

VASSIL LEVSKI NATIONAL SPORTS ACADEMY
Department of Theory of sport

MAXIM DIMITROV MIKHAILOV

ABSTRACT BOOK

**IMPACT OF SPECIALISED
SPORTS-MOTOR COMPLEXES FOR THE PREVENTION OF
THE TRAUMATISM IN YOUNG VOLLEYBALL PLAYERS**

for the award of educational and scientific degree

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SUPERVISOR:

Full Prof. Daniela Dasheva, DN

OFFICIAL REVIEWERS:

Full Prof. Vadsilka Hristova Serafimova – PhD

Assoc. Prof. Lyuben Krastev Krastev - PhD

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The dissertation contains 141 standard type-written pages. It is illustrated with 30 figures and 13 tables. The bibliography includes 114 literary sources, 99 of which are in Cyrillic and 15 in Latin.

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The official defense of the dissertation will take place on 13 September, at 2 pm, in Hall A3 of Vassil Levski National Sports

I. STATEMENT OF THE PROBLEM

The sports traumatism is characterized by certain features that distinguish it from other types of traumatism. From the literature we have studied, we have found consensus on several main issues that concern this study, namely:

1. Sports traumatism mainly affects childhood and adolescence.
2. The fight against sports injuries includes the correct management of the educational and training process, which is also aimed at successful prevention.

In modern volleyball literature – ours and abroad, studies on the problems of traumatism in adolescent volleyball players are extremely few and mostly descriptive. This, in turn, reflects the objective difficulties associated with the study of this problem and, above all, with the search for means to prevent sports injuries in young volleyball players.

There are various scientific and practical studies on the problems of sports traumatism (Slanchev, P., 1998; Stefanov, Zdr., 2010; Taskova, V., Ganchev, D., 2018; Belcheva, P. et al., 2011; Albert, E., 2017; Dimitrova, E., 1999; Kamburova, V., 2000; Papadopoulou, T., 2001; Mizhorkova, P., 2010; Shaush, A., 2001, etc.).

Studies show that the incidence of injuries varies from 2,4 (Beneka, A., Malliou, P., Glofsidou, A., Tsiggano, G., Zetou, H., Godollas, G., 2009) to 4,2 (Ferretti, A., Puddu, G., Mariani, P., Neri, M., 1985) volleyball player injuries per 1000 training hours.

There are different factors that can affect the cases of trauma. As internal factors we can determine age, gender, basic instability, muscle imbalance, while to the external ones are the position

of play, way of serving (Reeser, J., Joi, E., Porucznik, C., Berg, R., Colliver, E., Willick, S., 2010).

The need for a thorough analysis of volleyball injuries is present. The analysis of the literature indicates the mechanisms that cause traumatism and this obliges to find means and methods to avoid it. It is no longer enough to just recover the athlete from an injury, but to prevent it altogether.

The modern volleyball training process requires purposeful and specific work that also includes activities that protect against trauma. We recognize the need for the development of training complexes, tailored to the sport-specific requirements of volleyball, through which strengthening of health, effective and safe training and competition activity will be achieved, especially for adolescent volleyball players.

Of course, the relationship between age and traumatism in the volleyball, as a non-contact sport, is still controversial, but filling the scientific space regarding the occurrence of injuries, their type, severity, the anatomical location, as well as the information when they occurred (during training or competition), is available.

Targeted and specialized work to strengthen the joint connections of the lower and upper limbs of the young volleyball players will allow them to work more effectively for the development of the motor and sports-technical abilities necessary for successful participation in the game. On the other hand, targeted work with specific complexes of exercises will reduce the risk of injuries.

From this point of view, **the Working Hypothesis** of the dissertation work is based on the assumption that *after the application of specialized sports-motor complexes aimed at influencing*

the musculoskeletal system of adolescent volleyball players, a reduction in the occurrence of injuries will be achieved, and at the same time, it will increase the level of their special physical fitness and sports-technical performance.

II. PURPOSE, TASKS, ORGANIZATION AND METHODOLOGY OF THE RESEARCH

On the basis of the presented theoretical statement on the problem of traumatism in young volleyball players, the purpose and tasks of the study, as well as the methods and organization for their solution, are derived.

I.1. Purpose, tasks, subject and object of the study

The *purpose* of the present study is related to the possibilities of reducing the occurrence of injuries in young volleyball players and improving their working capacity, by including in the training programs specialized complexes aimed at influencing the musculoskeletal system.

To solve the set goal, we formulated the following *tasks*:

1. Analytical overview of the specialized literature on the problems of sports injury prevention in volleyball.
2. Study of the opinion of coaches and players regarding the causes, frequency and prevention of injuries in volleyball.
3. Development and testing of specialized complexes for impacting the locomotor apparatus in adolescent volleyball players.
4. Establishing the level of development and the variability of the signs of the specific work ability and technical preparedness of adolescent volleyball players.
5. Revealing the correlation-factor structure of specific work ability and technical preparation in adolescent volleyball players.

6. Establishing the effect of the application of the developed complexes for the prevention of the traumatism in young elite volleyball players.
7. Derivation of methodological guidelines for the application of the developed motor complexes for the prevention of traumatism in young volleyball players.

The **subject** of the study is sports traumatism in adolescent volleyball players.

The **object** of the study is the learning and training process for 13–14-year-old volleyball players and the risks of sports injuries.

The study involved 81 adolescent volleyball players, of which 21 boys and 60 girls aged 13–14, from the CSKA, “Maritza” and “Zvezdi” Volleyball clubs. The sports-pedagogical experiment was conducted with competitors from the team of CSKA, 11 of which participated in the experimental group and 10 in the control group.

II.2. Organization and methodology of the research

Organization of the study

The current study covers the period September 2017 – June 2021, which is divided into the following **stages**:

First stage – the main activities in this stage were aimed at researching the specialized literature and developing, on this basis, of a survey card to study the opinion of coaches and competitors about the frequency and causes of sports traumatism in volleyball.

Second stage – October 2019 – January 2020 – a selection of sports-pedagogical tests was carried out and a test battery was

developed for the study of the specific working capacity of adolescent volleyball players (girls and boys). In November 2019, a sports-pedagogical testing was held. This was followed by the development of complexes of exercises for a specialized impact on the locomotor apparatus during the training activities of the adolescent volleyball players.

Third stage – February – September 2020 – a sports-pedagogical experiment with adolescent volleyball players was carried out. Due to the COVID pandemic, the experiment was conducted only with the team of the boys of CSKA. However, this allowed us to personally carry out the work on the implementation of the specialized complexes.

Fourth stage – October 2020 – March 2021 – mathematical and statistical processing of the initial data from the conducted research and analysis of the obtained results was carried out.

