be viewed as a manageable complex system where different links are connected in a logical sequence, the necessary ratio between the parameters of the training load is determined along with the way different elements of the training session are connected. **The management of a system is invariably related to control.**

To observe the regularities of the development of sports preparation, we should know the peculiarities of the structural organization of the educational-training process. When working with adolescent basketball players, these regularities are hard to achieve. Besides being in top sports shape during the most important competition of the year, they should be **coached systematically all the year round, and the elements regarding play technique and tactics should be perfected over time.** According to the gender-age characteristics, coaches should develop young players' physical qualities and perhaps the most difficult part is that they must obey the main methodological principles such as the unity of education and motor development, two-sidedness, and parallel technical-tactical coaching in basketball.

The organization of scientific-methodological provision in basketball is aimed at improving the efficiency of the management of the educational processes through the application of scientific technologies for obtaining information about the functional condition of the athletes, about the level of general and specific physical, technical, and psychological preparation. On the basis of this information, some duly corrections in the educational-training process should be made. Pedagogical control lies in the basis of the scientific-methodological support of sports preparation. **In the process of athletes' preparation, it should be used to establish the relationship between education and training loads, as well as the level of the achieved results in competitions.**

In basketball, sports-pedagogical testing is done on the court. This is a preferable method for most coaches in Bulgaria and abroad.

The development and implementation in practice of an objective normative system for control of the preparation of adolescent basketball

players in sports clubs would assist not only their efforts to achieve a high level of sports mastery but also sports specialists' efforts to increase the efficiency of the educational-training process.

The researched Bulgarian and world experience in the field of control of adolescent basketball players' sports preparation allows us to outline the following *theoretical conclusions*:

1. There are criteria and means for control in order to establish the level of physical development, physical preparation, and technical skills of adolescent players in basketball practice, but the surveys done show that some corrections in the variables should be made.
2. The management of the training process requires an obligatory, permanent control which provides different information through the various stages of sports preparation.
3. The age distribution of the competitive categories and the early sports specialization in basketball suggest that the control of adolescent basketball players should start from U12.
4. The unified complex test battery with its normative system, which is applied from U12 to U16 with both genders, would facilitate control.

The outlined conclusions lead to the formulation of the central research thesis of this dissertation: *The control of the specific efficiency of adolescent basketball players in the form of a complex test battery as a novel approach for effective management of the training process and a premise for sports realization in elite basketball.*

II.DESIGN OF THE RESEARCH

1.The primary purpose of the research is the development of a complex system for control of the specific efficiency of adolescent basketball players as a significant factor in increasing the efficacy of sports preparation.

2. Tasks of the research:

1. To establish the state of the research problem on the basis of literary data and documentary sources.

2.To survey the opinion of sports specialists about the system for control of sports preparation in basketball.

3.To develop and implement a complex test battery.

4. To establish the mean level and variability of the researched indicators along gender and age.

5.To establish the significance of the researched indicators along gender and age through ratified criteria for comparison.

6. To establish the statistical reliability and content validity of the complex test battery.

7. To identify the major factors for physical development and specific efficiency for each age group.

8. To develop a Normative system for evaluation and control of adolescent basketball players (girls aged up to 12, 14, 16 years and boys aged up to 12, 14, 16 years).

3. Methodology of the research

This research was done in the period June 2020 – March 2022. **The subject** of research is the system for control of sports preparation of adolescent male and female basketball players in Bulgaria. **The object** of research is some basic indicators of physical development and specific

physical and technical preparation and their development at the age of 12-16 years under the influence of basketball training.

The research was done among 351 subjects – 41 basketball coaches and 330 male and female basketball players, divided into three age groups, presented in Table 1.

Table1.

Examined persons

Study	Subjects studied	Number examined				Total
1. Questionnaire survey.	1. Basketball coaches.	41				351
2. Sports and pedagogical testing.	2. Basketball players.	Gender	U12	U14	U16	
		Boys	45	45	47	137
		Girls	71	49	53	173
		Total	116	94	100	310

4. Organization of the research

The research was done with the help of the voluntary cooperation of coaches and competitors from leading clubs in Bulgaria, who took part in the National Championship for the different age groups up to U12, up to U14, and up to U16 years. Ten thirist-year students-volunteers from NSA “Vassil Levski” with a major Basketball coach took part in the research. For them, the participation in the testing was of practical-applicable and educational character in sports-pedagogical scientific field research.

5. Research methods and indicators

To fulfill the aim and the research tasks, we applied the following research **methods**: *a comprehensive survey and theoretical analysis of the*

specialized literature and documentary sources, a questionnaire method and an interview, anthropometry, and sports-pedagogical testing.

The results from the research were subjected to **math-statistical processing** with *analysis of frequencies, variation analysis, body mass index, relative share, method of sigma deviations, comparative Student's t-criterion, comparative U-criterion of ManWhitney, Cohen-d, ordinary linear regression, factor analysis.*

COMPLEX TEST BATTERY

Depending on the information they provide in each age group, the variables are distributed in three groups, as follows: for physical development; for specific physical preparation; and for specific technical preparation (technical skills).

For the needs of this research, from indicators N 15 “Dribble on the court with high speed and execution of shooting-time”, N 16 “Dribble on the court with high speed and execution of shooting-number of baskets made”, N 18 “Catch and pass with high speed and execution of shooting-time”, and N 19 “Catch and pass with high speed and execution of shooting-number of baskets made”, presented in Table 8, we outlined the indicators N 17 “Dribble on the court with high speed and execution of shooting-difference (t-number) and N 20 “Catch and pass with high speed and execution of shooting-difference (t-number)”. These indicators are calculated by subtracting the number of baskets made from the time of the researched individual, and for every technical mistake, we take away 1 s.

Table2.

Description of the complex test battery

No	Indicators	Measuring units	Measurement accuracy	Direction of increase
1.	Height	cm	1,0	+
2.	Weight	kg	0,5	
3.	Body Mass Index	kg/m ²	0,01	
4.	Horizontal extension	cm	0,5	+
5.	Vertical extension	cm	0,5	+
6.	Chest measurement – Pause	cm	0,5	+
7.	Chest measurement - respiratory difference	cm	0,5	+
8.	Sprint 20 m	s	0,01	-
9.	Vertical jump	cm	1,0	+
10.	Maximum Vertical jump	cm	1,0	+
11.	Squat jump	m	0,01	+
12.	Flexibility	cm	1,0	+
13.	“Shuttle” run - 140 m	s	0,01	-
14.	Test for swift moving - Agility	s	0,01	-
15.	Dribble and shooting at high speed – time	s	0,01	-
16.	Dribble and shooting at high speed- number of baskets scored	number	1.00	+
17.	Dribble and shooting at high speed (time-number) – difference	s	0,01	-
18.	Catching and passing, shooting the basket – time	s	0,01	-
19.	Catching and passing, shooting the basket- number of baskets scored	number	1.00	+
20.	Catching and passing, shooting the basket-(time-number) – difference	s	0,01	-
21.	Shooting – time	s	0,01	-
22.	Shooting- number of baskets scored	number	1,00	+
23.	Free throw	%	0,01	+

III. SYSTEM FOR CONTROL OF SPORTS PREPARATION OF ADOLESCENT BASKETBALL PLAYERS

According to their age, when working with young basketball players, we should emphasize the changes resulting from their biological development and age and gender characteristics. We should bear in mind that the increase in sports experience means that basketball players develop their physical qualities and improve their technical skills and that the functional state of their organisms is also increased. In the different age groups and the distribution along the factor gender, we observe different levels of increase in development which should be established, analyzed, and optimized during the training process.

