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An analysis of variations in body movement difficulty of 2016 Olympic Games rhythmic gymnast candidates

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ABSTRACT

The aim of this study was to determine the use and the variety of body movement difficulty in the routines of individual rhythmic gymnasts aiming to compete in the 2016-Olympic Games, both those who qualified and those who did not. The research data was collected from the routines of 24 rhythmic gymnasts, from a total of 96 videos that were recorded during an Olympic qualification competition for the 34th Rhythmic Gymnastics World Championships of 2015 in Stuttgart/Germany. The gymnasts were divided into $G_1$1-15, the top 15 gymnasts, and $G_2$16-24, the remaining 9 gymnasts. The number of body movements (jumps/leaps, balances and rotations) and their comparative execution "difficulty" values were examined by quality and quantity. *Penché* rotation on a flat foot (79.2%), a *jeté with a turn* jump (66.67%) and balancing with a high back scale leg (57.29%) were the most frequently used body movements. The preferences of G_1 gymnasts over G_2 gymnasts for different types of static and dynamic difficulties across different movements even where there was not a wide variety. Rhythmic gymnasts at different performance levels generally tend to use the same body movement difficulties for all of their routines and this clearly indicates a lack of body difficulty variation.

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KEYWORDS
Rhythmic gymnastics; video analysis; individual routine; body movement difficulty

1. Introduction

Rhythmic gymnastics is an Olympic sport (Di Cagno et al., 2009) that combines elements of gymnastics, ballet, modern dance, music and it demonstrates aesthetic characteristics through manipulation of various apparatus. According to the structure of this sport, rope, hoop, ball, clubs and ribbons are used as apparatus. All exercise routines have to be presented through choreography within the entire floor and have to contain compulsory body movement difficulties and elements of apparatus.

The gymnasts must compete with exercise routines according to the Code of Points (CoP) rules set by the International Gymnastics Federation Rhythmic Gymnastics Technical Committee (FIG-RC-TC) every four years. As the CoP changes for every Olympic cycle, the routines become more challenging and the requirements for the

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choreography become increasingly difficult (Ávila-Carvalho, Da Luz Palomero, & Lebre, 2010; Ávila-Carvalho, Klentrou, & Lebre, 2012b).

According to the 2013–2016/CoP (Fédération International De Gymnastique-FIG, 2013) the evaluation of the routines is based on difficulty and execution values. Body difficulty and apparatus elements (Jumps/Leaps, Balances, Rotations, Apparatus Mastery, Dance Steps and Dynamic Elements with Rotation and throws) determine the difficulty (technical) value of the choreography. Since 2013 in the CoP (Fédération International De Gymnastique-FIG, 2013), the body movement difficulties consisted of three groups: Jumps/Leaps, Balances and Rotations. For each apparatus, basic apparatus technique is specified as well as a group of body elements by means of which a rhythmic gymnast realises a particular element of difficulty (from 0.1 up to 1.50 points, or sometimes higher).

Within this complex structure, rhythmic gymnasts face the difficult task of combining the aesthetic, the apparatus elements and the physical components of their performance. The primary determinant of success is the ability to perform an exercise of high difficulty with a high execution score. Therefore, as well as physical components, especially in terms of elite gymnasts, it is important that the choreography is versatile and flawlessly created according to the rules of the competition. According to Lissizkaja (1985), respective physical components (endurance, strength, speed, flexibility, agility, etc.), the technical execution of elements and exercises and producing good choreography are the top three factors that affect competition results.

One of the most important measures of rhythmic gymnastics is to demonstrate both quantitative and qualitative features through choreography (Hökelmann, Liviotti, & Breitkreutz, 2013). From this point of view, although there are many studies about world championships and world cups (Ávila-Carvalho, Da Luz Palomero, Klentrou, & Lebre, 2012a; Ávila-Carvalho, Da Luz Palomero, & Lebre, 2009; Ávila-Carvalho et al., 2010, 2012b; Batista, Garganta, & Ávila-Carvalho, 2019; Kwitniewska, Dornowski, & Hökelmann, 2009; Liviotti & Hökelmann, 2012) concerning the quality and quantity of technical and artistic requirements of both group and individual exercises in rhythmic gymnastics, there are few studies (Amila et al., 2018; Agopyan, 2014; Kovalenko & Boloban, 2017) on the exercises of elite gymnasts, especially in the Olympic Games. Agopyan (2014) analysed body movement difficulties of the finalists of the 2012 Olympics using 2009–2012 FIG-RG-CoP, while Amila et al. (2018) analysed them using 013–2016 FIG-RG-CoP. The results of these studies indicated that individual elite gymnasts at the Olympic level tend to use the same quality of body movement difficulties for all of their routines, and it clearly indicates a lack of selection in body movement difficulties (Amila et al., 2018; Agopyan, 2014). Analysing the choreography of elite level gymnasts is especially important in order to detect the effects of novel FIG-RG-CoP rules in the creation of new choreography (Agopyan, 2014). Although rhythmic gymnastics rules are amended every four years (Batista, Garganta, & Ávila-Carvalho, 2017), and the compositions are interesting, authentic and appealing low diversity in body difficulty, particularly for elite gymnasts competing in Olympic finals (Amila et al., 2018; Agopyan, 2014), indicates the need to take remedial measures. Furthermore, it is remarkable that both the usage level and variety in body movement difficulty used by gymnasts who take part in the Olympics qualifications at different levels are not examined.

