ANALYSIS OF HAND-FOOT/LEG PREFERENCES AND LATERALITY IN MOVEMENT DIFFICULTIES OF INDIVIDUAL ELITE RHYTHMIC GYMNASTS

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Abstract

The aim of this study is to determine the number and ratio of hand-foot/leg preferences in movement difficulties used by individual elite senior rhythmic gymnasts in their routines. In the World Cup Competitions and European Championships held in 2021, the final competition routines (N=75) of gymnasts (N=28) were examined, and body and apparatus difficulties, and the number and rate of use of the preferred side were determined. Since gymnasts participated in more than one competition, their most recent competition routines were included in the research. The data were obtained by analyzing the routines recorded during the competitions. Explanatory statistical analyses of the data were conducted by using the IBM SPSS 25.0 statistical program. In all routines, while higher rates of between 56.2% and 87% were found in the right hand when compared to the left hand in throwing and catching, higher rates were found in the hoop and ribbon apparatus in throwing with the left foot when compared to the right foot. In the right foot/leg catches, the highest rates were observed in the hoop apparatus (49.6%). Left foot usage preferences were observed at rates varying between 65.1% and 97.4% in jumps/leaps difficulties and between 58% and 71% in balance difficulties. In rotation difficulties, the use of the right foot had higher rates of between 72.6% and 80% when compared to the left foot. Gymnasts showed a tendency to use the right hand predominantly in throws and catches, the left foot in jumps/leaps and balances, and the right foot in rotations.

Keywords: Rhythmic gymnastics, individual routines, body and apparatus difficulties, hand-foot/leg preferences, video analysis.

INTRODUCTION

Motor laterality or hand preference results from a natural asymmetry in the functional organization of the left and right hemispheres (Sainburg, 2016). Hand preference is generally inherited and affected by genetic, hormonal, developmental and cultural factors (Musalek, 2015; Faurie et al. 2016). Left-handed dominance makes up approximately 10-12% of the general population (Gilbert, & Wysocki, 1992), while 90% of them preferentially use their right hand (Peters et al. 2006). In studies, left brain dominance is often related to complex motor activities such as movements and tool use (Cochet, & Byrne, 2013; Faurie, & Raymond, 2004). Additionally, footedness is smilarly described as the leg used to manipulate an

object or bring forward in action (Peters, 1988).

Laterality in sports is related to the issues, such as coaching, skill, acquisition, performance, athlete development, motor control and understanding of perceptual-cognitive processes, talent identification, rehabilitation and injury prevention. Athletes determine their laterality by choosing their hands, feet, eyes, direction of rotation, support leg and jumping leg while performing their movements (Loffing et al. 2016). The relationship between hand/foot tapping performance (Kalaycıoğlu et al. 2008; Peters, 1988; Ziyagil, 2011), and the relationships between hand preference and rotational preference (Heinen et al. 2016) have been examined while taking into consideration the synergy between the support and functions of the extremities. In complex motor skill performances, lateral profiles of athletes have also been studied (Castañer et al. 2018).

Rhythmic gymnastics (RG), a sport practiced with aesthetic and technical movements (body and apparatus) accompanied by music, requires high-level motor control. It includes major goals, such as training, creating reserves in body movements and apparatus skills, increasing artistic effect, increasing dance and music motor skill reserve, maintaining flexibility, coordination, speed, strength and endurance skills at a desired level and improving the individual style and perfecting the presentation, improving compositions and achieving high results in competitions (Jastrjembskaia, & Titov, 1999). To increase the technical perfection of the movements and ensure their harmony with the music, many repetitions are necessary during training. However, these repetitions should be performed carefully. If exercises that support the development of the non-dominant side are not included, unilateral loads can cause cumulative musculoskeletal problems.

In a study (including a physician), the highest regional distribution rates (%) of RG injuries were reported: 23.9 in the back, 17.3 the knee, 15.2 the leg (tibia), 15.2 fthe oot, and 10.9 the ankle (Hutchinson, 1999). Muscle-tendon unit injuries were reported in 85% of gymnasts (Zetaruk et al., 2006). It has been stated that muscle-tendon unit imbalances are among the risk factors for stress fractures (O'Neill, & Micheli, 1988). In RG, movement patterns are performed against the laws of physics (gravity force, momentum force, etc.) and gymnasts' physical fitness abilities must be at the optimum level in order to perform their movements (involving the use of different axes, planes and levels) at a high technical level.

