Complexity of combining elements of structural groups of rhythmic gymnastics as a criterion of performance skill of sportswoman

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Dr. Hab., Professor **E.N. Medvedeva**[1]
Dr. Hab., Professor **R.N. Terekhina**[1]
Dr. Hab., Professor **I.A. Viner**[1]
PhD, Associate Professor A.A. Suprun1
[1]Lesgaft National State University of Physical Education, Sports and Health, St. Petersburg

Corresponding author: zavkaf58@mail.ru

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Abstract

Objective of the study was to specify the factors of coordination complexity of combining elements of rhythmic gymnastics structural groups, which contribute to the objectification of the assessment of the performance skills of athletes.

Methods and structure of the study. To identify biomechanical factors of complexity of combining elements of various structural groups, a set of pedagogical and synchronized biomechanical techniques was used: analysis of special literature and program documents, pedagogical observations, a survey, a method of contactless study of a video sequence of movements in combination with surface electromyography and stabilometry, designing, pedagogical experiment, methods of mathematical statistics.

Results and conclusions. The article substantiates the position that characterizes the possibility of an objective evaluation of the complexity of combined elements and the ranking of athletes by the level of their execution skills. The author's approach to determining the technical value of combined elements on the basis of taking into account the biomechanical laws of technique creates conditions for increasing the complexity and compositional perfection of competitive routines in accordance with modern requirements of rhythmic gymnastics.

The purposeful development of the technical components of combined elements ensures the implementation of a perspective-prognostic approach to the formation of execution skills of rhythmic gymnastics athletes.

Keywords: *rhythmic gymnastics, elements of structural groups, biomechanical characteristics, complexity of combination, execution skills.*

Introduction. The current stage of the development of rhythmic gymnastics is characterized by the constant growth of the technical complexity of competitive programs and the desire to improve the external aesthetic characteristics of their performance [1-2]. However, the high competition of female athletes with a general tendency to minimize the elements of rhythmic gymnastics structural groups in mastering led to the problem of the uniformity of competitive compositions and the difficulty of differentiating gymnasts by the level of their performing skills.

Combining various movements as a way of demonstrating the motor abilities of an athlete is one of the ways to solve this problem in a complex coordination sport, since the construction of new ligaments and connections from the mastered elements is one of the ways to demonstrate the individuality and skill of an athlete. However, the lack of tables of the technical value of elements based on an objective biomechanical assessment of the complexity of combination hinders this process [3-4].

Objective of the study was to specify the factors of coordination complexity of combining elements of rhythmic gymnastics structural groups, which contribute to the objectification of the evaluation of the performance skills of athletes.

Methods and structure of the study. In the course of the study, the analysis of special literature and program documents, pedagogical observations (n=39), survey (n=60), method of non-contact study of the video series of movements (optoelectronic

hardware and software complex Qualisys), surface electromyography (16-channel electromyograph "MegaWin ME 6000"), stabilometry ("Stabilan-01"), design, pedagogical experiment, methods of mathematical statistics.

Results of the study and their discussion. In the process of preliminary studies, it was found that the reduction in the number of elements in the tables of technical value of the rules of rhythmic gymnastics competitions in 2016 to 9 elements led to a reduction in the proportion of combined elements used. Studying the reason for such a sharp decline, during the survey it was found that not all elements are "conveniently" connected to each other, and the combination causes various difficulties, which, according to the rules of the competition, are not taken into account when determining the technical value.

The analysis of the content of modern competitive compositions of international level gymnasts for the presence of combined elements made it possible to establish that 75% of such elements fall on balance. Most often they are included in the exercise with the ball (65.4%), but only 19.2% of the finalists performed elements with a transition to a more complex form. Basically, when combining elements, athletes move from a more complex form to simpler ones without changing the direction, plane and structure of the element. This confirmed the need for scientific substantiation and specification of the biomechanical factors of the complexity of combining elements that determine their technical value.

In the process of specifying the biomechanical factors that determine the complexity of combination, various degrees of relationship between the kinematic characteristics of the combined elements were revealed, which indicated the need to take into account not only the complexity of the combined elements, but also their structural compatibility, as well as the complexity of motor actions that serve as a transition from one element to another. It has been established that the quality performance of the attached element depends on the distances of movement of the gymnast's body links during the implementation of the transition motor program. The greatest indicators of the lengths of movement are characteristic for the points of the free links of the body when performing amplitude movements and combining elements by changing the position of the free leg or torso in space. The simplest combination option is a combination of elements similar in shape. At the same time, a comparison of the acceleration indicators of the points of body links in isolated and combined execution of elements showed that in isolated elements in the final phase, these indicators always approached zero, and when combining the same elements, the acceleration indicators were due to the degree of change in the attached element. Based on the data of the analysis of the kinematic characteristics of the combined elements, it was concluded that the simplest is the combination of elements of one structural group, in particular, balances, and the most difficult is from different structural groups, namely, balance and jump.

Considering that, regardless of the nature and complexity of motor actions, the result of the performance of all combined elements is the preservation of a stable position during the transition from one element to another, the indicators of stabilography have become objective characteristics that allow differentiating the elements according to their degree of complexity. A comparative analysis of the stabilographic characteristics of the combined elements with leg abduction in different directions, the addition of torso or head tilts showed that the "ellipse area" indicator has the most informative value, the dynamics of which indicates a change in the vestibular load and the complexity of combination. Based on the data obtained, all balances were ranked in ascending order of complexity by changing the position of the body and the direction of the free leg. It has been established that the most stable positions are combined vertical equilibria. Their complexity increases with a change in the direction of the leg: from a side position to a forward position; then - translation from the forward-to-side position; back and forth; to the side-back; back-side; back forward. Transferring the leg from vertical to horizontal balance, not only with a change in body position, but also with a change in direction, is the most difficult option: from lateral balance back; and even more difficult - translation from lateral balance forward.

