THE EFFECT OF SCORE COMPONENTS ON TOTAL SCORE IN THE INDIVIDUAL APPARATUS QUALIFICATION OF 1ST RHYTHMIC GYMNASTICS JUNIOR WORLD CHAMPIONSHIPS

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Abstract

The study aims to determine the effect of the total score components on the total score and the differences between the score components in the 1st Rhythmic Gymnastics Junior World Championship individual apparatus qualification held in Moscow, Russian Federation, in2019. In this study, 1708 scores of 138 gymnasts from 61 countries were analyzed in all routines. For all routines, the effects of difficulty subgroup scores (D_{1-2}, D_{3-4}) on difficulty total scores (DTS), execution subgroup deduction scores (E_{1-2}, $E_{3-4-5-6}$) on execution total scores (ETS), and the effects of DTS and ETS on total scores (TS) were examined. Descriptive statistics, linear regression, and one-way ANOVA analysis were used. In linear regression analysis results, it was observed that the effect of DTS on TS was higher than the effect of ETS on TS in rope, ball, clubs, and ribbon routines. Among all apparatus, the effects of DTS and ETS on TS were observed as the highest in the clubs routines and the lowest in the rope routines. The effect of D_{3-4} on TS was higher than D_{1-2}. The effect of deduction $E_{3-4-5-6}$ on TS was higher than E_{1-2} (p<0.001). Statistically significant differences were found only between the DTS mean scores of the apparatus (p<0.000) analyzed with one-way ANOVA. This has led to a conclusion that the balance in the effect of TS components on TS scores will contribute to the integrity and the artistic impact of routines and also lead to better results, therefore more time should be devoted to rope and ribbon routines in the early stages of physical preparation.

Keywords: Rhythmic gymnastics, Individual routines, Score analysis.

INTRODUCTION

Rhythmic gymnastics (RG) is a sports specialty of great technical demand and a high number of difficulties of extreme coordination and aesthetic complexity (Vernetta et al., 2017). Competition routines involve mastery of five manual apparatus (rope, hoop, ball, clubs, and ribbon) in combination with body elements involving various components for high performance: physical, technical, tactical, and psychological factors (Douda et al., 2007; Di Cagno et al., 2009). RG is one of the early specialized sports branches (Malina, 2010; Balyi, 2001; Law et al., 2007). Most of the skills necessary for successful competitive compositions take a gymnast a long time to learn and master (Jastrjembskaia, & Titov, 1999). And also, the harmony of these skills with music can increase the volume of the training.

In RG, The Code of Points (CoP) is taken into account in the preparations of the gymnasts and the evaluation of their performance. In RG, CoP is determined by the Internationale Gymnastics Federation (FIG) for RG rules and is updated every Olympic Cycle. For this reason, the CoP is considered a factor as important as it is fundamental to the inner logic of the sport or strategy (the gymnast's possibilities for interaction with space, time, apparatus, compatibility with other gymnasts, and criteria of success or failure) when creating competition routines and training plans (Ávila-Carvalho et al., 2012a; Leandro et al., 2017).

Competitive analysis (score or performance) in sports brings different new perspectives to coaches and training. There have been performance and score analysis studies on individual and group routines in the literature (Ávila-Carvalho et al., 2012b; Leandro et al., 2017; Batista et al., 2019; Kutlay, & Yardımcı, 2007; Agopyan, 2014; Örs, 2020; Ávila-Carvalho et al., 2011; Hökelmann et al., 2012). Batista et al., (2019) emphasize that quantitative information obtained from the analysis of elite routines is important. Because these data allow us to identify the main areas and categories of the elements used and to examine the relative importance of these elements, which can meet the current trends of RG, it provides a better training process (Batista et al., 2019).

Gymnasts practice increasingly intense routines in RG. In recent years, there has been a tendency to increase the points to be obtained per unit time in routines. It is important to design and present compositions that are unforgettable in the minds that are compatible with music, but there has been an increase in BD and AD scores, especially in AD (numbers and values). Although it is known that complex abilities should be included in routines to get high scores it is thought that the increase in AD numbers to increase the total score affects the balance of unity in routines. The analysis of the score components that affect the total result in RG routines can guide the decisions to be taken regarding the evaluation and guide the physical preparation of the gymnasts. The study aims to determine the effect of the total score components on the total score and the differences between the score components in the 1st Rhythmic Gymnastics Junior World Championship.

METHODS

138 elite gymnasts (thirteen-, fourteen-, and fifteen-year-old) from 61 countries participated in the individual apparatus qualifications of the 1st RG Junior World Championships (WCh), organized for the first time for the junior categoryin Moscow in 2019. 61 gymnasts competed in each apparatus. A total of 1708 scores were evaluated.