Research methods and indicators

To solve the purpose and tasks of the research, the following basic ***research methods*** are applied:

1. ***Theoretical analysis*** of the specialized scientific and methodological literature. To clarify the researched problem, 114 literary sources, of which 99 were in Cyrillic and 13 were in Latin, were studied and analysed.

2. ***Questionnaire survey*** – to establish the opinion of sports specialists and competitors regarding the causes, types and prevention of injuries in the volleyball. For this purpose, a questionnaire was developed, including 9 questions, 7 of which refer to the sports traumatism and are the same for coaches and athletes. In the survey involved 35 leading Bulgarian volleyball coaches and 88 players.

3. *Sports-pedagogical testing* – in order to carry out effective control and assessment of the specific work capacity of the adolescent volleyball players, the System for Evaluating the results of Sports training (volleyball) for students from Bulgarian Sports Schools (2012) was implemented. This system enables operational control over the development of the motor qualities and volleyball skills of the players of the respective age and gender (*Table 4*).

Table 4. Sports-pedagogical tests

№	Variables	Units of measurement	Measurement accuracy	Increment direction
1.	<i>Height</i>	cm	1,0	+
2.	<i>Horizontal stretch</i>	cm	1,0	+
3.	<i>Vertical rebound with both hands</i>	cm	1,0	+
4.	<i>Vertical rebound with one hand</i>	cm	1,0	+
5.	<i>Shuttle</i>	s	0,01	-
6.	<i>Specific speed</i>	s	0,01	-
7.	<i>Pass with two hands on top in goal</i>	number	1,0	+
8.	<i>Two-handed feed from below in goal</i>	number	1,0	+
9.	<i>Kick-off on target</i>	number	1,0	+
10.	<i>Stuck in target</i>	number	1,0	+

4. Sports-pedagogical experiment

As stated above, the sports-pedagogical experiment was conducted for 6 months – from February 2020 to August 2020.

To implement the sports-pedagogical experiment, two groups of CSKA's junior team were formed – an experimental group (EG) of 11 athletes and a control group (CG) of 10 athletes.

The sports injury prevention classes with the experimental group were conducted by the doctoral student.

The training sessions with the control group were carried out according to a standard training methodology established in the club, without the inclusion of traumatism prevention complexes.

For the needs of the experimental methodology, three (3) complexes of exercises have been developed, aimed at strengthening the most stressed joints in young volleyball players. These complexes were applied three times a week.

Complex 1 was applied immediately after the general-preparatory part of the training, for 10–12 minutes. The main method was circular.

Complexes 2 and 3 were developed with a clear directionality of impact on an individual joint and were administered at the end of the training of the experimental group. Working with these complexes also lasts 10–12 minutes.

In order to monitor the effect of the applied training complexes, as well as their impact on the specific working capacity of the volleyball players, sports and pedagogical testing of the participants in the experimental and control groups was carried out both at the beginning and at the end of the observed period.

Mathematical-statistical methods for data processing

The results of the study were subjected to mathematical and statistical processing using the SPSS V.25 software package. Alternative analysis, variance analysis, correlation analysis, factor analysis, hypothesis testing when comparing dependent and independent samples (using Student's t-criterion), hypothesis testing when comparing frequency distributions (using χ^2 -criterion of Pearson) and analysis of variance, were applied.

III. ANALYSIS OF THE RESULTS

III.1. Survey of the opinion of coaches and players regarding the types, causes and prevention of the traumatism in the volleyball

The first aspect of analysis is aimed at characterizing the traumatism in the volleyball, based on the questionnaire survey in which 35 coaches and 88 players were participated. Seven of the survey questions were the same for coaches and athletes.

The general conclusion of the conducted survey is reduced to the following conclusions:

1. Three are the most common injuries among volleyball players: dislocation and sprain of the joints of the upper limb, injuries of the ankle joint and injuries in the knee joint.
2. Approximately 97% of the surveyed coaches believe that it is necessary to apply specialized complexes for injury prevention in the training process with adolescent volleyball players. The percentage for competitive ones is similar.

III.2. Mean values and variability of signs of physical development and specific workability of young elite volleyball players (girls and boys)

The second aspect of analysis is related to determination of average values and variability of the signs of the physical development, the specific working capacity and the technical preparation of young elite volleyball players (girls and boys).

It is known that height is a very valuable constitutional feature in volleyball. From the *Table 5* it is shown that the average

height for girls is 174.85 ± 7.71 cm and the horizontal stretch is 224.3 ± 10.60 cm.

Table 5. Mean values and variability of indicators in girls (n = 60)

Показатели	R	Min	Max	Mean	S	As	Ex	V%
1. Height	39	156	195	174,85	7,71	0,42	0,73	4,04
2. Horizontal stretch	53	198	251	224,30	10,60	0,15	0,58	4,72
3. Vertical rebound with both hands	37	10	47	27,06	7,59	0,50	0,30	28,04
4. Vertical rebound with one hand	48	15	63	40,48	8,90	0,03	0,84	22
5. Shuttle	4,99	10,27	15,3	12,05	1,06	0,62	0,62	8,29
6. Specific speed	8,46	12,58	21	17,34	2,69	-0,4	-1,43	15,51
7. Pass with two hands on top in goal	5	1	6	3,63	1,04	-0,13	-0,34	4,44
8. Two-handed feed from below in goal	3	2	5	3,75	0,84	-0,39	-0,23	22,4
9. Kick-off on target	3	2	5	3,70	0,89	0,04	-0,87	24,05
10. Stuck in target	4	1	5	3,42	1,03	-0,15	-0,79	30,11

In the study of these two anthropometric indicators, the maximum measured height of girls (195 cm) is impressive. A 14-year-old competitor with such a height is difficult to be selected in Bulgarian volleyball.

The maximum measured height in boys is 186 cm. In boys, the average height is 174.33 ± 8.63 cm and the horizontal stretch is 223.33 ± 11.42 cm (**Table 6**).

Table 6. Mean values and variability of indicators in boys (n = 21)

Показатели	R	Min	Max	Mean	S	As	Ex	V%
1. <i>Height</i>	34	152	186	174,33	8,63	-1,10	0,93	4,95
2. <i>Horizontal stretch</i>	50	195	245	223,33	11,42	-0,69	0,77	5,11
3. <i>Vertical rebound with both hands</i>	40	15	55	35,42	12,46	0,28	-1,28	35,17
4. <i>Vertical rebound with one hand</i>	45	30	75	50,47	12,97	0,30	-0,94	25,69
5. <i>Shuttle</i>	3,93	9,57	13,5	11,14	1,12	0,64	-0,22	10,05
6. <i>Specific speed</i>	6,3	11,5	17,8	14,01	1,68	0,61	-0,10	12,00
7. <i>Pass with two hands on top in goal</i>	5	0	5	2,71	1,45	-0,20	-0,27	53,50
8. <i>Two-handed feed from below in goal</i>	4	0	4	1,90	1,22	0,19	-0,38	64,21
9. <i>Kick-off on target</i>	6	0	6	3,09	1,75	-0,15	-1,18	56,63
10. <i>Stuck in target</i>	2	0	2	0,95	0,66	0,05	-0,49	69,47

The indicated variables are stable ($V \leq 4-5\%$) and therefore, the sample in this case is homogeneous (uniform) in terms of the signs for which the relevant indicators provide information, both for girls and for boys (**Figure 21**).

