

TECHNICAL CONTENT OF ELITE RHYTHMIC GYMNASTICS

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Abstract

The primary aim of this study was to analyse all technical elements used in the Rhythmic Gymnastics Kiev World Championship 2013, and identify the Structural characteristics of the technical content of elite Rhythmic Gymnastics individual routines. The data has been collected from the difficulty forms concerning 288 individual routines. To allow the comparison between gymnasts with different levels the individual routines were clustered into 3 subgroups according to their final ranking competition. Body difficulty elements were organized, according to the composition requirements stated in the RG Code of Points (FIG, 2012). Non-parametric tests - Kruskal-Wallis, Mann-Whitney and Friedman test were applied to determine whether there were significant differences between groups. As main results we can point out that in general the rhythmic gymnasts used similar body difficulties with limited variety. The highest valued elements are Dynamic Elements with Rotation and throw (DER) and rotations and these represent 50% of the total value of the routine. Concerning the dance steps and mastery, no differences were found between the routines of gymnasts place in the three parts of the ranking. The routines had differences in the composition pattern between the gymnasts according to the final ranking of the gymnasts in following items: (i) on the number of rotations of flat foot or other part of the body, Fouetté rotations and Mixed Difficulties; (ii) on the value of jumps, rotations, DER and Mixed Difficulties.

Keywords: *body difficulty, individual routines, evaluation, rhythmic gymnastics.*

INTRODUCTION

The main reason for the success in RG competition is the capacity to perform the exercise, with high level body elements and apparatus technic, with perfect execution, in harmony with the character and rhythm of the music, respecting the

principle of originality and diversity. This is a guarantee of an exciting high performance sport to watch.

The rules which guide the routines composition can also have influence in the gymnasts' performance (Massidda, 2012).

The limited variety on the choice in difficulty elements makes the routine composition boring and puts in risk its artistic value (Ávila, 2012a).

The skilful interaction between the gymnast and the apparatus and the increase difficulty elements in the routines composition are the development in RG (Lebre, 2011).

The analysis of these factors can, according to Ávila, (2012b), influence the developmental programs for the practice and the experimental designs used in the scientific research in RG. The knowledge can also contribute to preview and characterize the effort requirements allowing improvements in the gymnasts' preparation to the competition readiness (Ferreirinha, 2009).

Ferreirinha (2009) refers that to determine the training models it is important to know the characteristics competition routines for high level gymnasts including the details concerning the specificity of their components.

Is, than, fundamental to analyse the development tendencies for the sport in general and to identify specificities of each component as we propose to do with the structural characteristics of the difficulty elements including the diversity and variety in the routines.

The routines composition is not stable concerning their content because they have to be adapted to changes done in the Code of Points (CoP) every Olympic cycle.

An individual RG routine is composed by a series of body and apparatus elements linked in a specific way which we call difficulty elements (D). On the present Olympic cycle, the content of and individual RG routine should respect the specific requirements that are common to the routines of all 4 apparatus: jumps/leaps, balances, rotations, apparatus mastery, dance steps and dynamic elements with rotation and throw (DER) (FIG, 2012).

The value of each difficulty element is from 0.10 points to 1.50 points or more, which may be absolutely determinant in the

final score obtained in competition. The inclusion of complex abilities in the routines is essential to have a high score (Massida, 2012).

The CoP holds a great variety of difficulty elements to be used in the routines. One important characteristic of the RG is to allow the gymnast to link it in her own way, with a stylish presentation, clever configuration, and perfect presentation (Wang, 2013). An eventual lack of variety in the body difficulty included in the routines can cause judges and audience dissatisfaction from the point of originality and variety. RG is a visually appealing sport, thus, it is very important to keep the high interest of the public (Agopyan, 2014).

The studies published concerning the content of the RG routines (Caburrasi, 2003; Bobo, 2010; Ávila, 2011; Ávila, 2012; Trifunov, 2013; Agopyan, 2014), include the analysis of the number and the level of difficulty elements but they have no information about contribution of each type of element for the final D score. Also in consequence of the constant and quickly evolution of this sport, a permanent upgrade of these kind of studies are needed (Caburrasi, 2003; Cuk, Fink & Leskošek, 2012; Massidda, 2012; Hökelmann et al., 2012; Bucar, 2013; Pelin, 2013).

Within this context, the main goal of the present study is to identify the difficulty elements included in the routines that contribute the most to the success in competition and to analyse the diversity of the body movements included in the difficulty elements.