ANALYSIS OF THE RESULTS

III.1. Indexes of dispersion and significance of the differences along the indicators of physical development of boys and girls from U12, U14, and U16

Figure 1 presents a comparative analysis of the mean values along all researched indicators of physical development.

The presence of higher values in the means ones and in the coefficients of variance, however, make us believe that as regards these indicators, boys and girls are superior to each other. For this purpose, we applied the comparative Student's t-criterion for independent samples. The results from the comparative analysis between the two groups are presented in Figure 2.

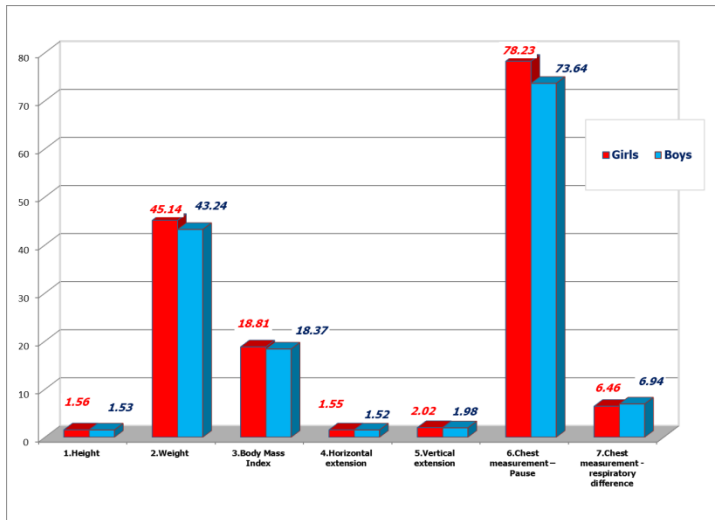


Fig. 1. Comparative analysis of the average values for the signs of physical development in U12 boys and girls

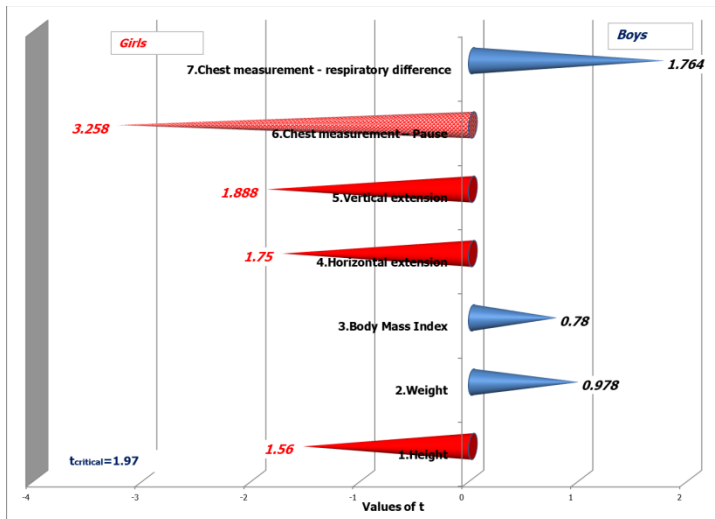


Fig. 2. Significance of differences in physical development indicators in boys and girls U12

The indicators which show that the group of the girls has an advantage are presented in the left part of the figure. With a high guarantee probability ($P_t \geq 95\%$), we can claim that in the researched sample, the girls from U12 have a significant advantage as regards the development of their chest compared with the boys from the same age group. The boys have an edge along all the other indicators (the right part of the figure), but all indicators have lower values of temp than the critical one. This allows us to claim, with a high guaranteed probability ($P_t \geq 95\%$), that the difference between the two mean arithmetical values of the two samples for U12 along the particular indicators can be explained with random reasons with 95% guaranteed probability.

The research conducted with young basketball players from U12, who practice basketball in Bulgarian clubs, provides us with some guidelines and information about *the level of physical development*:

1. According to the laws of biological development, girls surpass boys on the indicators related to the length of the body, but as for the functional capacity, they surpass them significantly.

2. In the selection of children up to U12, who practice basketball, we should make some corrections and select taller children.

The results from the comparative analysis of basketball players from U14, girls and boys, are presented in Figure 3.

The analysis of Figure 3 shows that in the age group U14 girls already lag along all indicators. This is due to the abrupt leap forward in the biological development of boys. We applied a comparative Student's t-criterion for independent samples and a comparative U-criterion of ManWhitney for the indicators "Weight" and "Chest circumference - pause" (Figure 4).

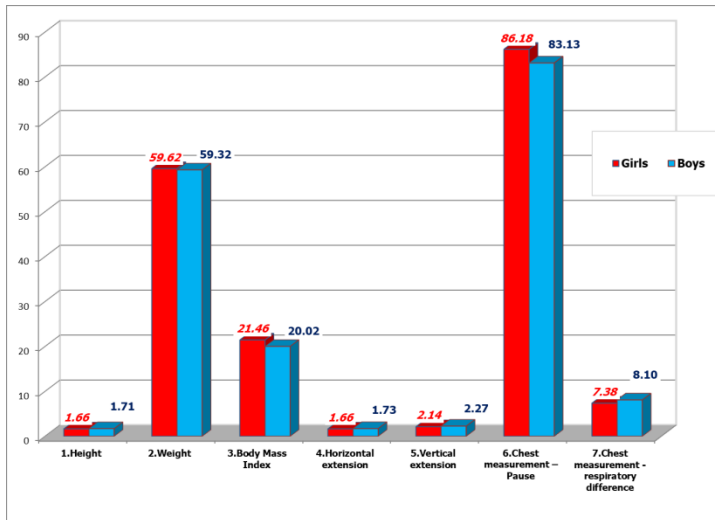


Fig. 3. Comparative analysis of the average values for the signs of physical development in U14 boys and girls

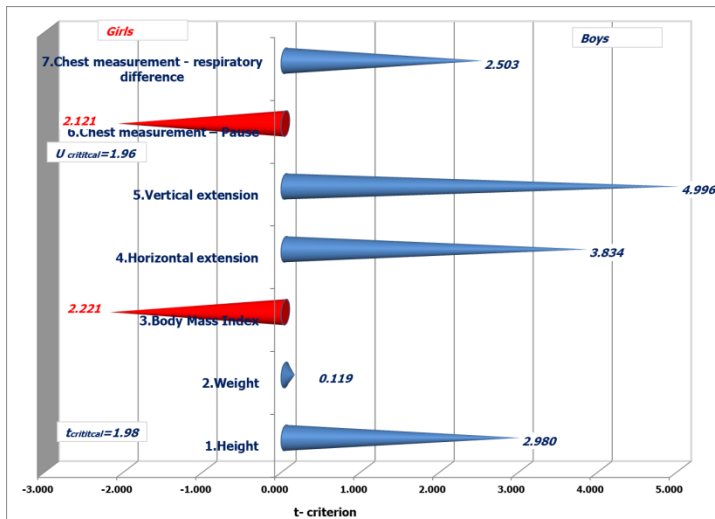


Fig. 4. Significance of differences in physical development indicators in boys and girls U14

The indicators showing that the group of the girls has an advantage are in the left part of the figure. These are the indicators related to the level of obesity and chest circumference – pause. There is a statistical significance of the difference in favor of the girls along both indicators. The indicator which provides information about the level of obesity cannot be defined as good or bad, or more precisely, it is only a reference point for coaches. However, if we do not conduct more detailed research to determine the fat tissue percentage in the overall body mass, we cannot make general conclusions.