In light of this information, this study aims to identify the rate of use and variety of body movement difficulties of elite rhythmic gymnasts who aimed to participate in the 2016 Olympics in hoop, ball, clubs and ribbon events. In this approach, the aim was to suggest different strategies for gymnasts and their trainers to aid technical development of rhythmic gymnasts who can be nominated as candidates for the Olympics and for new choreography to be created. Also, it was aimed at creating a basis on which FIG-RC-TC could rearrange commonly or rarely used body difficulty scores and configure new rules.

2. Methods

2.1. Participants and data collection

The research data were collected from the routines of 24 individual senior rhythmic gymnasts recorded at the 34th Rhythmic Gymnastics World Championship of 2015 in Stuttgart/Germany, which was the qualification event for the 2016 Olympic Games. Demographic characteristics and competition data were obtained from the official website of the FIG (https://database.fig-gymnastics.com/public/results/5347). The 24 participants performed 4 routines with hoop, ball, clubs and ribbon, to produce a total of 96 choreographies to analyse. In the qualification competitions, depending on the results with the 4 types of apparatus, the top 15 gymnasts directly qualified for the 2016 Olympic Games. As a result, the gymnasts in this study were divided into two groups as follows: $G_1$1-15 represents the top 15 gymnasts (who qualified for the Olympics) and $G_2$16-24 represents the remaining 9 gymnasts (who failed to qualify for the Olympics). This study complied with the ethical principles stated by the Declaration of Helsinki.

2.2. Analysis of the compositions

There are 10 points available for the most difficult individual exercises for each apparatus. In accordance with the contents of this research, only the body movement difficulty of the compositions was analysed, and the data were evaluated according to 2013–2016 FIG-RG-CoP rules (Fédération International De Gymnastique-FIG, 2013). The values were entered onto an Excel spreadsheet. Access to the official form-sheets of the gymnasts where their exercise compositions were recorded using symbols and submitted prior to the competition were not available. All exercises routines were analysed instead from video clips recorded by FIG and published on YouTube. Personal computers (Intel Core i7-47000HQ CU @ 2.40 GHz, 16.0 GB Ram, 64 bit) were used for video analysis. Three judges with many years of international judging experience in RG evaluated each routine at the same time, but separately, by watching the video recordings of the competition based on FIG-RG-CoP rules (Fédération International De Gymnastique-FIG, 2013). Intra-examiner (test–retest method) and inter-examiner (three observers) reliability of the observers were tested to guarantee the quality assurance of the observation system. The intra-class correlation coefficient (ICC) of each examiner was 0.99. The ICC between the observers was 0.98.

2.2.1. Analysis of the body movement difficulties

Each type of body movement difficulty (jumps/leaps, balances and rotations) were evaluated and analysed based on the 2009–2013 FIG-RG-CoP (Fédération International De Gymnastique-FIG, 2013). The difficulty values attempted during the performances' of the gymnasts were recorded under the value column in the tables in this study.

2.2.2. Analysis of the body movement difficulties for each apparatus

The types (jumps/leaps, balances and rotations), values and total number of body movement difficulties for each gymnast with the hoop, ball, clubs and ribbon apparatus were recorded. The analysis was conducted in two steps. In step one, a maximum of nine body movement difficulties were recorded for each exercise for each gymnast. In step two, all the body movement difficulties of the 96 performances were determined by value, and the overall repetition numbers, the repetition numbers for each apparatus, and all mixed and multiple movement difficulties were counted separately. The number of body movement difficulties and values were examined quantitatively and qualitatively.

3. Results

A descriptive statistical analysis and the groups' differences in anthropometric and training characteristics are summarised in Table 1. There were no significant differences between groups in terms of age, height, body mass, body mass index (BMI) or age of starting in sport ($p > 0.05$). The groups were found to be homogeneous according to their general characteristics and training profiles.

The numbers and the percentage of the body movement difficulties used in $G_1$1-15, $G_2$16-24 and for the whole group are shown according to apparatus and with totals in Table 2 to 4. Also, Table 3 shows the summary of the most performed body movement difficulties (a. jumps, b. balances and c. rotations) for each apparatus, the total for $G_1$1-15 and $G_2$16-24 and the total for all the gymnasts together.

It was determined that all groups used 15 different difficulty levels in jumps/leaps. Although both groups have different difficulty jump/leap percentages (Table 2) for each apparatus and in total both groups of gymnasts tended to initially perform a *jeté with a turn* jump in their compositions.