The present study can have an important contribution for the coaches mainly to: supporting the coaching process, defining performance profiles for individual gymnasts, ranking performances, creating data bases in order to identify the most influencing performance indicators and the tendencies in the development of RG (Liviotti, 2012).

METHODS

288 difficulty forms concerning individual routines were analysed. The routines were performed by gymnasts from 45 different countries competing at Rhythmic Gymnastics World Championship in Kiev, Ukraine in 2013. This study was done with the permission of the International Gymnastics Federation (FIG).

The official Difficulty forms, submitted prior to the competition, included the routine compositions recorded using the RG CoP symbols. All difficulty elements reported in the difficulty forms were analysed. The analyse was done considering the all sample, and the sample clustered into 3 subgroups according to gymnasts final ranking as follows: the first part of the ranking - the top 24 gymnasts, the second part of the ranking - 24 middle gymnasts and third part of the ranking - the 24 lower placed gymnasts on the ranking, to allow the comparison the technical elements within gymnasts of different levels.

The analysis was conducted by two international RG judges. The intraclass correlation coefficient (ICC) in test-retest method (intra-examiner) was 0.99. The ICC between the observers (inter-examiner) was 0.98.

The data were analyzed using the Statistical Package for Social Sciences – version 20.0 (SPSS 20.0, Chicago, USA) and Microsoft Office Excel 2007. The level of significance was set at $\alpha = 0.05$ (confidence interval of 95%). Descriptive statistics were calculated using the mean values as a measure of central tendency, standard deviation (SD) as a measure of dispersion, and minimum and maximum as measures of data range. After checking the abnormalities in the data distribution ($p < 0.05$) using the Kolmogorov-Smirnov normality test, we resorted to non-parametric test (Kruskal-Wallis, Mann-Whitney and Friedman test) to determine whether there were significant differences between the three subgroups in the

Rhythmic Gymnastics World Championship ranking.

A multiple regression was used to analyze the influence of each difficulty element in the gymnasts' final difficulty score.

RESULTS

The difficulty elements reported in the individual routines were grouped by technical categories: balances, jumps, rotations, masteries, dance steps, and DER, mixed difficulties (MixDif) and criteria associated to difficulty (waves and pre-acrobatics). The results for each category are presented both quantitatively (number of occurrences) and qualitatively (technical value and type) in Figure 1. From Figure 1 we can highlight the number of the mastery (4.0 ± 2.80) and the value of the rotations with 29% of the total value of the routine (2.7 ± 0.83 points). When we observe the three difficulty groups that are based on the body movements (jumps, balances and rotations) we can see that the rotations have the higher number (3.3 ± 0.61) and the balances the lower number (2.4 ± 1.00). Concerning the rotations, the gymnasts included preferably those with 0.30 points values in their routines. Between them it is possible to highlight the “pivot attitude” (0.52 ± 0.50), the “pivot free leg in ring in back with help” (0.42 ± 0.50) and the “rotation penché” (0.76 ± 0.43). The most used jumps were those with 0.5 points value, mainly the “jeté with turn” (0.82 ± 0.80) and the “jeté with a turn with back bend” (0.45 ± 0.53); The balances with base value 0.5 points were the most performed by the gymnasts, mainly the balance “side scale with split, without help” (0.44 ± 0.49) and balance “back scale leg high up” (0.40 ± 0.49). The most used MixDif were the link of the balance “front scale with back split” and “ring without help” (0.15 ± 0.52). For DER, the most used criteria to raise the value were: “change of level”, “change of body rotation axis”, “throw/catch outside of visual

control” and “throw/catch without the help of the hands”.

Analysing the sample according to final ranking of the gymnasts, significant differences were found on the number of balances, MixDif, rotations on the flat foot or other part of the body, and “fouetté” rotations (Table 1). No other significant differences in the number of technical difficulties were found according to the final ranking of the gymnasts (Figure 2).

The number of balances was significantly higher in the gymnasts of the 3rd part of the ranking and the MixDif significantly higher in the gymnast of the 1st part of the ranking. The number of rotations on the flat foot or other part of the body is higher in the 1st part of the ranking and decreases significantly in the 2nd and 3rd parts. The number of “fouette” rotations is significantly higher in the gymnast of the 2nd part of the ranking (Table 1).

