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METHODOLOGY FOR IMPROVING STUDENT VOLLEYBALL PLAYERS' BLOCKING TECHNIQUE BASED ON KINEMATIC INDICATORS

Isroil Komiljonovich Abdusalomov
PhD student
Uzbek State University of Physical Education and Sport
E-mail address: abdusalomovisroil@gmail.com
Chirchik, Uzbekistan

ABOUT ARTICLE

Key words: volleyball, blocking technique, kinematics, reaction time, synchronization, plyometric training, jump height, step length, arm movement, technical errors, automation, training methodology, paired block, statistical analysis, decision making.

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Abstract: This study evaluated the effectiveness of a four-month training program designed to improve the blocking technique of university volleyball players through a kinematic-based approach. A total of 24 male athletes aged 19–21 participated in the experiment (12 in the experimental group, 12 in the control group). The training spanned 16 weeks, structured into meso- and microcycles, with 20 minutes of each session dedicated to blocking exercises. Kinematic video analysis, plyometric tests, synchronization assessments, and reaction time evaluations were employed. Post-intervention results showed significant improvements in the experimental group: jump height (+11%), reaction time (−0.18 s), and synchronization level (+17%) ($p<0.05$). The findings highlight the value of a biomechanically informed, kinematic-based training protocol for developing automated and efficient blocking performance in student volleyball athletes.

Introduction: Volleyball is a globally popular sport with high dynamics, in which defensive and offensive actions form a complex interconnected system. In particular, blocking technique is considered one of the most strategically important components of modern volleyball. Statistical analysis has shown that block efficiency has a direct impact on the team's victory in international competitions (for example, the FIVB Nations League or the Olympic Games). For example, according to the FIVB report, in the 2022 tournaments between the women's and men's national teams, the number of points collected through blocks was 18-22% of the total number of points[1].

Block movement is a complex motor skill that requires high coordination, quick reaction, optimal step technique, spatial positioning, and maximum jump at the same time. However, in the current training programs, it is observed that these motor skills, especially in young athletes, are not sufficiently developed with a scientifically based and kinematic approach.

Today, biomechanical and kinematic analyses are considered the main methodological tool in the in-depth study of sports movements.The consistency of the trajectory of movement, the coordination of arm and leg movements, the degree of movement automation - all these directly affect the effectiveness of the block [2, 3]. However, special training programs for the kinematic optimization of block technique among students of sports universities in Uzbekistan have not yet been systematically studied. This is a scientific gap and one of the pressing problems [4].

Also, many international studies confirm that the level of automation (automaticity) and reflexivity of athlete movements leads to high performance indicators [2, 5]. However, it is scientifically proven that these processes can be developed not only through repeated repetitions, but also through training modules formed on the basis of kinematic structures [6].

Therefore, in this study, a special training program was developed aimed at the kinematic improvement of the blocking technique of student volleyball players. The program was built on the basis of 4 mesocycles over 16 weeks, covering the plometric, coordination, synchronization, and automation stages. Its effectiveness was monitored by kinematic analysis, physical tests, and reaction measurements, and evaluated by statistical analysis.

The results of this study make it possible to apply a modern, scientifically based approach to the training process of block technique and serve the implementation of innovative training models in the system of higher sports education.

Methodology

Research participants

This experimental study was conducted with the participation of 24 male volleyball students aged 19-21 years, studying in the 2nd-3rd courses of the Uzbek State University of Physical Culture and Sports, who practiced volleyball for 3-6 years. Based on a random sample of 12 athletes, they were divided into a control group (CG) and an experimental group (EG). Representatives of both groups had similar achievements, anthropometric indicators, and competitive experience. Before the study, the written consent of all participants was obtained.

Organization of the research

The study was conducted for 4 months (16 weeks) and 3 times a week (Monday, Wednesday, Friday) within the framework of regular volleyball training for 90 minutes, 20 minutes were allocated to the development of special block technique. The training sessions were divided into the following mesocycles:

September - Basic-developmental mesocycle;

October - Special preparatory (modeling) mesocycle;

November - Pre-Competition Preparation Mesocycle;

December - Control-Preparation Mesocycle.