The second cognitive task of our research is aimed at revealing the average levels and variability of the studied signs of the special physical fitness of the volleyball players we observed.

The analysis of the indicators, characterizing the explosive capabilities of the lower limbs during vertical muscle efforts shows that these signs are relatively stable, and the two groups studied (girls and boys), in general, are relatively homogeneous with respect to this motor quality (**Figure 22**).

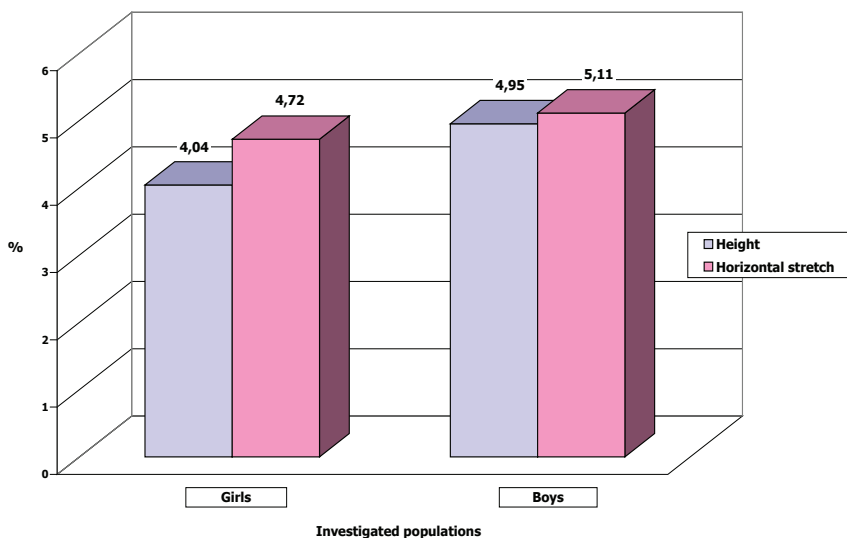


Figure 21. *Variability of the morphological signs examined*

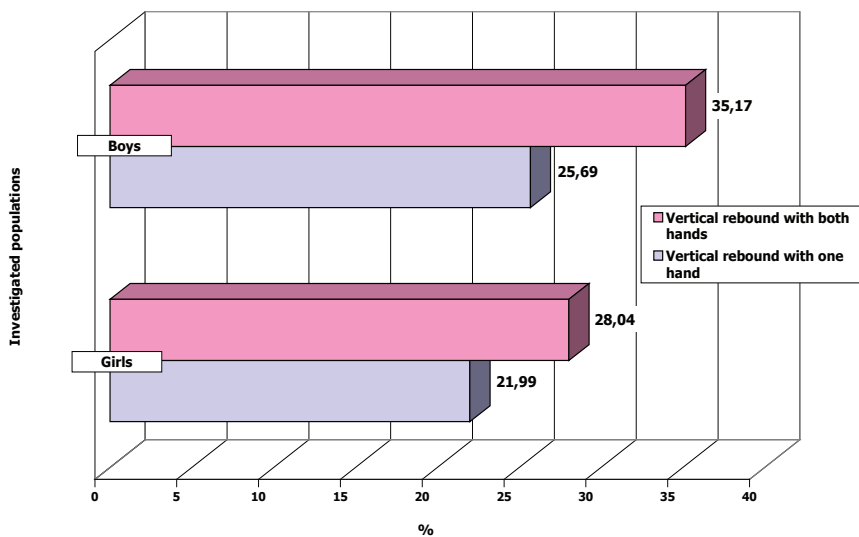


Figure 22. *Variability of the explosive force indicators in the vertical plane*

Information about the level of development of the special endurance is carried by test 5 (“shuttle”) and about the speed of movement, which is extremely important for the effective application of technical techniques in the volleyball game, inform test 6 “specific speed”.

As can be seen from **Figure 23**, the studied girls completed the shuttle in an average of $12.05 \text{ s} \pm 1.06 \text{ s}$, and for boys the average achievement is $11.14 \text{ s} \pm 1.12 \text{ s}$.

The calculated values of the coefficient of variation V for this indicator (**Tables 5 and 6**) prove that both populations (girls and boys) are homogeneous in terms of the special endurance of the young volleyball players included in them ($V_{\text{girls}} = 8.29\%$ and $V_{\text{boys}} = 10.05\%$).

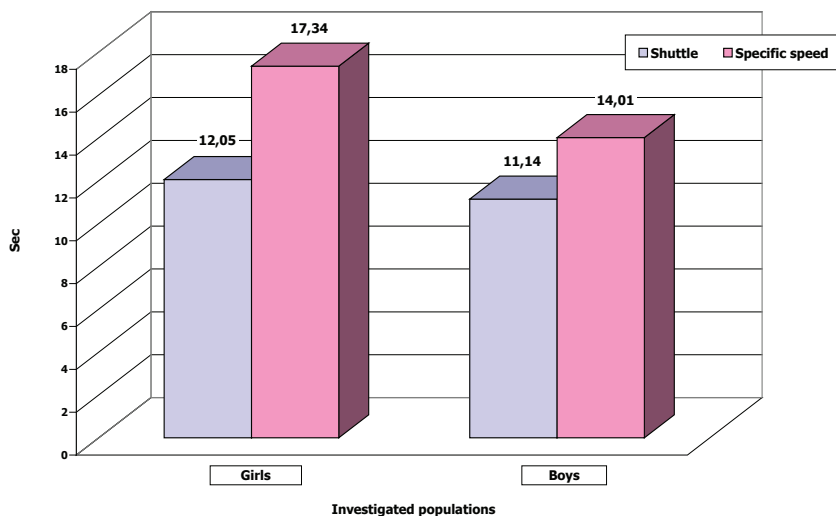


Figure 23. *Average values for the specific speed capabilities of the young volleyball players studied*

In the test for specific speed, the main quality in complex-coordination movements, which abounded in the volleyball game, the average value for girls is $17.34 \pm 2.69 \text{ s}$, and for boys – 14.01

± 1.68 s (**Figure 23**), and with this indicator, the coefficients of variation show a relative homogeneity of the two studied groups of young volleyball players ($V_1 = 15.51\%$ and $V_2 = 12\%$).