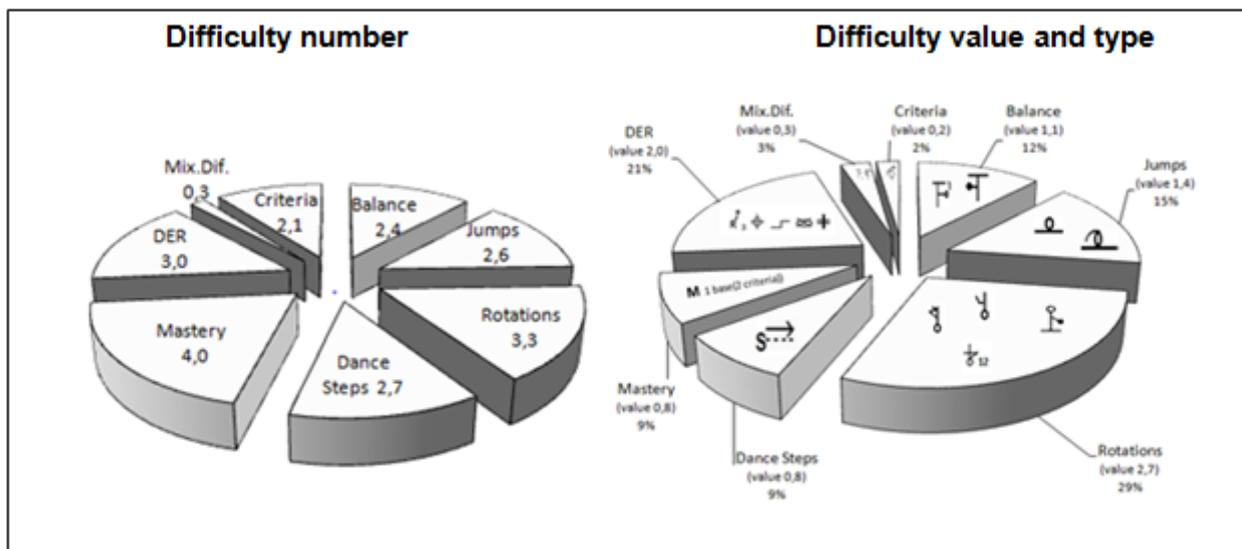


Figure 1. Difficulty elements presented in the Rhythmic Gymnastics individual routines in the 2013 World Championships clustered according to number, value and type.

Table 1

Number of balances, MixDif and Rotations in the Rhythmic Gymnastics individual routines clustered according to gymnasts’ final ranking in the 2013 World Championships.

Difficulty number	1 st part of the ranking (n=96)		2 nd part of the ranking (n=96)		3 rd part of the ranking (n=96)		Kruskal-wallis test P=	Pairwise Comparisons
	Mean+sd	Min-Max	Mean+sd	Min-Max	Mean+sd	Min-Max		
Balance	2.16±1.08	0-4	2.48±0.91	1-4	2.66±0.93	0-4	0.002*	rk1-rk3 0.001
Mix. Dif.	0.75±0.97	0-2	0.56±0.90	0-2	0.38±0.78	0-2	0.016*	rk3-rk1 0.012
Rot.flat foot..	1.03±0.49	0-2	1.00±0.50	0-2	0.68±0.53	0-2	0.000*	rk3-rk1 0.000 rk3-rk2 0.000
Rot. "Fouette"	0.28±0.49	0-2	0.65±0.69	0-2	0.58±0.57	0-2	0.000*	rk1-rk3 0.001 rk1-rk2 0.000

