INFLUENCE OF THE COMPETITION COMPONENTS ON PLACEMENT IN RHYTHMIC GYMNASTICS

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Abstract
Analyses of the development trends in rhythmic gymnastics have so far provided a lot of useful information to sports experts, which as important guidelines in the training process can significantly contribute to the development of the athletes' competitive abilities. The aim of this paper was to determine the impact of different routine components on the competitive performance of gymnasts in the rhythmic gymnastics individual competition program. In accordance with the aim of the paper, the competition routines performed by the participants in the 37th and 38th World Championships were analyzed i.e., a total of 1044 and 261 routines with each type of apparatus (hoop, ball, clubs and ribbon). For the purpose of the analysis, official data on the results achieved in these competitions were used, and four variables were examined, pertaining to the scores for specific routine components (body difficulty, apparatus difficulty, routine artistic value and quality of execution). The relation between individual routine components and the ranking achieved was assessed by the Spearman's test, while the application of linear regression analysis determined the extent to which individual routine components were predictors of the achieved rankings. The results of the analysis of all routines, regardless of the type of apparatus used, have shown the highest correlation between the score for the technical quality of execution and the achieved ranking, while the lowest correlation was found between the score for the apparatus difficulty and the achieved ranking. However, there are significant differences in terms of the impact of different routine components on competitive performance when the routines with different types of apparatus were observed separately. Regarding the routines of gymnasts at the top level of competition, precision and accuracy in execution generally have the greatest influence on performance, while depending on the type of apparatus used, performance is differently conditioned by the quality of execution of other components of the routine.

Key words: BODY DIFFICULTIES/ APPARATUS DIFFICULTIES/ ARTISTRY/ EXECUTION/

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INTRODUCTION

Rhythmic gymnastics belongs to the group of acyclic, polystructural and complex sports branches with very complex coordination (Koprivica, 2013) and a clearly expressed artistic component. The results achieved by the gymnasts in the competitions were expressed by the scores determined by the jury of judges and obtained on the basis of the assessment of the execution quality from the aspect of the four components of the competition routines. The two components refer to the routine's difficulty value and include body difficulty and apparatus difficulty, the values of which are added. The other two components refer to the technical quality of the execution itself, viewed from the aspect of the artistic and technical value of the routine, where points are deducted based on faults made within these components (FIG, 2022). Body difficulties consist of technical elements of jumps, leaps, balances, rotation and dance step combinations, while apparatus difficulties are technical elements from the groups of fundamental and non-fundamental apparatus elements. The artistic value of the routine is assessed on the basis of the presented routine from the aspect of the quality of the choreography originality, unity, diversity and expressiveness, while the technical value is expressed by deduction for any deviation from the ideal form and manner of executing the body and apparatus difficulties (FIG, 2017). The individual competition program for senior gymnasts includes four routines with different types of apparatus, namely routines with a hoop, ball, clubs and ribbon. The routines, depending on the type of apparatus, differ according to most competition components, which is attributed to the physical properties of the apparatuses themselves and the techniques performed using these apparatuses (Chiriac, Teodorescu, & Bota, 2019; Dobrijević & Moskovljević 2021).

Examining the body difficulty component, it was observed that the contestants and their coaches in this segment emphasized the execution of elements with the highest score value, ignoring the requirements for diversity, as an important factor in the artistic value of the routine. Within the routine with different types of apparatus, the same difficulties were found in the same gymnasts (Trifunov & Dobrijević, 2013; Agopyan, 2014), but also in the majority of different competitors over a certain period, and similar difficulties were found in the routines, which according to the regulations result in a higher number of points (Trifunov & Dobrijević, 2013; Leandro, Ávila-Carvalho, Sierra-Palmeiro, & Bobo-Arce, 2016; Agopyan & Örs, 2019). In addition, during the past decade, there has been a tendency to decrease the time of performing individual body difficulties, and consequently the total time needed to perform all body difficulties (Manos, & Popescu, 2014; Hashimoto, Kida, & Nomura, 2018; Chiriac, Teodorescu, & Botha, 2020). In this way, more time is provided for the execution of technical elements with apparatus (Chiriac et al., 2019; Örs, 2021), the number of which has increased significantly in the routines during the past decade (Sierra-Palmeiro, Bobo-Arce, Pérez-Ferreirós, & Fernández -Villarino, 2019), especially after the modifications to the rulebook, when an unlimited number of apparatus difficulties are allowed within one routine (FIG, 2017). The trend of increasing the number of difficulties in the routines was observed in all levels of competitors, regardless of the level of performance (Batista, Garganta, & Ávila-Carvalho, 2017). This has had an effect on the increase of the overall score for the difficulties in the routines, while the quality of the execution, seen as the unity of the technical and artistic components, has not changed (Örs, 2020). All this influenced the gymnasts and their coaches to create and direct the training process towards the development of those capacities that will enable the execution of technical elements that bring a greater number of points at competitions.