In all routines (rope, ball, clubs, ribbon), the effects of the score components on total scores (TS) and the differences between difficulty total score (DTS), execution total score (ETS), and TS were analyzed. The source of individual routines' official competition scores was the results book of 1st RG Junior WCh that is published on the International Gymnastics Federation (FIG) official web page (https://www.gymnastics.sport/site/events/searchresults.php, 2021).

The terms used in the RG judges panels were taken into account in the definitions (D_{1-2}, D_{3-4}, E_{1-2}, $E_{3-4-5-6}$) of the score components. D_{1-2} and D_{3-4} scores were added for each routine and DTS were determined. Execution artistic (E_{1-2}) and execution technique' ($E_{3-4-5-6}$) deduction scores were added and subtracted from 10.00 points and ETS was determined. Sum of DTS and ETS made variable total score (TS) .

SPSS 22.0 program (SPSS Inc., Chicago, IL) was used for statistical analysis of the study. Descriptive statistical

analyses were performed to determine the mean ± standard deviation values of the components and subcomponents for all routines (rope, ball, clubs, ribbon).

Differences in DTS, ETS, and TS mean scores among all apparatus were analyzed with one-way ANOVA. Differences between apparatus were analyzed with least significant difference (LSD) from post hoc tests.

Linear regression analysis was performed to determine the effects of routines' total score components on TS. For each routine, the effects of difficulty subgroup scores (D_{1-2}, D_{3-4}) on DTS, the execution subgroup deduction scores (E_{1-2}, $E_{3-4-5-6}$) on ETS, the effects of DTS, and ETS on TS were determined. The level of significance was accepted at $p < 0.05$.

RESULTS

Descriptive statistical analyses of D_{1-2}, D_{3-4}, DTS, E_{1-2}, $E_{3-4-5-6}$, ETS, and TS of all routines are shown in Table 1.

The descriptive statistics analysis of the rope, ball, clubs, and ribbon apparatus scores showed that the highest total score was obtained in the clubs' apparatus routine (14.21 ± 3.07). The second highest TS results were in the ball (14.09 ± 2.88), followed by the rope (12.95 ± 2.73) and the ribbon (12.75 ± 2.67) apparatus routines, respectively. The highest score in DTS results was in the ball apparatus routine (7.72 ± 1.79) followed by clubs (7.69 ± 1.83), rope (6.72 ± 1.42), and ribbon (6.54 ± 1.59). The highest scores in the ETS results were again found in the clubs' apparatus routines (6.54 ± 1.33) followed by the ball (6.49 ± 1.22), rope (6.45 ± 0.91), and ribbon (6.22 ± 1.18) apparatus (Table 1).

The One-way ANOVA analysis results for all routines DTS, ETS, TS are shown in Table 2.

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Table 1
Descriptive Statistics of All Routines.

Score Components	Rope x̄ and SD (N=61)	Ball x̄ and SD (N=61)	Clubs x̄ and SD (N=61)	Ribbon x̄ and SD (N=61)
D_{1-2}	3.47 ± 0.56	3.39 ± 0.72	3.54 ± 0.73	3.54 ± 0.84
D_{3-4}	3.26 ± 1.02	4.34 ± 1.23	4.15 ± 1.26	2.93 ± 1.02
DTS	6.72 ± 1.42	7.72 ± 1.79	7.69 ± 1.83	6.54 ± 1.59
E_{1-2}	-1.79 ± 2.91	-1.40 ± 0.45	-1.42 ± 0.52	-2.38 ± 7.13
$E_{3-4-5-6}$	-2.12 ± 0.62	-2.11 ± 0.81	-2.04 ± 0.89	-2.29 ± 0.81
ETS	6.45 ± 0.91	6.49 ± 1.22	6.54 ± 1.33	6.22 ± 1.18
TS	12.95 ± 2.73	14.09 ± 2.88	14.21 ± 3.07	12.75 ± 2.67

N; Number of routines, x̄, and SD; Mean ± Standard Deviation, D_{1-2}; BD score, D_{3-4}; AD score, DTS; D total score, E_{1-2}; EA deduction score, $E_{3-4-5-6}$; ET deduction score, ETS; E total score, TS; Total score.

Table 2

The One-way ANOVA Analysis of DTS, ETS, and TS in All Routines.