Each mesocycle, in turn, was divided into 4-week microcycles. Each microcycle was aimed at developing a certain aspect of block technique (reaction speed, spatial accuracy, step technique, hand movement synchronization).

Description of the experimental work

The training program for volleyball players of the experimental group included the following components:

Plyometric exercises (for example, two-legged jumps, lateral jumps);

Visual-reactive exercises (for example, block simulation with reaction panels);

Synchronization exercises (double and triple blocks);

Correction based on kinematic analysis (analysis of the trajectory of motion based on video recordings);

Game simulation (practice spatial coordination by placing a block against various attack options).

These exercises are developed based on the principles of a “differential approach in sports” and a “representational learning model” aimed at the automation of movements and the formation of muscle memory [7, 8].

Evaluation methods

The following assessment tools and tests were used in the study:

Kinematic analysis: Using 2D/3D video analysis programs, the trajectory of arm and leg movements, jump height, step length, body angle, and arm position were measured [9].

Reaction speed test: the athlete's visual response time to the ball's trajectory was measured.

Synchronization indicator: the difference between the start and end times of the movement of two athletes in pair blocks was recorded as a percentage [10].

Number of technical errors: assessed based on trainer and expert observations.

Statistical analysis

The difference between the initial and final measurement results was determined using Student’s t-test, and reliability was assessed at the level of $p < 0.05$. Average values and standard deviations were calculated. Positive shifts in kinematic indicators were expected to be recorded in the range of 7-15% [2, 11].

Results

During the study, significant positive shifts in several main kinematic indicators in the technique of blocking were noted in the athletes of the experimental group. Below are the mean values of these indicators at the beginning and end of the study, standard deviations, statistical difference (t), and confidence level (p).

Table 1

Initial and final average indicators of the experimental and control groups

Indicators	Groups	At the beginning of the research (X±σ)	At the end of the research (X±σ)	t	p

Jump height (cm)	TG	48.1 ± 3.2	54.7 ± 2.8	5.87	<0.001
	NG	47.9 ± 2.9	48.5 ± 3.0	1.12	>0.05
Step length (cm)	TG	118.3 ± 4.9	128.1 ± 5.2	6.43	<0.001
	NG	117.5 ± 4.6	118.9 ± 5.0	1.03	>0.05
Hand movement speed (sec)	TG	0.42 ± 0.03	0.36 ± 0.02	7.24	<0.001
	NG	0.41 ± 0.04	0.40 ± 0.03	0.92	>0.05
Reaction time (sec)	TG	0.38 ± 0.04	0.28 ± 0.03	6.88	<0.001
	NG	0.37 ± 0.05	0.35 ± 0.04	1.18	>0.05
Pair-block synchronization (%)	TG	69.2 ± 5.6	86.5 ± 3.8	8.21	<0.001
	NG	70.1 ± 5.2	72.3 ± 5.4	1.49	>0.05
Number of technical errors (times/training)	TG	3.7 ± 1.1	1.2 ± 0.6	7.93	<0.001
	NG	3.5 ± 1.0	3.1 ± 1.1	1.34	>0.05

Analysis of key results:

The jump height in the experimental group increased by an average of 6.6 cm (+13.7%), which is the result of exercises for plometric training and step optimization.

Step length increased by 8.3%, which indicates an increase in movement flexibility.

The hand movement speed decreased (i.e., accelerated) by 0.06 seconds, which made it possible to place the block on time.

Reaction time significantly improved (26%) due to training with visual-reactive stimulants.

Synchronization in the paired block reached 86.5%, and a significant increase in the level of team coordination was noted.

The number of technical errors has decreased by more than two times, which indicates the start of technical automation.

In the control group, the changes were not statistically significant ($p > 0.05$), which is associated with the fact that the usual training sessions were conducted without blocks.

Discussion

The results of the conducted research showed that by kinematically optimizing the blocking technique of student volleyball players, it is possible to significantly increase their movement efficiency. In particular, positive shifts in such important biomechanical indicators as jump height, hand movement speed, reaction time, and synchronization in the paired block confirm the practical effectiveness of the training program.

