COMPONENTS OF COMPETITION ROUTINES IN RHYTHMIC GYMNASTICS DEPENDING ON THE TYPE OF APPARATUS

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ABSTRACT
Monitoring and analysis of competition routines in rhythmic gymnastics have so far provided a lot of useful information on the development trends of this sport and current models in elite sport, but also pointed out shortcomings in the development system of this sports discipline, trying to guide its development in the right direction. However, there are still insufficiently researched areas in this field, numerous doubts and incomplete analyses, and this study was organized as a certain contribution to solving these problems. The aim of this paper was to determine whether routines with different types of apparatus differ in the routine components, which describe the competitive performance i.e., score in rhythmic gymnastics. The analysis included a total of 1044 routines from the two Rhythmic Gymnastics World Championships, including 261 routines with each apparatus (hoop, ball, clubs, ribbon). There were 7 variables examined in relation to the scores achieved by the competitors for individual components of the routine, as well as in regard to the total score. Statistical data analysis was performed using the SPSS 21 program and Microsoft Excel 2015. The Kruskal-Wallis test for independent samples was used to test the differences in scores between the routines with different types of apparatus. The results have shown that differences between the routines with different types of apparatus exist in all components of the routine, except in the component of artistry.

Key words: ANALYSIS**,** BODY DIFFICULTIES, APPARATUS DIFFICULTIES, ARTISTRY, EXECUTION

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INTRODUCTION

Rhythmic gymnastics, as a sports discipline, is a unique combination of sport and art. By using different patterns of body and apparatus movements, integrated and shaped into a unique choreographic idea, a gymnast demonstrates her sport mastery through a competition routine in order to achieve specific competitive performance. In order to define the sports characteristics of rhythmic gymnastics clearly, and to evaluate and assess the presented skills as objectively as possible, the International Gymnastics Federation *(Fr.* Fédération Internationale de Gymnastique - FIG) has defined the code of points, which envisages the quality assessment of competition routines from the aspect of four components. The two components assign a difficulty value to the routine, including body difficulties and apparatus difficulties, while the other two components express the reached level of technical execution mastery and the artistry of the routine (FIG, 2017). Each of these components is evaluated by a special panel of judges.

The code of points in rhythmic gymnastics is often changed and adjusted to the development trend of this sport, guiding it in a specific direction, and with the aim of improving the judging objectivity (Leandro, Ávila-Carvalho, Sierra-Palmeiro, & Bobo Arce, 2015, 2017; Manos, & Popescu, 2014; Pajek, Čuk, Pajek, Kovač, & Leskošek, 2013). Every four years, at the beginning of a new Olympic cycle, the FIG prescribes a new code of points, but its changes also occur within the Olympic cycle itself, often causing significant changes in the training process of female competitors (Örs, 2021). In order to get the best possible result i.e., achieve a higher apparatus difficulty score, according to the currently applicable code of points (FIG, 2017), routines should provide for as many of the apparatus difficulty elements as possible in the routine that is time-limited (75-90 s), which requires well-perfected technical mastery and a significant increase in the speed of their execution (Chiriac, Teodorescu, & Bota, 2020). This development trend of rhythmic gymnastics, aimed at increasing the number of apparatus technical elements, can affect the quality of other routine components, especially artistry.

Monitoring and analysis of the competition routine components have so far provided a lot of useful information about the development trends of rhythmic gymnastics and its current models at the highest level. The most frequently analysed components of the routine included body difficulties. In the previous period, these proved to be a component that negatively affected the diversity in routines, since most competitors mostly use the same difficulty elements in all their routines, choosing those that bring them more points according to code of points (Agopyan, 2014; Batista, Garganta, & Ávila-Carvalho, 2017; Hashimoto, Kida, & Nomura , 2018; Leandro, Ávila-Carvalho, Sierra-Palmeiro, & Bobo Arce, 2016; Sierra-Palmeiro, Bobo-Arce, Pérez-Ferreirós, & Fernández-Villarino, 2019; Trifunov & Dobrijevic, 2013). The routine component related to apparatus difficulties has been considered from the aspect of the number of difficulties executed, final score, and the relationship between the number of apparatus difficulties and the final score, as well as from the aspect of the impact of changes in the judges' code of points, which has been modified according to Olympic cycles (Batista et al., 2017; Leandro et al., 2016; Sierra-Palmeiro et al., 2019). The analysis of the apparatus difficulty structure in competition routines has shown that there are differences in the selection of elements depending on the type of apparatus (Dobrijević, Moskovljević, & Purenović-Ivanović, 2018). Technical execution and artistry, as the components evaluated in routines, were analysed as a single execution score in previous studies (Örs, 2021), while one of the studies examined the impact of the artistry score of the routine on competition success separately (Dobrijević, Moskovljevic, & Ranisavljev, 2021). As for group events, they have been analysed, from the aspect of difficulties, mainly in relation to collaborations and exchanges, which are the movement patterns characteristic of this competition program (Avila-Carvalho, Palomero, Levre, 2011; Avila-Carvalho, Clentrou, and Levre, 2012a, 2012b).