Score Components		Rope (1) (N=61)	Ball (2) (N=61)	Clubs (3) (N=61)	Ribbon (4) (N=61)	F	p	Post Hoc
DTS	$\bar{x}$ and SD	6.72 ± 1.42	7.72 ± 1.79	7.69 ± 1.83	6.54 ± 1.59	8.565	0.000*	1-2
	Minimum	3.70	3.50	3.40	2.90			1-3
	Maximum	10.90	12.80	12.40	12.80			2-4
								3-4
ETS	$\bar{x}$ and SD	6.45 ± 0.91	6.49 ± 1.22	6.54 ± 1.33	6.22 ± 1.18	0.874	0.455	-
	Minimum	3.95	3.70	1.55	2.30			
	Maximum	8.90	9.20	9.15	8.35			
TS	$\bar{x}$ and SD	12.95 ± 2.73	14.09 ± 2.88	14.21 ± 3.07	12.75 ± 2.67	4.342	0.005	-
	Minimum	1.32	7.65	5.05	5.90			
	Maximum	19.80	22.00	21.55	18.25			

N; Number of routines, $\bar{x}$, and SD; Mean ± Standard Deviation, DTS; D total score, ETS; E total score, TS; Total score, Post hoc; 1 (rope), 2 (ball), 3 (clubs), 4 (ribbon). *$p<0.001$.

Table 3

The Regression Analysis Results of the Rope and Ball Routines.

Score Components		Rope (N=61)				Ball (N=61)			
		B	t	F	R^2	B	t	F	R^2
D_{1-2}	→DTS	0.82*	11.08	122.80	0.68	0.87*	13.24	175.20	0.75
D_{3-4}	→DTS	0.95*	23.40	547.54	0.90	0.95*	24.98	624.17	0.91
DTS	→TS	0.82*	10.94	119.76	0.67	0.96*	25.66	658.34	0.92
E_{1-2}	→ETS	0.89*	14.97	224.04	0.79	0.94*	20.23	409.06	0.87
$E_{3-4-5-6}$	→ETS	0.97*	28.87	833.63	0.93	0.98*	112.33	1505.78	0.96
ETS	→TS	0.77*	9.25	85.62	0.59	0.94*	21.29	453.24	0.89

N; Number of routines, B; Beta, D1-2; BD score, D3-4; AD score, DTS; D total score, E1-2; EA deduction score, E3-4-5-6; ET deduction score, ETS; E total score, TS; Total score. *$p<0.001$.

Table 4

The Regression Analysis Results of the Clubs and Ribbon Routines.

Score Components		Clubs (N=61)				Ribbon (N=61)			
		B	t	F	R^2	B	t	F	R^2
D_{1-2}	→DTS	0.86*	13.03	169.76	0.74	0.61*	5.94	35.31	0.37
D_{3-4}	→DTS	0.96*	25.01	625.36	0.91	0.94*	21.87	478.33	0.89
DTS	→TS	0.98*	33.48	1120.91	0.95	0.97*	31.82	1012.17	0.95
E_{1-2}	→ETS	0.91*	17.10	292.50	0.83	0.91*	16.75	280.50	0.83
$E_{3-4-5-6}$	→ETS	0.97*	31.22	974.41	0.94	0.93*	19.13	366.02	0.86
ETS	→TS	0.96*	25.40	645.33	0.92	0.95*	22.98	528.07	0.90

N; Number of routines, B; Beta, D_{1-2}; BD score, D_{3-4}; AD score, DTS; D total score, E_{1-2}; EA deduction score, $E_{3-4-5-6}$; ET deduction score, ETS; E total score, TS; Total score. *$p<0.001$.

According to the ANOVA analysis results, statistically significant differences were found in the DTS results. According to the post hoc test analysis results, these significant differences were found between rope and ball, rope and clubs, ball and ribbon, and between clubs and ribbon. There was no significant difference between ETS and TS in any apparatus (Table 2).

Regression analyses of all routines' score components are shown in Table 3 and 4.

In the results of regression analysis, D_{3-4} had the highest effect on DTS from all DTS components in all apparatus. Again, for all apparatus, the highest effect on TS from TS components were the DTS components. $E_{3-4-5-6}$ had the highest deduction effects of ETS components on ETS in all apparatus. In all apparatus, the highest effects of DTS and ETS on TS were observed in the clubs routines and the lowest in the rope routines (Table 3 and 4).