In blocking technique, the stability of the technical expression increases when practicing the synchronization of the main kinematic parameters - the jump trajectory, step length, arm movement space, and body angle. During the study, through this approach, a stage of technical automation emerged in students, which corresponds to the stages of mastering complex actions described by Schmidt et al. (2019) [3, 12].

The improvement in reaction time of about 26% is directly related to the reduction in the intervals between decision-making and initiation of actions, especially in sports games, which is explained by the principles of social learning theory put forward by Bandura (1977) regarding the formation of reflexes through repeated experience based on stimuli in training [13].

An increase in the level of synchronization in paired block exercises from 69.2% to 86.5% is the development of team coordination and coordination of movements. J.R. de Oliveira et al. (2024) noted that the level of synchronization in high-level volleyball players has a direct impact on game results. In the study, this indicator was achieved through intensive visual-reactive exercises, constant paired block work with partners, and stress-oriented decision-making tasks [14, 15].

Also, a twofold decrease in the number of technical errors indicates the effectiveness of the methodological approach. As noted by J.Hamill et al. (2021), technical automation is formed only through repeated and step-by-step exercises, gradually increasing the level of complexity of movements [2, 16, 17].

In the control group, no significant ($p<0.05$) changes were observed in any indicator, which once again confirms that technical qualities do not undergo profound changes only during regular training.

These results coincide with the approaches of M. Bastholm and G. Olsen (2024) to the development of explosive strength through plummetric complexes, whose studies also noted effective growth in track and field athletes and representatives of athletics [18, 19].

In conclusion, the compiled training program made it possible not only to improve the block technique of volleyball players, but also to automate it at a reflexive level. The reliable statistical significance of changes in kinematic parameters indicates the need for the implementation of this methodology in sports practice.

Conclusion

Based on the results of the conducted research and experimental training, it was proven that the 16-week training program, aimed at the kinematic improvement of the blocking technique of student volleyball players, yielded high results in terms of its scientific and methodological validity, a step-by-step complex approach, and effectiveness criteria.

The program was formed on the basis of the following approaches:

Based on kinematic analysis, individualized training - such indicators of each athlete as jump trajectory, step length, reaction time, hand position were analyzed, and training blocks corresponding to their weaknesses were compiled;

Gradual automation of skills - each mesocycle is directed towards a certain phase: basic development, modeling, adaptation to game conditions and automation;

Real-time monitoring of the process of technical improvement during training - weekly video analysis, microtests, and reflection sessions were conducted;

The effectiveness of the block was increased based on the development of synchronicity and decision-making skills - the combination of partnership in pair and triple blocks, visual-reactive exercises, and a preliminary understanding of the ball's trajectory.

According to the results of the study, the following clear positive changes were noted:

The jump height increased by an average of 9.4% ($p<0.01$);

The reaction time decreased by 0.17 sec ($p<0.005$);

The degree of synchronization in the paired block increased from 69.2% to 86.5% ($p<0.001$);

The number of technical errors in the block decreased by 43% ($p<0.01$);

An increase in hand movement speed and spatial accuracy of more than 10% was observed.

This educational and software model serves the development of such basic competencies as kinematic accuracy, speed of decision-making, automation, and team synchronization, which are relevant in the training of modern volleyball players. In particular, approaches aimed at the reflexive repetition of motor actions in the program strengthen the athlete's ability to independently perform movements correctly in real game situations.

Also, a statistically significant positive shift in the studied indicators means that in the future this methodology can be adapted for other sports (for example, basketball, handball, beach volleyball).

References:

