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Features of the kinematics structure of ball throwing and catching techniques in rhythmic gymnastics at the stage of preliminary basic training

Natalia Olehivna Andreieva, Oleksandr Valeriiovych Zhyrnov, Yuriy Mykolayovych Salyamin

National University of Ukraine on Physical Education and Sport, Kyiv, Ukraine

Abstract

The purpose of the research is to study the features of the kinematics structure of the technique on throwing and catching ball by athletes engaged in rhythmic gymnastics at the stage of preliminary basic training. **Research methods** include analysis and generalization of data received from scientific and methodical literature, video shooting, biomechanical video-computer analysis of movements, method of expert assessment, methods of mathematical statistics. **The contingent** under study accounts for 20 gymnasts of the second youth category aged 9-10. The peculiarities of the kinematics structure of motor actions of gymnasts when performing two basic sets of ball exercises, which are learned at the stage of preliminary basic training, were examined. **Research results and their discussion.** Quantitative information was obtained about the indicators of the kinematics structure of the nodal elements for sports technique, associated with basic set of ball exercises: from two or three steps – throwing the ball in the "Cossack" jump – catching into the roll on both hands and back in rhythmic steps; and from two or three steps – throwing the ball in a jump touching in the ring – catching into the roll on both hands and back in rhythmic steps. Based on the indicators of biomechanical analysis of the two basic sets of ball exercises performed, the phase structure of exercises is specified and the key elements of sports technique of throwing and catching the ball are

studied. For a more detailed analysis in both studies, we selected three nodal elements: the starting pose of the body (the moment of releasing the ball), the multiplication of the body pose (body position during the jump) and the final body pose (the moment of catching the ball). **Conclusion.** Objective quantitative biomechanical information about indicators of kinematics structure of nodal elements for sport technique consisting of basic set of ball exercises is received: from two-three steps – throwing the ball in the "Cossack" jump – catching into the roll on both hands and back in rhythmic steps; and from two or three steps - throwing the ball in a jump touching in the ring – catching into the roll on both hands and back in rhythmic steps. The obtained characteristics of the kinematics structure of the nodal elements of throwing and catching the ball during both basic exercises, can be used as model indicators for more effective technical training of young gymnasts. **Conflict of interest.** The authors state that there is no conflict of interest. **The prospect of further research** is associated with development of the models of nodal elements motor structure, used as sport technique for exercises with objects at the stage of specialized basic training.

Key words: rhythmic gymnastics; ball; preliminary basic training; technique; kinematics structure of movements; nodal elements; starting pose; multiplication of poses; throwing, catching.

Особливості кінематичної структури техніки кидків і ловлі м'яча в художній гімнастиці на етапі попередньої базової підготовки

Наталія Олегівна Андрєєва, Олександр Валерійович Жирнов, Юрій Миколайович Салямін

Національний університет фізичного виховання і спорту України, Київ, Україна

Анотація

Мета досліджень. Вивчити особливості кінематичної структури техніки кидків і лову м'яча спортсменок, що займаються художньою гімнастикою на етапі попередньої базової підготовки. **Методи дослідження:** аналіз і узагальнення даних науково-методичної літератури, відео зйомка, біомеханічний відеокомп'ютерний аналіз рухів, метод експертних оцінок, методи математичної статистики. **Контингент** досліджуваних – 20 гімнасток II юнацького розряду віком 9-10 років. Було вивчено особливості кінематичної структури рухових дій гімнасток при виконані двох базових

зв'язок вправ з м'ячем, які вивчаються на етапі попередньої базової підготовки. **Результати дослідження та їх обговорення**. Отримано кількісну інформацію про показники кінематичної структури вузлових елементів спортивної техніки базової зв'язки вправ з м'ячем: з двох-трьох кроків – кидок м'яча в стрибку «козак» – ловля в перекат по двом рукам і спині на ритмічних кроках та з двох-трьох кроків – кидок м'яча в стрибку торкаючись в кільце – ловля в перекат по двом рукам і спині на ритмічних кроках. На підставі показників біомеханічного аналізу двох виконаних базових зв'язок вправ з м'ячем, виділені фазові структури вправ і вивчені вузлові елементи спортивної техніки кидків і лову м'яча. Для більш детального аналізу в обох досліджуваних вправах нами було обрано три вузлових елементи: пускова поза тіла (момент випуску м'яча), мультиплікація пози тіла (положення тіла під час виконання стрибка) та кінцева поза тіла (момент ловлі м'яча). **Висновок.** Отримано об'єктивну кількісну біомеханічну інформацію про показники кінематичної структури вузлових елементів спортивної техніки базової зв'язки вправ з м'ячем: з двох-трьох кроків – кидок м'яча в стрибку «козак» – ловля в перекат по двом рукам і спині на ритмічних кроках та з двох-трьох кроків – кидок м'яча в стрибку торкаючись в кільце – ловля в перекат по двом рукам і спині на ритмічних кроках. Отримані характеристики кінематичної структури вузлових елементів кидків і лову м'яча в обох базових зв'язках вправ, можуть бути використані в якості модельних показників для більш ефективної технічної підготовки юних гімнасток. **Конфлікт інтересів.** Автори заявляють, що конфлікт інтересів відсутній. **Перспектива подальших наукових досліджень** пов'язана з розробкою моделей рухової структури вузлових елементів спортивної техніки вправ з предметами на етапі спеціалізованої базової підготовки.