The program of official competitions in the senior category envisages the competitors' performance in routines with four types of apparatus: hoop, ball, clubs and ribbon. These apparatus differ both in their physical properties and in the specific techniques executed with the apparatus (Chiriac, Teodorescu & Bota, 2019, Moskovljević & Dobrijević, 2018), which are prescribed by the International Gymnastics Federation. The analysis of the routines of the world's best gymnasts, from the aspect of the selection of apparatus difficulties, has shown that routines with different apparatus differ in the total apparatus difficulty score, in the number of difficulties of different levels, and in the average value of the difficulties executed in the routine (Dobrijević et al, 2018). Also, the selection and the number of technical elements (Ávila-Carvalho et al, 2012), as well as the correlation between the number of technical elements and the final score, are specific to each apparatus (Sierra-Palmeiro et al, 2019).

The abovementioned studies clearly indicate the need and also authors' interest to analyse competition routines, which has contributed to a better understanding of the development trend of rhythmic gymnastics, detection and resolution of specific problems that occur in practice. However, there are still numerous doubts, insufficiently researched areas and incomplete analyses, which could provide new and useful feedback through future research, and thus contribute to the development of rhythmic gymnastics and improve work in practice. The analysis of previous studies has identified primarily the need to clearly define the specific characteristics of the components of competition routines with different types of apparatus as a basis for further improvement of the quality of competition events. In this regard, the aim of this paper was to determine whether competition routines with different types of apparatus differ in the components that make up the competitive performance i.e., score in rhythmic gymnastics.

METHODS

### Sample of respondents/variables

The sample of respondents included the gymnasts who participated in the 36th and 37th Rhythmic Gymnastics World Championships, in the individual competition program i.e., their official results (scores). The analysis included a total of 1044 competition routines i.e., 261 routines with each apparatus (hoop, ball, clubs, ribbon). There were 7 variables examined: Final Score, Total Difficulty Score (D score), Body Difficulty Score (D - body), Apparatus Difficulty Score (D - app), Total Execution Score (E score), Score (deduction) for the artistry of the routine (E - art), Score (deduction) for technical faults (E - tech). All the routines were evaluated by the world's most competent female judges, who judged at the 2018 World Championship in Sofia (Bulgaria) and the 2019 World Championship in Baku (Azerbaijan). The data (scores) were publicly available on the Internet and used herein in unchanged formats (https://usagym.org/PDFs/Results/r_18worlds_complete.pdf; https://usagym.org/PDFs/Results/r_19worlds_complete.pdf).

Statistical data processing

All the variables are represented by standard descriptive indicators: mean (SV), standard deviation (SD), minimum (min) and maximum value (max), median (med), range 25 - 75 percentiles (25 -75%). In addition, the normality of the distribution of results was tested by the Kolmogorov-Smirnov test. The Kruskal-Wallis test for independent samples was used to test the differences in scores between the routines with different types of apparatus. All the p values lower than 0.05 were considered significant. Statistical data analysis was performed using the SPSS 21 program and Microsoft Excel 2015.

RESULTS

Graph 1 shows the values of the final (total) scores for the routines with different types of apparatus, while Graph 2 shows the scores for each component of the routine separately. The highest average value of the final score was recorded in the routines with clubs, whereas the lowest average value of the final score was achieved in the ribbon routines. Statistical indicators have indicated that significantly higher scores were achieved in the routines with hoop, ball and clubs in relation to the total score achieved in the routines with ribbon (Table 1).
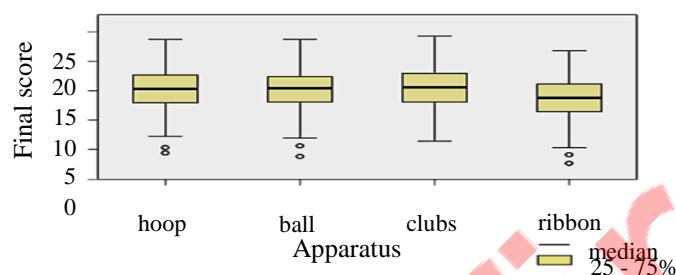
Graph 1. Total (final) score for routines with different types of apparatus

The total difficulty score (sum of the body and apparatus difficulties scores) was also the highest in the routines with clubs and the lowest in the ribbon routines (Graph 2a; Table 1). In the routines with hoop, ball and clubs, the gymnasts achieved significantly higher scores in relation to the total difficulty score achieved in the routines with ribbon (Table 1).