The research with young basketball players from U14, who practice basketball in Bulgarian clubs, provide us with some guidelines and information about *the level of physical development*:

1. Girls are more overweight than boys but are within the obesity norms for their age group.

2. The selection of both male and female basketball players is not so good.

The comparative analysis of the mean values of U16, boys and girls, is presented in Figure 5. The analysis shows that in the age group U16, boys are already domineering along all indicators for physical development. They have already completed the stage of puberty, and everything has begun to change abruptly. The body starts to reach its anthropometric size close to the one of an adult person; the chest circumference is increasing, and the strength is growing, which, influenced by an organized educational-training process, leads to changes in the functional capacity of the chest. There is a big difference between the mean values along all indicators – 2 cm. The results from the comparative analysis between the two groups are presented in Figure 6.

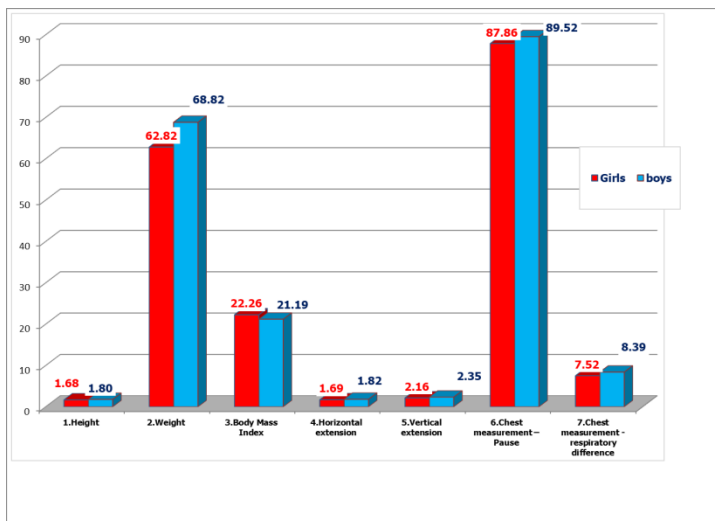


Fig. 5. Comparative analysis of the average values for the signs of physical development in U16 boys and girls

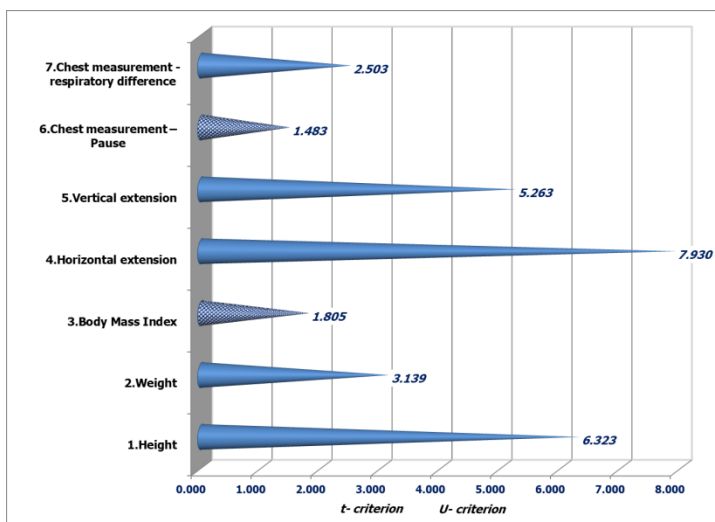


Fig. 6. Significance of differences in physical development indicators in boys and girls U16

The research with young basketball players from U16, who practice basketball in Bulgarian clubs, provide us with some guidelines and information about the *level of physical development*:

1. This is the age when the biological development and the prolonged educational-training process positively influence boys' physical development level compared with that of the girls.
2. There are no tall children, as desired in basketball, among both groups. The selection of boys, however, is better.

III.2.Indexes of dispersion and comparative analysis of the level of physical preparation of girls from U12, U14, and U16

The analysis of the results about the observed indicators of physical preparation of the girls from all age groups shows that the values are normally distributed, and the observed samples are homogeneous or relatively homogeneous as regards the researched indicators. The results are presented in Table 3.

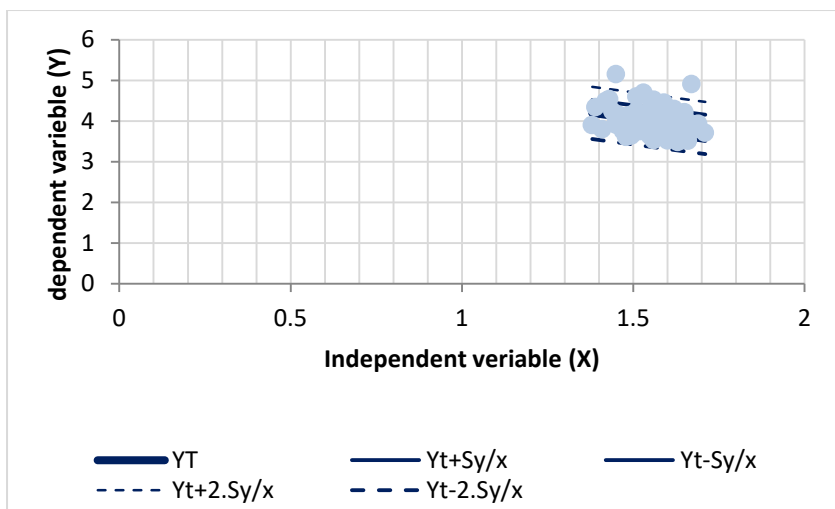
We found that the advancement in age is characterized by improved results along the indicators of physical preparation. We should point out that between the age groups U12 and U14 there is the most significant increase in the results along the indicators related to the speed of movement on the court without a ball, explosive power of lower limbs in horizontal efforts, and flexibility. Between the ages U14 and U16 there is a more significant increase in the explosive power of lower limbs in vertical efforts both from place and in the maximal leap.

Table 3.

Descriptive statistics of signs of physical preparation in girls

Age	Indicators	Girls			
		n	X	S	V
U 12	8. Sprint 20 m	71	4	0.332	8.30
	9. Squat jump	71	1.65	0.202	12.27
	10. Vertical jump	71	29.41	6.303	21.43
	11. Maximum Vertical jump	71	33.00	10.000	29.31
	12. Flexibility	71	100.64	6.703	6.66
	13. "Shuttle" run - 140 m	71	34.43	3.113	9.04
	14. Test for swift moving - Agility	71	19.65	1.865	9.49
U 14	8. Sprint 20 m	49	3.82	0.633	16.57
	9. Squat jump	49	1.76	0.164	9.35
	10. Vertical jump	49	32.41	5.377	16.59
	11. Maximum Vertical jump	49	38.00	6.600	17.10
	12. Flexibility	49	105.89	7.128	6.73
	13. "Shuttle" run - 140 m	49	33.71	1.15	3.41
	14. Test for swift moving - Agility	49	18.0	1.154	6.39
U 16	8. Sprint 20 m	53	3.78	0.189	5.01
	9. Squat jump	53	1.8	0.221	12.27
	10. Vertical jump	53	36.78	6.034	16.40
	11. Maximum Vertical jump	53	45.00	7.100	15.81
	12. Flexibility	53	109.23	5.714	5.23
	13. "Shuttle" run - 140 m	53	32.68	1.938	5.93
	14. Test for swift moving - Agility	53	17.06	0.96	5.63

It has been proven that after a prolonged basketball practice, the muscles of the upper and lower limbs develop on account of the muscles of the torso which develop at a later age. Nomogram 1 presents a regression analysis model based on the indicators: height and 20 m sprint among 12-year-old girls, practicing basketball.