*p<0,05

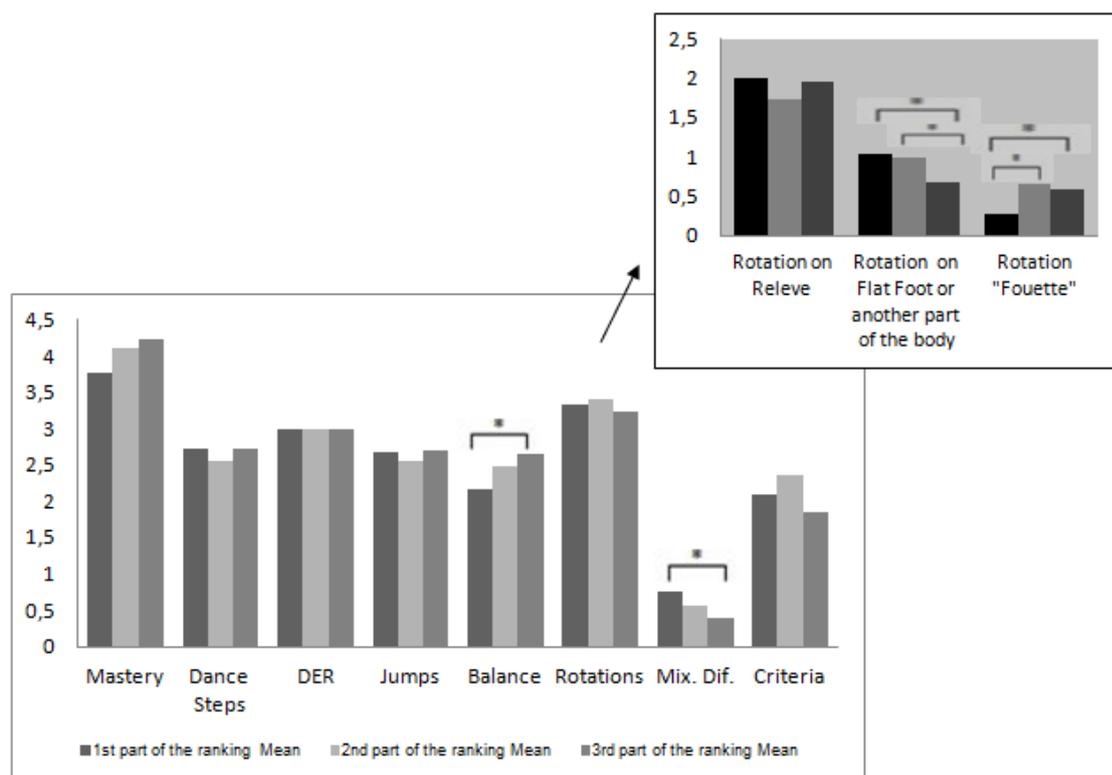


Figure 2. Average number of difficulty elements presented in the Rhythmic Gymnastics individual routines clustered according to the 2013 World Championships final ranking. (*p<0.05).

Table 2

Technical value of DER, Jumps, MixDif and Rotations presented in the Rhythmic Gymnastics individual routines clustered according to the 2013 World Championships final ranking.

Difficulty value	1 st part of the ranking (n=96)		2 nd part of the ranking (n=96)		3 rd part of the ranking (n=96)		Kruskal-wallis test P=	Pairwise Comparisons
	Mean±sd	Min-Max	Mean±sd	Min-Max	Mean±sd	Min-Max		
DER	2.05±0.30	1.3-2.7	2.01±0.27	1.4-2.8	1.83±0.35	1.0-2.8	0.000*	rk3-rk2 0.001 rk3-rk1 0.000
Jumps	1.54±0.44	0.7-2.8	1.4±0.45	0.7-2.7	1.25±0.33	0.5-2.3	0.000*	rk3-rk1 0.000
Mix. Dif.	0.37±0.49	0.0-1.7	0.25±0.41	0.0-1.0	0.16±0.34	0.0-1.0	0.005*	rk3-rk1 0.003
Rotations	3.00±0.88	1.2-4.7	2.89±0.66	1.2-4.3	2.22±0.71	0.7-3.9	0.000*	rk3-rk2 0.000 rk3-rk1 0.000
Rot. Releve	1.85±0.97	0.0-4.0	1.56±0.88	0.0-3.3	1.37±0.67	0.0-3.1	0.001*	rk3-rk1 0.001
Rot.flat foot.	0.89±0.44	0.0-2.3	0.80±0.37	0.0-1.7	0.49±0.40	0.0-1.4	0.000*	rk3-rk2 0.000 rk3-rk1 0.000
Rot.Fouette	0.25±0.47	0.0-2.0	0.53±0.59	0.0-2.0	0.36±0.38	0.0-1.2	0.001*	rk1-rk2 0.001