There are studies that show that asymmetry can be caused by excessive repetitions to ensure perfection in movements. In one study, lower extremity functional flexibility asymmetry was observed in gymnasts (Batista Santos et al. 2015). In addition, in a study examining the effect of lower extremity lateral preference on anthropometrics, the size of movement and isokinetic strength measurements in gymnasts, the observed differences were related to lateral preference and training (Frutuoso et al. 2016).

Motor preference tasks show an individual's tendency for laterality, but do not bring out the degree of lateralization in certain environments like sports (Utesch et al., 2016). Although there are limited resources, the determination of laterality, the rate and limits of laterality according to the apparatus, and the precautions to be taken have been specified. The degree of asymmetry also determines the methods of teaching an element, and if the asymmetry of an element of a young gymnast increases by 10%, it is recommended that the non-dominant arm/leg should perform this element 8-10 times. As the difficulty of the elements increases, the rate of asymmetry may be higher (17-54%), while this rate is lower (12-17%) in simple difficulties (Jastrejevskaya, 1995). The asymmetry of

acquired elements can be determined by the coach according to the evaluation rules.

Performance tasks, preference tasks, and questionnaires have been used as tools for evaluating laterality. Performance tasks have been used to evaluate the outcome and quality of left- and right-sided tasks, preference tasks have been used to elicit motor responses as an indicator of laterality, and questionnaires have been used to examine preferences in motor activities (Utesch et al. 2016; Oldfield, 1971; Elias et al. 1998; Prieur et al. 2017; İpek et al. 2021).

When compared to evaluations through questionnaires, observing the quality of performances to obtain additional objective information about the person's laterality may be valuable (Elliott, & Roy, 1996). This study was conducted in order to analyze the hand and foot/leg preferences of individual elite senior rhythmic gymnasts in the final competition routines, in apparatus and body difficulties.

METHODS

The final competition routines (N=75) in the apparatus (18 routines in the hoop, 17 in the ball, 21 in the clubs and 19 in the ribbon) of individual senior elite gymnasts (N=28) in the World Cup Competitions (in Tashkent, Baku and Pesaro) and European Championships in 2021 were examined.

The number and rate of use of the preferred side in the movements they perform with their hands and feet/legs in body difficulties (jumps/leaps (take off foot), balances (support foot) and pivots/rotations (support foot) and in apparatus difficulties, dynamic elements with rotation and dance steps combinations (small, medium and high throws and catches) without major execution technique mistakes (such as loss of apparatus, loss of balance with fall) were determined. The RG evaluation rules (FIG, RG-CoP, 2017) were taken into account in the analysis of all body and apparatus movements. The combined body

difficulties made up of the two movements were evaluated separately, while throws and catches performed with both hands and feet/legs, with any part of the body except the extremities, and jumps made with both feet with take off and landing were not included in the study. Since the club is a double apparatus, throwing and catching with both hands at the same time were included in the study. The catching hand was taken into account when a club was caught on the ground with another club in the other hand (the hand that carries a club to catch a club).

The data were obtained by analyzing the routines recorded during the competitions. The latest routines of gymnasts who participated in more than one competition were included in the research. An analysis of all competition routines was conducted and evaluated at the same time by three RG judges, one of whom is international, and recorded with the symbolic writing used in the sport (FIG, RG-CoP, 2017). When there was a difference in analysis (symbolic writing) among the judges, the video recording of the competition routine was slowed down and movements were compared and rechecked. Descriptive statistical analyzes of the data were made by using the IBM SPSS 25.0 statistical program.

RESULTS

The usage numbers and rates of individual elite gymnasts' preferred side (right or left) in the final competitions (hoop, ball, clubs and ribbon) in throws and catches with hand and foot/leg in apparatus difficulties, and jumps/leaps, balances, pivots/rotations in body difficulties are given in Table 1, 2 and Figure 1, 2, 3.

In all routines, hand throws had higher rates of between 67.1% and 87% for the right hand; the highest rate was observed in the ball routines and the lowest rate was observed in the clubs routines. Left hand throws were higher in the clubs routines than in other apparatuses. The highest

mean values in the number of throws were seen in the clubs routines, i.e., 17.8 ± 3.3 with the right hand and 8.7 ± 2.1 with the left hand (Table 1, 2 and Figure 1). In catching by hand, higher rates of between 56.2% and 85.8% for the right hand as opposed to the left hand were observed. While the highest rate was observed in the ball routines, the values for the clubs and ribbon routines were close to each other, but lower than for the hoop routines. The right and left hand catching rates in the clubs and ribbon routines were closer to each other when compared to the other routines. The highest mean values in the number of catches were seen in the clubs routines, i.e., 15.0 ± 4.1 for the right hand and 11.5 ± 2.9 for the left hand (Table 1, 2 and Figure 1).