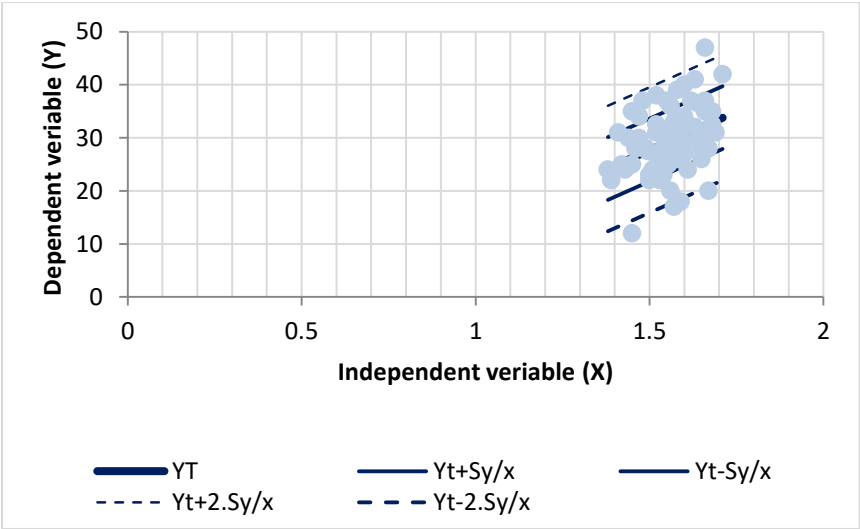


Nomogram 1. Regression analysis between height and 20 m sprint in U12 girls

The model is descending, unidirectional, and there is a tendency towards dependence among the variables. This is confirmed by the coefficient of correlation $r = -0.2650$ and by the coefficient of determination $r^2 = 70,30\%$, which shows that 70% of the differences in the sprint in 20 m are due to the different stature of the researched individuals, while in the rest 30% they are due to the influence of unknown factors (e.g., poor running technique, poor reaction at the start, etc.). We found that the taller the girls from U12 are, the faster they are, which is an essential factor in basketball. This confirms our claim that the major selection of the girls should be made by the time they reach U12.

Nomogram 2 shows a regression analysis model of the indicators: height and high jump from place among 12-year-old girls, practicing basketball. The model is ascending, unidirectional, and there is a tendency for dependence between the variables. We found that the taller the girls are,

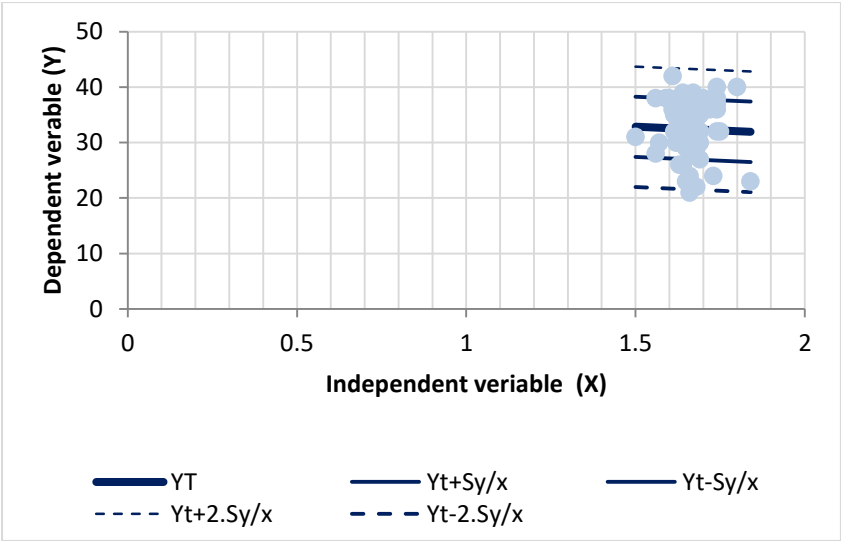
the greater their high jump is, which is an essential factor in basketball. According to the long-term planning of sports preparation in basketball, there will be enough time to manifest the cumulative effect of sports achievements in future training sessions with such children. This confirms our claim that the significant selection of female basketball players should be made by the time they reach U12. After that, only tall children may be included in the teams.



Nomogram 2. Regression analysis between height and high jump from a place in U12 girls

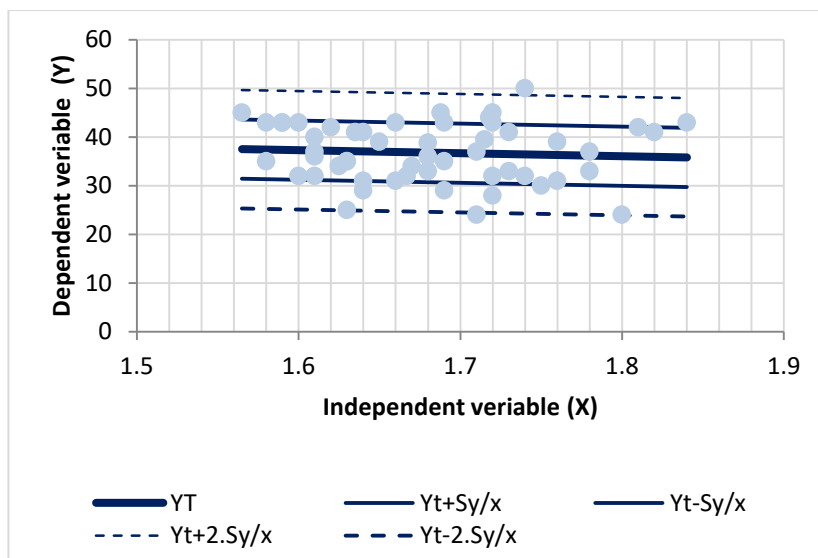
Nomogram 3 shows a regression analysis model of the indicators: height and high jump from place among 14-year-old girls practicing basketball. The model is descending, unidirectional, and there is a dependence between the variables. We found that the taller the girls are, the lower the high jump is in this age group, which is alarming. When we apply

the regression equation $Y=a+bX$, we can find how much stature influences the high jump among 14-year-old girls.



Nomogram 3. Regression analysis between height and high jump from a place in U14 girls

Nomogram 4 presents a regression analysis model of the indicators: height and high jump from place among 16-year old girls, practicing basketball. The model is unidirectional, but the dependence between the variables is not so significant. This is confirmed by the coefficient of correlation $r=-0.068$, which shows a small and descending dependence, and by the low coefficient of determination $r^2=47\%$, which shows that 47% of the differences in the high jump are due to the different stature of the researched individuals, while the rest 53% – are due to the influence of unknown factors (e.g., poor technique of execution, weak core muscles, etc.).