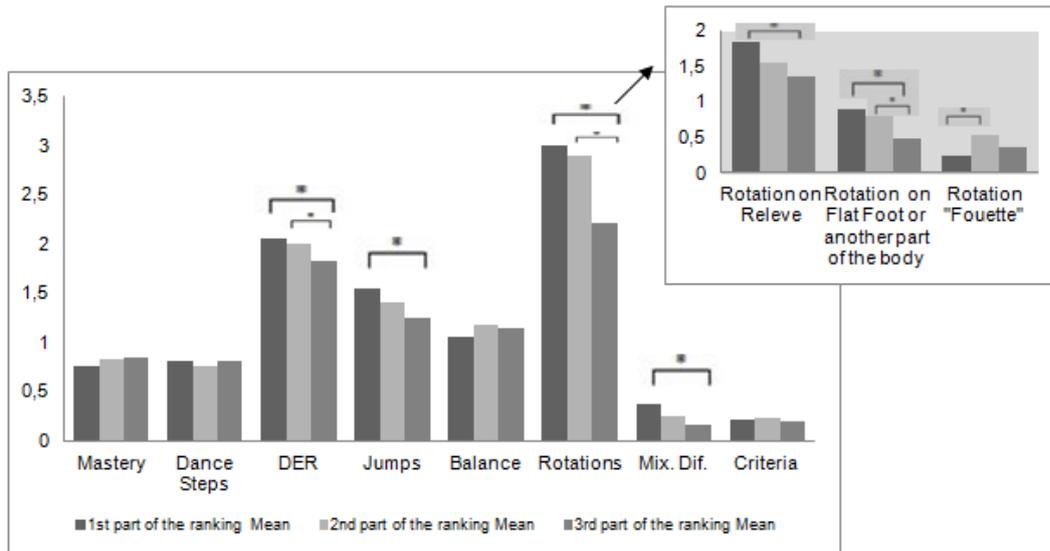


Figure 3. Technical value of the difficulty elements presented in the Rhythmic Gymnastics individual routines clustered according to the 2013 World Championships final ranking. (*p<0.05)

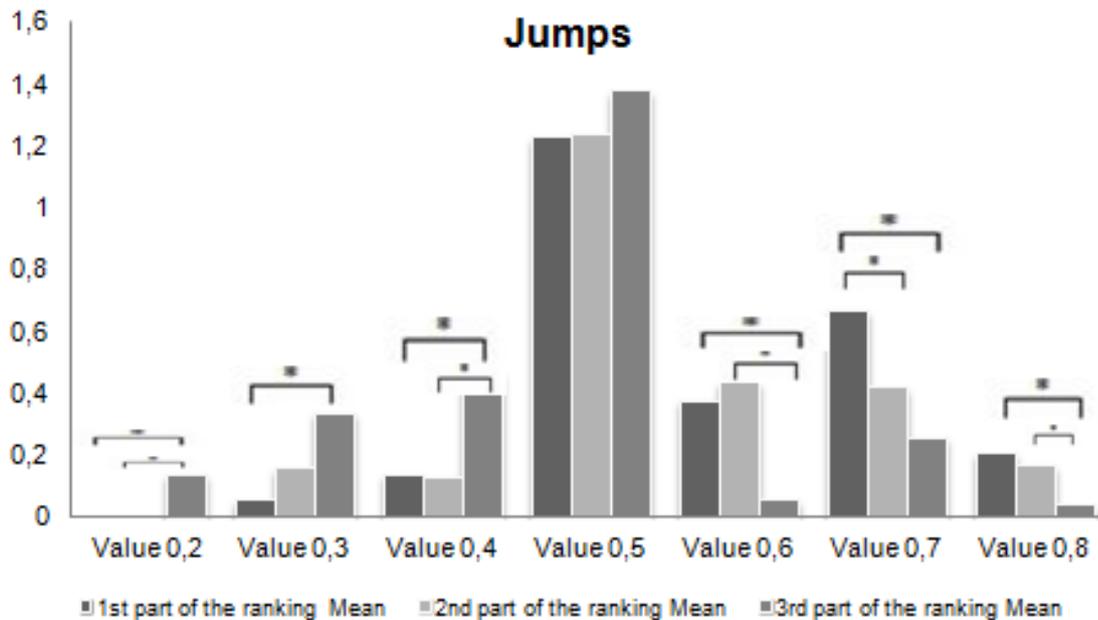


Figure 4. Number of Jump difficulties (different values) presented in the Rhythmic Gymnastics individual routines clustered according to the gymnasts' final ranking in the 2013 World Championships (Kruskal-wallis test * p<0,05).