In all routines, while higher rates for the left foot/leg were found (69.3% and 74.2%) in the hoop and ribbon routines respectively in throws with a foot/leg, the right foot/leg ratios were found to be higher in the ball and clubs routines. The highest mean values in throws were observed in the ribbon routines (1.0 ± 1.4 in the right foot/leg) and in the hoop and ribbon routines (2.7 ± 1.7 in the left foot/leg) (Table 1, 2 and Figure 2). In all routines, the highest rates of catching with feet/legs were observed in the right and left feet, i.e., 49.6% and 39.3%, in the hoop routines

respectively. The lowest rates for catching with right and left feet/legs were observed in the ribbon routines. The highest mean values in the number of catchings were observed in the hoop routines: 1.1 ± 0.9 for the right foot/leg and 1.0 ± 1.0 for the left foot/leg (Table 1, 2 and Figure 2).

In body difficulties in all routines, while left foot preference was observed in between 65.1% and 97.4% of jumps/leaps (take of foot) and in between 58% and 71.1% of balances (supporting foot), the right foot preference was higher in pivots/rotations (supporting foot), ranging from 72.6% to 80%. The right foot jumps/leaps had the highest rate in hoop routines; the left foot jumps had the highest rate in ribbon routines; right foot balance had the highest rate in clubs routines; left foot balance had the highest rate in hoop routines; right foot rotations had the highest rate in clubs routines, and left foot rotations had the highest rate in ribbon routines. The highest mean values in the number of uses related to jumps/leaps and balances were observed in the left foot, i.e., 3.5 ± 1.9 in ribbon routines and 2.5 ± 1.4 in ball routines. The highest mean values in the number of uses related to pivots/rotations were observed in the right foot, i.e., 3.3 ± 1.5 in ball routines (Table 1, 2 and Figure 3).

Table 1
Descriptive statistics of Hoop and Ball routines.

	⭘ Hoop (n=18)					⬤ Ball (n=17)				
	%	**x̄ and SD**	**Median**	**Min**	**Max**	**%**	**x̄ and SD**	**Median**	**Min**	**Max**
↗ **RH**	86.6	8.2 ± 2.9	8.0	3.0	15.0	87.0	11.4 ± 3.1	12.0	7.0	16.0
↗ **LH**	13.4	1.3 ± 1.2	1.0	0.0	4.0	13.0	1.5 ± 0.9	1.0	0.0	3.0
↓ **RH**	72.2	6.8 ± 3.1	6.0	2.0	12.0	85.8	9.0 ± 3.2	9.0	4.0	16.0
↓ **LH**	27.8	2.3 ± 1.6	2.0	0.0	6.0	14.3	1.5 ± 1.0	1.0	0.0	4.0
↗ **RF**	30.7	0.9 ± 0.8	1.0	0.0	3.0	52.4	1.0 ± 1.0	1.0	0.0	3.0
↗ **LF**	69.3	2.7 ± 1.7	2.5	0.0	6.0	24.0	0.5 ± 0.7	0.0	0.0	2.0
↓ **RF**	49.6	1.1 ± 0.9	1.0	0.0	3.0	14.7	0.2 ± 0.4	0.0	0.0	1.0
↓ **LF**	39.3	1.0 ± 1.0	1.0	0.0	3.0	20.5	0.2 ± 0.4	0.0	0.0	1.0
∧ **RF**	34.9	1.2 ± 1.2	1.0	0.0	4.0	10.0	0.4 ± 0.6	0.0	0.0	2.0
∧ **LF**	65.1	2.3 ± 1.7	2.0	0.0	6.0	90.0	2.2 ± 1.3	2.0	1.0	5.0
⊤ **RF**	28.9	1.2 ± 1.2	1.0	0.0	5.0	36.9	1.5 ± 1.0	2.0	0.0	3.0
⊤ **LF**	71.1	2.4 ± 1.0	2.0	1.0	4.0	63.1	2.5 ± 1.4	2.0	1.0	6.0
⟡ **RF**	78.4	2.9 ± 1.4	2.5	0.0	6.0	76.4	3.3 ± 1.5	3.0	1.0	6.0
⟡ **LF**	21.6	0.8 ± 0.8	1.0	0.0	3.0	23.6	1.1 ± 1.1	1.0	0.0	4.0