Ключові слова: художня гімнастика; м'яч; попередня базова підготовка; техніка; кінематична структура рухів; вузлові елементи; пускова поза; мультиплікація поз; кидок; ловля.

Introduction. Rhythmic gymnastics, like any sport, aims to achieve sports results [1, 4]. Ukrainian gymnasts have great sport achievements, however the ever-increasing sport competition among the world leading national teams requires new ways for coaches and athletes to improve their sport results. At the present stage of rhythmic gymnastics development, the promising ways to improve the result in the first place are associated with the improvement of basic technical training of athletes [1, 2].

The stage of preliminary basic training in complex coordination sports, in general, is focused on basic developmental classes aimed at the variability of approaches and techniques used in the development of technical actions [6, 7]. In rhythmic gymnastics it is necessary to expand the motor abilities of female athletes, to achieve harmonious physical development, to instill aesthetics in gymnasts. At the same time, athletes are subject to special requirements that reflect the specifics of rhythmic gymnastics. Even at the stage of preliminary basic training gymnasts must have specific coordination skills that allow them to perform single and compositional motor actions of a free nature as well as actions connected with manipulation of sports objects [2, 5].

At the same time, basic technical training is an insufficiently solved problem in the theory and methods of rhythmic gymnastics. It is primarily about the subject of basic training, performing biomechanically rational throws and catching objects in the compositions of gymnastic exercises [1, 2]. Evaluation of sport technique of throwing and catching objects, as well as analysis of the spatial movement of gymnasts, adequate movement of the object, is carried out in the educational process and during competitions, mainly visually. The results of biomechanical analysis of sport techniques of throwing and catching objects, a detailed study of the phase structure of rhythmic gymnastics exercises, consideration of the causes of technical errors are partly presented in the scientific and methodological literature on rhythmic gymnastics [2, 4]. The relevance of basic technical training is confirmed by theorists and practitioners of rhythmic gymnastics.

The aim of the research is to study the features of the kinematics structure of the technique on throwing and catching the ball of athletes engaged in rhythmic gymnastics at the stage of preliminary basic training.

Research methods include analysis and generalization of data received from scientific and methodical literature, video shooting, biomechanical video-computer analysis of movements, methods of mathematical statistics.

Research results and their discussion. During the study, the kinematics structure of motor actions of 20 gymnasts of the second youth category aged 9-10 was recorded and analyzed. For biomechanical analysis, we chose two combinations of exercises: throwing the ball in the "Cossack" jump – catching into the roll on both hands and back in rhythmic steps; and throwing the ball in a jump touching in the ring – catching into the roll on both hands and back in rhythmic steps.

Studies in sport gymnastics, athletics and other sports [3, 4] show that when athletes perform various exercises, there are body positions that determine the kinematics and

dynamic structure of the previous and subsequent movements, such body positions are called nodal elements.

In our research, we studied the features of the kinematics structure of motor actions of gymnasts when performing two basic sets of ball exercises, which are learned at the stage of preliminary basic training. Quantitative information was obtained about the indicators of the kinematics structure of the nodal elements for sports technique, associated with basic set of ball exercises: from two or three steps – throwing the ball in the "Cossack" jump – catching into the roll on both hands and back in rhythmic steps.

The kinematics characteristics of the basic set of ball exercises: from two or three steps – throwing the ball in the jump touching in the ring – catching into the roll with both hands and back in rhythmic steps – were also recorded.

Based on the indicators of biomechanical analysis of the two basic sets of ball exercises performed, the phase structure of exercises is specified and the key elements of sports technique of throwing and catching the ball are studied. For a more detailed analysis in both studies, we selected three nodal elements: the starting pose of the body (the moment of releasing the ball), the multiplication of the body pose (body position during the jump) and the final body pose (the moment of catching the ball). The results of the study of the indicators of the kinematics structure of the nodal elements for sports technique, associated with basic set of ball exercises: from two or three steps – throwing the ball in the "Cossack" jump – catching into the roll on both hands and back in rhythmic steps are presented in Table 1.

Analyzing the starting pose of the gymnasts' body when throwing the ball in the "Cossack" jump more attention should be paid to the following indicators: the angles in the joints due to which a straight, slightly tilted forward position of the body with a completely straight hand that releases the ball in forward-up position is created. Other important indicators are: the angle of launching the ball, which is equal to 75.8º; (S = 4.08º) and the speed of the wrist at the beginning of the throw, which is 4.12 m • s^{-1} (S = 0.33 m • s^{-1}). These indicators affect the entire subsequent flight of the equipment. In the analysis of the multiplication of poses in the "Cossack" jump, in addition to the body pose itself, which is evaluated by the judges, important indicators are those that characterize the flight of the ball. Some of them, such as the height of the ball, also affect the evaluation of the exercise. According to our data, the height of the ball is 4.29 m (S = 0.27 m). The main task of this phase is to maintain a given posture and create the conditions for successful catching the ball.