Although competition routines have been analyzed from several aspects, the effects of each of the components separately on the competition result has not been considered so far. In this regard, the aim of this study was to determine the impact of different routine components on the competitive performance of gymnasts in the individual competition program in rhythmic gymnastics.

METHOD

In this paper, the results achieved by competitors at the two world championships in rhythmic gymnastics were analyzed: the 36th World Championship held in Sofia (Bulgaria) in 2018, and the 37th World Championship held in Baku (Azerbaijan) in 2019. The impact of individual routine components on the competitive performance was considered.

Sample of respondents/variables

The sample of respondents included 160 competitors belonging to the senior category of gymnasts who participated in the 36th and 37th World Championships in rhythmic gymnastics in the individual competition program, i.e. their results (scores) achieved in the qualification rounds. The analysis included a total of 1044 competition routines, namely 261 routines with each apparatus (hoop, ball, clubs, ribbon). Four variables were examined: Score for body difficulties (D_{body}), Score for apparatus difficulties (D_{app}), Score (deduction) for the routine's artistic value (E_{art}), Score (deduction) for technical errors (E_{tech}). All routines were evaluated by the world's most competent judges, who assessed the gymnasts' performance at these world championships. The data (scores) were publicly available on the Internet and were used in
an unmodified format (https://usagym.org/PDFs/Results/r_18worlds;
https://usagym.org/PDFs/Results/r_19worlds).

The results were analyzed according to the overall ranking of the contestants with all four apparatuses, as well as separately for each type of apparatus.

Statistical data analysis

Statistical data analysis was performed using SPSS 21.0 and Microsoft Excel 2019. All variables are presented with standard descriptive indicators: mean value (Mean), standard deviation (SD), median (median), range of 25-75 percentiles (25-75 %). The normality of the distribution of the results was tested with the Kolmogorov-Smirnov test. The Spearman's test was used to test and assess the correlation between individual components of the routine and the achieved ranking, while linear regression analysis was used to determine the extent to which individual components of the routine were predictors of the achieved ranking. All p values lower than 0.05 were considered significant.

RESULTS

Table 1 shows the descriptive indicators of scores for different components of the routine, in total and for each type of apparatus separately. The results show that the values of the score for body difficulties in the routines with different types of apparatus were close to the average value of this component when all routines were observed, as well as observed according to the type of apparatus. A similar trend is shown by the scores (deductions) for the artistic value of the routine and technical execution faults. The highest scores for apparatus difficulties were achieved in the hoop and clubs routines, and the lowest scores were achieved in the ribbon routines.

Table 1. Descriptive indicators of the examined variables

Apparatus	D_{body} Mean ± SD	Median (25-75%)	D_{app} Mean ± SD	Median (25-75%)	E_{art} Mean ± SD	Median (25-75%)	E_{tech} Mean ± SD	Median (25-75%)
All	4.0 ± 0.8	4.1 (3.5-4.6)	4.6 ± 1.7	4.4 (3.4-5.7)	1.4 ± 0.5	1.4 (1.0-1.7)	2.2 ± 0.9	2.1 (1.5-2.7)
Hoop	3.8 ± 0.8	3.9 (3.3-4.5)	5.0 ± 1.6	4.8 (3.8-6.1)	1.4 ± 0.5	1.4 (1.0-1.7)	2.1 ± 0.8	2.0 (1.6-2.7)
Ball	4.0 ± 0.8	4.1 (3.5-4.5)	4.8 ± 1.5	4.6 (3.7-5.8)	1.4 ± 0.5	1.4 (1.0-1.7)	2.1± 0.9	2.0 (1.6-2.6)
Clubs	4.1 ± 0.8	4.2 (3.7-4.7)	5.0 ± 1.9	4.8 (3.5-6.3)	1.4 ± 0.5	1.4 (1.0-1.7)	2.2 ± 0.9	2.2 (1.6-2.8)
Ribbon	4.0 ± 0.9	4.1 (3.6-4.6)	3.6 ± 1.4	3.5 (2.6-4.6)	1.5 ± 0.5	1.4 (1.1-1.8)	2.4 ± 1.0	2.3 (1.7-3.0)

