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DYNAMICS OF HEMODYNAMIC PARAMETERS IN STUDENT WRESTLERS DURING TECHNICAL AND TACTICAL TRAINING

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ABOUT ARTICLE

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Abstract: This study examines the dynamics of hemodynamic parameters in student wrestlers during technical and tactical training and evaluates the adaptive capacity of their cardiovascular system under physical load. The study focuses on student wrestlers at the stage of advanced sports mastery and assesses their functional state through a two-stage exercise-load test. Key hemodynamic indicators, including heart rate and arterial blood pressure, were analyzed to determine the cardiovascular response to increasing physical demands. The research compares the responses of experimental and control groups and evaluates changes in cardiovascular parameters during technical and tactical exercises. The findings are intended to provide a scientific basis for assessing the adequacy of training loads, improving the organization of wrestling training, and developing effective methods for enhancing students' physical and functional preparedness. The results may contribute to the development of practical recommendations for optimizing technical and tactical training while maintaining an appropriate balance between training stress and the adaptive capabilities of student athletes.

Introduction. In developed countries, a considerable body of scientific research is being conducted in response to rapidly changing social conditions. Particular attention is paid to the importance of immune resilience for a healthy lifestyle, opportunities to develop the general population's ability to engage independently and regularly in physical activity, and the enhancement of the practical and professional competence of prospective physical education teachers. Accordingly, it is increasingly important to reconsider approaches to ensuring students' competitiveness in the labor market, to teach them to make extensive use of contemporary methods and elements of pre-professional disciplines at different stages of training, to develop their practical skills during teaching practice, and to investigate the formation of competence for pedagogical activity from a pedagogical perspective.

To determine the adaptive capacity of the cardiovascular system, interpretation of the results of a two-stage exercise-load test made it possible to assess the functional state of student wrestlers and the adequacy of the training load imposed on their bodies. To evaluate the cardiovascular response to the two-stage load, hemodynamic indicators were analyzed, in particular heart rate per minute and arterial blood pressure in student wrestlers at the stage of advanced sports mastery, as presented in Tables 1.1, 1.2, and 1.3 (Appendix 1).

Table 1

Effect of a Two-Stage Exercise Load on Heart Rate in EG Student Wrestlers at the Beginning of the Study

Athletes	Heart rate (beats/min)			
	Before load	During load	Immediately after load	3 min after load
XTSU, n=8	59.5±14.5	125±12	126±19	65±13
SU, n=10	63.5±10.5	117±21	124±10	67±13

In our experiments, the mean pre-exercise heart rate ranged from 45 to 74 beats per minute.

Table 2

Effect of a Two-Stage Exercise Load on Arterial Blood Pressure in EG Student Wrestlers at the Beginning of the Study

Athletes	Arterial blood pressure (mmHg)			
	Before load	During load	Immediately after load	3 min after load
XTSU, n=8	110/70±10/10	130/69±10/11	135/65±5/5	110/65±10/5
SU, n=10	105/70±15/10	120/70±10/10	130/65±10/5	110/65±10/5

Before exercise, the mean heart rate was 60.5 beats/min, while mean arterial blood pressure was 108/69 mmHg. Following the initiation of the two-stage exercise-load test, heart

rate and blood pressure increased, reaching mean values of 124 beats/min and 132/65 mmHg, respectively. After completion of the two-stage load test, heart rate increased by 90–98%, whereas blood pressure increased by 10–33%. Subsequent observations showed that in some student wrestlers heart-rate recovery was completed during the first minute of rest, whereas in others it was delayed for up to 3 minutes. A similar trend was observed in the dynamics of blood pressure values.

Table 3

Effect of a Two-Stage Exercise Load on Arterial Blood Pressure in Experimental-Group Student Wrestlers at the End of the Study

Student wrestlers	Arterial blood pressure (mmHg)			
	Before load	During load	Immediately after load	3 min after load
XTSU, n=8	110/65±10/5	135/65±5/10	135/65±5/5	110/65±5/5
SU, n=10	110/70±10/10	120/70±10/10	130/65±10/5	100/65±10/5
	Pulse rate (beats/min)			
XTSU, n=8	58±12	120±14	120±15	68±10
SU, n=10	63±10	119±18	122±8	66±12

As shown in Table 3.13, the levels of hemodynamic indicators differed among highly qualified student wrestlers at the end of the preparatory period. Functional capacity improved in 50.0% of the student wrestlers, hemodynamic indicators remained unchanged in 26.7%, and average values were recorded in 23.3% at this stage.