It was seen that all groups performed 14 different difficult isolated balance movements. Although the usage percentages for balance difficulty in each apparatus and the total were different in both groups (Table 4), both groups of gymnasts tended to initially perform one of the balance variations in the back bend of the trunk in their compositions.

It was identified that all groups used 15 isolated and eight multiple movements, with a total of 23 different rotational difficulties. Although the percentages for the use of rotational difficulties in each apparatus and in total (Table 5), both groups of gymnasts tended to initially perform a *penché* rotation on a flat foot in their compositions.

It was determined that the most variations are in balances, and the least variations are in jump/leap difficulties. Both groups tended to perform similar body difficulty movements in their compositions. Although the difficulty rates of use are different for

Table 1. General characteristics and training profiles of the individual rhythmic gymnasts at the elite level.

	$G_1$1-15 (n = 15)				$G_2$16-24 (n = 9)					
VARIABLES	Min.	Max.	Mean	SD	Min.	Max.	Mean	SD	z	p
Age (year)	16.00	29.03	20.18	3.22	16.10	22.11	19.52	1.73	−0.67	0.505
Height (cm)	163	173	168.0	0.03	162	176	167.7	0.04	−1.42	0.155
Body mass (kg)	44	53	48.07	2.56	42	58	49.25	5.23	−0.17	0.868
*BMI (kg/m^2)	15.22	18.82	17.04	0.91	16	19.03	17.41	1.09	−0.69	0.488
Age of starting to sport (year)	4	7	5.36	1.22	4	9	5.75	1.83	−0.34	0.732

both groups of gymnasts, their preferred jump and rotation difficulties were found to be very similar. The body difficulty movements preferred by most of the 24 gymnasts competing in the finals were found to be as follows (as shown in Tables 2,4,5):

a) Jumps: Jeté with a turn jump ($G_1$1-15: 64.06%, $G_2$16-24: 63.89% and total: 66.67%)
b) Balances: Balance in back scale with leg high up for $G_1$1-15: 70%, and total: 57.29%

Front split back bend of the trunk for s$G_2$16-24: 47.22%

c) Rotations: Penché rotation on flat foot $G_1$1-15: 60.94%, $G_2$16-24: 94.44% and total: 76.04%

4. Discussion

The most important finding of this study was that despite having a huge variety and number of body movement difficulties in 2013–2016 FIG-RG-CoP (Fédération International De Gymnastique-FIG, 2013), the elite rhythmic gymnasts who competed at the 34th Rhythmic Gymnastics World Championships in 2015 in Stuttgart/Germany tended to perform mainly *penché* rotation (flat foot), *jeté with a turn* jump and *back scale leg high up* balance. Every gymnast tended to use the same movements in jump, balance and rotation, even though the apparatus differed. While G_1 gymnasts who qualified for the Olympics preferred the *back scale leg high up* balance or *jeté with a turn* jump difficulties first in respect of the apparatus, G_2 gymnasts preferred the *penché* rotation with all four apparatus. This is more obvious in G_2 gymnasts who did not qualify for the Olympics, and shows the inability of the gymnasts in both groups to use a variety of body movement difficulties in their choreography.

In the 2013–2016 FIG-RG-CoP (Fédération International De Gymnastique-FIG, 2013); there are 150 difficulties in total including 56 jumps/leaps, 47 balances and 46 rotations. As the variety in the difficulties increase with new rules, it is expected that the difficulties performed by gymnasts should also show differences. In contrast to this hypothesis, it is clear that as the rules have changed over time, the diversity of the components remains unchanged.

Of all the gymnasts mentioned in this study, 24 preferred *penché* rotation (76.04%), *jeté with a turn* jump (66.67%) and *back scale leg high up* balance (57.29%) body movement difficulties, respectively. The results of this study support the findings of Agopyan (2014), who determined similar results for the previous Olympic cycle. Our results were also similar to the findings of Leandro, Ávila-Carvalho, Da Luz Palmeiro,

Table 2. The numbers and percentage of body movement difficulty for jumps/leaps used in all compositions.