Nomogram 4. Regression analysis between height and high jump from a place in U16 girls

We found that the taller the girls are, the lower the high jump is. When we apply the regression equation $Y=a+bX$, we can establish the influence of the stature on the high jump. If we want to do more detailed research, we may also apply multiple linear regression and add the indicator “weight”, which will provide more information about the dependence. This confirms our claim that the completed selection of girls aged U16 is not good.

Table 4 presents the dispersion criteria obtained after the comparison of the researched indicators of the girls. We made a comparison only of the intergroup dispersion. The high values of F show the strong influence of the factor of age on the development of the primary indicators for the physical development of the children.

Table 5 presents the significance of the differences along the indicators for physical preparation of the girls from U14 and U16.

Table 4.

Dispersion criteria for girls ($F_{tabl}= 3,34$)

№	Indicators	F(emp)	P
8.	Sprint 20 m	5.09	99.29
9.	Squat jump	13.12	100
10.	Vertical jump	23.13	100
11.	Maximum Vertical jump	33.90	100
12.	Flexibility	27.13	100
13.	"Shuttle" run - 140 m	8.34	99.96
14.	Test for swift moving - Agility	50.71	100

Table 5.

Significance of differences in signs of physical preparation in U14 and U16 girls

Indicators	U 14			U 16			Difference	Statistical significance	
	n_1	X_1	S_1	n_2	X_2	S_2	d	t_{emp}	P (t)
8. Sprint 20 m	49	3.82	0.633	53	3.78	0.189	-0.046	0.503	38.36
9. Squat jump	49	1.76	0.164	53	1.82	0.193	0.065	1.823	92.86
10. Vertical jump	49	32.41	5.377	53	36.78	6.034	4.372	3.851	99.98
11. Maximum Vertical jump	49	38.43	6.573	53	44.97	7.108	6.543	4.815	100.00
12. Flexibility	49	105.89	7.128	53	109.23	5.714	3.339	2.619	98.98
14. Test for swift moving - Agility	49	33.75	1.230	53	32.68	1.938	-1.072	3.304	99.87
Показател	n_1	X_1	S_1	n_2	X_2	S_2	d	U_{emp}	P (t)
13. "Shuttle" run - 140 m	49	18.06	1.154	53	17.06	0.960	-0.994	3.955	100.00

When we analyzed Table 5, we found that along five indicators, there are higher values of $t_{\text{emp}} \geq 1.98$, therefore, as regards the explosive power of the lower limbs in the vertical plane, flexibility, speed endurance, and agility, with high guaranteed probability, the alternative hypothesis can be accepted according to which the differences are statistically significant and the girls from U16 surpass those from U14. There is no statistically significant difference between the two age groups only as regards the explosive power of the lower limbs in horizontal plane and speed abilities.

III.2.1. Indexes for dispersion and comparative analysis of the level of physical preparation of boys from U12, U14, and U16

To fulfill the aim and tasks of the research, we made a comparative analysis of the results obtained from 137 competitors from U12, U14, and U16, which are presented in Table 6. In the three age groups there is a relative homogeneity along the indicators related to the explosive power of the lower limbs in the vertical plane. To check the zero hypothesis about the significance of the observed differences between the mean levels of the researched indicators in the different samples (basketball players from U12, U14, and U16), we made a one-factor dispersion analysis. For this purpose, we calculated $F_{\text{criterion}}$ of Fisher at a high level of statistical reliability ($P \geq 95\%$). The calculated values of the $F_{\text{criterion}}$ of Fisher of all indicators are higher than the critical one ($F_{\text{tabl}}=3.35$). This makes us, with high guaranteed probability, reject the zero hypothesis and accept the alternative one as the true hypothesis, according to which the observed differences between the mean levels of the researched indicators among the different groups are significant. This fact is confirmed by the level of significance α , which takes

values lower than 0.05. the analysis shows that a higher value of F is observed along all researched indicators.

Table 6.

Descriptive statistics of signs of physical preparation in boys

Age	Indicators	Boys			
		n	X	S	V
U12	8. Sprint 20 m	45	3.87	0.273	7.050
	9. Squat jump	45	1.76	0.188	10.66
	10. Vertical jump	45	35.36	7.388	20.90
	11. Maximum Vertical jump	45	40.00	9.700	24.38
	12. Flexibility	45	96.82	9.074	9.37
	13. "Shuttle" run - 140 m	45	34.75	3.38	9.73
	14. Test for swift moving - Agility	45	19.00	2.099	11.05
U14	8. Sprint 20 m	45	3.53	0.254	7.19
	9. Squat jump	45	2.03	0.238	11.73
	10. Vertical jump	45	45.19	9.049	20.02
	11. Maximum Vertical jump	45	59.00	10.900	18.34
	12. Flexibility	45	101.38	6.29	6.20
	13. "Shuttle" run - 140 m	45	30.79	2.997	9.74
	14. Test for swift moving - Agility	45	16.43	1.024	6.23
U16	8. Sprint 20 m	47	3.40	0.25	7.37
	9. Squat jump	47	2.28	0.243	10.65
	10. Vertical jump	47	55.36	8.45	15.26
	11. Maximum Vertical jump	47	70.00	9.900	15.50
	12. Flexibility	47	103.36	7.702	7.45
	13. "Shuttle" run - 140 m	47	30.45	2.486	8.17
	14. Test for swift moving - Agility	47	15.88	1.278	8.05

Unlike the girls, boys showed more significant differences between the mean values in the different age groups U12, U14, and U16. To establish the statistically significant differences between the mean values in the different groups of researched indicators of physical preparation, we used the so-called Post Host statistics together with the one-factor dispersion analysis. We used

Tukey's Honestly Significant Difference (HSD). The results show that along all researched indicators of physical preparation, there are statistically significant differences between the mean values for the boys from U12 and U14, as well as between U14 and U16. **To sum up, the boys from U12, U14, and U16, who practice basketball in Bulgarian clubs and take part in the National Championships of BBF in different age groups, improve their level of physical preparation with the advancement in age.**

III.3. Indexes of dispersion and significance of the differences of the indicators of technical preparation of girls and boys from U12, U14, and U16

Figure 7 presents a comparative analysis of the mean values along the indicators for technical preparation of the girls and boys from U12. When analyzing Figure 7, we can see that the boys are 2 sec faster than the girls when executing dribble with high speed on the court and shooting at the basket, and 1 sec faster when catching and passing with high speed on the court and shooting at the basket. They are also faster when shooting at the basket from 5 positions and have made more baskets ($X_{\text{boys22}}=3.36$; $X_{\text{girls22}}=2.93$). When executing free throws, the boys have achieved 51.78%, while the girls – 44.79%.