*n; Number of routines, %; preference rates, x̄ and SD; mean and standard deviation, **Min;** minimal values, **Max;** maksimal values, **RH;** right hand, **LH;** left hand, **RF;** right foot, **LF;** left foot, ↗ ; throws, ↓ ; catches, ∧; jumps/leaps, ⊤; balances, ⟡; pivots/rotations.*

Table 2
Descriptive statistics of Clubs and Ribbon routines.

	🎳 Clubs (n=21)					⟨ribbon⟩ Ribbon (n=19)				
	%	**x̄ and SD**	**Median**	**Min**	**Max**	**%**	**x̄ and SD**	**Median**	**Min**	**Max**
↗ **RH**	67.1	17.8 ± 3.3	19.0	11.0	23.0	78.4	7.6 ± 2.7	8.0	4.0	12.0
↗ **LH**	32.9	8.7 ± 2.1	9.0	5.0	12.0	21.6	2.1 ± 1.3	2.0	0.0	4.0
↓ **RH**	56.4	15.0 ± 4.1	15.0	7.0	25.0	56.2	7.5 ± 2.4	8.0	3.0	12.0
↓ **LH**	43.6	11.5 ± 2.9	11.0	6.0	18.0	43.8	5.9 ± 2.7	6.0	2.0	11.0
↗ **RF**	56.3	0.7 ± 0.6	1.0	0.0	2.0	25.8	1.0 ± 1.4	0.0	0.0	4.0
↗ **LF**	19.8	0.3 ± 0.6	0.0	0.0	2.0	74.2	2.7 ± 1.7	3.0	0.0	7.0
↓ **RF**	38.8	0.5 ± 0.6	0.0	0.0	2.0	5.2	0.05 ± 0.2	0.0	0.0	1.0
↓ **LF**	23.8	0.3 ± 0.5	0.0	0.0	1.0	5.2	0.05 ± 0.2	0.0	0.0	1.0
∧ **RF**	9.8	0.3 ± 0.6	0.0	0.0	2.0	2.6	0.1 ± 0.3	0.0	0.0	1.0
∧ **LF**	90.2	2.7 ± 1.4	3.0	0.0	5.0	97.4	3.5 ± 1.9	3.0	1.0	8.0
⊤ **RF**	42.0	1.4 ± 1.1	1.0	0.0	4.0	36.6	1.1 ± 0.8	1.0	0.0	3.0
⊤ **LF**	58.0	1.9 ± 1.1	2.0	0.0	5.0	63.4	2.0 ± 1.2	2.0	0.0	4.0
⟡ **RF**	80.0	2.8 ± 1.2	2.0	0.0	5.0	72.6	2.6 ± 0.8	2.0	2.0	4.0
⟡ **LF**	20.0	1.9 ± 1.2	0.0	0.0	4.0	27.4	1.3 ± 1.3	1.0	0.0	4.0