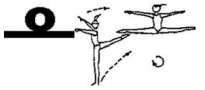
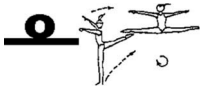
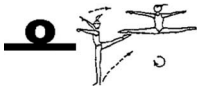
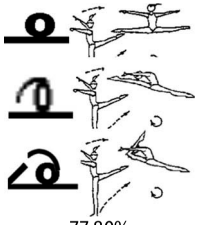
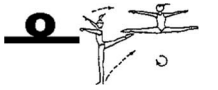
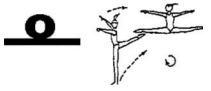
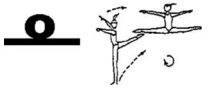
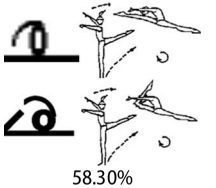
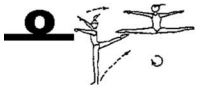
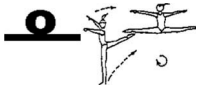
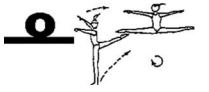
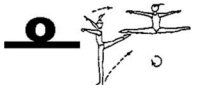
Body movement difficulty JUMPS/LEAPS	Values symbols		APPARATUS									
			Hoop		Ball		Clubs		Ribbon		Total	
		Groups	N	%	N	%	N	%	N	%	N	%
1. Jeté with a turn	0.5	$G_1$1-15	11	73.30	13	86.70	10	66.70	7	46.70	41	64.06
		$G_2$16-24	6	66.70	6	66.70	4	44.40	7	77.80	23	63.89
		ALL	17	70.80	19	79.20	14	58.30	14	58.30	64	66.67
2. Jeté with a turn. and back bend of the trunk	0.7	$G_1$1-15	10	66.70	8	53.30	8	53.30	7	46.70	33	51.56
		$G_2$16-24	5	55.60	2	22.20	5	55.60	4	44.40	16	44.44
		ALL	15	62.50	10	41.70	13	54.20	11	45.80	49	51.04
3. Stag leap with turn. with back bend of the trunk	0.5	$G_1$1-15	5	33.30	5	33.30	5	33.30	5	33.30	20	31.25
		$G_2$16-24	3	33.30	4	44.40	4	44.40	4	44.40	15	41.67
		ALL	8	33.30	9	37.50	9	37.50	9	37.50	35	36.46
4. Jeté with a turn. and back bend of the trunk. and ring	0.8	$G_1$1-15	3	20	4	26.70	5	33.30	7	46.70	19	29.69
		$G_2$16-24	3	33.30	3	33.30	5	55.60	3	33.30	14	38.89
		ALL	6	16.70	7	29.20	10	41.70	10	41.70	33	34.38
5. Stag leap with turn. and back bend of the trunk. and ring	0.6	$G_1$1-15	2	13.30	3	20	2	13.30	3	20	10	15.63
		$G_2$16-24	0	0	1	11.10	0	0	0	0	1	2.78
		ALL	2	8.30	4	16.70	2	8.30	3	12.5	11	11.46
6. Jeté. with back bend of the trunk. and ring	0.5	$G_1$1-15	1	6.70	1	6.70	0	0	0	0	2	3.13
		$G_2$16-24	3	33.30	2	22.20	1	11.10	1	11.10	7	19.44
		ALL	4	16.70	3	12.50	1	4.20	1	4.20	9	9.38
7. Stag leap with turn. and ring	0.4	$G_1$1-15	1	6.70	1	6.70	1	6.70	2	13.30	5	7.81
		$G_2$16-24	0	0	0	0	0	0	0	0	0	0.00
		ALL	1	4.20	1	4.20	1	4.20	2	8.30	5	5.21

(*Continued*)

Table 2. (Continued).

Body movement difficulty JUMPS/LEAPS	Values symbols	Groups	APPARATUS Hoop N	Hoop %	Ball N	Ball %	Clubs N	Clubs %	Ribbon N	Ribbon %	Total N	Total %
8. Cossack. with ring and take-off and landing on the same foot	0.3	$G_1$1-15	1	6.70	1	6.70	2	13.30	1	6.70	5	7.81
		$G_2$16-24	0	0	0	0	0	0	0	0	0	0.00
		ALL	1	4.20	1	4.20	2	8.30	1	4.20	5	5.21
9.Split leaps with back bend of the trunk. with take-off from both feet	0.4	$G_1$1-15	0	0	0	0	0	0	0	0	0	0.00
		$G_2$16-24	1	11.10	1	11.10	1	11.1	1	11.1	4	11.11
		ALL	1	4.20	1	4.20	1	4.2	1	4.2	4	4.17
10. "Switch" split leaps. passing with straight leg in: stag and back bend of trunk	0.4	$G_1$1-15	0	0	0	0	0	0	2	13.30	2	3.13
		$G_2$16-24	0	0	1	11.10	0	0	0	0	1	2.78
		ALL	0	0	1	4.20	0	0	2	8.30	3	3.13
11. Switch" split leaps. passing with bent leg in: stag; ring; back bend and trunk rotation	0.4	$G_1$1-15	0	0	1	6.70	0	0	1	6.70	2	3.13
		$G_2$16-24	0	0	0	0	0	0	0	0	0	0.00
		ALL	0	0	1	4.20	0	0	1	4.20	2	2.08
12. Split leaps with back bend of the trunk	0.4	$G_1$1-15	0	0	0	0	0	0	0	0	0	0.00
		$G_2$16-24	0	0	1	11.10	0	0	0	0	1	2.78
		ALL	0	0	1	4.20	0	0	0	0	1	1.04
13. Stag leap with turn with ring take-off from both fee	0.4	$G_1$1-15	0	0	0	0	1	6.70	0	0	1	1.56
		$G_2$16-24	0	0	0	0	0	0	0	0	0	0.00
		ALL	0	0	0	0	1	4.20	0	0	1	1.04
14. Stag leap with turn	0.3	$G_1$1-15	0	0	1	6.70	0	0	0	0	1	1.56
		$G_2$16-24	0	0	0	0	0	0	0	0	0	0.00
		ALL	0	0	1	4.20	0	0	0	0	1	1.04
15. Butterfly	0.5	$G_1$1-15	0	0	0	0	0	0	0	0	0	0.00
		$G_2$16-24	0	0	0	0	0	0	1	11.10	1	2.78
		ALL	0	0	0	0	0	0	1	4.20	1	1.04