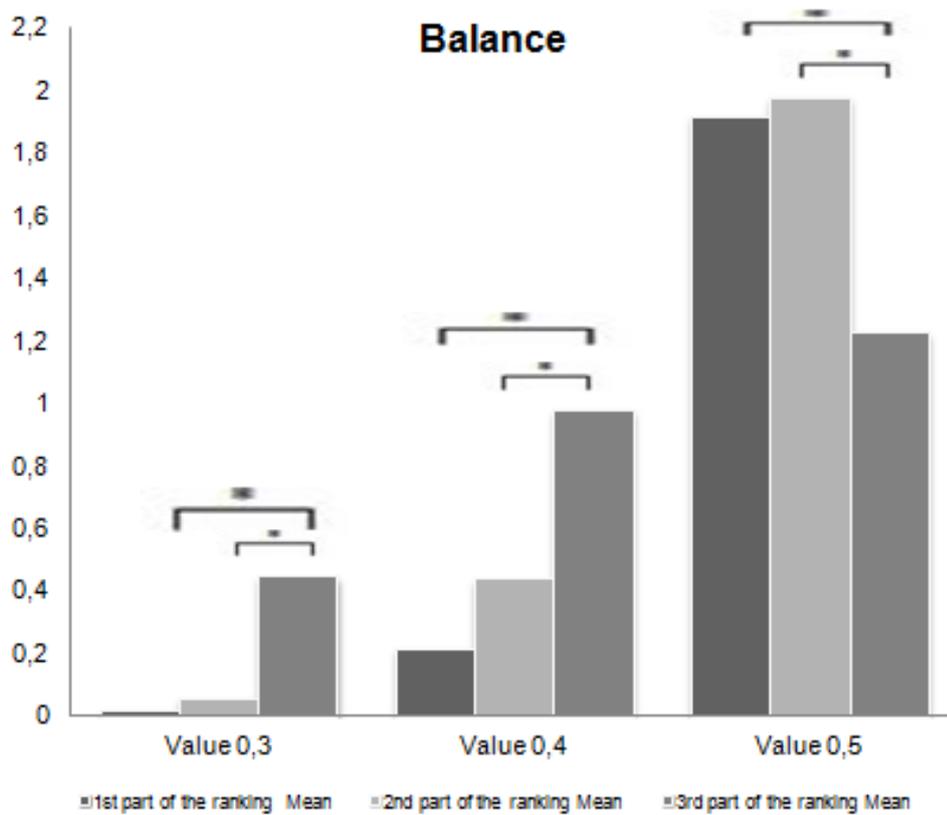


Figure 5. Number of balance difficulties (different values) presented in the Rhythmic Gymnastics individual routines clustered according to the gymnasts' final ranking in the 2013 World Championships (Kruskal-wallis test * $p < 0,05$).

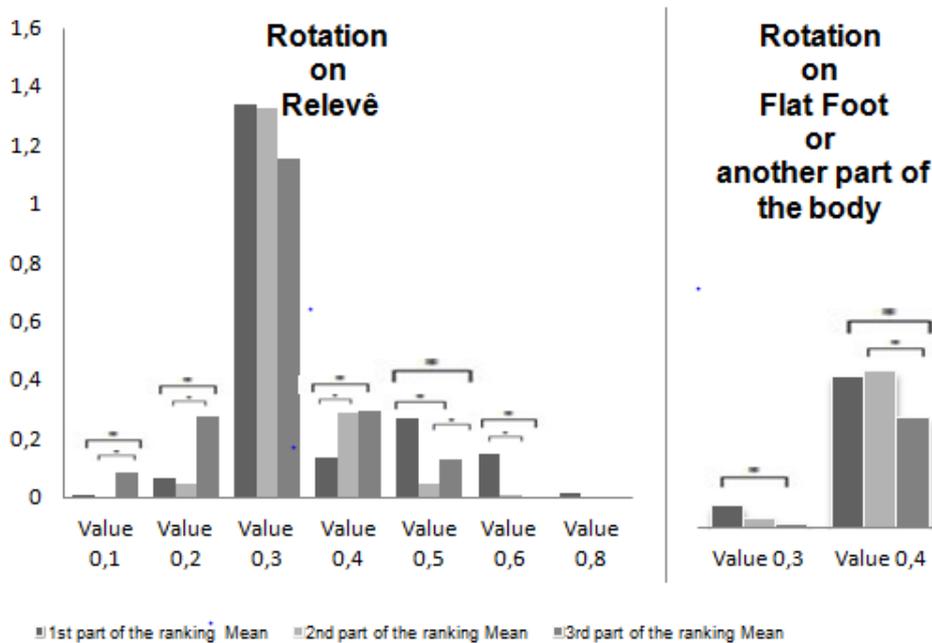


Figure 6. Number of Rotations difficulties (different values) presented in the Rhythmic Gymnastics individual routines clustered according to the gymnasts' final ranking in the 2013 World Championships. (Kruskal-wallis test * $p < 0,05$).