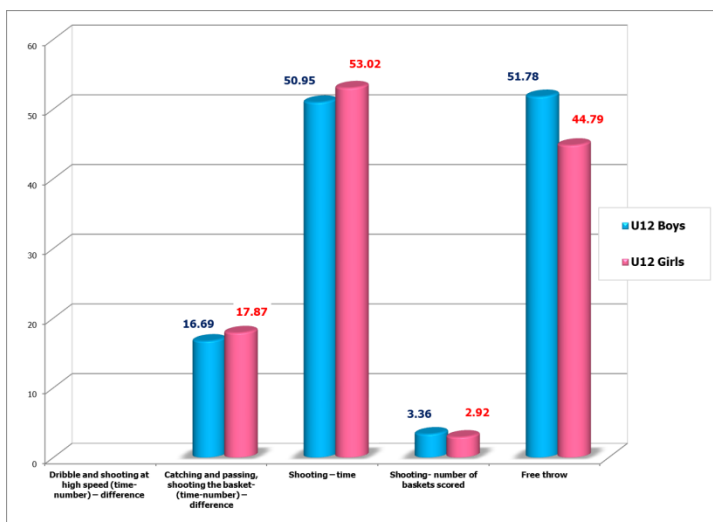


Fig. 7. A comparative analysis of mean values for technical preparation attributes in U12 boys and girls

However, the presence of higher values in the mean values and in the coefficients of variation does not make us believe that as regards these indicators, the boys or the girls surpass one another. For this purpose, we applied the comparative Student's t-criterion for independent samples and the comparative $U_{\text{-criterion}}$ of Mann Whitney.

The results from the comparative analysis between the two teams is presented in Figure 8. When analyzing the figure, we can see that the boys have an advantage along all indicators. The values of t_{emp} and U_{emp} are higher than the critical one ($t_{\text{critical}}=1.98$ and $U_{\text{critical}}=1.97$) along three researched indicators: dribble with high speed on the court and shooting while moving; catch and pass on the court and shooting, and successful free throws. This makes us claim, with a high guaranteed probability ($Pt \geq 95\%$), that along

these researched indicators the boys from U12 have a significant advantage compared to the girls.

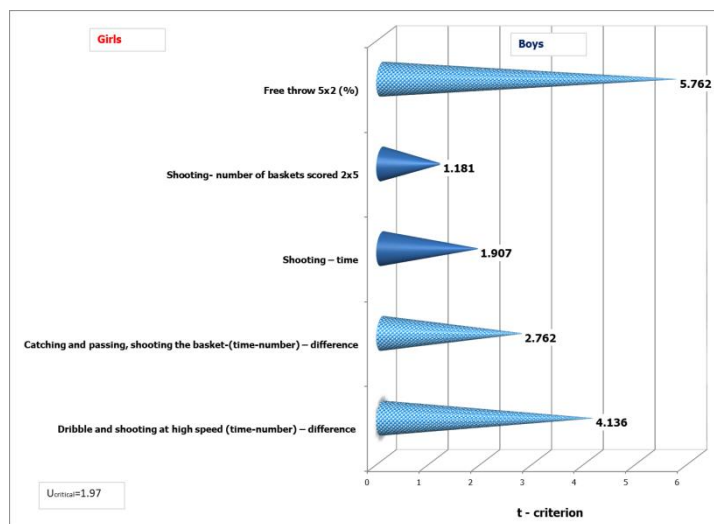


Fig. 8. Significance of differences in technical preparation indicators for U12 boys and girls

The results from the research enable us to summarize the trends in the **level of technical preparation of children up to U12, practicing basketball in Bulgarian clubs:**

1. At the end of the stage of the initial sports preparation of the children from both groups, they still find it difficult to master the most important technical skills in play: dribble with high speed and catch and pass with high speed on the court, but boys have mastered them significantly better than the girls at the same age.

2. Shooting at place and from the free throw line is the most difficult and exact skill which explains the non-homogeneity of the two groups.

Figure 9 presents a comparative analysis of the mean values of the indicators for technical preparation.

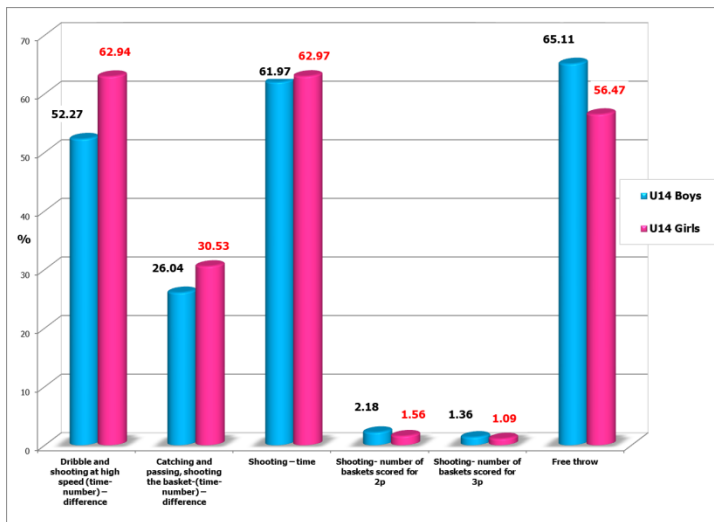


Fig. 9. A comparative analysis of mean values for technical preparation attributes in U14 boys and girls

When analyzing Figure 9, we can see that the boys are 10 sec faster than the girls when dribbling with high speed on the court and shooting at the basket, and are almost 5 sec faster when catching and passing with high speed on the court and shooting at the basket. When shooting at the basket from 5 positions, the time is very close, but the boys have made more 2 and 3-pointers ($X_{boys22}=2.18$ and $X_{girls22}=1.56$; $X_{boys23}=1.36$ и $X_{girls23}=1.09$). When executing free throws, the boys have achieved almost 10% higher results (65.11%) than the girls (56.47%). To establish the significance of the differences, we used Student's t-criterion for independent samples, and the comparative $U_{\text{criterion}}$ of Mann Whitney (Figure 10).

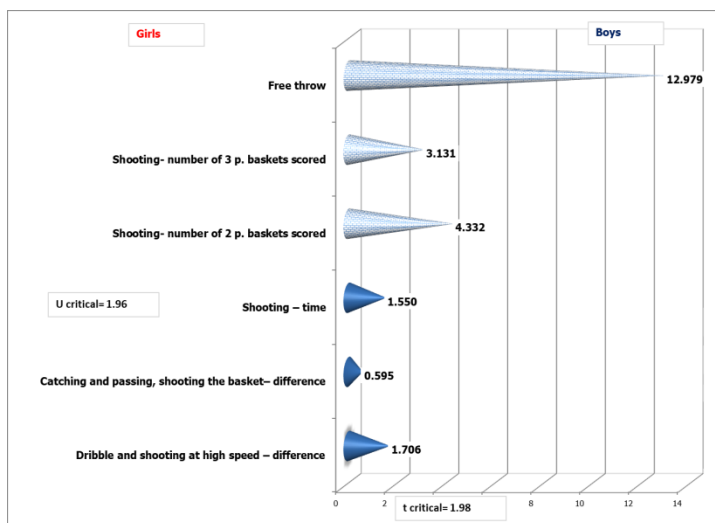


Fig. 10. Significance of differences in technical preparation indicators for U14 boys and girls

When analyzing Figure 10, we can see that the boys have an advantage along all indicators. The values of t_{emp} and U_{emp} are higher than the critical one ($t_{critical}=1.98$ and $U_{critical}=1.97$) along three researched indicators: shooting at the basket from position for 2 and 3-pointers, and successful free throws. With a high guaranteed probability ($Pt \geq 95\%$), this makes us claim that along the researched indicators, the boys from U14 have a significant advantage over the girls at the same age. According to a person's physical and biological development in this age group, gender characteristics have a considerable influence. Girls are supposed to achieve greater success when shooting compared to boys, but the obtained data prove that along these indicators, boys surpass them significantly, and this is statistically justified.