Developing the specific speed capabilities of young volleyball players in this age group (13–14 years) is extremely important, in order to improve the work of mastering the elements of the game technique. The obtained higher values of the coefficients of variation for some of the indicators are grounds for activating the work on developing the specific speed capabilities of those young volleyball players who are lagging behind in the level of development of the corresponding signs of physical fitness.

The third cognitive task is related to revealing the level of technical and tactical preparedness of young volleyball players. For solving this task four specific tests have been applied.

The first two tests of this group provide information on the skills of young volleyball players to pass the ball into a goal with both hands – both above and below. This is a basic volleyball skill that is an extremely important part of the model characteristic of a successful player. The analysis of the results shows that the girls showed a higher accuracy of these passes (respectively 3.63 successful hits when passing from above and 3.75, when passing from below) than boys (2.71 and 1.90). Moreover, the girls' group was homogeneous in terms of both overhead and underhand goal passing skill, and the boys' group was inhomogeneous in both skills. This is evidenced by the corresponding values of the coefficient of variation V , which are 4.44% and 22.4% for girls, and 53.5% and 64.21% for boys (**Figure 24**). It is necessary to note here that according to literature data, due to the high variability of game activity in volleyball, dispersion within 50% gives reason to consider that the relevant population is homogeneous.

The reason for the high variability of the commented indicators among the young volleyball players, in our opinion, is the fact that some of them did not manage to achieve even one suc-

successful hit on the goal. This means that in the future educational and training process, it is necessary to increase the amount of training work aimed at improving this important sport-technical skill in those athletes who have shown a low level of accuracy when they are passing to the goal.

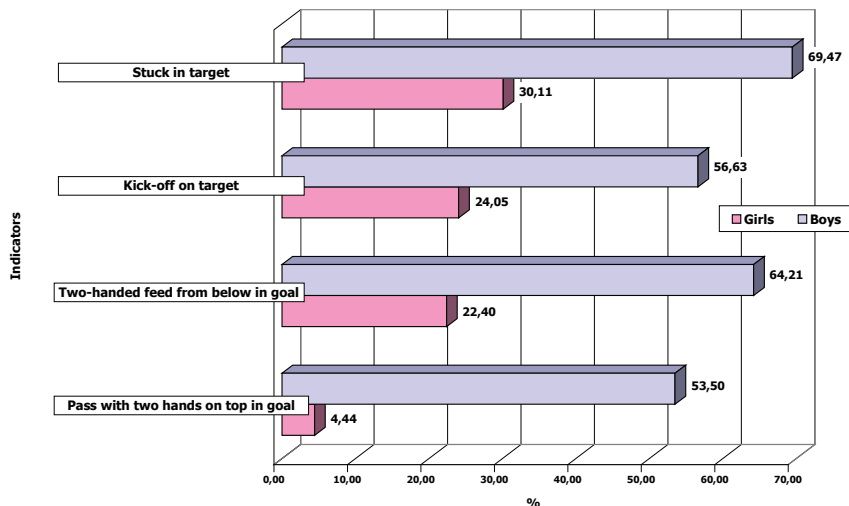


Figure 24. Variability of the signs, characterizing the specific technical-tactical preparedness (%)

The next investigated sports-technical indicator (No. 9) is related to the execution of a kick-off at a goal and characterizes the level of technical-tactical preparation for accurate execution to make it difficult for the opponent. The results show that out of a total of 6 completed serves, the girls achieved an average of 3.70 ± 0.89 hits on the target, and the boys – 3.09 ± 1.75 hits. Like the previous two technical-tactical indicators, this one for girls is stable and, accordingly, their group is homogeneous in terms of the ability to accurately execute kick-offs ($V_{\text{girls}} = 24.05\%$), while for boys it is unstable and their group is inhomogeneous on this basis ($V_{\text{boys}} = 56.63\%$). Naturally, the accuracy of the initial shot

leads to the achievement of points and gives an advantage to the better ones. This requires additional individual work with volleyball players who have a problem with the precision of their serve.

The last indicator (the 10-th) is “stuck in a goal in the direction of strengthening”. Here, the average value for girls is 3.42 ± 1.03 successful hits, and for boys it is much lower – 0.95 ± 0.66 . According to the accepted norms of sports statistics, the obtained results give reason, with a high guaranteed probability, to consider that the group of girls is homogeneous ($V_{\text{girls}} = 30.11\%$) and in terms of the ability to successfully dunk the ball in the direction of reinforcement, while in the case of boys, inhomogeneity is also observed on this indicator ($V_{\text{boys}} = 69.47\%$). We believe that making adequate efforts in the future to develop this important technical-tactical skill will greatly enrich the game of young volleyball players.

III.3. Dependencies between the studied signs in young elite volleyball players

The correlation analysis shows that 11 correlation dependencies are observed in girls – 2 negative and 9 positive (at $\alpha \geq 0.05$). Of interest are the dependencies between indicators from different groups. As can be seen, for girls, there are 3 moderate correlations between: two-handed vertical rebound and kick-off ($r = 0.300$), one-handed vertical rebound and two-handed overhead pass at goal ($r = 0.310$), and one-handed vertical rebound arm and two-handed pass from below into a target ($r = 0.340$).

For the boys, the significant correlational interdependencies are also 11 of number – 6 negative and 5 positive. In the built correlation-structural model, a very large dependence is observed between the morph-functional indicators ($r_{1-2} = 0.955$), as well as

between the two indicators characterizing the explosiveness of the muscular efforts of the lower limbs ($r_{3,4} = 0.916$).

The results also prove that in the age groups studied by us, the indicators of physical development do not have a significant impact on the level of development of the signs of physical fitness, as well as on the effectiveness of the technical and tactical skills of the volleyball players. L. Vasileva (2023) achieved similar results, but only with 10–12-year-old volleyball players.

In conclusion, the correlation analysis shows that the specific technical-tactical preparation of young volleyball players depends significantly on the level of their special physical preparation. In this sense, the application of training motor complexes to strengthen the locomotor apparatus, respectively, increases the possibility of effectively performing specific technical-tactical actions.

III.4. Factor structure of the special physical and specific technical-tactical preparation of elite young volleyball players

As can be seen from *Table 9*, the factor structure of the physical development and specific working capacity of the young elite volleyball players, participating in our sports-pedagogical experiment, is determined by 4 main factors, which together explain a relatively high percentage (76.45%) from the initial variance of the investigated phenomenon.