It should be noted that, as the training status of student wrestlers improved, a more economical chronotropic function of the heart at rest was observed due to increased parasympathetic tone of the autonomic nervous system. This was manifested as sports-related bradycardia (heart rate), with a value of 59.5 ± 14.5 beats/min in the research group.

All planned sports-training sessions were conducted in full across the groups, with an average attendance rate of 85%. The participants fully mastered the instructional content of the Kurash Federation's kurash program for supplementary educational institutions and sports schools in accordance with the requirements applicable to this group of students. At the end of the pedagogical study, final testing was conducted. The results demonstrated substantial positive changes in most of the assessed indicators, reflecting different aspects of the development of the required qualities, the level of preparedness for performing technical and tactical actions in kurash, and competitive performance outcomes.

The results of the assessment of preparedness for performing technical and tactical actions in kurash and of competitive performance outcomes are presented below.

Comparison of the results obtained in the groups of student wrestlers showed that, at the beginning of the experiment, the indicators of performance of kurash techniques used in competition were almost identical. Following the control tests conducted at the beginning of the study, a clear increase in the performance indicators of kurash techniques was observed in all groups. For example, the relative increase in the control group (CG) was 6.46 points ($p < 0.05$), whereas the corresponding increase in the experimental group (EG) was 13.80 points ($p < 0.001$) (see Table 3.14).

Table 4

Dynamics of Technical Preparedness Indicators for the Performance of Kurash Techniques in Competition in the Experimental and Control Groups During the Study

Indicators	Experimental group			Control group		
	$\boldsymbol{x}$	σ	**V %**		**σ**	V %
Technique performance score on a 9-point scale (points)	4.42	0.53	11.99	5.03	0.56	11.13
"Activity" (points)	4.66	0.60	12.94	5.16	0.63	12.14
"Effectiveness" (points)	4.54	0.63	13.96	5.38	0.71	13.20
"Combinationality" (%)	20.53	2.24	10.91	21.56	2.18	10.11
"Efficiency of technical actions" (%)	24.65	3.44	13.96	28.32	3.72	13.13

Note: Improvement of technique through the performance of specialized exercises.

Comparison of the relative rates of improvement in the performance of kurash techniques indicates that the results recorded in all groups reflect effective work with student wrestlers at the sports school aimed at mastering the general technical foundations of kurash.

Particularly pronounced differences between the control and experimental groups were recorded for the performance of throwing techniques. For example, participants in the experimental group achieved the largest increase, amounting to 13.80 points ($p < 0.001$), whereas the corresponding value in the control group was only 6.46 points ($p > 0.05$).

Performance of Kurash Techniques in the Experimental and Control Groups During the Study

Changes in 9-Point Scale Scores for the Performance of Throwing Techniques During the Formative Experiment in the Experimental and Control Groups.

The greater increase in the performance indicator for throwing techniques in the experimental group indicates a positive effect of the experimental exercise methodology on the participants.

Analysis of the "Activity" indicator showed positive growth in the final assessment across all groups, although the magnitude of improvement differed. The experimental group demonstrated the largest increase in this indicator, reaching 10.80, whereas a lower increase of 5.68 was recorded in the control group.

Analysis of the dynamics of the "Effectiveness" indicator showed a positive shift during the study in all groups, although the magnitude varied between groups. The experimental group demonstrated the largest increase in the indicator, reaching 18.50, whereas a substantially lower value of 7.58 was recorded in the control group.

Table 5

Dynamics of Technical and Tactical Performance Indicators Based on the Time Required to Perform Kurash Techniques Six Times in the Experimental and Control Groups During the Study

Measured indicator	Experimental group			Control group		
	x	σ	V %	x	σ	V %
Shoulder throw (s)	11.36	1.01	8.89	10.76	0.87	8.12
Hip throw (s)	14.63	1.6	10.94	13.61	1.38	10.14
Lifting throw from between the legs (s)	13.87	1.66	11.97	12.88	1.43	11.10
Waist throw (s)	12.69	1.38	10.87	12.02	1.22	10.15
Backward body-lock throw (s)	11.35	1.34	11.81	10.63	1.18	11.13
Inner-leg hook takedown (s)	12.48	1.37	10.98	11.86	1.21	10.20

Note: Technical and tactical training exercises.

Changes in the time required to perform kurash techniques six times in the experimental and control groups at the beginning and end of the study (see Table 3.15).

The improvement in the shoulder-throw performance indicator in the experimental group was more pronounced than that observed in the control group, indicating a substantial positive effect.