The highest values of the body difficulty scores were achieved by gymnasts in the routines with clubs. It can be noticed that significantly higher scores were achieved in the routines with clubs and ribbon in relation to the hoop routines, as well as in the routines with clubs in relation to the ball routines (Graph 2b; Table 1). The lowest apparatus difficulty scores were achieved in the routines with ribbon. These were significantly lower in relation to the scores achieved in the routines with all other types of apparatus (Graph 2c; Table 1).
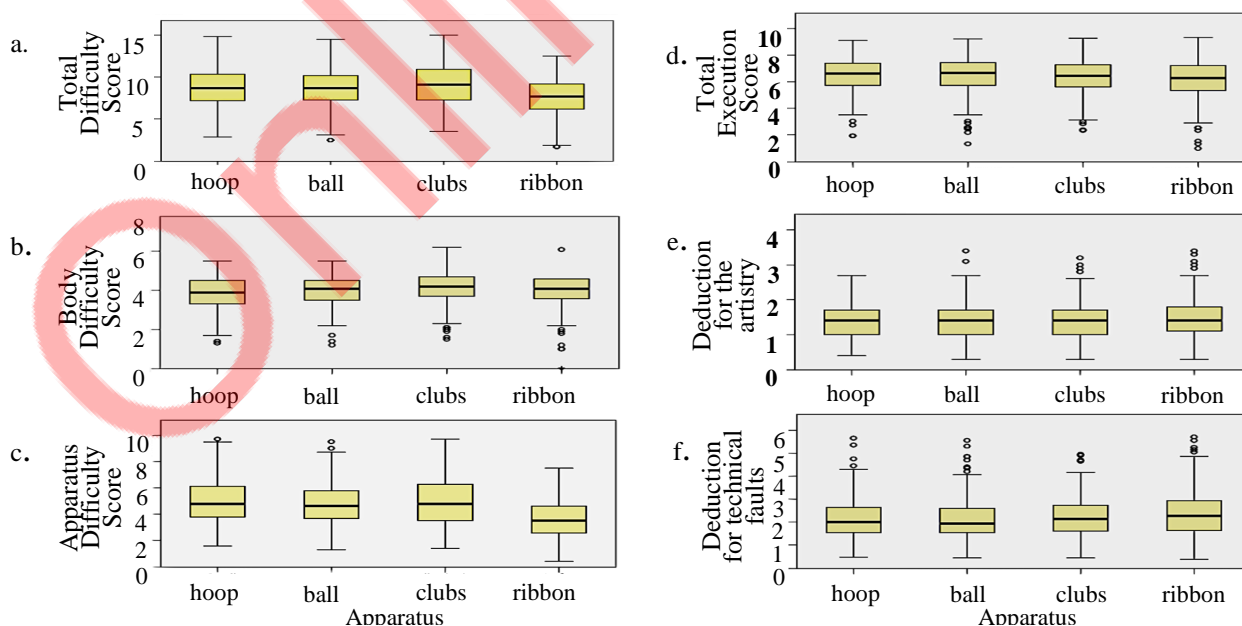
Graph 2. Scores by the routine components

The highest total execution score (sum of the technical execution and artistry scores) was achieved in the routines with hoop and ball, and it is significantly higher in relation to the score achieved in the routines with ribbon (Graph 2d; Table 1). Examining the technical execution and artistry components of the routine separately, it can be clearly noticed that this difference was influenced by the technical execution score (technical faults deduction) since the routines with different types of apparatus did not differ in the artistry score of the routine (Graph 2e,f; Table 1).

Table 1. Descriptive statistics and comparison of the scores for different components of routines with different types of apparatus