The analysis of the table and presented in *Figure 27* relative shares of the output variance explained by each factor shows that the first and most important factor explains 25.22%, the second – 21.94% and the third – 18.41%. The last, fourth factor has the smallest contribution to the specific working capacity of the athletes from the studied population (10.89%), but the information

it brings is important and builds up the factor structure of the studied phenomenon.

Table 9. Factor structure of physical development and specific workability of elite young volleyball players

№	I	II	III	IV	h ²	1 - h ²
1.	-0,02	0,971	-0,039	0,036	0,946	0,054
2.	0,048	0,963	0,041	0,041	0,934	0,066
3.	0,934	0	0,144	-0,037	0,895	0,105
4.	0,926	0,045	0,181	-0,139	0,911	0,089
5.	-0,364	0,177	0,071	0,798	0,806	0,194
6.	0,272	0,216	0,083	0,849	0,848	0,152
7.	0,265	0,077	0,772	0,083	0,678	0,322
8.	-0,115	-0,171	0,835	0,035	0,741	0,259
9.	0,199	0,081	0,659	0,064	0,484	0,516
10.	0,141	0,246	-0,051	-0,567	0,404	0,596
Σα	25,22%	21,94%	18,41%	10,89%	76,47%	

The first derived factor is determined by only 2 indicators and explains 25.22% of the output variance. With the highest factor weights here are the indicators determining the contribution to the general level of physical development and specific working capacity of the explosive power of the lower and upper limbs (vertical rebound with two hands from a place and with one hand after strengthening – indicators 3 and 4, with factor weights 0.934 and 0.926 respectively).

This gives a reason to identify the most important factor from the factor structure of physical development and specific work ability as “*specific speed-power abilities*”.

In the analysis of **Figure 27**, it is also clear that the relative share of the initial variance unexplained by the derived factors is 23.53%.

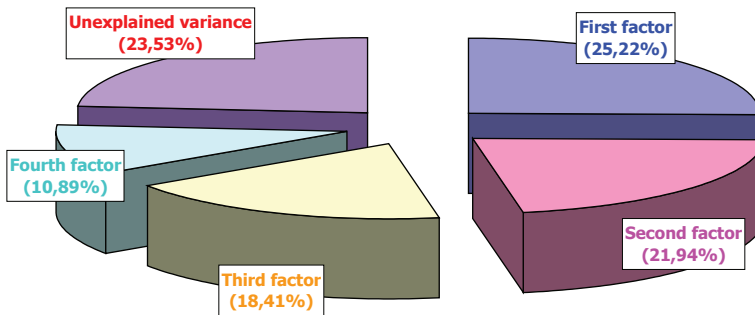


Figure 27. *Relative shares of the explained and unexplained variance of the initial variance of the physical development and specific working capacity of elite young volleyball players*

The second factor also included only 2 indicators, explaining 21.94% of baseline variance of physical development and specific workability. These indicators provide information on the morphological development of adolescent volleyball players (indicators 1 and 2, height and horizontal stretch, respectively, with factor weights 0.971 and 0.963). Therefore, this factor can be defined as *morphological, revealing the importance for success in the volleyball of the linear dimensions of the body*.

The third factor is determined by three indicators, but explains a lower percentage (18.41%) of the initial variance of the studied phenomenon (**Figure 28**). What all these indicators have in common is the fact that they are related to the technical-tactical preparedness of young volleyball players (indicators 7, 8 and 9 – factor weights 0.772, 0.835 and 0.659, respectively). The factor can be defined as *“specific technical-tactical skills”*.

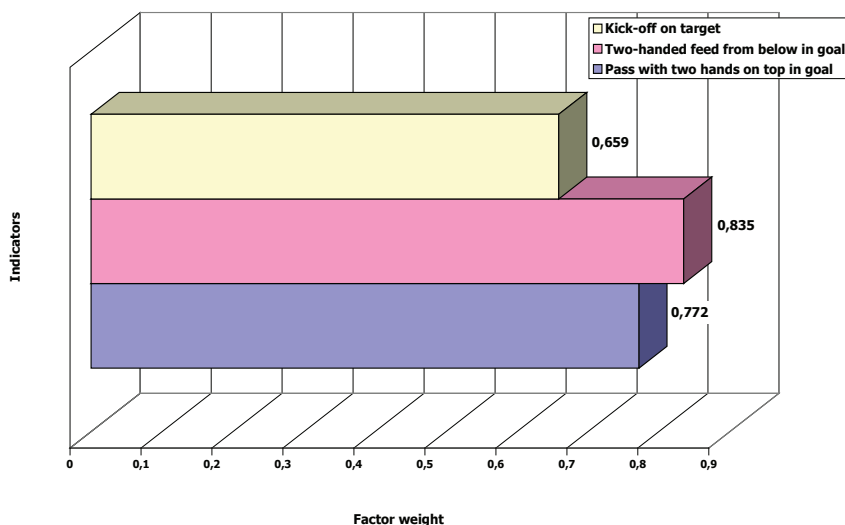


Figure 28. Factor structure of physical development and specific workability – III factor

The last, *fourth factor* completes the factor structure of the physical development and specific workability of young volleyball players and, although it has a much lower relative contribution to it (10.89%), in our opinion, it affects important qualities for the volleyball game. Reasonably, the factor can be identified as *“specific quickness and speed endurance of the volleyball players, which have a beneficial effect on the success when they are driving the ball”*.

In conclusion, the factor structure of the physical development and specific working capacity of young volleyball players is determined by 4 main factors, which in their totality explain a relatively high percentage of the initial variance of the investigated phenomenon. With the most significant contribution are *the specific speed-power abilities, the linear dimensions of the body and the specific technical-tactical skills*.

In the spirit of correctness, however, it is necessary to note that the indicators have been selected extremely expertly. In order to go deeper into the structure of the game, some other indicators, which bear information both about the specific technical-tactical skills, as well as, about the body structure and the special physical fitness of the young competitors, could be additionally included.

III.5. Establishing the effect of the applied specialized training program for the prevention of trauma

To verify the effectiveness of the sports-pedagogical experiment, a comparative analysis of the initial (entry level) and final (output level) results of the sports-pedagogical testing of the young volleyball players from the experimental and control groups was performed. For this purpose, as indicated in the research methodology, the procedures for statistical testing of hypotheses were applied, using the comparative Student's t-criterion, with dependent samples and a high guarantee probability ($P_t \geq 95\%$), where $t_{\text{emp}} = 2,23$.

It is necessary to note here, once again, that during the experiment, the competitors of the working group were subjected to the impact of the specialized training program developed by us for the prevention of the traumatism in adolescent volleyball players. In the same period, the control group was trained according to the current training program, approved by Bulgarian Volleyball Federation.