Table 3. The summary table of the most performed body difficulties (a. jumps. b. balances. c. rotations) in each apparatus and in totally in $G_1$1-15. $G_2$16-24 and for all gymnasts together.

GROUPS	Hoop	Ball	Clubs	Ribbon	Total
			(a) JUMPS		
$G_1$1-15	73.30% 	86.70% 	66.77% 	46.70% 	64.06% 
$G_2$16-24	66.70% 	66.70% 	55.60% 	77.80% 	63.89% 
ALL	70.80% 	79.20% 	58.30% 	58.30% 	66.67% 
			(b) BALANCES		
					

(*Continued*)

Table 3. (Continued).

GROUPS	Hoop	Ball	Clubs	Ribbon	Total
$G_2$16-24	44.44% 	44.44% 	55.56% 	%55.56 	57.29% 
ALL	62.50% 	58.33% 	58.33% 	58.33% 	57.29% 
			(c) ROTATIONS		
$G_2$16-24	100% 	100% 	100% 	77.80% 	94.44% 
ALL	79.20% 	75% 	79.20% 	70.80% 	76.04% 

Table 4. The numbers and percentage of body movement difficulties for balance used in all compositions.

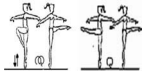
Body movement difficulty BALANCES (Isolated Difficulties)	Values symbols	Groups	APPARATUS Hoop N	Hoop %	Ball N	Ball %	Clubs N	Clubs %	Ribbon N	Ribbon %	Total N	Total %
1. Back scale leg high up	0.50	$G_1$1-15	11	73.33	9	60.00	10	66.67	12	80.00	42	70.00
		$G_2$16-24	4	44.44	4	44.44	3	33.33	2	22.22	13	36.11
		ALL	15	62.50	13	54.17	13	54.17	14	58.33	55	57.29
2. Front splite back bend of the trunk	0.50	$G_1$1-15	10	66.67	10	66.67	9	60.00	7	46.67	36	60.00
		$G_2$16-24	3	33.33	4	44.44	5	55.56	5	55.56	17	47.22
		ALL	13	54.17	14	58.33	14	58.33	12	50.00	53	55.21
3. Side scale with split. without help-*ecarte*-	0.50	$G_1$1-15	7	46.67	5	33.33	7	46.67	7	46.67	26	43.33
		$G_2$16-24	3	33.33	2	22.22	1	11.11	2	22.22	8	22.22
		ALL	10	41.70	7	29.17	8	33.33	9	37.50	34	35.42
4. Front scale with back split *panché*-	0.50	$G_1$1-15	4	26.67	2	13.30	4	26.67	7	46.67	17	28.33
		$G_2$16-24	2	22.20	0	0	1	11.11	1	11.11	4	11.11
		ALL	6	25	2	8.33	5	20.83	8	33.33	21	21.88
5. *Fouetté*	0.50	$G_1$1-15	1	6.67	0	0	3	20	1	6.67	5	8.33
	Different shapes	$G_2$16-24	1	11.11	2	22.22	2	22.22	3	33.33	8	22.22
		ALL	2	8.33	2	8.33	5	20.83	4	16.67	13	13.54
6. Side scale with split. without help-*ecarte*-on flat foot	0.40	$G_1$1-15	2	13.33	2	13.33	2	13.33	1	6.67	7	11.67
		$G_2$16-24	0	0	1	11.11	0	0	0	0	1	2.78
		ALL	2	8.33	3	12.50	2	8.33	1	4.17	8	8.33
7. Front scale with back split *panché*- on flat foot	0.40	$G_1$1-15	1	6.67	4	26.67	0	0	1	6.67	6	10
		$G_2$16-24	1	11.11	1	11.11	0	0	0	0	2	5.56
		ALL	2	8.33	5	20.83	0	0	1	4.17	8	8.33
8. Sideway split without hand -*A la secondé*- on flat foot	0.20	$G_1$1-15	0	0	0	0	1	6.67	1	6.67	2	3.33
		$G_2$16-24	0	0	0	0	0	0	0	0	0	0.00
		ALL	0	0	0	0	1	4.17	1	4.17	2	2.08

(*Continued*)

Table 4. (Continued).