*n; Number of routines, %; preference rates, x̄ and SD; Mean and Standard Deviation, **Min;** minimal values, **Max;** maksimal values, **RH;** right hand, **LH;** left hand, **RF;** right foot, **LF;** left foot, ↗ ; throws, ↓ ; catches, ∧; jumps/leaps, ⊤; balances, ⟡; pivots/rotations*
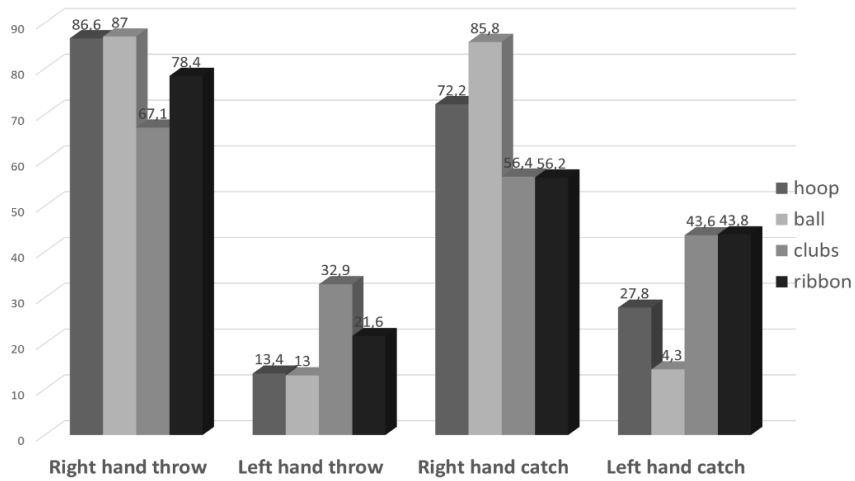
Figure 1. Right and left hand throwing and catching rates according to routines.
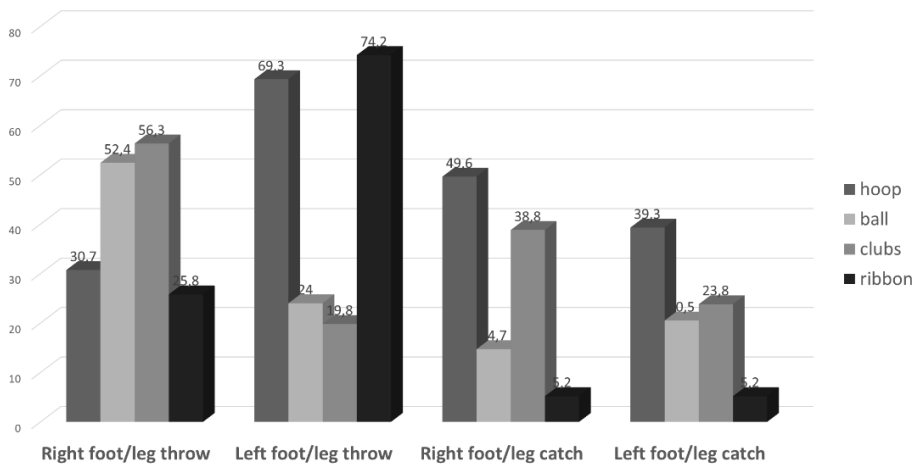

Figure 2. Right and left foot/leg throwing and catching rates in each routine.
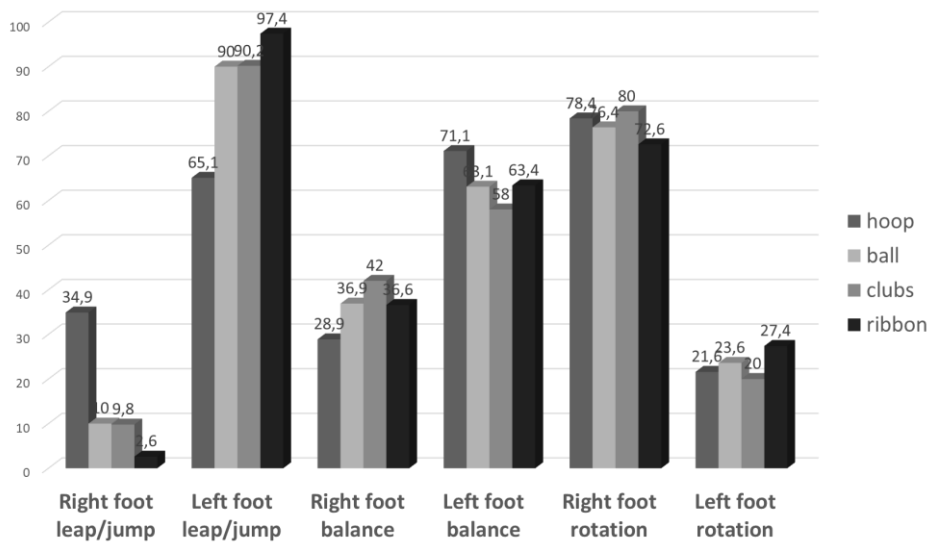

Figure 3. Right and left foot preference rates in body difficulties.