Analysis of the "shoulder throw" indicator showed positive improvement in the final assessment in both groups, although the magnitude differed. The experimental group demonstrated the largest increase in the indicator, reaching 8.12, whereas a lower value of 7.13 was recorded in the control group.

Analysis of the dynamics of the "hip throw" indicator showed a positive shift during the study in both groups, although the magnitude differed. The experimental group demonstrated

the largest increase in the indicator, reaching 10.14, whereas a lower value of 9.39 was recorded in the control group.

Analysis of the dynamics of the "lifting throw from between the legs" indicator showed a positive shift during the study in both groups, although the magnitude differed. The experimental group demonstrated the largest increase in the indicator, reaching 11.10, whereas a lower value of 9.56 was recorded in the control group.

Analysis of the dynamics of the "waist throw" indicator showed a positive shift during the study in both groups, although the magnitude differed. The experimental group demonstrated the largest increase in the indicator, reaching 10.15, whereas a substantially lower value of 7.34 was recorded in the control group.

Analysis of the dynamics of the "backward body-lock throw" indicator showed a positive shift during the study in both groups, although the magnitude differed. The experimental group demonstrated the largest increase in the indicator, reaching 11.13, whereas a substantially lower value of 8.48 was recorded in the control group.

Analysis of the dynamics of the "inner-leg hook takedown" indicator showed a positive shift during the study in both groups, although the magnitude differed. The experimental group demonstrated the largest increase in the indicator, reaching 10.20, whereas a substantially lower value of 8.26 was recorded in the control group.

Table 6

Evaluation of Physical Fitness Test Results in the Control and Experimental Groups (Baseline)

Exercise	Unit	Assessment domain	Control group ($\bar{X} \pm m$)	Experimental group ($\bar{X} \pm m$)
30-m sprint	s	Speed	4.6 ± 0.2	4.5 ± 0.2
100-m run	s	General endurance	13.8 ± 0.4	13.7 ± 0.3
Standing long jump	cm	Explosive strength	225 ± 8	228 ± 7
Pull-ups	repetitions	Upper-body strength	9.2 ± 1.1	9.4 ± 1.0
Push-ups	repetitions	Strength endurance	28 ± 3	29 ± 3
Leg raises	repetitions	Abdominal strength	22 ± 2	23 ± 2
End of study				
30-m sprint	s	Speed	4.4 ± 0.2	4.1 ± 0.1
100-m run	s	General endurance	13.4 ± 0.3	12.8 ± 0.3

Standing long jump	cm	Explosive strength	232 ± 7	245 ± 6
Pull-ups	repetitions	Upper-body strength	10.1 ± 1.0	13.2 ± 1.1
Push-ups	repetitions	Strength endurance	31 ± 3	36 ± 4
Leg raises	repetitions	Abdominal strength	25 ± 2	30 ± 3

Note: Tests used to assess the physical fitness of student wrestlers.

At the beginning of the study, 30-m sprint performance was almost identical in the control (4.6 ± 0.2 s) and experimental (4.5 ± 0.2 s) groups, indicating comparable baseline speed levels. By the end of the study, positive changes were observed in both groups; however, the experimental group improved to 4.1 ± 0.1 s, demonstrating a markedly better result than the control group (4.4 ± 0.2 s). This finding supports the effectiveness of the experimental training system in developing speed.

General endurance, assessed using the 100-m run, was similar at baseline in the control (13.8 ± 0.4 s) and experimental (13.7 ± 0.3 s) groups, with no substantial difference between the groups. At the end of the study, the experimental group improved to 12.8 ± 0.3 s, indicating a higher level of endurance development and exceeding the improvement recorded in the control group (13.4 ± 0.3 s).

At baseline, standing long-jump results were 225 ± 8 cm in the control group and 228 ± 7 cm in the experimental group, indicating nearly identical levels of explosive strength. By the end of the study, the experimental group increased this indicator to 245 ± 6 cm, demonstrating the high effectiveness of the specialized exercise system aimed at developing explosive strength and a substantial improvement compared with the 232 ± 7 cm recorded in the control group.

At the beginning of the study, pull-up performance was 9.2 ± 1.1 repetitions in the control group and 9.4 ± 1.0 repetitions in the experimental group, indicating no major difference in upper-body muscular strength between the groups. By the end of the study, performance in the experimental group increased to 13.2 ± 1.1 repetitions, substantially exceeding the 10.1 ± 1.0 repetitions recorded in the control group. This finding supports the high effectiveness of the experimental strength-development training.