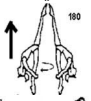
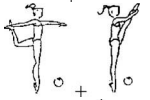
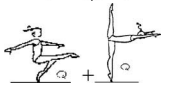
Body movement difficulty BALANCES (Isolated Difficulties)	Values symbols	Groups	APPARATUS									
			Hoop		Ball		Clubs		Ribbon		Total	
			N	%	N	%	N	%	N	%	N	%
9. *Attitudé* with back bend of the trunk	0.40	$G_1$1-15	0	0	0	0	0	0	1	6.67	1	1.67
		$G_2$16-24	1	11.11	0	0	0	0	0	0	1	2.78
		ALL	1	4.17	0	0	0	0	1	4.17	2	2.08
10. Front splite back bend of the trunk on flat foot	0.40	$G_1$1-15	0	0	0	0	1	6.67	1	0	1	1.67
		$G_2$16-24	0	0	0	0	0	0	0	0	0	0.00
		ALL	0	0	0	0	1	4.17	1	0	1	1.04
11. Side way split without hand	0.30	$G_1$1-15	0	0	0	0	1	6.67	0	0	1	1.67
		$G_2$16-24	0	0	0	0	0	0	0	0	0	0.00
		ALL	0	0	0	0	1	4.17	0	0	1	1.04
12. Front split without hand	0.30	$G_1$1-15	1	6.67	0	0	0	0	1	0	1	1.67
		$G_2$16-24	0	0	0	0	0	0	0	0	0	0.00
		ALL	1	4.17	0	0	0	0	1	0	1	1.04
13 Ring without hand	0.40	$G_1$1-15	0	0	0	0	0	0	0	0	0	0.00
		$G_2$16-24	0	0	1	11.11	0	0	0	0	1	2.78
		ALL	0	0	1	4.17	0	0	0	0	1	1.04
14. Back scale leg high up on flat foot	0.40	$G_1$1-15	1	6.67	0	0	0	0	1	0	1	1.67
		$G_2$16-24	0	0	0	0	0	0	0	0	0	0.00
		ALL	1	4.17	0	0	0	0	1	0	1	1.04

Table 5. The numbers and percentage of the rotation difficulty for most commonly used in all compositions.

Body movement difficulty ROTATIONS	Symbols	Groups	APPARATUS Hoop N	Hoop %	Ball N	Ball %	Clubs N	Clubs %	Ribbon N	Ribbon %	Total N	Total %
1. Penché		$G_1$1-15	10	66.7	9	60	10	66.7	10	66.7	39	60.94
		$G_2$16-24	9	100	9	100	9	100	7	77.8	34	94.44
		ALL	19	79.2	18	75	19	79.2	17	70.8	73	76.04
2. Free leg in ring. with help in back		$G_1$1-15	6	40	6	40	6	40	7	46.7	25	39.06
		$G_2$16-24	8	88.9	6	66.7	6	66.7	7	77.8	27	75.00
		ALL	14	58.3	12	50	12	50	14	58.3	52	54.17
3. Attitudé		$G_1$1-15	5	33.3	7	46.7	8	53.3	8	53.3	28	43.75
		$G_2$16-24	5	55.6	5	55.6	5	55.6	3	33.3	18	50.00
		ALL	10	41.7	12	50	13	54.2	11	45.8	46	47.92
4. Fouetté with leg stretched out		$G_1$1-15	2	13.3	4	26.7	2	13.3	3	20	11	17.19
		$G_2$16-24	2	22.2	2	22.2	1	11.1	3	33.3	8	22.22
		ALL	4	16.7	6	25	3	12.5	6	25	19	19.79
5. Fouetté with leg alternating out and in passe		$G_1$1-15	4	26.7	4	26.7	4	26.7	3	20	15	23.44
		$G_2$16-24	0	0	0	0	1	11.1	1	11.1	2	5.56
		ALL	4	16.7	4	16.7	5	20.8	4	16.7	17	17.71
6. Reverse illusion		$G_1$1-15	3	20	3	20	3	20	3	20	12	18.75
		$G_2$16-24	0	0	0	0	0	0	0	0	0	0.00
		ALL	3	12.5	3	12.5	3	12.5	3	12.5	12	12.50
7. Arabesqué		$G_1$1-15	1	6.7	2	13.3	1	6.7	0	0	4	6.25
		$G_2$16-24	2	22.2	2	22.2	2	22.2	1	11.1	7	19.44
		ALL	3	12.5	4	16.7	3	12.5	1	4.2	11	11.46
8. Fouetté with leg stretched alternating out + and in Passé		G11-15	2	13.3	1	6.7	3	20	2	13.3	8	12.50
		G216-24	1	11.1	0	0	1	11.1	0	0	2	5.56
		ALL	3	12.5	1	4.2	4	16.7	2	8.3	10	10.42
9. 4. Free leg in split. with help in back		$G_1$1-15	1	6.7	0	0	1	6.7	0	0	2	3.13
		$G_2$16-24	2	22.2	1	11.1	2	22.2	2	22.2	7	19.44
		ALL	3	12.5	1	4.2	3	12.5	2	8.3	9	9.38

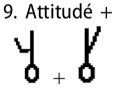
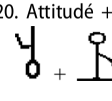
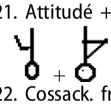
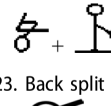
(*Continued*)

Table 5. (Continued).