One of the important procedures for solving the research tasks is to study the form of the distribution of the signs in the studied populations, i.e. to establish the degree of proximity to the so-called Gauss-Laplace normal distribution. This ensures correctness in hypothesis testing, as well as in the application of correlation and factor analyses. The values of the statistical parameters A_s and E_x , obtained in the variance analysis of the

results of our research, show that both in the control and in the experimental group, the corresponding indicators have a normal or close to normal distribution.

The results of the comparative analysis of the input and output data from the conducted sports-pedagogical testing of the participants in the control group are presented in **Table 10**.

Table 10. Significance of the differences between the initial and final level of the investigated signs in the control group

Indicators / Parameters	Mean	S	t	Sig. (2-tailed)
1. Height	0,80	0,63	<i>4,00</i>	0,003
2. Horizontal stretch	1,40	1,26	<i>3,50</i>	0,007
3. Vertical rebound with both hands	1,40	0,96	<i>4,58</i>	0,001
4. Vertical rebound with one hand	2,10	1,52	<i>4,35</i>	0,002
5. Shuttle	-0,04	0,22	0,56	0,583
6. Specific speed	-0,55	1,27	1,38	0,199
7. Pass with two hands on top in goal	0,50	0,53	<i>3,00</i>	0,015
8. Two-handed feed from below in goal	0,20	0,42	1,50	0,168
9. Kick-off on target	0,40	0,70	1,80	0,104
10. Stuck in target	1,00	0,66	<i>4,74</i>	0,001

Their analysis allows us to establish the reliability of the observed changes in the average levels of the investigated characteristics of the boys from this group.

From the table and **Figure 29**, it can be seen that, as a result of the applied training effects provided for in the active sports

training methodology, during the experiment, positive changes occurred in all observed signs of the physical development and specific working capacity in the players from the control group.

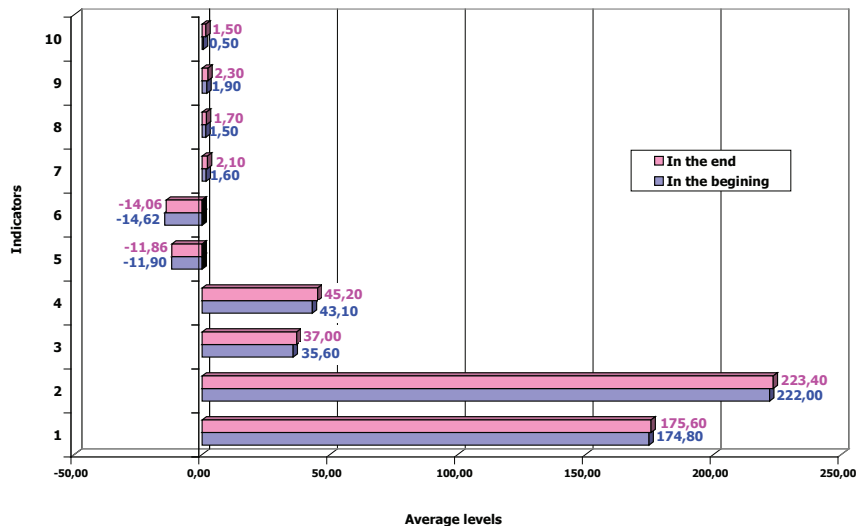


Figure 29. Comparative analysis of mean values in the control group

The analysis of the table, however, shows that only in 6 of the investigated signs the observed increases are significant. Proof of this is the values of the calculated comparative t-criterion, presented in **table 10**, which for indicators 1, 2, 3, 4, 7 and 10 are higher than the critical one ($t_{\text{critical}} = 2.23$). This gives reason, with a high guarantee probability ($P_t \geq 95\%$), to consider that, under the influence of the training work performed during the experimental period, significant positive changes occurred in the boys of the control group in terms of:

- the linear dimensions of the body;
- the level of development of the explosive power of the lower and upper limbs;

- the skill of passing into a goal with 2 hands from above and
- the efficiency of the stuck in a goal.

Of greater interest to us are the changes that occurred in the experimental group, which was subjected to the impact of the specialized program for the prevention of traumatism through motor complexes. As can be seen in **Figure 30**, positive changes occurred in the levels of all investigated signs of physical development and specific working capacity during the experiment.

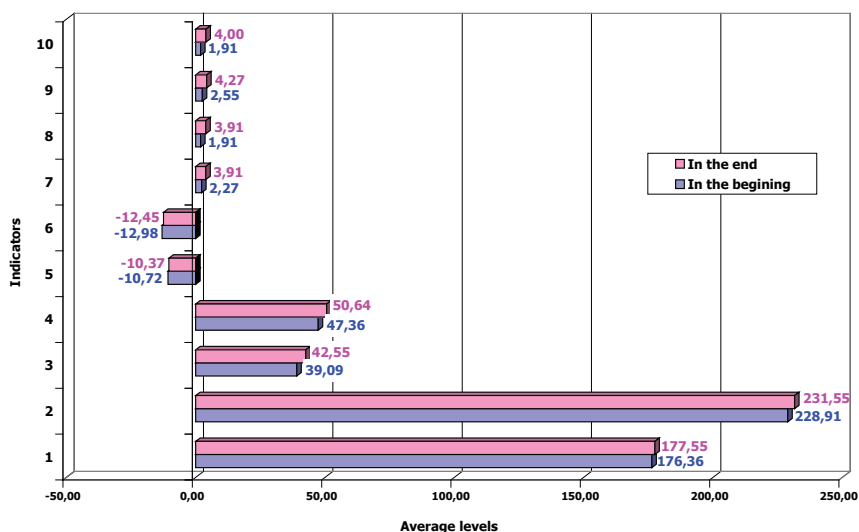


Figure 30. Comparative analysis of the average values at the experimental group

The verification of the significance of the observed increases in the experimental group shows that, for all the investigated signs, the null hypothesis can be rejected with full reason and the alternative hypothesis accepted as true, according to which, under the influence of the applied motor complexes, significant positive changes have occurred in both the linear dimensions of

the body, as well as in the level of development of the main signs of special motor preparedness and more - in the effectiveness of the specific motor skills of young volleyball players, which is the task of our research.

This is evidenced by the values of the comparative t-criterion of Student, which for all indicators are higher than the critical one (*Table 11*).