The difficulty in catching the ball on both arms and back is that the athlete does not see the equipment.

Table 1

Characteristics of the kinematics structure of the nodal elements for sports technique, associated with basic set of ball exercises: from two or three steps – throwing the ball in the "Cossack" jump – catching into the roll on both hands and back in rhythmic steps (n = 20)

	Characteristics Value													
	nodal element - the starting pose of the body					nodal element - multiplication of body pose						nodal element - the final pose of the body		
	thigh-torso angle, degrees	torso-shoulder angle, degrees	shoulder-forearm angle, degrees	wrist speed, m·s-1	angle of ball launch, degrees	flight altitude, m	the length of the ball trajectory , m	initial speed of the ball, m· s-1	leg forward-torso angle, in a jump, degrees	thigh-shin angle of the push leg, in the jump, degrees	lifting height of General center of weight for the gymnast's body, m	shin-thigh angle, squat, degrees	hip-torso angle in a semi-squat, degrees	torso-arm angle, in a semi-squat, degrees
$\bar{x}$	169,6	121	180	4,12	75,8	4,29	1,48	3,85	63	48	0,29	132	128	101
S	4,85	8,6	1,4	0,33	4,08	0,27	0,05	0,22	3,58	1,66	0,04	1,96	2,38	4,11
m	1,62	3,10	0,55	0,11	1,36	0,09	0,02	0,07	1,19	0,55	0,01	0,65	0,79	1,37
V%	2,87	9,13	0,93	7,97	5,38	6,24	3,58	5,70	5,67	3,47	14,47	1,49	1,86	4,06

The results of the study of the indicators of the kinematics structure of the nodal elements for sports technique, associated with basic set of ball exercises: from two or three steps - throwing the ball in a jump touching in the ring – catching into the roll on both hands and back in rhythmic steps are presented in Table 2.

Angular indicators of the starting position of throwing the ball in the jump touching in the ring are almost identical to the indicators when performing the throw of the ball in the "Cossack" jump, this is due to the fact that they influence assessment of the exercise performance. The speed of the wrist at the beginning of the throw is 4.01 m • s-1 (S = 0.26 m • s-1). The height of the ball is 4.48 m (S = 0.33 m).

Indicators of the kinematics structure of movements in the process of throwing and catching the ball, demonstrated during the performance of both basic sets of exercises, are guidelines for young gymnasts and a basis for the coach to adjust the performance of key elements of sports technique for these exercises.

Table 2

Characteristics of the kinematics structure of the nodal elements for sports technique, associated with basic set of ball exercises: from two or three steps - throwing the ball in a jump touching in the ring – catching into the roll on both hands and back in rhythmic steps (n = 20)

	Characteristics Value													
	nodal element - the starting pose of the body					nodal element - multiplication of body pose							nodal element - the final pose of the body		
	thigh-torso angle, degrees	torso-shoulder angle, degrees	shoulder-forearm angle, degrees	wrist speed, $m \cdot s^{-1}$	angle of ball launch, degrees	flight altitude, m	the length of the ball trajectory, m	initial speed of the ball, $m \cdot s^{-1}$	leg forward-torso angle, in a jump, degrees	thigh-shin angle of the push leg, in the jump, degrees	lifting height of General center of weight for the gymnast's	shin-thigh angle, squat, degrees	hip-torso angle in a semi-squat, degrees	torso-arm angle, in a semi-squat, degrees	thigh-torso angle, degrees
$\bar{x}$	169,4	100,4	177	4,01	77,00	4,87	1,48	3,77	0,31	105,3	86,8	109,1	125,6	116,30	92,10
S	2,59	2,80	1,05	0,26	2,98	0,33	0,08	0,29	0,02	3,47	2,25	1,88	3,50	3,47	8,41
m	0,86	0,93	0,35	0,09	0,99	0,11	0,03	0,10	0,006	1,16	0,75	0,63	1,17	1,16	2,80
V%	1,52	2,79	0,60	6,57	3,87	6,71	5,12	7,68	6,0	3,29	2,59	1,72	2,79	2,98	9,13

Conclusion. Objective quantitative biomechanical information about indicators of kinematic structure of nodal elements for sport technique consisting of basic set of ball exercises is received: from two-three steps – throwing the ball in the "Cossack" jump – catching into the roll on both hands and back in rhythmic steps; and from two or three steps – throwing the ball in a jump touching in the ring – catching into the roll on both hands and back in rhythmic steps. The obtained characteristics of the kinematic structure of the nodal elements of throwing and catching the ball during both basic exercises, can be used as model indicators for more effective technical training of young gymnasts.

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The prospect of further research is associated with development of the models of nodal elements motor structure, used as sport technique for exercises with objects at the stage of specialized basic training.

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