Body movement difficulty ROTATIONS	Symbols	Groups	APPARATUS Hoop N	Hoop %	Ball N	Ball %	Clubs N	Clubs %	Ribbon N	Ribbon %	Total N	Total %
10. Panché. with relevé		$G_1$1-15	2	13.3	2	13.3	3	20	1	6.7	8	12.50
		$G_2$16-24	0	0	0	0	0	0	0	0	0	0.00
		ALL	2	8.3	2	8.3	3	12.5	1	4.2	8	8.33
11. Free leg at the horizontal. with ring and trunk backward		$G_1$1-15	0	0	0	0	0	0	0	0	0	0.00
		$G_2$16-24	1	11.1	1	11.1	1	11.1	1	11.1	4	11.11
		ALL	1	4.2	1	4.2	1	4.2	1	4.2	4	4.17
12. Free leg in split. with help. in front		$G_1$1-15	1	6.7	1	6.7	1	6.7	1	6.7	4	6.25
		$G_2$16-24	0	0	0	0	0	0	0	0	0	0.00
		ALL	1	4.2	1	4.2	1	4.2	1	4.2	4	4.17
13. 8. Free leg in split. without help in front		$G_1$1-15	1	6.7	0	0	1	6.7	1	6.7	3	4.69
		$G_2$16-24	0	0	0	0	0	0	0	0	0	0.00
		ALL	1	4.2	0	0	1	4.2	1	4.2	3	3.13
14. Free leg in split. with help. in side		$G_1$1-15	0	0	1	6.7	1	6.7	1	6.7	3	4.69
		$G_2$16-24	0	0	0	0	0	0	0	0	0	0.00
		ALL	0	0	1	4.2	1	4.2	1	4.2	3	3.13
15. Start from the floor + ½ turn without help with split position and back bend of the trun		$G_1$1-15	1	6.7	2	13.3	0	0	0	0	3	4.69
		$G_2$16-24	0	0	0	0	0	0	0	0	0	0.00
		ALL	1	4.2	2	8.3	0	0	0	0	3	3.13
16. Free leg straight on the horizontal level + Passé		$G_1$1-15	0	0	1	6.7	0	0	1	6.7	2	3.13
		$G_2$16-24	0	0	0	0	0	0	1	11.1	1	2.78
		ALL	0	0	1	4.2	0	0	2	8.3	3	3.13
17. Attitudé+ Free leg in split. with help in front		$G_1$1-15	1	6.7	1	6.7	0	0	1	6.7	3	4.69
		$G_2$16-24	0	0	0	0	0	0	0	0	0	0.00
		ALL	1	4.2	1	4.2	0	0	1	4.2	3	3.13
18. Cossack. free leg on the horizontal level + Penché in relevé		$G_1$1-15	1	6.7	0	0	1	6.7	0	0	2	3.13
		$G_2$16-24	0	0	0	0	0	0	0	0	0	0.00
		ALL	1	4.2	0	0	1	4.2	0	0	2	2.08

(*Continued*)

Table 5. (Continued).

Body movement difficulty ROTATIONS	Symbols	Groups	APPARATUS									
			Hoop		Ball		Clubs		Ribbon		Total	
			N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
19. Attitudé + Free leg in split. without help in front		$G_1$1-15	0	0	0	0	1	6.7	0	0	1	1.56
		$G_2$16-24	0	0	0	0	0	0	0	0	0	0.00
		ALL	0	0	0	0	1	4.2	0	0	1	1.04
20. Attitudé + Penché		$G_1$1-15	1	6.7	0	0	0	0	0	0	1	1.56
		$G_2$16-24	0	0	0	0	0	0	0	0	0	0.00
		ALL	1	4.2	0	0	0	0	0	0	1	1.04
21. Attitudé + Passé		$G_1$1-15	0	0	0	0	0	0	0	0	0	0.00
		$G_2$16-24	0	0	0	0	0	0	1	11.1	1	2.78
		ALL	0	0	0	0	0	0	1	4.2	1	1.04
22. Cossack. free leg on the horizontal level + Penché		$G_1$1-15	0	0	0	0	0	0	1	6.7	1	1.56
		$G_2$16-24	0	0	0	0	0	0	0	0	0	0.00
		ALL	0	0	0	0	0	0	1	4.2	1	1.04
23. Back split with help and side rolls		$G_1$1-15	0	0	0	0	0	0	0	0	0	0.00
		$G_2$16-24	0	0	1	11.1	0	0	0	0	1	2.78
		ALL	0	0	1	4.2	0	0	0	0	1	1.04

and Arce (2017) who reported *penché* rotation as the most commonly performed element by top-level gymnasts. Batista et al. (2019) found that the gymnasts of various ranks taking part in the 2013–2014 Portugal World Cup mainly preferred *jeté with a turn* jump movement difficulty. The results of this study are similar to the findings of the study conducted by Trifunov and Dobrijević (2013) stating that *jeté with a turn* jump was the most commonly used jump difficulty in the 2010 World Championship.