DISCUSSION

RG abilities and skills are quite complex. They not only include body movement techniques but also physical fitness and elegant and artistic presentation (Jastrjembskaia, & Titov, 1999). Gymnasts perform their movements (steps, hops, tabs, gallops, swings, circles, figure of eights, rolls, bounces, body waves, jumps/leaps, balances, rotations, throws and catches etc.) at different speeds, planes, axes and levels according to the rules of evaluation. In the process from learning the movements to their perfect presentation with music, repetitions can cause unilateral use of body parts. Unilateral works can lead to asymmetry in physical characteristics (such as anthropometry) and physical abilities (such as strength, flexibility, balance), and over time, musculoskeletal problems may develop. It has been stated that the movement symmetry can improve the technique, reduce the physical loads on the dominant limbs and prevent injuries (Starosta, 2018). Symmetrical trainings practised from the early stages of physical preparation not only can protect the health of the athlete, but can also increase the variety of movements during the specialization periods and contribute to the holistic beauty of the composition. In this study, we wanted to determine the number and ratio of hand-foot/leg preferences in movement difficulties used by senior elite rhythmic gymnasts in their final routines.

A gymnast may use her right hand/foot predominantly in her daily life activities, but she can also use her left hand/foot in RG movements or choreography. That is, sometimes the preferences can be sport-specific. Elite athletes are the people who represent the movement culture of the sport branch perfectly. Therefore, in our study we wanted to investigate these preferences/tendencies in gymnasts competing in finals.

In our study, the right-hand preference was observed in hand throws in all aparatuses, and the highest rate was observed in the ball routines. The highest rate in left-handed throws was observed in the clubs routines (Table 1, 2 and Figure 1). Apparatuses in RG are known as single (hoop, ball, ribbon) or double (rope, clubs). The reason why the rate of left-hand use is higher in the clubs routines when compared to the others may be due the fact that the clubs are a double apparatus and allow gymnasts to use both hands in their compositions. The highest mean values in the number of throws were again seen in the clubs routines (17.8 ± 3.3 in the right hand and 8.7 ± 2.1 in the left hand (Table 1, 2 and Figure 1)). In order to increase the total difficulty score by achieving a good score in apparatus difficulties, gymnasts tend to increase the number of elements in the clubs apparatus.

When the innate and acquired components of motor asymmetry are taken into consideration, the importance of using the right and the left arm in RG competition compositions increases since motor asymmetry may increase or decrease (Jastrejevskaya, 1995). In this study, in catches with hand, higher rates were found (between 56.2% and 85.8%) for the right hand. While the highest rate was observed in the ball routines, the values for the clubs and the ribbon routines were similar yet lower than the hoop routines. The lowest rate of left-handed catches was observed in the ball routines. In ball routines, catches can be performed with body parts (back, waist, knees, both feet, side of the waist, abdomen, under the legs, between the neck/nape and shoulders, etc.). Gymnasts may have preferred different catch styles as they would give them a variety of motion. The highest mean values in the number of catches were observed in the clubs routines (15.0 ± 4.1 for the right hand and 11.5 ± 2.9 for the left hand (Table 1, 2 and Figure 1)). The reasons of this may be due to the clubs being a double-apparatus and gymnasts'

desire to increase their apparatus difficulty score.

In our study, while higher rates were observed in foot/leg throws (in all routines), i.e., 69.3% and 74.2% in the left foot/leg in the hoop and the ribbon routines respectively, the right foot/leg ratios were higher in the ball and the clubs routines. It is thought that gymnasts make these choices due to the structural features of the apparatus and choreographic requirements. The characteristics of the apparatus (weight, size and shape) used in RG are different from each other, and these differences may also affect the movement patterns and extremity preferences.

In foot/leg catches, the highest rates were observed in the right and the left feet in the hoop routines, 49.6% and 39.3%, respectively (Table 1, 2 and Figure 2). The structural feature of the hoop apparatus may enable catching either with the right or the left foot. The lowest rates for catching with both feet/legs were observed in the ribbon apparatus. Because the ribbon aparatus is long (6m) and difficult to control, the gymnasts may not have wanted to make a mistake by risking catching it with their feet. In the evaluation rules, the penalty for loss of apparatus is high. That's why gymnasts do a lot of throwing and catching repetitions in training practice for perfect timing. Special exercises (such as catching with eyes closed, using a double tool, or using a double tool of different weights and lengths) to improve the catching skills are also practiced in the preparatory training. However, in order to get a good score, generally the side on which mistakes are fewer is preferred.