Further, the study of the indicators of the maximum amplitude of the turns of the electrical activity of muscles during the performance of combined balances made it possible to establish that the connection of elements requires taking into account differences in the localization and strength of muscle

activation. The greater the differences were in the profiles of muscle activation in the connected elements, the more difficult it was to rebuild the first motor program for the second one. So, when analyzing the activation of the muscles of the supporting leg, it was found that for most of the compared combined balances and turns, it is similar. This indicated both the lower complexity of connecting such elements, and the fact that the complexity of combining depends primarily on changes in the shape and direction of the free links of the body. In addition, when determining the complexity, it was taken into account that the integrated bioelectrical activity of the muscles is a kind of characteristic of the electrical capacity and can be taken into account when determining the complexity of the transition from element to element. Based on the data of the integrated bioelectrical activity of the muscles, the simplest methods of combination were the transfers of the leg with the help of the hand without changing the position of the body, and the most complex ones were the combination of balances of different forms by means of movements by all parts of the body in different planes or directions.

Thus, the main factors in the complexity of combining elements are differences in the structural affiliation of the combined elements, in the lengths of the levers of the free links of the body, in the directions and speeds of movement of the links of the body, in the planes and amplitudes of movements by the links of the body, in the number of simultaneously combined movements and the axes of rotation of the body in the combined elements.

The specified objective complexity factors made it possible to develop algorithms for designing the complexity of combined elements for each of the 9 subgroups: "balance-balance", "balance-turn", "balance-jump", "turn-turn", "turn-balance", "turn-jump", "jump-jump", "jump-balance", "jump-turn". The algorithms determined the possible trajectories for constructing combined elements of varying complexity and were a tool for designing a matrix of their technical value, involving several levels of complexity according to the methods of combining elements of structural groups. Each subsequent level of difficulty assumed an increase in the value of 0.1 points. On the basis of the technical value matrix, tables of the technical value of the combined elements of rhythmic gymnastics were designed. In general, 9 complexity algorithms were developed; 9 technical value matrices; 9 tables of technical value, and in total 1737 combined elements are considered.

Evaluation of the effectiveness of the use of tables of technical value of the combined elements was carried out on the basis of the analysis of the effectiveness of the differentiation of highly qualified athletes by the level of performance. Assessment of the accuracy of qualimetry according to the current rules of the competition and using the developed tables of the technical value of the combined elements testified that the technical value of the all-around competitive programs, obtained on the basis of the use of a scientifically based table, changed in 100% of cases. In general, the total technical value of the combined elements in the all-around for each athlete changed from 0.1 points to 0.6 points. At the same time, the increase in the technical value of these combined elements of the finalists' competitive compositions was reliable, and the scores of the winners in each kind of all-around began to have greater differences. This indicated an improvement in the differentiation of athletes in terms of the complexity of the competitive programs being performed.

Conclusions. The results of the study allow us to state that the qualitative mastering of the technique of various elements of structural groups is a condition for the design of new combined forms of movements and the progressive development of rhythmic gymnastics. The developed algorithms, matrices and tables of the technical value of the combined elements are: a tool for improving the quality of the expertise of performing skills; a way to encourage the complexity of competitive programs; a guideline for the logical and staged development of combined elements; the trajectory of achieving the maximum possible complexity and spectacular effect of the performances of gymnasts.

References

1. Viner-Usmanova, I.A. Integralnaya podgotovka v khudozhestvennoy gimnastike [Integral training in rhythmic gymnastics]. Doct. diss. (Hab.). SPb, 2013. 210 P.
2. Medvedeva, E.N., Suprun, A.A. and Kotelnikova, E.B. Obosnovaniye neobkhodimosti reglamentatsii osvoyeniya tekhniki pryzhkov v khudozhestvennoy gimnastike [Justification of the need to regulate the development of techniques of jumping in rhythmic gymnastics]. Uchenye

zapiski universiteta im. P.F. Lesgafta. 2018. Vol. 158. No. 4. pp. 215-217.
3. Terekhin R.N., Medvedev E.N., Suprun A.A., Kryuchek E.S., Malnev A.S. Obosnovaniye neobkhodimosti konkretizatsii sposobov osvoyeniya kombinirovannykh elementov v khudozhestvennoy gimnastike [Substantiation of the need to concretize the methods of mastering combined elements in rhythmic gymnastics]. Uchenye zapiski universiteta im. P.F. Lesgafta. 2021. No. 8 (198). pp. 316-320.
4. Medvedev E.N., Terekhin R.N., Suprun A.A., Kryuchek E.S., Malneva A.S. Ustoychivost ravnovesiy kak faktor slozhnosti osvoyeniya kombinirovannykh elementov v khudozhestvennoy gimnastike [Equilibrium stability as a factor in the complexity of mastering combined elements in rhythmic gymnastics]. Uchenye zapiski universiteta im. P.F. Lesgafta. 2021. No. 8 (198). pp. 176-181.