Strength endurance, assessed using push-ups, was nearly identical at baseline in the control (28 ± 3 repetitions) and experimental (29 ± 3 repetitions) groups. By the end of the study, this indicator increased to 36 ± 4 repetitions in the experimental group, which was substantially higher than the 31 ± 3 repetitions recorded in the control group, demonstrating the effectiveness of the exercise complex used to develop strength endurance.

At baseline, leg-raise performance was 22 ± 2 repetitions in the control group and 23 ± 2 repetitions in the experimental group, indicating no substantial difference in abdominal muscular strength. At the end of the study, the experimental group improved to 30 ± 3 repetitions, demonstrating the high effectiveness of the training system aimed at developing abdominal strength and endurance and clearly exceeding the 25 ± 2 repetitions recorded in the control group.

Analysis of the pedagogical experiment showed that, at the beginning of the study, athletes in the control and experimental groups had almost identical levels of physical fitness across all indicators characterizing speed, general endurance, explosive strength, upper-body muscular strength, strength endurance, and abdominal muscular strength. This finding indicates that the experimental process was organized appropriately from a methodological perspective and that the selected groups had comparable baseline capacities.

Although positive changes in the development of physical qualities were observed in athletes from both groups by the end of the study, the rates of improvement in key qualities—including speed, general endurance, explosive strength, muscular strength, and strength endurance—were markedly higher in the experimental group as a result of the specially designed training system.

In particular, the substantial improvements recorded in the 30-m and 100-m running tests in the experimental group indicate effective development of speed and general endurance, while the pronounced gains observed in the standing long jump clearly demonstrate the high effectiveness of the training complex designed to develop explosive strength.

In addition, the substantial improvements demonstrated by athletes in the experimental group in pull-ups, push-ups, and leg raises confirm the appropriateness of the pedagogical approach used to develop upper-body and abdominal muscular strength and strength endurance, thereby providing scientific support for the developed methodology as an effective means of physical preparation for athletes.

Overall, the findings indicate that integrating the training system used in the experimental group into athletes' educational and training process contributes to a comprehensive improvement in physical fitness and that the proposed methodology has scientific and practical significance for sports practice.

Conclusions and Recommendations. To improve the effectiveness of exercises in the training process of student wrestlers and further enhance their physical preparedness, a questionnaire survey was conducted among specialists and coaches working at higher education institutions. The survey addressed the organization of technical and tactical and pre-

competition training for student wrestlers, as well as the planning of pre-competition sessions aimed at improving their physical preparedness.

• In competitive kurash bouts, throwing techniques are an effective means of achieving victory before the end of regulation time or of gaining a substantial competitive advantage;

• According to the majority of respondents, the development and refinement of throwing techniques should begin with the study of the techniques and tactics demonstrated by the world's leading wrestlers at major competitions, while taking into account objective factors that arise in the training of students;

As athletes progress through the stages of preparation, increasing the proportion of specialized physical and technical–tactical training enhances their readiness for competitive activity, their ability to analyze an opponent's actions, and their capacity to apply effective technical solutions. At the same time, the gradual expansion of competition exposure strengthens athletes' psychological stability and facilitates adaptation to real competitive conditions. The rational planning of control, qualification, main, and major competitions contributes to the systematic accumulation of competitive experience.

Overall, the proposed training system is oriented toward the long-term and sustainable development of athletes, creating the conditions necessary to preserve their health, enhance their technical and physical capacities, and achieve high sports performance. This approach may serve as an effective methodological framework in the preparation of student wrestlers.

During the pre-competition preparation of Uzbek student wrestlers, effective monitoring and systematic refinement of technical actions are important factors in achieving high performance. A systematic approach based on the control of technical preparedness ensures thorough planning of the content of each training stage and enables the athlete's level of preparedness to be increased progressively.

The weekly microcycle of pre-competition preparation for student wrestlers is intended to elevate technical and tactical mastery to a high level. The content of this microcycle is structured according to the principles of sequence and systematicity and is aimed at developing entries into technical techniques, deceptive actions, attacks using the legs, balance control, and coordination during gripping. Repeated execution of technical techniques under unopposed conditions during training develops movement patterns toward automaticity. Exercises performed with specialized resistance bands and with changing partners enhance the athlete's individual technical style, strength–speed qualities, and ability to adapt to different types of opponents. At the same time, precisely regulated training duration makes it possible to control the level of fatigue and organize recovery effectively.

Overall, the findings indicate that integrating the training system used in the experimental group into athletes' educational and training process contributes to a comprehensive improvement in physical fitness and that the proposed methodology has scientific and practical significance for sports practice.

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