The results from the research enable us to summarize the trends in the level of technical preparation of children **up to U14, who practice basketball in Bulgarian clubs:**

1. The level of mastering technical skills is good for both genders, but boys do better when dribbling with high speed and when catching and passing with high speed.

2. The claim that at the age of up to 14 years, girls perform better and are more accurate when shooting at the basket and when executing free throws has been refuted in this research. Boys are better but there are no statistically significant differences.

Figure 11 shows a comparative analysis of the mean values of the researched indicators between the boys and girls from U16.

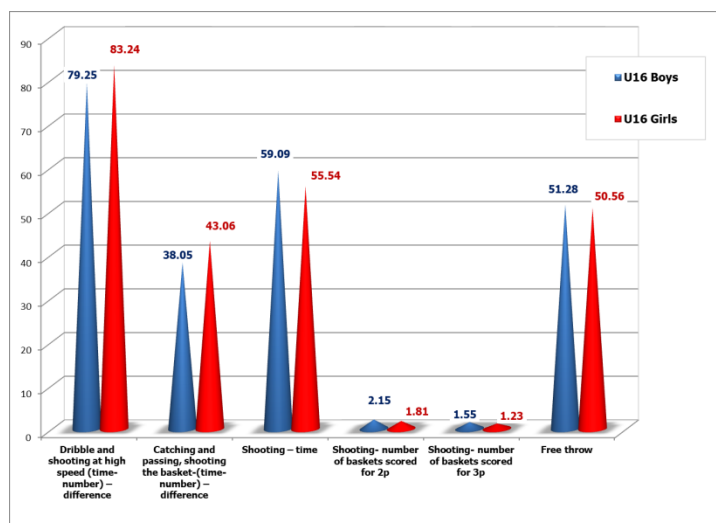


Fig. 11. A comparative analysis of mean values for technical preparation attributes in U16 boys and girls

When analyzing Figure 11, we can see that the boys surpass the girls along as many as five of the researched indicators the boys are much faster when dribbling with high speed on the court and when shooting at the basket, when catching and passing with high speed on the court and shooting at the basket, but as regards the time for execution of the shots, the girls are 3 sec faster but not more accurate. The boys make $X_{\text{boys}22}=2.15$ no., the girls $X_{\text{girls}22}=1.81$ no. for 2-pointers, and $X_{\text{boys}23}=1.55$ no., $X_{\text{girls}23}=1.23$ no. for 3-pointers.

The number of successful free throws for both groups was almost equal.

If we present the shooting in general, we will see that out of 10 attempts the boys have 37% successful shots. The value for the girls is lower than 30.4%. If this is the achieved result in the educational-training process, in the extreme conditions of a competition, when there is an actual rival, a variety of play situations, accumulated fatigue, and psychological stress for achieving victory, we could expect that this efficiency will significantly decrease and reach the limit of 20%. This is a very low-efficiency percentage for male and female basketball players in their sports mastery stage.

The presence of higher values in the mean values and the coefficients of variation, however, makes us believe that as regards these indicators either boys or girls have an advantage and we used the comparative Student's t-criterion for independent samples, and for the indicator "Shooting from position – time", we used the comparative $U_{\text{-criterion}}$ of Mann Whitney because in the two samples the distribution of the values is different from the normal one.

The results from the comparative analysis between the two groups is presented in Figure 12.

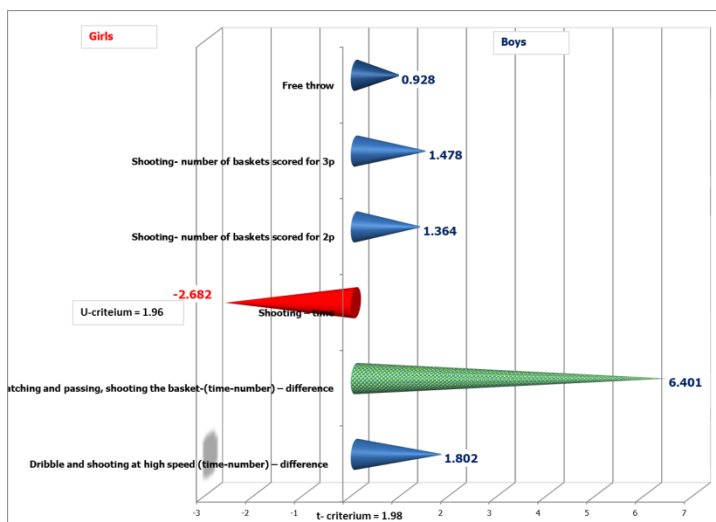


Fig. 12. Significance of differences in technical preparation indicators for U16 boys and girls

When analyzing Figure 12, we can see that the boys have an advantage along five of the indicators. The values of t_{emp} and U_{emp} , which are higher than the critical one ($t_{\text{critical}}=1.98$ and $U_{\text{critical}}=1.96$), are only along one of the indicators, namely the percentage of successful free throws. With a high guaranteed probability ($P_t \geq 95\%$), this makes us claim that along the researched indicators, the boys from U16 have a significant advantage over the girls at the same age. As we have mentioned above, the girls are better than the boys only in the speed of execution of the shots and this is statistically justified, because the value of $U_{\text{emp}}=2.682$ is higher than the critical value ($U_{\text{critical}}=1.96$). Therefore, the girls execute the shooting faster and move to different positions more quickly than the boys.

The results from the research enable us to summarize the trends in *the level of technical preparation of children up to U16, who practice basketball in Bulgarian clubs*:

1. The obtained results and the data analysis enable us to believe that more efforts should be made with the researched individuals in this group to perfect their technical skills during the educational-training process.

2. The age U16 is characterized with setting the beginning of the most important stage of the transition to high-performance sport, namely – sports mastery. The first period of this stage begins at the age of 15, and when children turn 16, they enter the second period which is crucial for their probable future development in the elite sport after the age of 17-19 years.

3. The excellent mastery of the technique of basketball play for U16 is a premise for the individual realization in elite sport and achieving high sports results.

III.3.1.Comparative analysis of the level of technical preparation of the girls from U12, U14, and U16

The analysis of all the obtained data about the observed indicators of technical preparation of the girls from the three age groups shows that in each group there are values with a distribution different from the normal one, and the observed samples are homogeneous, relatively homogeneous and non-homogeneous as regards the researched indicators. The attention could be drawn only to several indicators which are the same for the three age groups. These are the time for execution of the shooting from position and the percentage of the successful free throws.

Table 7 presents the dispersion categories obtained after comparing the researched indicators for the girls. We made a comparison only of the intergroup dispersion.

Table 7.

Dispersion criteria for girls ($F_{tabl} = 3,34$)

№	Indicators	F(emp)	P
21.	Shooting – time	82.60	100
24.	Free throw– %	5.01	99.30%

The high values of F show the strong influence of the factor of age on the time achieved in shooting and the percentage of the successful free throws. Here, the factor age has a moderate impact on the execution and success of the free throws. We consider these data normal and expected since as regards the time for execution of shooting, the physical qualities, sports experience, and age help the faster movement on the court after shooting, while the execution of free throws is a matter of repetition and practice which make the psyche more stable, and the players realizes more shots.