Table 11. Significance of the differences between the initial and final level of the studied signs in the experimental group

Indicators	Mean	S	t	Sig. (2-tailed)
1. Height	1,18	0,87	<i>4,48</i>	0,001
2. Horizontal stretch	2,63	1,02	<i>8,50</i>	0
3. Vertical rebound with both hands	3,45	1,12	<i>10,15</i>	0
4. Vertical rebound with one hand	3,27	1,10	<i>9,83</i>	0
5. Shuttle	-0,34	0,14	<i>7,87</i>	0
6. Specific speed	-0,52	0,19	<i>8,70</i>	0
7. Pass with two hands on top in goal	1,63	0,50	<i>10,75</i>	0
8. Two-handed feed from below in goal	2,00	0,77	<i>8,56</i>	0
9. Kick-off on target	1,72	0,64	<i>8,85</i>	0
10. Stuck in target	2,09	0,53	<i>12,85</i>	0

It is known, that in order for an experiment to be correct, it is necessary at its start that the average level of development of the studied signs be equal for all the populations participating in it. In order to verify the correctness of the sports-pedagogical experiment conducted by us, a comparative analysis of the results of the initial testing of the two groups of volleyball players (experimental and control) is performed, as well as of the results obtained at

the end of the period. For this purpose, hypothesis testing procedures were applied, using Student's comparative t-criterion for independent samples and a high guarantee probability ($P_t \geq 95\%$), where the critical value of t (t_{emp}) is 2.20 (**Table 12**).

Table 12. Significance of the differences between the average levels of the investigated signs both at the beginning and at the end of the experimental period

Indicators	F	Sig.	t	Sig. (2-tailed)
1. Height	2,832	0,109	1,42	0,171
2. Horizontal stretch	1,219	0,283	1,77	0,093
3. Vertical rebound with both hands	1,880	0,186	2,20	0,050
4. Vertical rebound with one hand	1,179	0,291	1,96	0,065
5. Shuttle	0,214	0,649	1,78	0,091
6. Specific speed	2,986	0,100	6,44	0
7. Pass with two hands on top in goal	5,988	0,024	1,81	0,086
8. Two-handed feed from below in goal	2,290	0,147	0,44	0,681
9. Kick-off on target	1,233	0,281	0,68	0,507
10. Stuck in target	0,574	0,458	0,58	0,570

The analysis of the table shows that for 8 of the indicators both at the beginning and at the end of the observed period, no significant differences are observed between the average levels of the two groups participating in the experiment. Proof of this is the calculated t-criterion of Student, which for these indicators take values between 0.44 (in indicator 8 „two-handed pass from below into the goal“) and 1.96 (in indicator 4 „one-handed vertical rebound“). Therefore, with a high guarantee probability, the null

hypothesis can be confirmed here, according to which, the differences between the average levels of the studied signs of physical development and the specific working capacity of the studied groups of volleyball players before and after the sports-pedagogical experiment can be explained by random reasons.

The only exceptions are for metrics 3 and 6 („two-handed vertical bounce“ and „special quickness“, respectively). As it is clear from **Table 12**, for these indicators the values of the comparative t-criterion are higher than the critical one (respectively 2.20 and 6.44 at $\alpha \leq 0.05$). This gives reason, in relation to these signs, with a high guarantee probability, to reject the null hypothesis and accept as true the alternative, according to which the young volleyball players, as a result of the applied motor complexes for the prevention of traumatism, have improved their specific speed and jumping capabilities. This fact is extremely important, since modern volleyball places high demands on players in terms of their special speed and bounce.

For the purposes of the study, a comparison of the increases observed in the experimental and control groups was also performed for all indicators included in the test battery (**Table 13**).

The analysis of the table shows that, in general, the gains in the experimental group were greater and statistically significant, compared to those of the control group. Therefore, with a high guarantee probability ($P_t \geq 95\%$), it can be claimed that under the influence of the applied specialized sports-motor complexes aimed at strengthening the musculoskeletal system, the young volleyball players from the experimental group increased the level of their special physical fitness preparedness, as well as the effectiveness of their specific technical-tactical skills.

As can be seen from the table, however, the advantage of the experimental group, in terms of the special speed and height of

the competitors, is insignificant and can be explained by random reasons.

Table 13. *Significance of the differences between the reported increases in the examined signs of physical development and specific working capacity*

Indicators	F	Sig.	t	α
1. Height	0,475	0,499	1,14	0,270
2. Horizontal stretch	0,235	0,633	2,47	0,023
3. Vertical rebound with both hands	0,053	0,82	4,46	0
4. Vertical rebound with one hand	0,538	0,472	2,20	0,056
5. Shuttle	0,105	0,750	3,75	0,001
6. Specific speed	3,340	0,083	0,09	0,928
7. Pass with two hands on top in goal	0,727	0,404	5,05	0
8. Two-handed feed from below in goal	1,531	0,231	6,51	0
9. Kick-off on target	0,264	0,613	4,52	0
10. Stuck in target	0,117	0,736	4,14	0,001

The calculated values of R. Fisher's F-criterion and their corresponding significance levels α and $P_{(F)}$, at a high degree of guarantee probability ($P_t \geq 95\%$), confirm the null hypothesis of equality of variances of the two groups or their homogeneity according to the studied indicators.

III.6. Methodological guidelines for the prevention of trauma in adolescent volleyball players

As stated in the working hypothesis of the study, the application of specialized sports-motor complexes aimed at strengthening the musculoskeletal system of young volleyball players is a

reliable basis for the prevention of sports injuries and at the same time leads to an increase in the level of their special physical preparedness and sports-technical performance. This, of course, requires daily efforts and hard specialized work with the help of appropriate motor complexes, such as those that the author of the present study (doctoral student) has developed and approved in sports practice in the training of young volleyball players.

In order to ensure a higher efficiency of this process, it is also necessary for young volleyball players to increase their level of knowledge about the meaning of prevention, the mechanisms of impact on the body, the damage that sports injuries cause to the athlete's body, as well as their reflection on the effectiveness of specific technical-tactical skills.

It is extremely important for both coaches and athletes to know and follow *the basic working principles*:

1. Strengthening of the locomotor apparatus through specific motor training

In order to prevent sports injuries, it is necessary to carry out special conditioning-oriented training, which includes work on the basic motor qualities (strength, speed, endurance, flexibility, agility and bounce), as well as to develop the speed of the complex motor reaction, starting speed, etc. similar. Of course, the development of a special motor quality also requires a good development of the basic motor qualities, and to a large extent it must be taken into account with the peculiarities of the elements of the volleyball technique, in the execution of which it is manifested. For example, mastering a proper defensive stance requires strengthening the quadriceps muscle strength, which in turn reduces the relative load on the knee joint and protects it from injury. When strengthening the four lobes of both muscles and the thigh, specific work is done to prevent tension.