The number of repetitions of movements, parts and routines in training is evaluated and recorded by coaches. In the training analyses of the competition period, the gymnasts performed routine repetitions 16-30 times in each training with 2 or 4 apparatuses per day (Jastrjembskaia, & Titov, 1999). These repetitions may cause stress in the musculoskeletal system and asymmetry

may develop. There are studies on asymmetry in the literature and attention has been drawn to these problems. In their study, Radaš and Bobić have emphasized that bad scoliotic posture may be more common in rhythmic gymnasts, and some sport-specific postural problems may develop due to an asymmetric overload, with continuous use of the dominant hand as one of the possible causes (Radaš, & Bobić, 2011). A ten times higher incidence of scoliosis has been found in rhythmic gymnasts than in their non-trained peers, and researchers have observed a significant physical load with persistently repeated asymmetrical stress on their spine (Tanchev, et al., 2000). In another study focusing on functional asymmetry and aiming to find out which flexibility variables better determine performance, gymnasts were observed to have 69.4% and 71.4% functional asymmetry in passive and active flexibility, respectively (Batista et al. 2019). In a review examining the relationships between asymmetry and athletic performance, these issues were comprehensively addressed (Maloney, 2019).

When we examined the hand and foot/leg usage preferences in body difficulties in this study, we found between 65.1% and 97.4% preference in the left foot in jumps/leaps and between 58% and 71% in balances. The right foot preference was found to be higher than for the other foot, with a changing ratio of 72.6% to 80% in pivots/rotations. Although some body difficulties are embedded in the movement culture of rhythmic gymnastics, athletes prefer the side on which they can perform most accurately. Differences in technical skill between the two sides of the body are disadvantageous because athletes may later become dependent on the preferred or dominant extremities (Parrington, & Ball, 2016). In senior category (FIG, RG-CoP, 2017), a total of 3-9 body difficulties including at least 1 jumps/leaps, 1 balance and 1 rotation in each routine are required, and gymnasts can use their body

difficulties that they can perform well more than once. Since low valued (0.10 points) body difficulties in aparatus difficulties were also included in the study, the number of body difficulties was found to be high (Table 1, 2 and Figure 3).

A rhythmic gymnastics competition has its own classification. All gymnasts participate in Competition I - Qualifications, and in Competition I, the best 8 athletes in each apparatus compete again in the finals (Competition III). In this study, the routines of top elite gymnasts who reached the finals in four major competitions were examined. If all the gymnasts participating in these competitions (Competition I - Qualifications) had been analyzed, the results might have been slightly different. These analyses can identify trends in the development of the performance structure. Undoubtedly, further studies are needed to evaluate these issues.

RG used to be a sport in which mainly females were interested, but nowadays we can see that men also participate in competitions. All gymnasts participating in the competitions in our study were females and we could not find any laterality research by gender regarding our subject in the literature, so its discussion was limited. However, it was noted in a previous study that females tend to be more lateralized, that is, more right-handed or more left-handed, than males (Tan, 1988). It has also been noted that sport-specific laterality evaluation results may show certain laterality distributions that may be inconsistent when compared to hand preferences (Loffing et al. 2014).

Obviously, training for gymnasts should be well-designed in terms of providing a recognition for their neural pathways, which is highly crucial for a long-lasting career. The central nervous system is an important complex network of components. Upper motor neurons, one of the components of the central nervous system, further subdivide into multiple tracts, each of which has specific functions within the body. Specifically, the pyramidal tract is the main pathway that carries signals for voluntary movement (Lohia, & McKenzie, 2022). In this study, a cross-sectional study of the gymnasts' preferred side in apparatus and body difficulties was conducted, and their number and ratios were determined. Why an athlete prefers one side of her body while performing these movements, and the neural control mechanisms depending on this preference can be further investigated with advanced laboratory studies (such as electrophysiological studies) in the future.

The results of this study contribute to our better understanding of certain features of high-level competitive routines. Its aim is to inform athletes so that they can continue their sports career in a healthy way for many years. There are explanations for the use of the non-dominant body part in the evaluation rules (FIG, RG-CoP, 2017). However, some adjustments to the evaluation rules or the methods that coaches will use can optimize the design of training. With this awareness, sports clubs can implement specific organizational and intervention strategies based on research.

CONCLUSION

In RG, pedagogical effects, habits, structural features of the apparatus, choreographic requirements, tendency to increase the difficulty score can affect the preferences of using hands, feet/legs. Gymnasts showed a tendency to use the right hand predominantly in throws and catches, the left foot in jumps/leaps and balances, and the right foot in rotations. From the very early stages of the physical preparation of the gymnasts, symmetrical trainings for apparatus and body difficulties should be included. This study may offer a different perspective to reduce injuries. The skill development of the non-dominant side can both protect the gymnast's health and

contribute to the beauty of composition in terms of movement variety.

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