	HOOP		BALL		CLUBS		RIBBON		
	SV ± SD Med (25-75%)	min÷max	SV ± SD Med (25-75%)	min÷max	SV ± SD Med (25-75%)	min÷max	SV ± SD Med (25-75%)	min÷max	*p*
Total score	15.3 ± 3.4 15.2(12.9-17.6)[a]	4.5÷23.7	15.2 ± 3.2 15.4(13.0-17.4)[a]	3.9÷23.7	15.5 ± 3.5 15.5(13.1-17.9)[a]	6.5÷24.3	13.8 ± 3.4 13.8(11.5-16.1)	2.7÷21.7	**0.000**
D-score	8.8 ± 2.3 8.7 (7.2-10.4)[a]	2.9÷14.8	8.7 ± 2.1 8.7 (7.3-10.2)[a]	2.5÷14.5	9.1 ± 2.4 9.1 (7.3-10.9)[a]	3.5÷15.0	7.6 ± 2.1 7.7 (6.2-9.2)	1.7÷12.5	**0.000**
D-Body	3.8 ± 0.8 3.9 (3.3-4.5)[a,b]	1.3÷5.5	4.0 ± 0.8 4.1 (3.5-4.5)[b]	1.2÷5.5	4.1 ± 0.8 4.2 (3.7-4.7)	1.5÷6.2	4.0 ± 0.9 4.1 (3.6-4.6)	0.0÷6.1	**0.000**
D-App	5.0 ± 1.6 4.8 (3.8-6.1)[a]	1.6÷9.7	4.8 ± 1.5 4.6 (3.7-5.8)[a]	1.3÷9.5	5.0 ± 1.9 4.8 (3.5-6.3)[a]	1.4÷9.7	3.6 ± 1.4 3.5 (2.6-4.6)	0.4÷7.5	**0.000**
E-score	6.5 ± 1,3 6.6 (5.8-7.4)[a]	2.0÷9.1	6.5 ± 1.3 6.7 (5.7-7.5)[a]	1.4÷9.2	6.4 ± 1.3 6.5 (5.6-7.3)	2.4÷9.3	6.2 ± 1.5 6.3 (5.4-7.2)	1.0÷9.3	**0.028**
E-art	1.4 ± 0.5 1.4 (1.0-1.7)	0.4÷2.7	1.4± 0.5 1.4 (1.0-1.7)	0.3÷3.4	1.4 ± 0.5 1.4 (1.0-1.7)	0.3÷3.2	1.5 ± 0.5 1.4 (1.1-1.8)	0.3÷3.4	0.537
E-tech	2.1 ± 0.8 2.0 (1.6-2.7)[a]	0.5÷5.7	2.1± 0.9 2.0 (1.6-2.6)[a]	0.5÷5.6	2.2 ± 0.9 2.2 (1.6-2.8)	0.5÷5.0	2.4 ± 1.0 2.3 (1.7-3.0)	0.4÷5.7	**0.002**

Legend: SV- mean; SD - standard deviation; min - minimum value; max -maximum value; med - median; a - difference in relation to the routines with ribbon; b - difference in relation to the routines with clubs

DISCUSSION AND CONCLUSION

The aim of this study was to determine the specific characteristics of routines with different apparatus in rhythmic gymnastics from the aspect of their competition components. The analysis of the results achieved by all of the two World Championships participants has provided the full view of the specificities of routines with different apparatus.

In the routines with ribbon, the final score was lower in relation to the scores achieved with any other apparatus. The analysis of the routines of the best European gymnasts has also shown that the lowest final score is, on average, achieved in ribbon routines, however, a significant difference has been found only between the routines with ball (Örs, 2021). These differences are conditioned by the physical properties of the apparatus, as well as by the related complexity of the ribbon technique.
Örs (2020) has indicated that the total difficulty score is the best predictor of success in rhythmic gymnastics, regardless of the type of apparatus, noting that the difficulty score in the routines with ball had the greatest impact on the qualifying scores and rankings of the gymnasts at the 37th World Championship (Örs, 2020). As shown by the results of this study, the total difficulty score, as well as the final score, indicate the inferiority of the routines with ribbon respective to other apparatus. The situation is similar when only more successful gymnasts are considered (Örs, 2021). However, a clearer insight of the causes underlying these differences is obtained when the components of body

and apparatus difficulties are observed separately. The routines with clubs and ribbon are characterized by the highest body difficulty scores, while the routines with ribbon have the lowest scores for apparatus difficulties. High body difficulty scores in the routines with clubs and ribbon are provided mainly by large-amplitude jumps, backbends and rotations, as well as by a large number of rotations with difficulties from the group of turns, which are also performed with large amplitudes (Chiriac et al, 2019). The fundamental ribbon technique ("snakes" and "spirals") easily fits into and combines with high-level body difficulties, which is used most by coaches, when composing a routine, in order to achieve the appropriate routine difficulty. In sports practice, the ribbon technique is also known as extremely complex and difficult in regard to achieving the high-level apparatus difficulties. For this reason, ribbon routines show the lowest score values. Lower scores in this routine component have been conditioned by the specific and very complex technique of the manipulation of ribbon, as well as by the difficult conditions for achieving the higher-level difficulties, due to the dimensions of the apparatus itself. In this regard, other authors have also pointed out that the physical properties of the apparatus, on the one hand, and the requirements of the code of points, on the other, greatly affect the selection of apparatus technical elements, and thereby affecting the score achieved in the partial score related to apparatus difficulties (Dobrijević et al., 2018).