It is useful to use the so-called lumbar exercises both to increase the strength of the involved muscles and to strengthen the ligaments. However, such exercises should be avoided in cases of low back fatigue and difficulty in movement. It is necessary to treat the injury of the lumbar region in a timely manner and only after complete healing, volleyball players should perform strength exercises. The same goes for preventing joint injuries. In order to correctly master the technical movements of passing, meeting and blocking, it is necessary to work on strengthening the strength of the fingers and increasing the strength of the muscles of the hands, to develop the flexibility and stability of the metacarpophalangeal and interphalangeal joints.

2. Scientific assurance of the training and competition processes

Training must be conducted in accordance with the age of the volleyball players, their state of health and their sports and technical level. A reasonable arrangement of the exercises, as well as a correct determination of their dosage, is necessary to avoid excessive load.

3. Proper conduct of pre-season training and preventive strategies throughout the game season

Conditioning and proprioceptive balance work are at the heart of injury prevention in young athletes. There is substantial and clear evidence to specifically support various injury prevention strategies based on a combination of:

- pre-season fitness training;
- functional training;
- strength and proprioceptive balance training that continues throughout the season.

Resistance training can consist of no more than nine basic exercises, with a focus on proper technique and form. It is recommended that the resistance be in the range of 80–85% of 1 RM to develop maximal strength. At a later stage it is possible to have resistance variability to avoid the so-called „plateaus or power barriers“. It is necessary to work on the different muscle groups and especially on those with a high traumatic profile. It is also necessary to carry out control over the load parameters. Preventive programs must be individualized and meet the specifics of the volleyball. Not without significance is the position in which a given player plays, his strengths and weaknesses.

4. Training in proper technique

The most important form of prevention, however, remains the training in correct technique, the construction of individual models of technical behavior of the competitors. For example, the element of landing after a bounce is extremely important as the forces and loads affect the player's joints and tendons. Here, training in proper technique is paramount.

5. Adequate warm-up

The preparation of the musculoskeletal system for a more intense training load is extremely important.

Specifically in our case, when working with the experimental and control groups of 12–14-year-old boys, we benefited from the fact that the same coach worked with them. At our request, in all three training sessions during the week, he conducted the same warm-up in the general motor part, as well as the same training activity - in the main part of the activity. In contrast to the control group, in the experimental, the general preparatory part continued with exercises from complex 1, and in the final part of the training, within 8–10 minutes, the complexes developed for

the final part of the training activities were worked consecutively. The exercises selected and systematized by us, are sufficient and do not require additional material. They are entirely aimed at healing for the prevention of the joints, ligaments and muscles of the upper limbs, trunk and lower limbs of young volleyball players. All the exercises are selected in such a way that they have an individual character – they can be performed independently, without the need for help from others. The specialized exercises are tailored to the age characteristics of adolescents.

IV. CONCLUSIONS

The analysis of the literary sources, the questionnaire survey conducted, the application of the traumatism prevention complexes, the testing and the interpretation of the obtained results give us the reason to make the following more important conclusions and recommendations for the sports-pedagogical practice:

1. According to volleyball coaches, the conditions for conducting a training process are to a greater extent satisfactory and to a lesser extent - good, while for the athletes, they are rather good than satisfactory.
2. The coach's frivolous attitude towards the training process, the making of methodological mistakes in the organization of the training and the lack of specialized exercises for prevention are indicated as the main reasons for the occurrence of injuries and contusions.
3. It has been confirmed that the most common injuries in adolescent volleyball players are joint buckling and spraining of the upper limb joints, ankle joint trauma and knee joint injuries. The inclusion of prevention complexes in the training process will increase its effectiveness.
4. The comparative analysis of the average levels and variability of the investigated signs shows that:
 - in general, the studied population of young elite young volleyball players is homogeneous in terms of the signs of physical development;
 - inhomogeneity with the highest coefficient of variation is observed in the technical indicators – passing with two hands from below to the goal, execution of

the initial kick to the goal and driving into the goal in the direction of reinforcement;

- in terms of specific performance, the groups of studied young volleyball players are homogeneous in terms of sprint capabilities and speed endurance.
5. The analysis of correlation matrices and models shows that the success rate of technical volleyball skills is closely related to the level of specific motor preparedness. The application of training motor complexes to strengthen the locomotor apparatus improves the ability to effectively perform technical-tactical actions.
 6. The factor structure of the special physical and specific technical-tactical preparation of young elite volleyball players is determined by 4 main factors, which in their totality explain a relatively high percentage (76.45%) of the initial variance of the investigated phenomenon:
 - the most significant place is occupied by the specific speed-power capabilities (25.22% of the output variance);
 - the second factor determines the importance of the morphological factor in young volleyball players;
 - the third factor is the specific technical-tactical skills.
 7. The effectiveness of the developed motor complexes for injury prevention among young volleyball players has been confirmed. The greatest effect is on specific jumping, speed capabilities and technical preparation.
 8. Methodological guidelines for the prevention of injuries among adolescent volleyball players are proposed.

RECOMMENDATIONS

1. The coaches should take into account all the factors that influence the frequency of injuries and, on this basis, to develop their training plans.
2. We suggest to volleyball coaches who work with adolescents to apply in the training process the motor complexes, developed by us, for injury prevention.
3. Conducting of the specific conditioning training that includes strength, speed, endurance, flexibility, agility, and proprioceptive balance work is central to injury prevention in youth volleyball players.
4. It is necessary a battery of tests with a specific orientation to assess the risk of traum in young volleyball players to be created.
5. A textbook for coaches with exercises for the prevention of sports injuries to be developed.

CONTRIBUTIONS TO SPORTS SCIENCE

The theoretical, practical and scientific research, the analyzes made and the systematized findings in the present study, allow us, to highlight the following more important scientific and applied contributions to sports science:

1. The selection of the test battery used for the scientific study has proven statistical reliability and validity for 13–14-year-old volleyball players.
2. A rich literature study was made on the problems related to sports traumatism in volleyball. The opinion of the volleyball coaches and players on the causes of injuries and the need to use complexes for prevention has been studied in detail.
3. The motor performance of 13–14-year-old volleyball players was revealed.
4. A scientific experiment was conducted by applying complexes of exercises for the prevention of sports injuries in adolescent volleyball players in the training process.

DISSERTATION RELATED PUBLICATIONS

1. **Antonov, Il., Mihailov, M., Mihailov, D., Antonova, V.** Study of some motor abilities of female volleyball players. // Sports and Science, Special issue, 2003, ISSN: 1310-3393, pp. 84-87.
2. **Mihailov, M.** Study on the causes, frequency and prevention of traumatism in elite volleyball players. // Sport and Science, Issue 2, 2018, ISSN: 1310-3393, pp. 101-110.
3. **Mihailov, M.** Characteristics of traumatism in volleyball players. // Yearbook of the National Sports Academy “Vassil Levski”, Volume 1, 2019, ISSN: 2682-9908, pp. 370-374.