DISCUSSION

Rhythmic gymnastics is a sport that combines technical, aesthetic, and artistic parameters to reproduce an optimal execution model, both in the matter of form and execution (Díaz-Pereira et al., 2014). Performance is evaluated by the judges according to the rhythmic gymnastics Code of Points (RG-CoP) (FIG, 2017). Since the performance does not come out from an objective measure, but from a complex judging process, quite often RG is considered to be a subjective sport. The analysis of the competition results (subgroup scores that make up the result score) can guide the future decisions and the preparations of the gymnasts. In this study to determine the effect of the total score components on the total score and the differences of DTS, ETS and TS mean scores among all apparatuses were analyzed in 1st Rhythmic Gymnastics Junior WCh individual apparatus qualification.

According to the descriptive statistics of the routines of this study, in DTS, ETS, and TS of means, the ball and clubs routine had the highest results (Table 1). Soft apparatuses (rope and ribbon) can be a little more difficult to control in composition than other apparatus, mistakes made may reduce the execution and difficulty scores. 13, 14, and 15-year-old gymnasts competed in the same category in this competition, which may affect the mean and standard deviation values. In RG, time is needed to master the routines in each apparatus. Junior category' gymnasts are just at the beginning of their performance peak and their DTS, ETS, and TS scores may be lower than in the senior category. In RG, apparatuses have different handling characteristics (weight, dimension, and shape) and at these ages and levels, some apparatus may be more easy and sympathetic to the gymnasts.

In this study, according to the results of the one-way ANOVA analysis of the differences between the DTS, ETS, and TS components means of the apparatuses, significant results were obtained between the DTS components (Table 2) (F=8.565, p=0.000). Gymnasts perform increasingly intense routines in terms of apparatus and body difficulties to increase DTS. At the same time, it is known that many factors are affecting DTS. In general, the high mistake rate of gymnasts in routines, the level of technical preparation of the gymnast, the low values of AD and BD difficulties selected for the routines affect the DTS score. The structural features of the apparatuses can also make it difficult to control the apparatus during BD, AD, R, S. In addition the fact that trainers choose a different starting apparatus can also affect the apparatus experience time and apparatus skill between apparatuses. The reason why there is no significant difference between ETS averages maybe because trainers and athletes tend to increase DTS. Because as DTS increases, TS can also increase.

In this study, according to the Regression Analysis, the effect of D_{3-4} on TS was higher than D_{1-2} ($p<0.001$). This result shows that AD and R (Motion components of D_{3-4}) are the most effective movement groups in DTS in all routines, and gymnasts include more AD and R movement groups in their routines to increase their scores per unit time. The lack of a limit on the number of AD in RG-CoP (FIG, 2017) may have increased the number of AD in routines. In effect rates by apparatuses, the effect of D_{1-2} on DTS determined highest in the ball routines (87%) and the lowest in the ribbon routines (61%). Execution mistakes may be higher in ribbon routines than in ball routines, which may negatively affect the D_{1-2} scores. Because, according to the rules, difficulties are not counted in major execution mistakes. The effect of D_{3-4} on DTS was observed the most in the clubs (96%), while the values of the other apparatuses were close to each other. The effect of DTS on TS was observed the most in clubs (98%) and the lowest in rope routines (82%) (Table 3, 4) ($p<0.001$). In general, gymnasts perform apparatus difficulties more often in their clubs' routines, which can increase their D_{3-4} scores. In addition, some trainers may prefer rope apparatus as a starting apparatus to improve the gymnasts' skills on a difficult apparatus. This situation may vary depending on the physical readiness of the gymnast or the decisions taken by the technical committees in the countries. Naturally, gymnasts need to develop body techniques as well as apparatus techniques. For this, each trainer determines the body difficulties (with different characteristics and values) specified in the rules, according to the level of the gymnasts. The skillful interaction between gymnast and apparatus and the increasing difficulty components in routine composition as the development of RG (Lebre E, 2011). However, Ávila-Carvalho et al., (2012b) emphasized that the limited variety in the selection of difficult elements makes routine composition boring, and artistic value may be compromised (Ávila-Carvalho et al., 2012b). An increase in the number of ADs in routines can lower the EA score. Additionally, the increase of AD may be well tolerated (with variety and creativity) in good-level gymnasts, but the EA scores may be adversely affected in low-level gymnasts.