The same jump, balance and pivot challenges performed by the athletes in both groups show the lack in their choreography movements. Contrary to our findings, Ávila-Carvalho et al. (2010) reported that there was a tendency toward an increase in the variety of body and apparatus movements of RG elements as rhythmic gymnastics evolves over time. However, Agopyan (2014) indicated a lack of variety in the 2012 Olympic Games in individual compositions and these results are in accordance with this current study. Our results are also similar to Leandro et al. (2017) who investigated the variety and diversity of rhythmic gymnastics routines and reported that the gymnasts at the 2013 World Championship in Kiev performed similar body movement difficulties in the composition of their exercises with the different apparatus.

Of the 24 athletes, 79.20% preferred the hoop, 79.20% preferred the clubs, and 70.80% preferred the ribbon. The most preferred body movement difficulty was *penché* rotation (76.04%). As for the ball, *jeté with a turn* jump (79.20%) and *penché* rotation (flat foot) (75%) were the most preferred difficulties. Preferences for rotational difficulty can most commonly be associated with the higher scores for the gymnasts when increasing the number of rotations within a single difficulty (Batista et al., 2019). Additionally, it is seen that gymnasts are choosing *penché* rotation (value 0.40 per rotation) mostly isolated but also combined with other rotational difficulties such as cossack and attitudé. Furthermore, selecting the balance difficulties from the groups with high values indicates that movement abilities are developed in both groups. However, it is remarkable that balance difficulties are preferred less than other body difficulties. The reason may be that the maximum score is 0.50, since balance difficulties are performed as slow and static elements (Gateva et al., 2015), the apparatus is used with more technical and difficult movements and there are no additional criteria. Contrary to the *penché* rotation difficulty, G_1 gymnasts who qualified for the Olympics mostly preferred the *back scale leg high up* balance (70%) in total. Other body difficulties that G_1 gymnasts commonly preferred were *jeté with a turn* (64.06%) and *penché* (60.94%) rotation. Moreover, it is remarkable that they preferred the *back scale leg high up* balance difficulty with the hoop (73.33%) and ribbon (80%), and *jeté with a turn* jump difficulty with the ball (86.70%) and clubs (66.67%). The inclusion of complex abilities in compositions is essential to get a high score in the competition (Massidda & Calò,, 2012). In this approach, it is important to perform body difficulties and apparatus difficulties simultaneously. The preferences of G_1 gymnasts for different types of static and dynamic difficulties, even though not wide in variety, with different apparatus compared to G_2 gymnasts showed that G_1 gymnasts may have more technical skills. The increase in the value of apparatus difficulty in the RG competition routines could be contributing to the quality and diversity of the RG competition in the Olympic Games (Leandro, 2018).

The gymnasts who did not qualify for the Olympics used *penché* rotation first in hoop (100%), ball (100%), clubs (100%) and all the four apparatus (94.44% in total),

while they preferred *penché* rotation (77.80%) and *jeté with a turn* jump (77.80%) with ribbon. The preference of G_2 gymnasts to use *penché* rotation difficulty first with all apparatus indicated that they could perform body difficulties less competently than G_1 gymnasts. Furthermore, it can be inferred that G_2 gymnasts can struggle to enhance the value of a difficulty with any apparatus based on the number of turns.

5. Conclusions

Although the composition of the exercises is characterised as unique through using diversity and creativity (Balcells, Martín, Anguera, & Dinušová, 2009), the results of this study indicate that the gymnasts at the 2015 World Championship, which was the qualification competition for the 2016 Olympic Games, performed similar body movement difficulties in the composition of their exercises with different apparatus. The most frequently performed difficulty elements were *penché* rotation (flat foot), *back scale leg high up* balance and *jeté with a turn* jump. The preferred body difficulties for all gymnasts with all apparatus were similar. The G_2 gymnasts most commonly used the same body movement difficulties in their compositions.

As a result of this study, it will be possible for trainers and gymnasts to develop new strategies for use in teaching, developing body movements, and creating new choreography. Using this approach, the most preferred body movements should not initially be used more commonly in new choreography. The findings of this study are important as they can provide a different perspective on the new regulations in the competition rules that are regulated every four years by the FIG-RG-TC authorities. Reorganisation of the scores in the *preferred* and *not preferred* body movements of high difficulty, in particular, may create differences in the rate at which these movements are used. Increasing the scores of the body movements with high difficulty that are interesting and spectacular but harder to perform may encourage trainers and gymnasts to use them more frequently. Teaching different body movements that will gain higher scores, increase their use and add variety to the choreography.

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No potential conflict of interest was reported by the authors.

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