Legend: Mean – mean value; SD – standard deviation; Median – median;

Table 2 shows the correlation between the achieved rankings and the score values for individual routine components. In general, the highest correlation was observed between the ranking and the score for the quality of execution (technical errors), and the lowest one between the ranking and the score for the apparatus difficulties. According to the type of apparatus, the correlation between individual components of the routine and the ranking was almost uniform in the hoop routines, and in the ball routines, the situation was quite similar, whereby the score for the artistic value of the routine showed the highest correlation with the ranking. In the clubs routines, the highest correlation was observed between the ranking and the score for technical execution, while the correlation with the score for the routine's difficulties was low. In the ribbon routines, the score for technical execution predominantly showed the highest correlation with the gymnasts' rankings.

Observing all the routines, regardless of the type of apparatus, the components of the artistic value of the routine and the quality of technical execution proved to be the best predictors of the achieved ranking (Table 2). Analyzing the routines with different types of apparatus separately, the score for the artistic value of the routine had the highest predictive power in the hoop and ball routines, while in the clubs and ribbon routines, the score for the quality of technical execution was the best predictor of the achieved rankings of the contestants.

Table 2. Competition routine components as predictors of the achieved rankings

Apparatus	Criterion variable	Predictive equation	Std. Beta	Spearman's correlation	R^2	SEE
All	D_{body}	-38,483x + 220,37	0,783	-0.803[**]	0.613	25.146
	D_{app}	-15,727x + 139,81	0,661	-0.663[**]	0.437	30.312
	E_{art}	65,765x - 25,387	0,852	0.871[**]	0.727	21.127
	E_{tech}	38,788x - 17,873	0,855	0.893[**]	0.731	20.956
Hoop	D_{body}	-42,155x + 227,59	0,855	-0.870[**]	0.731	20.920
	D_{app}	-20,532x + 170,47	0,836	-0.856[**]	0.699	22.119
	E_{art}	72,092x - 33,073	0,867	0.882[**]	0.751	20.120
	E_{tech}	39,938x - 17,29	0,842	0.897[**]	0.710	21.726
Ball	D_{body}	-43,14x + 238,11	0,820	-0.853[**]	0.673	22.891
	D_{app}	-21,557x + 169,89	0,810	-0.829[**]	0.657	23.450
	E_{art}	64,429x - 24,43	0,874	0.900[**]	0.763	19.473
	E_{tech}	38,442x - 13,753	0,829	0.886[**]	0.688	22.352
Clubs	D_{body}	-38,193x + 225,85	0,731	-0.754[**]	0.534	28.051
	D_{app}	-10,847x + 121,63	0,491	-0.472[**]	0.241	35.798
	E_{art}	66,367x - 24,045	0,845	0.849[**]	0.714	21.969
	E_{tech}	42,028x - 25,256	0,875	0.899[**]	0.766	19.880
Ribbon	D_{body}	-35,084x + 207,59	0,770	-0.785[**]	0.593	25.921
	D_{app}	-21,27x + 145,15	0,722	-0.735[**]	0.522	28.101
	E_{art}	62,169x - 22,52	0,834	0.860[**]	0.696	22.417
	E_{tech}	37,42x - 20,845	0,895	0.922[**]	0.800	18.162

Legend: Std. Beta - multiple correlation; R^2 - coefficient of determination; SEE - standard error of estimation; ** $p > 0.001$

DISCUSSION

This research was conducted in order to determine the impact of different routine components on the competitive performance of gymnasts in the individual competition program in rhythmic gymnastics. As the main finding of this study, there is a strong correlation between the quality of technical execution

and the achieved ranking, regardless of the type of apparatus used, while the realized score for the apparatus difficulties had the least predictive power.

Given that the routines with different types of apparatus differ in most components (Dobrijević & Moskovljević, 2021), since their physical properties influence the specificity of technical execution (Moskovljević & Dobrijević, 2018; Chiriac et al., 2019, Dobrijević, Moskovljević, & Purenović - Ivanović, 2019), the descriptive indicators of routine components have been shown for each type of apparatus separately. They indicate that the score values for the body difficulties in the routines with each type of apparatus were approximately equivalent, which is partly in accordance with the requirements of the jury's rulebook, which envisages a limited number of body difficulties, as well as their uniform distribution by structural groups of body elements (FIG, 2017). On the other hand, the need to score as many points as possible for this component of the routine has led to the fact that female competitors in all the routines performed the same or approximately the same body difficulties, which were most suitable for safe and correct technical execution according to their physical abilities and technical skills, and which, according to the Rulebook, can result in the highest score possible (Trifunov & Dobrijević, 2013; Agopyan, 2014; Leandro et al., 2016).