The value of the DER, rotations, jumps and MixDif is higher in the gymnast placed in the 1st part of the ranking and decreases significantly in the 2nd and 3rd parts. For mastery, dance steps, balances and criteria associated to difficulty (waves and pre-acrobatics) there were no statistically significant differences regarding the technical value, and the gymnasts' final ranking (Table 2). Concerning the value of the rotations we can highlight that the fouetté rotations had a significant higher value in the gymnasts placed on the 2nd part of the ranking when compared to the gymnast in the 1st part. The rotations of flat foot or another part of the body registered a higher value in the 1st part of the ranking (Figure 3).

Jumps

Analysing the value of the jumps included in the routines according to the final ranking of the gymnasts, we found significant differences for all jumps except the jumps with 0.5 points value. The routines of the gymnasts placed in 1st part of the ranking had a higher number of jumps 0.7 and 0.8 points value. The jumps of value 0.2, 0.3 and 0.4 points were the preferred of gymnasts placed in the 3rd part of the ranking. The jumps with 0.6 points value are performed preferably by the gymnasts on the 2nd part of the ranking. The jumps with 0.5 points value jumps were the preferred of all gymnasts independently of their place on the final ranking. There were not significant differences for the gymnasts ranking regarding the jumps of 0.5 value jumps (Figure 4).

Balances

We found significant differences in the number of balance difficulties when we compare the routines performed by the gymnasts of different parts of the final ranking. The gymnasts ranked in the 3rd part of the ranking had a higher number of balances with 0.30 and 0.40 points value in their routines. On the other hand the gymnasts ranked on the 1st and 2nd parts

preferred to include in their routines balances of 0.50 points (Figure 5).

Rotations

There were significant differences in the rotations included in the routines in all parts of the final ranking excepted for the rotation of 0.5 points value. The routines of the gymnasts ranked in the 3rd part had a higher number of rotations on "relevé" of 0.1, 0.2 and 0.4 points value. On opposite, the gymnasts placed in the 1st and 2nd parts preferred to include 0.5 and 0.6 points value rotations on "relevé" in their routines. The rotations on relevé with 0.3 points value were the most performed by all gymnasts independently of their position in the final ranking (Figure 6). Concerning the rotations on flat foot or another part of the body, it was clear that the gymnasts placed in the 1st and 2nd parts of the ranking preferred to include this type of rotation with 0.4 points value in their routines.

DISCUSSION

This study provides a quantitative and qualitative analysis of the difficulty elements used in the individual routines of the 2013 RG World Championships.

The 288 individual routines studied were clustered into three subgroups according to the gymnasts' final ranking in the World Championships. We discussed the results (number, value and type) in 3 dimensions: (1) global analysis of the composition of the routines; (2) analysis by group of difficulty elements; (3) ranking of the gymnasts.

In a global point of view the routines hold an average value of 9.30 points, very close to the maximum possible score of 10 points. Despite the World Championships being one of the most important competition in the calendar, this result may lead to a false analysis, as it could mean such a high a plateau of international excellence which in reality only occurs amongst gymnasts at the top of the ranking. Ávila, (2011) studied the difference between the departure score (presented by

the coach in the difficulty form) and the final score obtained by the gymnast and concluded that the majority of the gymnasts reach very significant differences, of 2 or more points between these two scores.

We also highlight the fact that the rotations and the DER, together represented 50% of the total value of the composition. This result showed an important change in the global content of the routines in this Olympic Cycle. Studies such as Caburrasi (2003) and Ávila (2011) showed that in the previous Olympic cycles the highest contribution in the routines value came from the Jumps. The increase in the rotations and DER values happens because in the present Olympic cycle it is possible to add some criteria to these difficulties that allow the gymnast to increase its value and degree of complexity (FIG, 2012). These results can be analysed in two different perspectives. On the one hand, it represents an upgrade of the execution quality, but on the other hand, it means that an extreme importance is given to 2 types of difficulty elements leading to an under estimation of the other groups. We also remarked the lack of variety and diversity in the elements chosen that has been repeatedly mentioned in previous studies concerning individual routines (Bobo, 2003; Agopya, 2014) and group routines (Ávila, 2011b; Ávila 2012; Ávila, 2012b). Therefore it is possible to conclude that the RG routines present a consistent pattern in the usage of the difficulty elements.