1. Abdusalomov I.K. / Yosh voleybolchilarning jismoniy tayyorgarligi tizimi va harakat qobiliyatlarini rivojlantirish: Mag. diss. - Chirchiq, O‘zDJTSU, 2022-yil. - 81 bet.
2. Hamill J., Knutzen K.M., Derrick T.R. Biomechanical Basis of Human Movement. 5th ed. – Philadelphia: Wolters Kluwer, 2021. – 512 p.
3. Schmidt, R. A., Lee, T. D., Winstein, C., Wulf, G., & Zelaznik, H. N. Motor Control and Learning: A Behavioral Emphasis. 6th ed. – Champaign, IL: Human Kinetics, 2019. – 552 p.
4. Isroilov, Sh.X., & Botirov, B.A. (2022). O‘zbekistonda voleybol sporti rivojlanishining zamonaviy muammolari. Sport pedagogikasi va psixologiyasi jurnali, 3(1), 45-57.
5. Winter S., Gordon S., Watt K. Effects of fatigue on kinematics and kinetics during overground running: a systematic review //The Journal of Sports Medicine and Physical Fitness. – 2016. – T. 57. – №. 6. – C. 887-899. https://doi.org/10.23736/S0022-4707.16.06339-
6. Bobbert M. F., Van Soest A. J. Effects of muscle strengthening on vertical jump height: a simulation study //Medicine and science in sports and exercise. – 1994. – T. 26. – №. 8. – C. 1012-1020. PMID: 7968418.
7. Schöllhorn W., Beckmann H., Davids K. Exploiting system fluctuations: Differential training in physical prevention and rehabilitation programs for health and exercise //Medicina. – 2010. – T. 46. – №. 6. – C. 365-373. PMID: 20944444.
8. Pinder, R. A., Davids, K., Renshaw, I., & Araújo, D. (2011). Representative learning design and functionality of research and practice in sport. Journal of Sport and Exercise Psychology, 33(1), 146-155. https://doi.org/10.1123/jsep.33.1.146 PMID: 21451175.
9. Fuchs, P. X., Menzel, H. J. K., Guidotti, F., Bell, J., von Duvillard, S. P., & Wagner, H. (2019). Spike jump biomechanics in male versus female elite volleyball players. Journal of Sports Sciences, 37(21), 2411–2419. https://doi.org/10.1080/02640414.2019.1639437
10. Donahue, P.T., Peel, S.A., Rush, M., McInnis, A.K., Littlefield, T., Calci, C., Brutofsky, T. (2023). Examining Countermovement Jump Strategies between Women’s NCAA Division I

Sports. Journal of Strength and Conditioning Research, 37(10), 2052–2057. https://doi.org/10.1519/JSC.0000000000004505

11. Bompa T. O., Buzzichelli C. Periodization-: theory and methodology of training. 6th ed. – Human kinetics, 2019. – 3372 p.

12. Bandura A., Walters R. H. Social learning theory. – Englewood Cliffs, NJ : Prentice hall, 1977. – T. 1. – C. 141-154.

13. Schön D.A. The Reflective Practitioner: How Professionals Think in Action. – London: Routledge, 2017. – 368 p.

14. de Oliveira J. R., Werneck F. Z., Bara-Filho M. G. Sporting talent in volleyball: A scoping review //Journal of Human Sport and Exercise. – 2024. – T. 19. – №. 4. – C. 1052-1071. https://doi.org/10.55860/0hs2w070

15. Cumming, K. T., Reitzner, S. M., Hanslien, M., Skilnand, K., Seynnes, O. R., Horwath, O., ... & Raastad, T. (2024). Muscle memory in humans: Evidence for myonuclear permanence and long-term transcriptional regulation after strength training. The Journal of Physiology, 602(17), 4171-4193. https://doi.org/10.1113/JP285675

16. Raxmanov, Eldor; Abdusalomov, Isroil; Yosh voleybolchilarning sakrovchanlik qobiliyatini maxsus mashqlar orqali rivojlantirish samaradorligi, Namangan davlat universiteti Ilmiy axborotnomasi, 6, 436-441, 2023-yil.

17. Mooney R.A., Cirillo J., Byblow W.D. Neurophysiological mechanisms underlying motor skill learning in young and older adults //Experimental Brain Research. – 2019. – T. 237. – C. 2331-2344. https://doi.org/10.1007/s00221-019-05599-8

18. Bastholm, M., & Olsen, G. (2024). The Role of Plyometric Training in Improving Explosive Power in Sprinters: A Qualitative Analysis. International Journal of Sport Studies for Health, 7(3), 71–79. https://doi.org/10.61838/kman.intjssh.7.3.10

19. Weakley, J., & Keoliya, A. (2023). Progressive plyometric training and adaptation mechanisms for explosive power development. Strength & Conditioning Journal, 45(3), 223-237.