The component related to apparatus difficulties has shown that the routines with different types of apparatus differed from each other, which is in line with the findings of previous studies (Ávila-Carvalho, Klentrou, Palomero, & Levre, 2012; Dobrijević et al., 2019; Sierra-Palmeiro et al., 2019). A particularly large difference was observed in the score for the ribbon routines compared to other apparatuses, which is related to the technical complexity of working with this apparatus, since the dimensions of the apparatus make it difficult to achieve higher level difficulties (Dobrijević & Moskovljević, 2021). The uniformity of the scores for the artistic value of the routine in all types of apparatus indicates that the quality of this component is not related to the type of apparatus, but the artistic characteristics are demonstrated through all movement structures (Dobrijević & Moskovljević, 2021; Dobrijević, Moskovljević and Ranisavljev, 2021). The technical value of the routine has shown a similar tendency in the majority of apparatuses, with the fact that the major faults occured in the ribbon routines due to the physical properties of this apparatus (Dobrijević & Moskovljević, 2021).

The correlation between the achieved ranking and the defined components of the routine indicates that the quality of technical execution itself, regardless of the type of apparatus, is most closely related to the competitive performance. The correct execution of all techniques, whether it is about body elements or apparatus elements, is a main prerequisite for a practitioner to be competitive for achieving a high ranking. Specifically, rhythmic gymnastics as an aesthetic sports branch requires and positively values precision and accuracy in the execution of all its movement structures, which implies a good foundation of body and apparatus technique from the very first steps in sports schools to the top training level of female competitors (Karpenko, 2003). On the other hand, the very quality of execution of the body and apparatus difficulties is directly related to this component, since a major technical error can result in certain elements of the difficulties not to be recognized by the judges, and to some extent it can also affect the artistic value of the routine (FIG, 2017). The lowest correlation between the ranking and the score for the apparatus difficulties can be explained by the development trend of modern rhythmic gymnastics, where in accordance with the current rules, the emphasis in the training process is placed on the development of this component in most gymnasts, and the focus is especially on an increase in the number of elements within this component (Sierra- Palmeiro et al., 2019). Gymnasts, regardless of their competitive level, perform a large number of technical elements with apparatus in their routines in order to achieve a higher overall score (Dobrijević et al., 2021).

The correlation between individual components and the ranking was the most uniform in the hoop routines, which can be explained by the very rich and diverse technique performed with this apparatus (Moskovljević & Dobrijević, 2018; Jastrjembskaia & Titov, 1999). This gives coaches a great opportunity to choose and combine techniques, as well as to adapt them to the technical and physical abilities of the gymnasts. Also, some authors have pointed out that there should be a good balance between the components, in order to preserve the routine's unity, emphasizing that the predominance of individual

components would spoil its beauty (Kutlay, Tatlıbal, & Oral, 2021). In the ball routines, regarding all components, the score for the artistic value of the routine has shown the highest correlation with the ranking. The ball is considered a lyrical apparatus, which requires the gymnast's body movements to be fluid and "plastic", in order to fit in with the work of the apparatus (Moskovljević & Dobrijević, 2018). In the routines with clubs and ribbon, the component of the routine's technical value has shown the highest correlation with the achieved ranking, which can be explained by the physical properties of these apparatuses and the complexity of execution of their technical elements. This has also been confirmed by the findings of a recent study that dealt with the analysis of group routines with ribbon, where the score for the technical value of the routine showed a high correlation with the final score (Kutlay et al., 2021). Regardless of the type of apparatus, the components of the artistic value of the routine and the quality of the technical execution were the best predictors of the achieved ranking, which indicates the need to work on the development and improvement of these components in the training process from the earliest age of the practitioners (Gantcheva, Borysova, & Kovalenko, 2021).

CONCLUSION

Generally speaking, accuracy and precision in the execution of body and apparatus elements and techniques have the greatest influence on the performance in the routines of the elite gymnasts, and depending on the type of apparatus, performance is differently conditioned by the quality of execution of the other components of the routine.

Analysis and monitoring of development trends in the components that are important for the gymnasts' success provide useful information and guidelines to coaches in the training process and when composing competition routines.

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