The highest values of the total execution score are achieved in the routines with hoop and ball. The explanation lies in the fact that gymnasts encounter the said apparatus first in the training process, and therefore they feel more confident in the apparatus manipulation. This consequently results in fewer technical faults and lower deductions for faults related to execution. Significantly lower execution scores achieved in the routines with ribbon indicate the complexity of the ribbon technique, which is also conditioned by the physical characteristics of this apparatus. A significant finding of this study is that the difference in scores found between the routines with different apparatus was reflected in the technical execution score, while the routines did not differ in the artistry score. The previous study (Örs 2020) found no differences in execution scores, as the analysis included only the total execution score. It is interesting that, although ribbon routines have lower execution scores in comparison to other apparatus, this routine component is another effective factor in the overall ranking of competitors i.e., it has a significant impact on the qualifying score and ranking of gymnasts (Örs 2020). Such results of the analyses clearly indicate that there is a need for certain corrections in the technical preparation of athletes, suggesting to coaches that additional work on improving the ribbon technique can contribute to achieving better competitive performance.

Routines with different types of apparatus do not differ in the component of artistry, which indicates that gymnasts express artistic characteristics equally through all movement patterns, regardless of the type of apparatus they use (Dobrijević, Moskovljević & Ranisavljev, 2021). On the other hand, the current code of points (FIG, 2017) clearly favours the component of apparatus difficulties, as a means by which an infinite number of points, and thereby a better ranking in competitions, can be provided (Chiriac, Teodorescu, & Bota, 2020). This situation, which indicates a negative influence of the scoring system on artistic expression in rhythmic gymnastics, has existed before. When composing competition routines, coaches mainly put emphasis on the body and apparatus difficulties, as well as on the quality of execution (Manos, & Popescu, 2014), while the component of artistry was neglected. Specifically, gymnasts tend to perform the same body difficulties in their routines regardless of the type of apparatus, which can be noticed in both young elite competitors (Chiriac et al., 2019) and senior athletes (Agiopan, 2014; Trifunov & Dobrijevic, 2013), leading to certain predictability of the composition content or even to monotonous routines. Additionally, in order to achieve better competitive performance, it is necessary to increase the number of apparatus difficulties (Chiriac et al., 2020), which, due to the speed necessary for performing a large number of elements in a limited time interval (Hashimoto, Kida, & Nomura,

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2018), disrupts the unity of composition and makes it difficult to express the artistic characteristics of competitors.

The conclusion is that differences between routines with different types of apparatus can be found in all of the routine components, excluding artistry. Ribbon routines have lower final scores in relation to routines with other types of apparatus, which is mainly due to the lower scores for apparatus difficulties and technical faults. The said routines are characterized by high body difficulty scores, which are also significantly higher in relation to the routines with hoop. The body difficulty score achieved in the routines with clubs is significantly higher than the one achieved in the routines with hoop and ball. The artistry component of the routine is equally manifested in all movement patterns, regardless of the type of apparatus used, indicating that this component is a general feature of all movement patterns of rhythmic gymnastics.
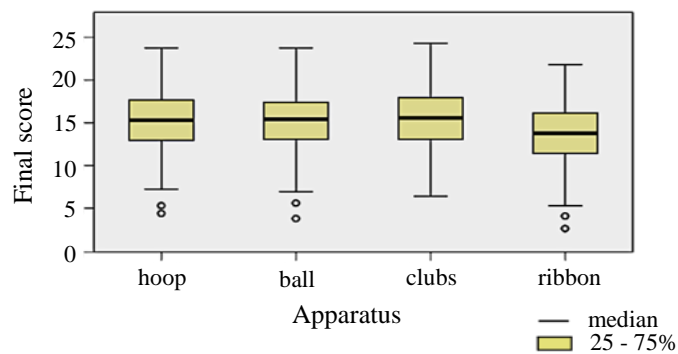
Such analyses of competition achievements provide sports professionals with very useful information about the development trend of rhythmic gymnastics at the top competitive level. They suggest opportunities for coaches or other experts to act in some segments of the training process to achieve better results. They also point out the strengths and weaknesses of the current system of competitive capacities evaluation, providing the necessary data needed by the management systems in sports, which can further influence the direction of development of this sports discipline by taking specific measures.

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Graph 1. Total (final) score for routines with different types of apparatus

Graph 2. Scores by the routine components