RG abilities and skills are quite complex and include physical fitness, elegant and artistic presentation as well as body movement techniques, so trainers should not limit RG training to technique only (Jastrjembskaia, & Titov, 1999). In our study, according to the regression analysis the effect of $E_{3-4-5-6}$ (deduction score) on TS was higher than E_{1-2} (deduction score) ($p<0.001$). In all routines, as stated in the RG-CoP (FIG, 2017), all deductions for mistakes of apparatus and body technique are higher in the evaluation of $E_{3-4-5-6}$ than deductions in evaluation of E_{1-2}. Therefore, $E_{3-4-5-6}$ deductions may have a high impact on TS. In effect rates by apparatuses, the effect of E_{1-2} (deduction score) on ETS was observed the most in the ball routines (94%) and the lowest in the rope routines (89%). It is thought that the harmony between the choreography and the chosen music (expressivity), as well as the apparatus experience, is better on the ball routines and therefore its effect may be higher. The effect of $E_{3-4-5-6}$ (deduction score) on ETS was greatest in the ball routines (98%) and the lowest in the ribbon routines (93%). In general, the deductions applied in the $E_{3-4-5-6}$ evaluation are more in the ribbon routines (the lack of clarity of the shapes created in the space affects both the execution score and the difficulty score), but there may be situations that develop for different reasons (loss of the apparatus, total loss of balance with fall) in the competition. Deduction scores for loss of the apparatus are highest in the RG CoP than in other deductions. The effect of ETS on TS was found the most in the clubs (96%) and the lowest in the rope routines

(77%) (Table 3, 4) (p<0.001). Because the clubs are double apparatus, it requires perfect coordination. For this reason, the movements performed with clubs are repeated a lot in training, this may have reduced the execution deductions and affected the TS.

In RG, apparatuses are divided into two as rigid (hoop, ball, and clubs), and soft (ribbon and rope) in terms of their structural features (Jastrjembskaia, & Titov, 1999). The rope's movement character of the routines is generally dynamic, energetic and the music choices are also of this feature. This dynamic structure can negatively affect the use of the rope apparatus and reduce the execution scores.

Bobo Arce, & Mendez Rial, (2013) emphasizes that to determine a higher performance in rhythmic gymnastics, research on all subjects related to the field, including studies involving dimensions related to technical aspects, should be increasingly continued (Bobo Arce, & Mendez Rial, 2013). Most of the published studies on the content of RG routines include analysis of the number and level of difficulty elements (Batista et al., 2019; Kutlay, & Yardımcı, 2007; Agopyan, 2014; Ávila-Carvalho et al., 2012b; Caburrasi, & Santana, 2003; Trifunov, & Dobrijević, 2013). The studies examining the number and types of difficulties, detailed score analysis studies for all competitions can be useful in terms of examining the effects of the rules.

There is a strong correlation between technical value points and final score Caburrasi, & Santana, 2003). In our study, the effect of DTS on TS in all routines was found to be higher than the effect of ETS on TS. This result also supports our hypothesis that RG can weaken the artistic and aesthetic emphasis by increasing the number of AD in routines to increase the scores to be obtained in unit time, especially in recent years. RG has static (balances) and dynamic moves/difficulties (jumps and rotations) at different values

and difficulty levels. Even if it is of the same value, the execution of somebody's difficulties takes a longer time in composition and is not preferred by the gymnasts.

In recent years, the tendency to score more points per unit time can negatively affect the integrity of the composition and limit its variety. Some difficulties limit the use of apparatus techniques and gymnasts may not prefer to use these difficulties in order not to reduce the execution score. All these situations can partially limit apparatus and body techniques, movement connections, and creativity in RG routines. All these features and the skill level of the gymnast determine the design of the composition. A balanced distribution of apparatus and body difficulties is essential for an effective composition. Due to this dynamic structure and rapid development of RG, it is necessary to follow and update all these issues with such studies. FIG-RG-TC can make new adjustments to the CoP, taking into account the reasons for the increase or decrease in the score components.

Competition rule changes guide the preparations of gymnasts. The present study may contribute mainly to the coaching process, to identify the most effective performance indicators and trends in the development of RG, and also to the database formation. In the future, score analyses to be made large-participation competitions may be beneficial.

CONCLUSION

Each score component that determines the total score is important for a good performance. The balance between the scores of the total score components can positively affect the variety of movement in the composition. Otherwise, routines with different music but similar movements patterns may develop. In recent years, the tendency to score more points per unit time has increased the number of ADs in routines, weakening

their artistic and aesthetic impact and limiting diversity as it negatively affects the integrity of the composition. The balance created through the effect of TS components on TS scores will contribute to the integrity and artistic effect in routines. For this reason, we think that limiting the number of ADs in routines will strengthen the compositions artistically. Also, for better results, more time should be devoted to rope and ribbon routines in the early stages of physical preparation.

LIMITATIONS

In this study, only one competition score analysis was conducted. The score components and performance analyses of competitions in which many gymnasts and groups participate (every World and European Championships) could make important contributions to the decisions related to the preparations of athletes and their coaches.

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