III.3.2.Comparative analysis of the level of technical preparation of the boys from U12, U14, and U16

The analysis of all the obtained data about the observed indicators of technical preparation of the boys from the three age groups shows that in each group there are values with a distribution different from the normal one, and the observed samples are homogeneous, relatively homogeneous, and non-homogeneous as regards the researched indicators. The results show the

time for execution of shooting from position and the percentage of the successful free throws.

Table 8 presents the dispersion criteria obtained after comparing the researched indicators for the boys. We applied a comparison only of intergroup dispersion.

Table 8

Dispersion criteria for boys ($F_{tabl} = 3,35$)

№	Indicators	F(emp)	P
21.	Shooting – time	6.67	99.97
24.	Free throw – %	6.81	99.98

The high values of F show the strong influence of the factor of age on the time achieved in shooting and the percentage of the successful free throws. The factor of age has a moderate effect on both indicators – the time for the execution of the shooting and the number of the successful free throws.

RELIABILITY AND CONTENT VALIDITY OF THE COMPLEX TEST BATTERY

The results from the variation analysis of the observed indicators show that the values have a normal or close to a normal distribution, and the observed sample is homogeneous or relatively homogeneous as regards the researched indicators.

All the tests were carried out twice and the results from the descriptive statistics (mean value and standard deviation) of the observed indicators

regarding different ages and gender were subjected to correlation analysis. To fulfill the aim and tasks of the research, we subjected the results from the conducted sport-pedagogical testing to correlation analysis. We wanted to reveal the interrelations between the researched indicators so that we could establish their strength and direction.

The correlation matrix analysis shows that the total number of the significant coefficients of the ordinary linear correlation of Parson among the observed 20 indicators of physical development, and physical and technical preparation for each age group and gender is over 80. The average correlation among the elements of all described variables has a mutual correlation within the correlation matrix and a statistically significant level of significance at $p < 0,001$; as for relative reliability test-retest (Bartlett's test of sphericity) the processed results show good reliability.

For the needs of the research we applied factor analysis to remove the indicators bearing duplicating information. This would allow for reducing the indicators to those that can participate in the control system and are highly informative about sports performance.

The applied factor analysis shows that there is a different classification of the researched indicators in the factor matrixes of the different age groups of *the boys from U12, U14, and U16*. For each age group, we reduced the number of the initial variables by grouping those correlating with each other in one factor, and dividing those which do not correlate in different factors, which enables the rational design and application of Normative system for evaluation of the physical development and specific efficiency regarding age among boys from U12, U14, and U16.

The applied factor analysis shows that *there is a different classification of the researched variables in the factor matrixes of the different age*

groups of the girls. Interestingly, for two age groups U12 and U16, the variables with the greatest factor weight are related to anthropometric indicators, while for U14 these are the variables related to specific basketball skills. The variables related to physical qualities have the smallest factor weights for U14 and U16, and they take the last places in the factor matrix.

For each age group, we reduced the number of initial variables by grouping those correlating with each other in one factor, and placing those which not correlate in different factors, which enables the rational design and application of Normative system for evaluation of the physical development and specific efficiency along the factor age of the girls from U12, U14, and U16.

Conclusions:

1. After the classification of the researched independent variables through their grouping in factors on the basis of their mutual correlation, as well as rejecting unsound initial variables, we obtained adequate multifactor models which explain to a large percent (over 70%) the changeability of the data.

2. On the basis of the experimental data, the factor analysis enables the design of a model of a Complex test battery for adolescent male and female basketball players from the ages U12, U14, and U16.

MAIN CONCLUSIONS AND SCIENTIFIC CONTRIBUTIONS FOR BASKETBALL PRACTICE

1. We established the mean values and variability of the different components of specific efficiency of adolescent basketball players – boys and girls as regards their age and gender.

2. We established the applicability of the tests for control of specific efficiency of adolescent basketball players – boys and girls. We established the reliability and content validity (specificity) of the tests used. We proved that most researched indicators are highly reliable which justifies their specificity and applicability in basketball.
3. We outlined the dynamics of the girls' physical development, which shows that between U14 and U16 there are no statistically significant differences. While among the boys, there was a strong influence of the factor of age on the development of the fundamental anthropometric indicators.
4. We proved that regarding the indicators for physical preparation in the three ages groups (U12, U14 и U16), boys have an advantage along the indicators related to speed abilities, the explosive power of the lower limbs in horizontal and vertical efforts, and agility, while girls have an advantage regarding flexibility. The values of the t-criterion increase dynamically over time.
5. We established that the girls and boys from U12, U14, and U16, who practice basketball in Bulgarian clubs, improve their level of physical development with the advance in age. As for the indicators of technical skills, the boys from the three age groups have an advantage along the indicators related to the skills for moving on the court and handling the ball with high speed, catching and throwing, shooting at the basket and successful shots. The girls have an advantage regarding shooting time but not regarding accuracy.
6. We statistically proved that in all age groups, for both genders, the high values of F show the strong influence of the factor of age on

the shooting time and on the percentage of the successful free throws.

7. We revealed the factor structure of the researched indicators of specific efficiency. We outlined three components (factors) of specific efficiency which explains over 70% of the general dispersion of the studied indicators. The grouping of the indicators in the different components is subjected to children's age-gender development.
8. We created a normative database for the evaluation of specific efficiency of adolescent basketball players along gender and age.

Evaluation of the contributions of the dissertation

There are four contributions of the applicability of the results in the field of specific control in basketball mentioned in the dissertation:

1. We gathered some information about the average level and variability of major indicators of the physical development and specific efficiency of adolescent basketball players in an age-gender aspect.
2. We designed a comprehensive system for control of adolescent basketball players, enabling coaches to have a novel approach to selecting young players and efficiently managing the training process.
3. We created a normative database and regression models which allow the evaluation of the results from the tests for specific efficiency of adolescent basketball players - boys and girls, in age aspect, which provide a lot of information about their

condition. The creation of other tests for the evaluation of indicators of specific efficiency is also possible.

4. Given the dependence of physical development on biological maturity, sports experience, and the specific coaching methods in play technique and tactics, we believe that for the different researched ages, the created sample models of young basketball players should be used in the modern sports practice.

PUBLICATIONS RELATED TO THE TOPIC OF THE DISSERTATION

1. **Borukova, M.(2021).**Control tests for growing up basketball players. Journal of Applied Sports Sciences, Volume 2, 2021., p. 51-65. DOI: 10.37393/JASS.2021.02.5
2. **Borukova, M. (2021).**Survey of basketball coaches' opinions about the system for control of sports preparation of adolescent players.Yearbook of the „Vassil Levski“, National Sports Academy volume 2, 2021. NSA Press, p.225-237, ISSN 2682-9908.
3. **Borukova, M. (2021).**Control of physical development of adolescent male and female basketball players. Sport&Science, Year LXV, edition of the Bulgarian Union for Physical Culture and Sports, National Sports Academy "Vassil Levski", "Bulgarian Sport" Foundation, Southwest University "Neofit Rilski", MNC and BOK, issue 3/4, 2021. p. 11-22.