The type of difficulty elements used in the routines is similar, with some difficulty elements being repeated several times in the routines. This means that the routines' composition is not defined by being unique, with diversity and creativity, characteristics that are necessary for the enrichment of the routines composition (Balcells, 2009; Leandro, 2015) and reflect the spectacular of the choreography (Pelin, 2013).

The analysis according to the type of difficulty showed us similar results as Agopyan (2014) for routines performed on the last Olympic cycle: the rotation

difficulties (mainly the "relevé" rotations) were the preferred of the gymnasts and the balance difficulties the less used. The rotation difficulties are very complex elements to perform (Lebre, 2011; Vitrichenko et al, 2011), but they are also those where the gymnast can get more points, once the CoP (FIG,

2012) allows to add the base value of the difficulty for each rotation performed. The lower number of balances in the routines is, probably, due to the fact that the gymnasts spend considerable time of the routine to perform them because they are static difficulty elements (Gateva, 2015) and they have low values: 0.50 points is the maximum possible value for a balance, according to the CoP (FIG,

2012). These are the main reasons for the preference of the gymnasts to include more difficulties in rotation and less in balance in their routines. The routines only last for maximum 90 seconds and they have to optimize the time available to get the maximum of points allowed (10 points). The gymnasts, with the intention of getting top scores should present routines with a high level of difficulty combined with good execution quality (Agopyan, 2014).

The mastery and dance steps have comparatively lower possible values than the jumps, rotations and balances. These groups have an inferior degree of execution complexity, they are less valued in the CoP (FIG, 2015). To promote the inclusion of these types of elements in RG routines, and therefore have more interesting choreographies their value should be increased (Livotti, 2012; Leandro, 2015). One of basic requirements of RG is that the gymnast should show an optimal use of the body together with the apparatus handling. In this way, to raise the difficulty departure score the gymnast must increase of both body and apparatus difficulty level included in the routine (Agopyan, 2014).

The analysis of the results according to the gymnasts' final ranking showed that the higher placed gymnasts chose preferentially elements with a higher complexity (MixDif, rotations on flat foot or other part of the

body and “fouetté” rotations) and the lower placed gymnasts chose elements with lower complexity (balances) as described also by Gateva (2015).

Regarding the difficulty elements value, the jumps were the elements with higher value for the gymnasts in the first and second parts of the ranking. With the exception of the jumps of 0.5 points value, the gymnasts higher placed (1st and 2nd part of the ranking) include preferably the jumps with higher value and the gymnast placed on 3rd part preferred the jumps of 0.3 and 0.4 points value, which confirms the expectable. According to Bobo (1998) and Bobo, (2003), as a norm the best gymnasts hold physical and artistic capacities that allow them to perform more and higher level elements with high execution complexity. The rotations, DER and MixDif had higher values in the routines of the gymnasts placed in 1st part of the ranking and decreased in the routines of the gymnasts placed in the second and third parts. The complexity of this type of difficulties is very high and demands an extraordinary coordination, a perfect control of the apparatus technic and a lot of practice hours, (Lebre, 2011; Vitrichenko et al, 2011), which justifies that they are preferably used by the gymnasts highly ranking.

CONCLUSIONS

The rhythmic gymnasts who competed at the 2013 World Championships used in their routines very similar difficulties elements with limited variety. The more used difficulties were the rotation “attitude”, rotation with “free leg in ring in back with help”, “rotation in penché”; balance “side scale with split, without help” and balance “back scale leg high up”; jump “jeté with turn” and “jeté with a turn with back bend”. The highest valued elements are DER and rotations and these represent 50% of the total value of the routine. These groups showed an important contribution to the final D score. The balances were the less used difficulty group.

The routines had differences in the composition pattern between the gymnasts according to their final ranking in the following items: (i) the number of rotations of flat foot or other part of the body, “fouetté” rotations and MixDif; (ii) the value of jumps, rotations, DER and MixDif. Concerning the dance steps and mastery, no differences were found between the routines of gymnasts place in the three parts of the ranking.

This study provides updated information about the individual routines content in rhythmic gymnastics, to be considered: (i) to the possible modifications of the present Code of Points, in particular for the definition of the composition requirements in order to have higher level of variety and diversity in the routines, and (ii) to the training process to achieve the high performance level in the individual gymnasts.

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